

Morath, Florian; Herbst, Luisa; Konrad, Kai A.

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## Balance of power and the propensity of conflict

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# Balance of power and the propensity of conflict

February 27, 2015

## **Abstract**

We study the role of an imbalance in fighting strengths when players bargain in the shadow of conflict. Our experimental results suggest: In a simple bargaining game with an exogenous mediation proposal, the likelihood of conflict is independent of the balance of power. If bargaining involves endogenous demand choices, however, the likelihood of conflict is higher if power is more imbalanced. Even though endogenous bargaining outcomes reflect the players' unequal fighting strengths, strategic uncertainty causes outcomes to be most efficient when power is balanced. In turn, the importance of exogenous mediation proposals depends on the balance of power.

*JEL codes:* C78, C91, D72, D74

*Keywords:* Conflict, balance of power, contest, bargaining, Nash demand game, conflict resolution, asymmetries, experiment

# 1 Introduction

The reasons for international military conflict and the question of how to prevent it have intrigued researchers from different social science disciplines. Countries can often earn a large peace dividend if they settle their conflict peacefully and find a means to share this peace dividend. Nevertheless, countries also frequently engage in war as an outcome of international conflict. Based on an experimental laboratory framework, this paper addresses the impact of power asymmetry on the likelihood and nature of peaceful settlements.

A considerable number of theories have been put forward to explain the occurrence of war, and the discussion is ongoing (see, e.g., Wagner 1994, Fearon 1995, Powell 1996, 1999, Wagner 2000, Chadeaux 2011, Benson et al. 2014; for surveys see Kydd 2010 and Jackson and Morelli 2011). Early theories suggest that the balance of military power is important. One school of thought (power transition theory) argues that military conflict is most likely whenever exogenous changes in power lead adversaries to be of roughly similar strength.<sup>1</sup> Another school of thought (balance of power theory) predicts that military conflict is most likely to break out if the conflicting nations have very different military power. Balance of power theorists (Morgenthau 1948, Kaplan 1957, Claude 1962, Wright 1965, Ferris 1973) argue that parity dissuades nations from fighting because parity is associated with high uncertainty regarding the war outcome. With equal power both countries are reluctant to fight unless both believe they have a good chance of winning, and a certain amount of military dominance is necessary for a successful attack of a weaker nation. Therefore, this theory predicts conflict with larger power imbalances and predicts peace when power is balanced.

Challenging these views, Wittman (1979) suggests that the balance of power should not matter for the probability of military conflict; it should only matter for the distribution of the resources. The intuition behind this argument is that players who differ in their military capacity take this asymmetry into account when negotiating about the peace dividend. If there is an imbalance of power and one side is more likely to win at war, this side's peaceful demands increase, but at the same time the other side's peaceful demands decrease. A settlement must make both countries better off than they are in case of war, but a settlement should be feasible with a small or a large imbalance of power, because the imbalance can be accounted for in the bargaining shares in the peaceful negotiation outcome.

Analyzing the relation between the balance of power and the likelihood of conflict with

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<sup>1</sup>This power transition theory, also called power shift theory (Gulick 1955, Organski 1958, Garnham 1976, Waltz 1979, Organski and Kugler 1980, Levy 1987, Blainey 1988, Kim and Morrow 1992; a survey is Tammen 2008), takes a dynamic approach. War will be initiated either by a weaker but rising challenger or by a country with superior but declining power. During periods of power preponderance (imbalance of power), the likelihood of wars decreases.

real world data is difficult since each potential conflict is full of idiosyncratic elements. Sample selection and endogeneity issues pose a major difficulty to empirical work (see, e.g., Houweling and Siccama 1988, Powell 2002, Wohlforth et al. 2007, Wallensteen and Svensson 2014). Our laboratory experiment evidently sidesteps a number of highly relevant issues. However, it can address many of the problems arising in this empirical work and clearly isolate the importance of the balance of power for the propensity of resource wasteful conflict.

Building on Wittman’s argument on the balance of power, we analyze how asymmetries in fighting strengths affect the probability of entering into resource wasteful conflict and the distribution of the peace dividend if the players reach a peaceful solution. We consider two alternative institutional arrangements in which bargaining takes place; both arrangements make a peaceful sharing outcome the clearly more attractive option. In one arrangement, the two players endogenously decide on the shares of the peace dividend which each of them demands. This arrangement may be interpreted as a direct confrontation of the players at the negotiation table. In the other arrangement, peaceful sharing follows an exogenously proposed division of the resources, which players may accept or reject. This arrangement can be interpreted as bargaining with a mediator. The mediator suggests an equitable peaceful division outcome, thereby structuring the negotiations according to clear and simple rules, and removing elements of strategic uncertainty.<sup>2</sup> As further robustness check, we also analyze an intermediate arrangement with a ‘weaker’ mediator who suggests a peaceful division but in which the two players still endogenously decide on the share they demand.

The next section provides an overview of the experimental setup and the main results, and it relates our study to the literature. Then, we describe the formal details of the theoretical and experimental framework (Section 3), derive the main hypotheses (Section 4), and present the results of the experiment (Section 5).

## 2 The research context

In the experimental setup, players first bargain over the division of a given amount of resources (the prize). If they fail to reach an agreement, they enter into a resource wasteful conflict, modeled as a Tullock (1980) lottery contest. The key feature of our experimental design is the variation of the players’ relative fighting strengths in the contest, which are known when bargaining. This variation enables us to identify whether an increased imbalance of power is reflected in the bargaining outcome and how the imbalance of power affects

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<sup>2</sup>This type of mediator is not a real player but acts more like a automated device, which is of course a simplification. The survey by Kydd (2010) highlights that a mediator may have several roles and may also be a player with own objectives. See, e.g., Bercovitch and Schneider (2000) and Bercovitch and Gartner (2009) on the selection of mediators and Beardsley (2011) on the limits of mediation.

the probability that players fail to reach a peaceful outcome at the bargaining stage.

We approach this question by analyzing two variants of the bargaining game. The bargaining variants isolate different effects that may be important for reaching a peaceful agreement. As the baseline treatment, players are (exogenously) offered a division of the prize, which they can either accept or reject. The exogenous division mechanism is a shortcut for a mechanism that implements the Nash bargaining solution, taking as threat points the players' conflict payoffs (which depend on their relative fighting strengths). We may also think of an impartial mediator who enters into the picture and makes this division proposal as a formative (procedural) mediation effort. We compare this benchmark game to a Nash demand game. In the Nash demand game, both players simultaneously choose a demand, and conflict occurs if and only if the endogenous demands sum up to more than the prize value.<sup>3</sup> Hence, the Nash demand game introduces strategic uncertainty and coordination problems, which are absent by construction in the baseline treatment. Varying the bargaining mechanism allows us to check for an interaction effect, that is, we analyze whether an imbalance of power has differential effects under different degrees of complexity of the bargaining mechanism. Moreover, we conduct two types of control treatments: one in which we change the exogenously given division to an equal split; and one in which we suggest a possible division in the Nash demand game which corresponds to the allocation under the exogenous division mechanism but is fully non-binding.

In all treatments, we observe a significant probability of resource wasteful conflict. A larger imbalance of power does not influence the likelihood of conflict in case of the exogenous division mechanism. In case of an exogenous division, the disadvantaged player consistently rejects the proposed division more often than the advantaged player. However, in case of endogenous demands the likelihood of conflict significantly increases with a larger imbalance of power. With large power asymmetry, the players' total demands chosen are too high and the 50-50 split is not predominant; conflict arises in more than half of the cases. If a peaceful agreement is reached, however, the player with the low fighting ability earns almost the entire surplus. With small power asymmetry, players successfully implement an endogenous peaceful 50-50 split in about half of the cases. Here, the conflict probability is lower and total payoffs are higher than under the exogenous division. In other words, if power is balanced, exogenous mediation proposals even lead to more conflict than own demand choices in the negotiations.

Our paper is related to the large literature on international politics, in particular on

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<sup>3</sup>For a related theory framework see Wittman (2009) who analyzes a Nash demand game in which the players have private information about their fighting abilities (which directly translate into the win probabilities). In his model, the relation between similarity in fighting capabilities and the likelihood of conflict depends on whether the (exogenous) cost of war is high or low.

rationalist theories of bargaining and conflict. This literature has already been referenced briefly above. Experimental work in this literature addresses several aspects of bargaining in the shadow of conflict. McBride and Skaperdas (2014) deal with the likelihood of conflict when players are symmetric, concentrating on differences in the imposed discount factors of the future. Ke et al. (forthcoming) consider acceptance of an exogenously imposed sharing rule within victorious alliances. Kimbrough et al. (2013) consider conflict avoidance through the choice of a lottery, focusing on the degree of commitment to the lottery outcome. Kimbrough and Sheremeta (2013, 2014) analyze the likelihood of conflict when one player can offer a side-payment to his co-player. They find that side payments are used to avoid conflict and that larger side payments decrease the probability of conflict. Lacomba et al. (2014) focus on choices between production and investments in arms when conflict arises exogenously but post-conflict appropriation is endogenous. In Smith et al. (2014), symmetric players can invest in arms before deciding whether to cooperate. The emergence of conflict with heterogeneous players is also analyzed by Kimbrough et al. (2014). In their experiment, subjects choose between a peaceful symmetric lottery and a contest. As peaceful sharing rules themselves are always exogenously given, a mismatch of sharing rules and fighting strength may occur, and fighting may be induced because one of the key mechanisms to prevent fighting is blocked. Our experiment accounts for Wittman's (1979) argument and isolates the effect of an increased imbalance of power on peaceful sharing and conflict avoidance, comparing different bargaining mechanisms.

Our paper is also related to the literature on bargaining experiments. The institutional design of bargaining becomes relevant in experimental work by Schneider and Krämer (2004) who consider different fair-division procedures, documenting the importance of rules and their credibility. Eisenkopf and Bächtiger (2013) consider the role of an impartial or biased mediator who may facilitate communication and/or may be able to punish conflict parties. Their frameworks hint at the role of norms and rules. Our results also underline the importance of institutional rules for negotiation failure. However, in their frameworks negotiation failure does not lead to wasteful conflict and to fighting for a prize in a contest. Two papers that consider asymmetries between players in a bargaining context are Anbarci and Feltovich (2013, 2014), varying the exogenously given disagreement payoffs for players (in a Nash demand game and an unstructured bargaining game). They find that players are less sensitive to changes in their bargaining position than theory predicts, as the players closely stick to the 50-50 split. Sieberg et al. (2013) study the effect of power asymmetries in a two-stage alternating offer game with shrinking pie; if no agreement is reached, a lottery with exogenous win probabilities determines the allocation. They find no clear relationship between the probability of early agreement and power asymmetry.

There is also a growing literature on contest experiments with asymmetric players, in particular asymmetric Tullock lottery contests; for a recent survey on contest experiments see Dechenaux et al. (2014). There is mixed evidence on the effect of asymmetry on rent dissipation in the contest. For instance, Davis and Reilly (1998) find that rent dissipation decreases with asymmetry, but not as much as theory predicts.<sup>4</sup> On the other hand, in Hörtnagl et al. (2013), heterogeneity even increases effort expenditures, and Anderson and Stafford (2003) find no effect of cost heterogeneity on rent dissipation. As a side result of our experiment, rent dissipation in the conflict is reduced if the imbalance of power increases, in line with the theory prediction.

### 3 Theoretical and experimental framework

#### 3.1 Formal framework and equilibrium prediction

We consider two players  $A$  and  $B$  who compete in a two-stage game about a prize that has monetary value  $V$ . Nature endows them with different fighting abilities which are common knowledge and are denoted  $c_A \geq 0$  and  $c_B \geq 0$ . These abilities will become important in stage 2.

In stage 1,  $A$  and  $B$  bargain about the division of the prize. We consider two variants of this stage which characterize two different games. (i) The first type of game is called the SPLIT game and described by shares  $s_A$  and  $s_B$  that are exogenously given. Players can accept or reject a division of  $V$  according to these shares. If both players accept, they divide the prize accordingly and the game ends. If  $A$  or  $B$  or both of them reject, they enter into stage 2. (ii) The second type of game is called the DEMAND game: The two players  $A$  and  $B$  simultaneously choose a share of the prize, which is then announced. If both shares sum up to not more than the value of the prize  $V$ , each player receives the share of the prize demanded and the game ends. If the shares sum up to more than  $V$ , then  $A$  and  $B$  fail to reach an agreement, and they enter into stage 2 of the game.

Stage 2 is the same for both variants of the bargaining stage. In stage 2, the players have to fight about the prize in a Tullock (1980) lottery contest.<sup>5</sup> Players  $A$  and  $B$  simultaneously choose efforts  $x_A \geq 0$  and  $x_B \geq 0$ . This is where players' fighting abilities matter:  $c_A$  and  $c_B$  represent the players' constant marginal effort cost. Hence,  $i$ 's expected material payoff

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<sup>4</sup>See also Kimbrough et al. (2014), Fonseca (2009) for a comparison of sequential and simultaneous contests, and Brookins et al. (2014) for a group contest.

<sup>5</sup>The Tullock (1980) contest is one of the most commonly used frameworks to describe a wasteful fight about the distribution of a prize. Several microfoundations (see, e.g., Hirshleifer and Riley 1992, Fullerton and McAfee 1999 and Baye and Hoppe 2003) and axiomatic foundations (see Skaperdas 1996 and Clark and Riis 1998) have been offered for this contest structure.

	Player $A$	Player $B$
Effort $x_i^*$	$\frac{c_B}{(c_A+c_B)^2}V$	$\frac{c_A}{(c_A+c_B)^2}V$
Win probability $p_i^*$	$\frac{c_B}{c_A+c_B}$	$\frac{c_A}{c_A+c_B}$
Expected payoff $\pi_i^*$	$\left(\frac{c_B}{c_A+c_B}\right)^2 V$	$\left(\frac{c_A}{c_A+c_B}\right)^2 V$

Table 1: Characterization of the equilibrium.

from conflict is equal to

$$\pi_i = p_i(x_A, x_B)V - c_i x_i \text{ for } i = A, B.$$

Here,  $p_i$  denotes player  $i$ 's probability of winning the prize and is equal to

$$p_i(x_A, x_B) = \frac{x_i}{x_A + x_B}, \quad i = A, B.$$

if  $x_A + x_B > 0$  and equal to  $1/2$  otherwise.

Existence and uniqueness of equilibrium of the stage 2 subgame is well known (Szidarowszky and Okuguchi 1997, Cornes and Hartley 2007). Table 1 characterizes the equilibrium. It has intuitively plausible properties. Equilibrium effort  $x_i^*$  is decreasing in a player's effort cost  $c_i$ , but equilibrium cost of effort  $c_i x_i^*$  is the same for both players. Hence, the player with the lower cost of effort (Player  $A$ ) wins with higher probability and has a higher expected payoff. We now turn to the details of the two different setups for stage 1.

**The bargaining game (stage 1): exogenous division mechanism.** In the SPLIT game, a division  $(s_A, s_B)$  of the prize is exogenously proposed with  $s_A$  being the solution to

$$\max_{s_A} (s_A - \pi_A^*)(V - s_A - \pi_B^*), \quad (1)$$

where  $\pi_i^* = (c_{-i}/(c_A + c_B))^2 V$ ,  $i \in \{A, B\}$ , is the expected equilibrium payoff of the stage 2 contest subgame (as given in Table 1). The solution to (1) yields

$$(s_A, s_B) = \left( \frac{c_B}{c_A + c_B}V, \frac{c_A}{c_A + c_B}V \right) \quad (2)$$



Note that these values are exogenous from the perspective of the players, and that their choice set is only about accepting or not accepting these values. Solution (2) splits the surplus from agreement evenly between the two players.<sup>6</sup> The choice of this division rule has intuitive appeal, not only because it is the solution to (1).<sup>7</sup>

For the experimental setup, we use  $s_A$  and  $s_B$  as the values that emerged from cooperative Nash bargaining assuming equal bargaining power and using the equilibrium payoffs of the contest as threat points. Players  $A$  and  $B$  learn these values and simultaneously decide whether to accept or to reject the division  $(s_A, s_B)$ . If both accept,  $A$  gets a payoff of  $s_A$  and  $B$  gets a payoff of  $s_B$ , and the game ends. If at least one player rejects the proposed division, the game enters into the fighting subgame in stage 2.

In the subgame perfect equilibrium, player  $i \in \{A, B\}$  anticipates the own expected equilibrium payoff  $\pi_i^*$  in the stage 2 contest subgame. Player  $i$  prefers acceptance of the division if and only if  $s_i \geq \pi_i^*$ . Note that  $s_i = p_i^*V > \pi_i^*$ : If players maximize their expected material payoff, both players will choose to accept the peaceful split in equilibrium.<sup>8</sup>

**The bargaining game (stage 1): Nash demand game.** Consider next the DEMAND game. Here, stage 1 follows closely the rules of a Nash (1953) demand game. Rather than being exogenously determined,  $s_A \in [0, V]$  and  $s_B \in [0, V]$  are simultaneously chosen by players  $A$  and  $B$ , respectively. If  $s_A + s_B \leq V$ , then  $A$ 's payoff is  $s_A$  and  $B$ 's payoff is  $s_B$  and the game ends. If  $s_A + s_B > V$ , then the game enters into the stage 2 contest subgame.

In the DEMAND game, there is a continuum of stage 1 choices  $(s_A, s_B)$  that belong to a subgame perfect equilibrium. The set of pairs  $(s_A, s_B)$  that characterizes the set of efficient pure-strategy equilibrium choices is characterized by  $s_A \geq \pi_A^*$ ,  $s_B \geq \pi_B^*$  and  $s_A + s_B = V$ . There is also a continuum of inefficient equilibria, which are generally characterized by

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<sup>6</sup>A symmetry assumption regarding the split rule corresponds to the symmetry assumption in the Nash demand game in the respective treatment and, hence, allows us to compare exogenous and endogenous division mechanisms. Moreover, since both players are equally pivotal in whether a division is accepted, this should provide them with the same bargaining power when dividing the aggregate surplus. While players may further be assumed to differ in their bargaining power, bargaining power should not be identified with fighting power, which is already reflected in the threat points and, thus, in the division  $(s_A, s_B)$ .

<sup>7</sup>This rule maximizes the minimum of the two players' gains from cooperation at stage 1. Since both players need to agree to the proposal, this maximin property makes this rule an attractive choice for a mediator who would like to make a proposal that is likely to be accepted. In addition, this rule emerges as subgame perfect equilibrium of a non-cooperative bargaining game with alternating offers and an exogenous probability of termination of the negotiations if this probability becomes very small such that the advantage of making the first offer vanishes.

<sup>8</sup>Strictly speaking, this is the payoff dominant equilibrium. Another equilibrium exists in which both players reject because none of them is pivotal if the other player rejects. This other equilibrium does not survive trembling. In the experimental setup, we allow for minor trembling to eliminate this equilibrium. More precisely, if one player rejects the division and the other chooses to accept, there is a 10% probability that the proposed division is implemented in order to ensure that, in the experiment, a player's choice reveals his preference even when he expects his co-player to reject the division.

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	SPLIT	DEMAND
SMALL: $(c_A, c_B) = (4, 5)$	72 subjects 9 independent obs.	72 subjects 9 independent obs.
LARGE: $(c_A, c_B) = (2, 7)$	72 subjects 9 independent obs.	72 subjects 9 independent obs.

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Note: SPLIT: exogenously proposed shares (Nash bargaining solution); DEMAND: Nash demand game.

Table 2: Experimental treatments:  $2 \times 2$  between subjects design.

$V - s_A < \pi_B^*$  and  $V - s_B < \pi_A^*$ : Suppose that player  $A$  asks for an excessively high share which does not leave sufficient resources on the bargaining table to make  $B$  at least as well-off as in the fighting equilibrium. Then,  $B$  will prefer to fight. As  $B$ 's choice of  $s_B$  is arbitrary and inconsequential,  $B$  may actually choose a very high demand as well. In this case, unilateral deviations to a lower demand  $s_i$  (with  $s_i \geq \pi_i$ ) cannot avoid conflict.

### 3.2 Experimental treatments and procedures

**Treatments.** The experiment is based on a  $2 \times 2$  between subjects design. The first dimension varies the bargaining mechanism in stage 1 (exogenously proposed SPLIT versus Nash DEMAND), and the second dimension focuses on the degree of asymmetry in fighting strengths (SMALL versus LARGE asymmetry).<sup>9</sup> In the treatments with small asymmetry, the players' effort cost in the contest in stage 2 are set to  $c_A = 4$  and  $c_B = 5$ , respectively; thus, players are "almost symmetric" in the contest stage.<sup>10</sup> In the treatments with large asymmetry, we increase the cost spread to  $c_A = 2$  and  $c_B = 7$ , keeping the average cost parameter and average effort constant. In all treatments, the prize value is equal to  $V = 549$ . Table 2 summarizes the treatments.

For the exogenous division mechanism (SPLIT), the choice of the cost parameters implies that the exogenous peaceful split option is  $(5V/9, 4V/9) = (305, 244)$  in case of small asymmetry and  $(7V/9, 2V/9) = (427, 122)$  for large asymmetry. Table A.1 in the appendix

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<sup>9</sup>Importantly, both bargaining mechanisms keep the bargaining protocol symmetric (i.e., the DEMAND treatment involves endogenous demand choices of both players). The only dimension of asymmetry relates to the conflict strengths.

<sup>10</sup>Choosing a small degree of asymmetry, instead of perfect symmetry, makes the identification of the treatment effect of increased asymmetry much cleaner (compare also Kimbrough et al. 2014). We refrained from setting  $c_i = 1$  for any of our players to keep the computational demands as similar as possible across types and treatments, and we stuck to integers for  $c_i$  to facilitate computations.

summarizes the parameters used in the experiment together with the theory prediction (in DEMAND, possible choices in efficient equilibria). Note that, for a given cost asymmetry in SPLIT, the sacrifice in payoffs when choosing conflict is the same for players  $A$  and  $B$  (that is,  $s_A - \pi_A^* = s_B - \pi_B^*$ ). Due to the higher effort cost with small asymmetry, however, this sacrifice in payoffs is higher in SMALL than in LARGE, following the standard theory result that rent dissipation is highest if the contestants are equally strong.

**Procedures.** The experiment was programmed using z-Tree (Fischbacher 2007) and run at the MELESSA laboratory in Munich, Germany. Subjects were recruited from the student body of Munich universities using ORSEE (Greiner 2004). We admitted 24 subjects to each session. Each subject participated in exactly one of the treatments outlined above. The game described in Section 3.1 was played repeatedly (30 independent interactions/rounds in total), but the subjects were randomly rematched in each round. To obtain a larger number of independent observations, random matching took place in subgroups, each consisting of 8 participants. No specific information was provided to the subjects about the precise nature of matching other than that they would be randomly re-matched between rounds. The total number of participants was 288 (72 subjects in 9 matching groups per treatment).

At the beginning of each session, written instructions were distributed and read out loud (see Appendix B for a sample of the instructions). Subjects had to complete a quiz to make sure they understand the experiment. In the main part of the experiment, the role as player  $A$  or  $B$  (the respective cost parameter) was randomly assigned to the players in each of the 30 rounds and announced at the beginning of a round.<sup>11</sup> In SPLIT, the division proposal  $(s_A, s_B)$  was shown to the participants. No specific information was provided about how this proposal was generated. Players decided whether to accept the division of the prize. In DEMAND, the participants had to enter their demand as an integer between 0 and 549.<sup>12</sup> The contest took place only if no agreement had been reached. At the contest stage, both players' choices in the bargaining stage were displayed on the screen and players chose their effort as a non-negative integer. The resulting win probabilities were illustrated in a circular area on the screen, with a pointer running clockwise determining the winner. At the end of each round, the subjects learned their payoff from this round.

Before subjects were paid, they had to undergo a questionnaire on individual charac-

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<sup>11</sup>Varying the players' roles (as  $A$  or  $B$ ) during the experiment ensures that participants have the same expected total payoff and do not feel disadvantaged or unfairly treated by the design.

<sup>12</sup>In all treatments, in order to help subjects with computing winning probabilities, the lower part of the screen displayed a calculator. Subjects could repeatedly enter hypothetical effort levels and compute the cost of effort and the probability of winning as often as they wished.

teristics and behavior in the main part of the experiment, including incentivized tests on distributional preferences (subjects had to repeatedly make two-person allocation decisions, following Bartling et al. 2009 and Balafoutas et al. 2012) and preferences for playing a lottery. The lottery was similar to the fighting subgame, but subjects had to decide whether to invest a fixed amount at a given win probability which increased from 0.1 to 0.9 in increments of 0.2. Moreover, the questionnaire contained several questions on the willingness to take risks (Dohmen et al. 2011) and one task to elicit ambiguity aversion.

At the end of the experiment subjects were paid separately and in private. In all treatments, the conversion rate was 50 points = 1 euro. Each participant received a show up fee of 4 euros, 10 euros to cover effort cost expenses, the earnings (possibly negative) of 3 randomly selected rounds from the main experiment plus the payoff (also possibly negative) from one randomly selected post-experimental task. On average, subjects earned 26 euros (plus the show-up fee), and a session took about 100 minutes.

## 4 Hypotheses

**Small versus large asymmetry.** The treatments with the exogenous division mechanism in the bargaining stage (SPLIT) serve as a baseline for measuring the effect of an imbalance of power. This treatment abstracts from strategic uncertainty and coordination problems in stage 1: players either agree to an exogenous split or not. Hence, this treatment isolates the effect of an increased asymmetry in fighting ability. In line with Wittman’s (1979) claim, focusing on rational players who maximize material payoff, the balance or imbalance of power should not matter for the likelihood of conflict since the imbalance of power translates into the bargaining shares that players obtain (reflected in the exogenously proposed division). Balance of power theory, in contrast, suggests that larger power imbalances lead to more conflict since larger asymmetry increases the advantaged player’s win probability and his conflict payoff, making it more attractive to incite war.<sup>13</sup> The two approaches lead to two competing hypotheses:<sup>14</sup>

**Hypothesis 1a (Wittman):** *The likelihood of conflict is independent of whether players are almost symmetric (SMALL) or asymmetric (LARGE) in terms of fighting strengths.*

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<sup>13</sup>Under power transition theory, larger power imbalances lead to peace, while times in which there is a balance of power are war-prone. This theory is concerned with dynamic shifts in the balance of power. It requires a dynamic setup and cannot be tested in our experiment.

<sup>14</sup>There is a caveat to the Wittman hypothesis. Wittman (1979) notes that the probability of war will only stay constant if the advantaged player’s increase in his subjective probability of winning is equal to the disadvantaged player’s decrease in his subjective probability of winning. If subjective probabilities differ from objective probabilities in a differential way for the advantaged and the disadvantaged player in SMALL and LARGE, then the hypothesis might no longer be fulfilled.

**Hypothesis 1b (Balance of power):** *The likelihood of conflict is lower when players are almost symmetric (SMALL) than when they are asymmetric (LARGE) in terms of fighting strengths.*

**Exogenous division versus Nash demand game.** Compared to the option to split according to exogenous shares (SPLIT), players face strategic uncertainty and the possibility of coordination failure in the demand game (DEMAND); we expect that these problems make conflict more likely. In the Nash demand game, players may not be able to coordinate on one of the equilibria. The sum of their demands may exceed the prize: they ask for “too much,” causing bargaining to break down. Similarly, there are inefficient equilibria that lead to conflict. Overall, we expect players to more frequently arrive at the conflict stage in DEMAND compared to SPLIT, both for small and for large asymmetry in the fighting strengths.

**Hypothesis 2 (Bargaining mechanism):** *The likelihood of conflict is lower for the exogenous division mechanism (SPLIT) than when players endogenously choose their demands (DEMAND).*

In the DEMAND treatments, the larger the asymmetry, the more likely coordination failure might be to occur. Table A.1 shows that the 50-50 split of the prize is not an equilibrium in case of large asymmetry ( $A$  should rationally demand at least  $\pi_A^* = 333 > 549/2$ ). Therefore, within the DEMAND treatments, we expect coordination to be easier and, hence, conflict to be less likely under SMALL than under LARGE asymmetry, in line with Hypothesis 1b.

In addition to the main hypotheses on the overall likelihood of conflict, we can also derive predictions for individual decisions in both stages of the experiment.

**On the choice whether to reject in the SPLIT treatments:** Players may care not only for their monetary rewards, but also for status, that is, their material payoff relative to that of others.<sup>15</sup> If the players accept the exogenous division, player  $B$  is disadvantaged and ends up with a lower payoff than player  $A$ . If  $B$  chooses to fight, then both players sacrifice some income, but  $B$  has a chance to end up with a higher payoff than  $A$ . The choice of fighting can be preferable for  $B$  if he is sufficiently strongly motivated by relative standing concerns.<sup>16</sup> This is most evident for the case of ordinal relative standing preferences. The

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<sup>15</sup>A considerable amount of theory and empirical evidence supports this hypothesis. Seminal work is by Hirsch (1976) and Frank (1984a, 1984b, 1985a, 1985b).

<sup>16</sup>Status concerns in the context of risky choices have been analyzed systematically by Konrad and Lommerud (1993). Generally, the decision outcome depends on the shape of the player’s utility function under risk.

disadvantaged player  $B$  can reverse the payoff ranking only by entering into the contest.<sup>17</sup> Accordingly, relative standing considerations suggest that the disadvantaged player  $B$  may have a stronger incentive to reject the proposed split than the advantaged player  $A$ .

**On sharing in the DEMAND treatments:** The payoff in the contest is the outside option of players in the Nash demand game. High relative fighting strength yields a high outside option. In turn, a high outside option suggests a higher demand. This relationship is not a sharp equilibrium prediction, as there is multiplicity of equilibrium in the demand game (recall Table A.1). The prediction becomes sharp if we assume, in addition, symmetry, or if we restrict consideration to risk dominant equilibria (a frequent restriction in the analysis of Nash demand games; see also Anbarci and Feltovich 2013, 2014). We therefore expect that a player's demand is positively correlated with the relative fighting strength. In other words, we expect the advantaged player  $A$  to choose a higher demand than the disadvantaged player  $B$  and this difference to be higher with large than with small cost asymmetry.

**On fighting efforts in the Tullock contest:** In line with the theory prediction on the Tullock (1980) contest for players who are motivated by monetary rewards, we expect the following: Effort cost (rent dissipation) should be decreasing in the degree of asymmetry. Thus, effort cost should be lower in LARGE than in SMALL, independent of the bargaining mechanism. This may contribute to a higher likelihood of conflict in LARGE compared to SMALL since bargaining failure is predicted to be less costly in LARGE; the treatment comparisons along the two dimensions will shed light on the role of such efficiency considerations. Finally, on the individual level we expect effort to be higher for the advantaged than for the disadvantaged players.

## 5 Results

Our main research question is on the relationship between power balance and conflict probability. We first consider the probability of conflict and overall efficiency. Then we discuss our result by analyzing individual choices at the conflict and the bargaining stage. The analysis in Sections 5.1 - 5.4 is mainly based on non-parametric tests; Section A.2 presents a regression analysis of individual-level data.

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<sup>17</sup>The role of rank order in relative standing comparisons has been recognized both in economics (see, for instance, Kuziemko et al. 2014 for recent experimental evidence on such ordinal preferences in the context of redistribution decisions and Powdthavee 2009 for survey data) and in psychology (see, for instance, Boyce et al. 2010 on the role of income rank for life satisfaction).

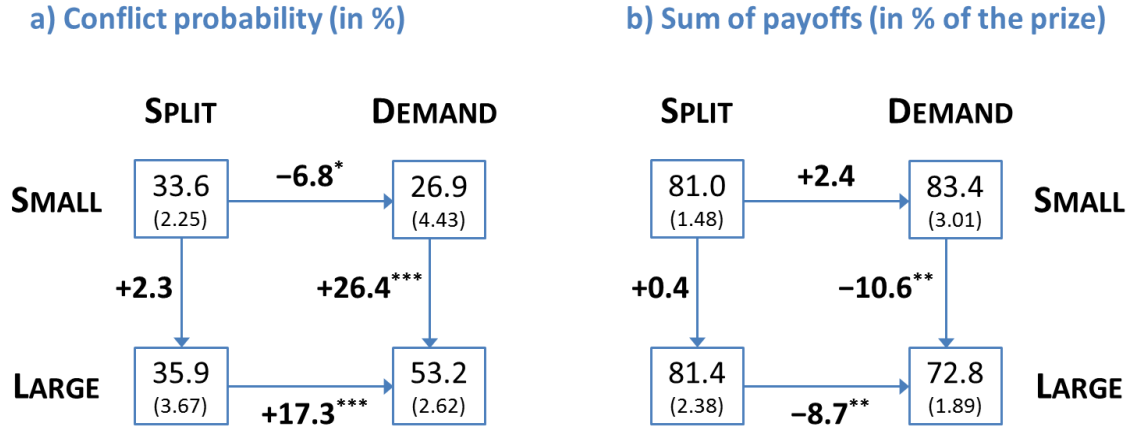


Figure 1: Probability of conflict and efficiency per treatment.

Note: Calculated are mean and standard error (in parentheses) of the probability that a game proceeds to the contest stage (panel a) and the total payoffs of A and B (panel b). Values based on matching group averages (8 subjects over 30 rounds per matching group). Differences are tested using Mann Whitney U tests on the matching-group level (18 observations per test), \*\*\*(\*) significant at the 1% (10%) level.

## 5.1 On the probability of conflict

The left panel in Figure 1 shows the frequency of conflict. Theory predicts that there should never be conflict, focusing on the efficient peaceful equilibrium outcomes in all four treatments. But there is a significant amount of conflict in all treatments. More importantly, consider the effect of increased asymmetry in Figure 1a. For the case of an exogenous division (column SPLIT), the probability of conflict does not differ significantly between the treatments with small asymmetry (33.6%) and with large asymmetry (35.9%). Thus, we cannot reject Wittman's (1979) hypothesis that the balance of power does not matter for the likelihood of conflict. An imbalance of power per se (as in LARGE), without strategic uncertainty and coordination problems, does not lead to more conflict (Hypothesis 1a).

In the Nash demand treatments, however, we see a different result: In the DEMAND column of Figure 1a, the probability of conflict doubles in case of a large imbalance (53.2%) compared to the case of small asymmetry (26.9%), in line with Hypothesis 1b. This shows that the effect of an increased imbalance of power depends on how difficult it is to reach agreement in the bargaining stage.

**Result 1** (a) *In case of exogenous divisions, peaceful agreement does not fail more often with large asymmetry than with small asymmetry in fighting strengths.*

(b) *In case of endogenous demands, peaceful agreement fails more often with large asymmetry than with small asymmetry in fighting strengths.*

Now turn to the effect of endogenizing demands for a given cost asymmetry in Figure 1a. With a large imbalance of power (row LARGE), the probability of conflict is significantly higher when players have to choose their demands endogenously (53.2%) instead of deciding on a given division (35.9%), in line with the bargaining mechanism hypothesis (Hypothesis 2).

At the same time, for the case of small asymmetry (row SMALL), the probability of conflict is *lower* when players can endogenously choose their demands (26.9%), compared to the case where they can accept or reject the exogenously given split (33.6%). Although there is strategic uncertainty in the Nash demand treatment, we observe less conflict. This contradicts the bargaining mechanism hypothesis (the difference of  $-6.8\%$  is significantly different from zero;  $p$ -value is 0.057). We will discuss this finding below when analyzing individual stage 1 decisions.

**Result 2** (a) *With small asymmetry in fighting strengths, peaceful agreement on endogenous demands fails less often than peaceful agreement on exogenous divisions.*

(b) *With large asymmetry in fighting strengths, peaceful agreement on endogenous demands fails more often than peaceful agreement on exogenous divisions.*

In line with the effect on the conflict probability, Figure 1b shows that total payoffs (and, hence, rent dissipation) are very similar in SPLIT-SMALL, SPLIT-LARGE, and DEMAND-SMALL. They are significantly lower (and, hence, rent dissipation is significantly higher) in the Nash demand game with large asymmetry. These lower payoffs are a consequence of the high conflict probability that is observed in this treatment.

In the remainder of this section, we consider in more detail the reasons for the observed relation between the balance of power and the emergence of conflict. First, we analyze the effort choices in the stage 2 conflict and the resulting cost of conflict. Then, we turn to the individual choices in stage 1 which form the basis of the observed conflict probability.

## 5.2 Stage 2 decisions: on fighting

Consider individual choices in the contest if the players cannot peacefully split the prize in stage 1. Figure 2 summarizes individual effort levels in the stage 2 contest.<sup>18</sup> The data reveal that, with small cost asymmetry, efforts of  $A$  and  $B$  are very similar. When the asymmetry increases, however, the advantaged player increases his effort while the disadvantaged player reduces his effort.<sup>19</sup> Second, from Figure 2, we can directly compute the effort

<sup>18</sup>There is overdissipation in all treatments. This is a standard result in experimental contests, especially winner-take-all contests (see Cason et al. 2013).

<sup>19</sup>The decrease in effort for player  $B$  with large asymmetry is weaker for SPLIT than for DEMAND. Since the contest stage is reached less often in SPLIT, players gain less experience in this treatment. The bargaining



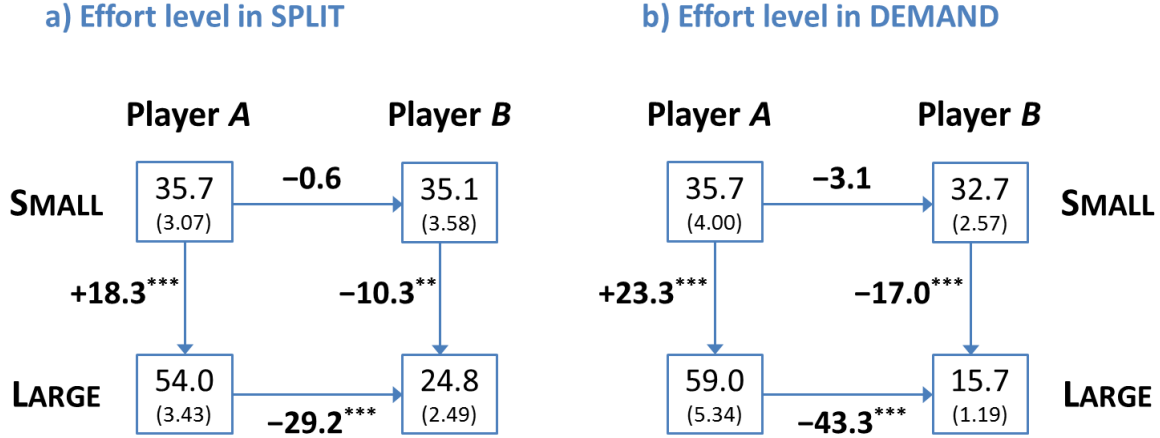


Figure 2: Effort choice  $x_i$  in the stage 2 contest.

Note: Calculated are mean and standard error (in parentheses) of the effort level conditional on reaching the contest in stage 2. Values are based on matching group averages (8 subjects over 30 rounds per matching group). Differences between SMALL and LARGE are tested using Mann Whitney U tests and differences between A and B are tested using Wilcoxon signed rank test; tests on the matching-group level (18 observations per test), \*\*\*(\*\*) significant at the 1% (5%) level.

cost expended with small asymmetry (effort cost parameters  $(c_A, c_B) = (4, 5)$ ) compared to a large asymmetry (effort cost parameters  $(c_A, c_B) = (2, 7)$ ). With the exogenous division in SPLIT, total effort cost (rent dissipation) with a small asymmetry is higher (318.1) than with a large asymmetry (281.5). Similarly, with endogenous demands in DEMAND, total effort cost with a small asymmetry is higher (306.2) than with a large asymmetry (227.8).<sup>20</sup> The difference in rent dissipated between SMALL and LARGE, although smaller than predicted, makes peaceful agreement more attractive (compared to the outside option of fighting) in case of a balance of power than in case of largely asymmetric fighting strengths.

**Result 3** *Total rent dissipation in the conflict decreases in the degree of asymmetry, making bargaining failure more costly when players are similar in terms of their fighting strength.*

While Result 3 addresses the sum of effort costs, we also see that the individual cost of entering stage 2 is larger in SMALL than in LARGE for both player A and player B (see the overview of the payoffs from both stages in Appendix A.3).

procedure might also affect non-monetary values of winning the contest or cause different selection effects. Note, however, that player B's average conflict payoff does not significantly differ between the bargaining mechanisms.

<sup>20</sup>The effect of an increased asymmetry on total effort cost is, however, only statistically significant in DEMAND ( $p$ -value is 0.01). The weaker effect in SPLIT is mainly due to the disadvantaged player who strongly overdissipates with large asymmetry; also see the remark on the effort levels above.

With endogenous demands, a peaceful outcome is more likely if the asymmetry in fighting strengths of the two players is small (Result 1(b)). This is in line with efficiency considerations. The predicted overall cost of conflict is higher if the players have more similar fighting strengths, making it more valuable to reach a peaceful agreement if players are very similar in terms of fighting strength (also compare Wittman 2009). Efficiency considerations would, however, also induce the conflict probability in SPLIT to be lower for small asymmetry than for large asymmetry, in contrast to Result 1(a). The following analysis of stage 1 choices will reveal that efficiency considerations alone cannot explain the observed treatment differences in the emergence of conflict.

## 5.3 Stage 1 decisions

### 5.3.1 On the choice to reject in the SPLIT treatments

According to the theory predictions, both players  $A$  and  $B$  have a strictly dominant strategy to accept the exogenously given division of the prize. Nonetheless, there is a significant probability of rejections in all treatments, as summarized in the left panel of Figure 3. Moreover, the rejection probability is lowest for the strongly advantaged player in case of large asymmetry (8.6%) and highest for the strongly disadvantaged player in LARGE (32.9%), revealing a simple pattern: The less a player is offered (the lower his relative fighting strength), the more likely he rejects the offer.<sup>21</sup> This effect is particularly strong when comparing the advantaged player  $A$  and the disadvantaged player  $B$ , both for small and for large asymmetry.

**Result 4** *The rejection probability is higher for the disadvantaged player than for the advantaged player.*

The significant difference in rejection probabilities of players  $A$  and  $B$  suggests that efficiency considerations (the cost of conflict in stage 2; Result 3) cannot be the main explanation of observed conflict probabilities in SMALL and LARGE. Rather, disadvantaged players seem to consider the proposed division inappropriate.<sup>22</sup> The result on the higher re-

<sup>21</sup>Recall that, in Figure 3a, the exogenous share offered to the players becomes lower when moving clockwise from A-LARGE to A-SMALL to B-SMALL to B-LARGE.

<sup>22</sup>During the experiment a calculator was offered on the screen as a help to compute win probabilities for possible effort choices. If we use the values entered for the co-player's effort as a proxy for the individual beliefs about the actual effort of the co-player, we can deduce the individuals' expected win probabilities (although with the caveat that not all subjects made use of the calculator). In SMALL, the expected win probabilities of  $A$  and  $B$  are about 52-54%; thus players may perceive themselves as basically symmetric. In LARGE, player  $A$ 's perceived win probability increases to 60% while  $B$ 's perceived win probability decreases to 42% (both for SPLIT and for DEMAND).

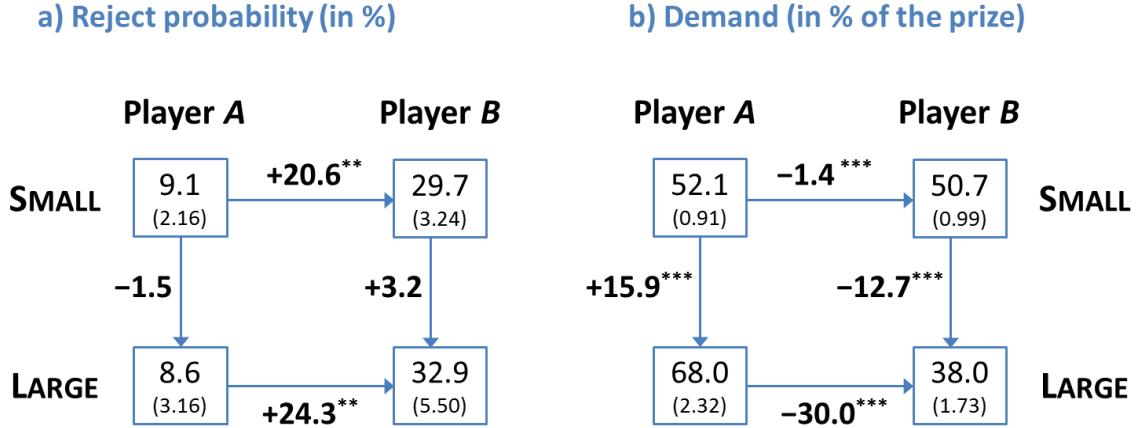


Figure 3: Probability of rejection of the exogenous split and endogenous demands in the Nash demand game.

Note: Calculated are mean and standard error (in parentheses) of the probability that a player rejects the exogenous division in SPLIT (panel a) and the demand (as % of the prize) in DEMAND (panel b). Values are based on matching group averages (8 subjects over 30 rounds per matching group). Differences between SMALL and LARGE are tested using Mann Whitney U tests and differences between A and B are tested using Wilcoxon signed rank test; tests on the matching-group level (18 observations per test), \*\*\*(\*\*) significant at the 1% (5%) level.

jection probability of disadvantaged players is in line with preferences on relative standing.<sup>23</sup> In Section 5.4 we will further discuss the rejection behavior in SPLIT when presenting a control treatment which uses a different exogenous division (an equal split).

### 5.3.2 On sharing in the DEMAND treatments

The right panel of Figure 3 summarizes the player's choices in stage 1 of the Nash demand game. We find: The lower a player's relative fighting strength, the lower is the player's demand. This effect emerges and is statistically significant both for the difference between small and large asymmetry for a given type of player (*A* or *B*) and the difference between advantaged and disadvantaged player for a given asymmetry (SMALL or LARGE).

**Result 5** *A player's demand is increasing in his relative fighting strength.*

Comparing the endogenous demands to the exogenous division in the SPLIT treatment, we find that the advantaged player *A* demands less whereas the disadvantaged player *B*

<sup>23</sup>Comparing SMALL and LARGE, increasing the advantage of *A* (the disadvantage of *B*) further lowers (increases) the rejection probability, yet the estimated differences (-1.5% and 3.2%, respectively) are not statistically significant.

demands more than what would be attributed by the division in SPLIT. Overall, both in SMALL and in LARGE, the two players' average demands sum up to more than 100%, but are very close to 100% of the prize value in case of small asymmetry (for the distribution of individual demand choices see the figures in Appendix A.4). Moreover, with large asymmetry, both players' average demands clearly differ from the 50-50 split: In LARGE, players demand half of the prize (274 or 275 points) in only 13% of the cases (compared to 67% in SMALL), and successfully achieve a 50-50 split in less than 1% of the observed pairs (compared to 46% in SMALL).<sup>24</sup> If power is almost balanced players may either perceive the setup of cost parameters with  $c_A = 4$  and  $c_B = 5$  as basically symmetric, or they may choose the 50-50 split as a coordination device. We will pick up on this question in Section 5.4. In the case of a large asymmetry, the 50-50 split loses its property as a focal point and coordination becomes seemingly more difficult.<sup>25</sup>

Figure 4 depict the distributions of bargaining outcomes with SMALL and LARGE asymmetry. The dark (green) combinations show demands that sum up to less than the prize  $V$  and lead to peaceful divisions, the light (orange) combinations show demand combinations that sum up to more than  $V$  and that lead to conflict. First, consider the players' actual payoff if they can reach a peaceful division in stage 1. In SMALL, conditional on bargaining being successful,  $A$  receives 268.9 points and  $B$  receives 267.9 points and, hence, almost the same payoff (see also Figure A.2a in the appendix).

With an imbalance of power in LARGE, successful peaceful agreements in DEMAND allocate 311.9 points to the advantaged player and 178.4 points to the disadvantaged player (see again Figure A.2a in the appendix).<sup>26</sup> The advantaged player  $A$  ends up with an average share upon peaceful division that is even slightly lower than his empirically observed average conflict payoff (which is 318.5; see Figure A.2b in the appendix). The disadvantaged player  $B$ , however, earns significantly more when a peaceful agreement is reached than what he would get in conflict (his observed conflict payoff is only 2.7 and, hence, even much less than predicted by theory). Thus, in the Nash demand game with large asymmetry, on average,

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<sup>24</sup>Already in the successful 50-50 splits with SMALL asymmetry we observe that the advantaged player  $A$  demands slightly more than the disadvantaged player  $B$  even if this can come at a high cost in case bargaining fails. With SMALL asymmetry, about 27% of the successful 50-50 splits allocate 275 points to  $A$  and 274 points to  $B$ , while the reverse with  $B$  earning 275 points and  $A$  earning 274 points only occurs in 7.6% of cases. (In the remaining 65.5% of successful 50-50 splits  $A$  and  $B$  each earn 274, forgoing one point of the prize.)

<sup>25</sup>Also compare Anbarci and Feltovich (2014) who observe that outcomes crucially depend on whether the 50-50 split is a viable split.

<sup>26</sup>These shares in successful agreements are considerably below the players' average demands in LARGE (Figure 3b). Further indication that settlement is more difficult with a large imbalance of power stems from the difference in the sum of realized peaceful shares: With small asymmetry, successful peaceful agreements allocate 98% of the prize, while, with large asymmetry, this number is reduced to 89%. Hence, more rent is left on the table when the imbalance of power becomes stronger.

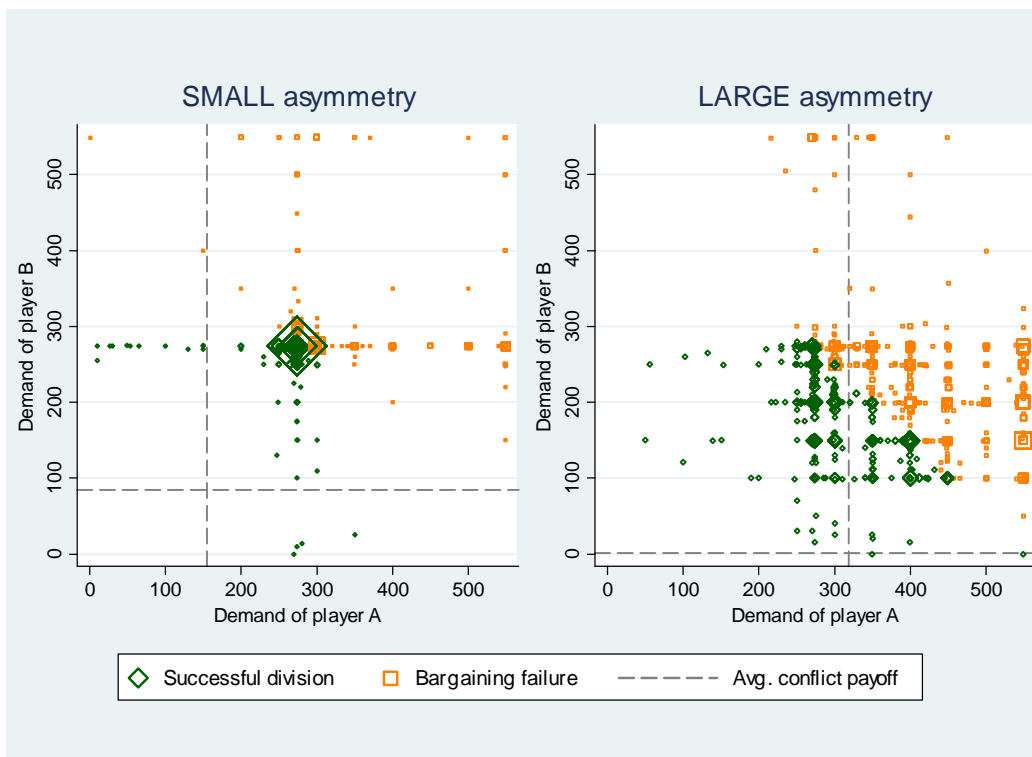


Figure 4: Stage 1 demands ( $s_A, s_B$ ) with SMALL and LARGE asymmetry; the dashed lines are the average observed conflict payoffs.

successful bargaining allocates the entire material surplus of peaceful sharing to the disadvantaged player  $B$ , while the advantaged player  $A$  only gets his outside option (a resource share close to his conflict payoff).

**Result 6** (a) *When asymmetry in fighting strengths is small, the distribution of demand choices by players  $A$  and  $B$  is concentrated at (and just below) 50% of the prize. Players successfully achieve a 50-50 split in about half of the cases.*

(b) *When asymmetry in fighting strengths is large, coordination on the 50-50 split is no longer predominant.*

(c) *If bargaining is successful, the division of the peace dividend (bargaining surplus) is biased in favor of the disadvantaged player.*

## 5.4 Discussion

The results that the conflict probability in the DEMAND treatments is (weakly) lower than in SPLIT if the asymmetry is small but significantly higher than in SPLIT if the asymmetry is large raises two main questions: First, do individuals consider the proposed Nash bargaining solution as “unfair” if power is almost balanced? Would they rather prefer an equal split

(which they can implement in DEMAND)? And second, is the high conflict probability in the Nash demand game with large asymmetry mainly due to coordination failure? That is, does large asymmetry simply make it more difficult to coordinate on one of the equilibria? To answer these questions and investigate further the observed relation of the balance of power and the likelihood of conflict, we conduct two sets of control treatments.

#### 5.4.1 SPLIT-50-50 treatment

First we conduct a variant of the SPLIT-SMALL treatment in which the exogenously proposed split is not the Nash bargaining solution but an equal division of the prize  $V = 549$ .<sup>27</sup> To be precise, the proposed split is (275, 274) and in each matched pair of players it is randomly decided who gets the additional point.<sup>28</sup> If the bargaining solution in SPLIT with small asymmetry is perceived as unfair by the players, the conflict probability in this control treatment SPLIT-50-50 should be lower than in SPLIT-SMALL and also lower than in DEMAND-SMALL (where coordination failure may still occur).

The results on conflict probabilities and rejection probabilities are summarized in Figure 5. We find that the likelihood of conflict in SPLIT-50-50 is even slightly higher than in SPLIT-SMALL (36.8% compared to 33.6%; the difference is statistically insignificant). Consequently, there is significantly more conflict in SPLIT-50-50 than in DEMAND-SMALL ( $p$ -value 0.069). Thus, an equal split is not the “fair” division that every individual prefers. Quite the contrary, the rejection probability of the stronger player (player  $A$  with the effort cost  $c_A = 4$ ) significantly increases to 35.1%. In turn, the rejection probability of the weaker player (player  $B$  with the effort cost  $c_B = 5$ ) who is favored by the equal division significantly decreases to 8.3%. Both for players  $A$  and  $B$ , the difference of the rejection probability in SPLIT-50-50 compared to SPLIT-SMALL is highly significant ( $p$ -value < 0.001); compare Figure 5b. These results can again be explained by relative standing comparisons, causing a larger share of players  $A$  to prefer conflict where their expected payoff is higher than  $B$ ’s expected payoff. Note also that player  $i$ ’s rejection probability in SPLIT-50-50 is higher in case of an allocation  $(s_i, s_{-i}) = (274, 275)$  than in case of  $(s_i, s_{-i}) = (275, 274)$  (see Figure A.3 in Appendix A.5); subjects do not like to be worse off even by a single point.<sup>29</sup> Overall, a change in the proposed division to an equal split does not reduce the conflict probability.

<sup>27</sup>Apart from the change in the proposed division, the setup is exactly as in SPLIT-SMALL outlined in Section 3.2. We have nine independent observations from 72 subjects who took part in this treatment.

<sup>28</sup>This allocation rule makes the SPLIT-50-50 treatment most comparable to the SPLIT-SMALL treatment, keeping the exact same total value of the prize as well as complete information about the proposed split. In addition, the proposed allocations are also part of the choice set in the DEMAND treatments.

<sup>29</sup>This finding is also in line with the observation that a substantial amount of subjects in DEMAND-SMALL choose a share  $s_i = 275$ , even though this more than doubles the likelihood of conflict compared to a choice of  $s_i = 274$ .

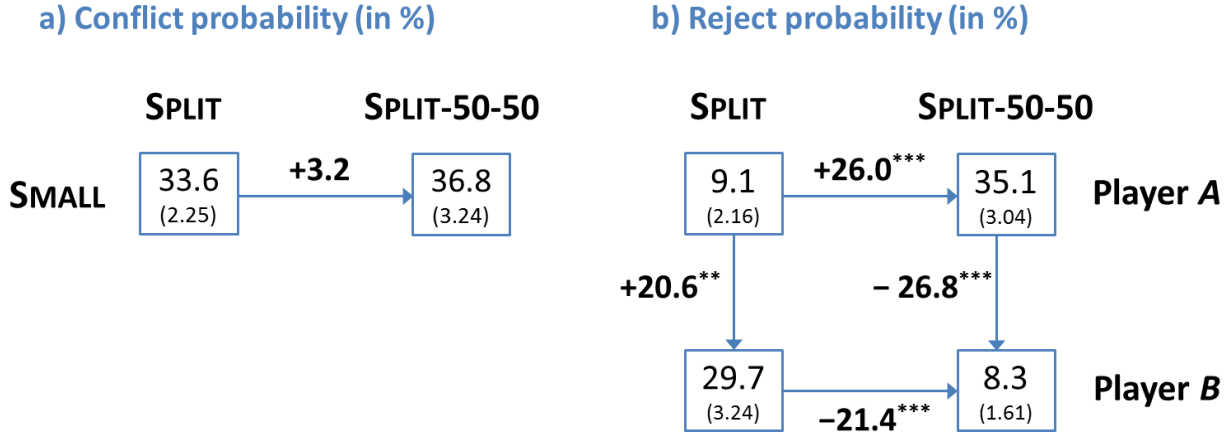


Figure 5: Conflict probability and rejection probability in the SPLIT-50-50 treatment.

Note: Calculated are mean and standard error (in parentheses) of the probability that a game proceeds to the contest stage (panel a) and the probability that a player rejects the exogenous division (panel b) for the SPLIT-50-50 treatment (compared to SPLIT). Values are based on matching group averages (8 subjects over 30 rounds per matching group). Differences between SPLIT and SPLIT-50-50 are tested using Mann Whitney U tests and differences between players A and B are tested using Wilcoxon signed rank tests; tests on the matching-group level (18 observations per test), \*\*\* (\*\*) significant at the 1% (5%) level.

Rather, endogenous demand choices seem to adjust better to potential heterogeneity across individuals if power is almost balanced.

To illustrate this latter point, suppose there are two types of individuals across players *A* and *B*: on the one hand, individuals who find the Nash bargaining solution appropriate (but would also accept a higher share if offered) and, on the other hand, individuals who find the equal split appropriate (but would also accept a higher share if offered). Then, in SPLIT-50-50 the probability of conflict is equal to the probability that *A* is a ‘Nash-bargaining-type.’ In SPLIT-SMALL, the probability of conflict is equal to the probability that *B* is an ‘equal-split-type.’<sup>30</sup> In DEMAND-SMALL, however, if players demand their share which they find appropriate, the probability of conflict is strictly lower: Conflict occurs only if *A* is a ‘Nash-bargaining-type’ and at the same time *B* is an ‘equal-split-type.’

#### 5.4.2 DEMAND treatments with focal point

Second, to investigate the reasons for the increase in the conflict probability in the Nash demand game with large asymmetry we conduct a variant of the DEMAND treatment in which a possible division of the prize is suggested to the players in stage 1 when choosing the

<sup>30</sup> Compare the rejection probabilities in Figure 5b: Conflict is mainly triggered by player *A* in SPLIT-50-50 and by player *B* in SPLIT-SMALL.

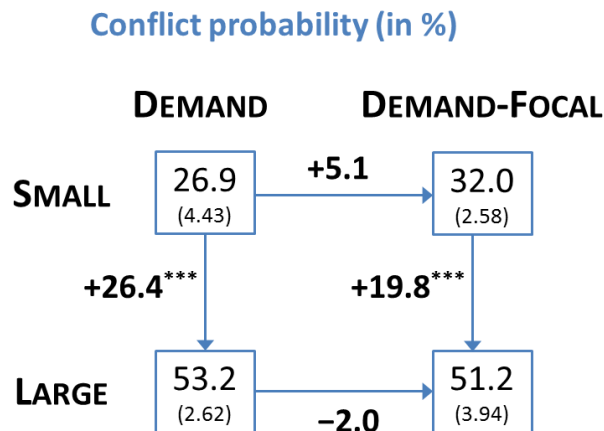


Figure 6: Conflict probability in the DEMAND-FOCAL treatments with small and large asymmetry.

Note: Calculated are mean and standard error (in parentheses) of the probability that a game proceeds to the contest stage for the DEMAND-FOCAL treatments (compared to DEMAND without focal point). Values based on matching group averages (8 subjects over 30 rounds per matching group). Differences between DEMAND and DEMAND-FOCAL and between SMALL and LARGE are tested using Mann Whitney U tests; tests on the matching-group level (18 observations per test), \*\*\* significant at the 1% level.

share of the prize they want to receive. This suggested division is fully non-binding but may serve as a focal point and solve the problem of multiple equilibria. The suggested division corresponds to the Nash bargaining solution; thus, the resulting DEMAND-FOCAL treatments can be considered intermediate treatments between the original SPLIT and DEMAND.<sup>31</sup> If conflict is mainly driven by coordination failure, the likelihood of conflict should be lower in the DEMAND-FOCAL treatments than in the DEMAND treatments without focal point, especially in the case of large asymmetry.

We find that even when coordination is facilitated as in DEMAND-FOCAL, conflict becomes more likely if power asymmetry is increased (compare rows SMALL and LARGE in Figure 6). When suggesting a division, the conflict probability slightly increases in case of small asymmetry (from 26.9% to 32.0%) and slightly decreases in case of large asymmetry (from 53.2% to 51.2%); in both cases, however, the difference is statistically insignificant. Similarly, the effect on individual demands is only weak, even though average individual demands are slightly closer to the focal point (see Figure A.4 in Appendix A.6).<sup>32</sup> As in

<sup>31</sup>We ran this treatment for the case of small asymmetry and for the case of large asymmetry between players, each case with 72 subjects in total (9 independent observations each). Except for mentioning the possible division in the instructions and on the screen, the setup remains exactly as outlined in Section 3.2.

<sup>32</sup>This change in average individual demands is mainly driven by more individuals choosing a demand in the neighborhood of the focal point. This also implies that less individuals choose demands of 274 or 275



the DEMAND treatment without focal point (Result 5), individual demand is increasing in a player's relative fighting strength, with the differences being significant at the 1% level.

**Summary:** The results of the control treatments suggest that the increased conflict probability in case of an imbalance of power and endogenous demands can only partially be explained by coordination failure and the fact that an equal split as coordination device is less appealing. Rather, the increased conflict probability in DEMAND-LARGE may be linked to the individual heterogeneity observed. If players differ in some relevant characteristics, such as their subjective value of winning the contest or their perception of win probabilities in the conflict, this turns the Nash demand game into a game under incomplete information.<sup>33</sup> In line with the much higher variance of individual choices under large asymmetry, the individual perceptions of winning the conflict may be more dispersed if the asymmetry between players is increased.<sup>34</sup> A higher variance of the distribution of types is generally considered as leading to a higher likelihood of conflict when bargaining in the shadow of conflict (Reed 2003; Wittman 2009).<sup>35</sup>

## 6 Conclusion

We have studied whether a balance of power or an imbalance of power leads to a higher likelihood of conflict. As Wittman (1979) hypothesized, the distribution of power should not matter for the emergence of conflict if players can bargain about the peace dividend, taking into account their respective conflict strengths. Our experimental results provide a richer picture. The results support Wittman's hypothesis for the case of a simple bargaining mechanism that makes it easy for players to coordinate. If, however, the bargaining mechanism involves strategic uncertainty and coordination problems, then the balance of power matters: Higher asymmetries in fighting strengths make the problem of strategic uncertainty more severe. Consequently, higher asymmetry leads to a higher probability of bargaining failure and conflict.

In our baseline treatments, players decide whether or not to accept an exogenous division of the prize (implemented by the laboratory as a shortcut for the Nash bargaining solution). Disadvantaged players are more likely to reject the resulting division, leading to a positive

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when the focal point is introduced; this effect is strongest in case of small asymmetry.

<sup>33</sup>Note that incomplete information is much less of a problem in the SPLIT treatments where individuals have a strictly dominant strategy at stage 1 (their acceptance decision is independent of the co-player's choice).

<sup>34</sup>The histograms of individual demands in the DEMAND treatments in Appendix A.4 illustrate the higher variance of choices under large asymmetry compared to small asymmetry.

<sup>35</sup>Also compare Morrow (1989) on the role of misperceptions and incomplete information for the probability of war.

overall conflict probability. But a higher asymmetry between players does not significantly affect this overall conflict probability. If, instead, bargaining follows the rule of the Nash demand game, players have to balance their peaceful demands. In case of a small asymmetry between players, there is a tendency to split the prize evenly; successful 50-50 splits occur in about half of the cases. Even if stronger players do not consider it appropriate, an equal split may serve as a focal point and facilitate coordination in case power is almost balanced.

With larger asymmetry, however, the strategic uncertainty in the Nash demand game becomes more important, as players do no longer consider the 50-50 split as an option to solve the coordination problem. Although bargaining choices adjust to the relative fighting strengths, bargaining fails to reach a peaceful agreement in more than half of the cases, even when the Nash bargaining solution is suggested to the players as a possible allocation. If players find an agreement, some inefficiency emerges in that players are not successful in dividing the full prize between them but leave a share of the peace dividend on the negotiation table.

In line with subgame perfection, the higher a player's relative fighting strength, the more this player demands for himself in the bargaining stage. This is true even though the asymmetry of players stems from different marginal costs that only become relevant when players enter the contest in stage 2. Empirically, bargaining power is biased towards the player who is disadvantaged in the contest; with large asymmetry in fighting strength, successful bargaining outcomes allocate basically the entire peace dividend to the player with the higher fighting cost.

What does our experimental study tell us on how to avoid conflict between individuals? Our results underline the importance of bargaining rules: the institutional structure of bargaining. These institutional rules matter, even in a context of perfect information. Coordination or a possible failure to coordinate constitute a major efficiency problem. We expect this finding to be relevant in situations of distributional conflict that may turn into a fight or, more generally, into a scenario in which players choose resource-wasteful investments to influence an allocation decision. Such efficiency problems may be even more severe in a context of incomplete information. Then, bargaining behavior may have informational value because it serves as a signal of players' strengths. This implies additional strategic considerations and reputation concerns which may make players less willing to compromise. If the institutional bargaining environment involves strategic uncertainty, it may be difficult to agree even in a context of perfect information.

Our results also speak in favor of a mediator as an effective way to prevent resource-wasteful conflict in the presence of coordination problems. The treatments with the exogenous division mechanism effectively propose an "equitable" settlement. Such binding

third-party suggestions for settlement make the outbreak of a contest seemingly much less dependent of whether parties to the conflict are rather symmetric or asymmetric. This outcome depends, of course, on whether the conflicting parties perceive the proposed division as being in line with their relative fighting strengths. Information about the perceived fighting strengths as well as feasibility of the corresponding peaceful division becomes crucial for successful mediation. As our results show, if power is almost balanced, the bargaining game with endogenously chosen demands even leads to more efficient outcomes than the exogenous mediation proposal because endogenous divisions can be better adjusted to individual heterogeneity in unobservable characteristics.

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# A Appendix

## A.1 Theory prediction

Stage 1: bargaining shares			
		Player <i>A</i>	Player <i>B</i>
SPLIT	SMALL	$s_A = 305$	$s_B = 244$
	LARGE	$s_A = 427$	$s_B = 122$
DEMAND	SMALL	$s_A \in [169.4, 440.5]$	$s_B \in [108.4, 379.6]$
	LARGE	$s_A \in [332.1, 521.9]$	$s_B \in [27.1, 216.9]$

Stage 2: conflict behavior			
		Player <i>A</i>	Player <i>B</i>
Contest effort $x_i^*$	SMALL	33.9	27.1
	LARGE	47.4	13.5
Effort cost $c_i x_i^*$	SMALL	135.6	135.6
	LARGE	94.9	94.9
Expected conflict payoff $\pi_i^*$	SMALL	169.4	108.4
	LARGE	332.1	27.1

Note: SMALL: effort cost  $(c_A, c_B) = (4, 5)$ ; LARGE: effort cost  $(c_A, c_B) = (2, 7)$ . For SPLIT, stage 1 bargaining shares are outcomes of a Nash bargaining game with equal bargaining power. For DEMAND, stage 1 bargaining shares are choices in efficient equilibria of Nash demand game only. In the experiment, choice of shares in DEMAND and effort levels are restricted to integers.

Table A.1: Theory prediction for bargaining shares and conflict behavior.

## A.2 Regression analysis

A panel regression analysis confirms the findings of the non-parametric tests on the summary statistics. Table A.2 presents results of three sets of random-effects regressions: logistic regressions of the individual choice whether to reject the exogenous division in SPLIT and in SPLIT-50-50, respectively; Tobit regressions of the individual demand chosen in DEMAND and in DEMAND-FOCAL, respectively; and a Tobit regression of the individual effort choice in the stage 2 contest.<sup>36</sup> All regressions include an individual's effort cost parameter as the main independent variable, assuming for illustrative purposes a linear effect of the stage 2 effort cost. Moreover, we include socioeconomic information from the post-experimental questionnaire and a number of individual-specific control variables generated in post-experimental tests. The latter include measures of risk preferences and distributional preferences as well as a measure for ambiguity aversion (compare Section 3.2).

In line with the non-parametric tests, we find that higher effort cost leads to a significantly higher probability to reject the Nash bargaining solution in SPLIT but to a significantly lower probability to reject the equal split in SPLIT-50-50 (compare the first two estimations in Table A.2). Moreover, demand choices in the Nash demand game are significantly lower the higher the stage 2 effort cost; this effect is stronger in the DEMAND-FOCAL treatments where demands are closer to the Nash bargaining solution and hence more reactive to changes in the effort cost (see estimations 3 and 4 in Table A.2).<sup>37</sup> Finally, effort is significantly lower the higher a player's effort cost (see estimation 5 in Table A.2). The explanatory power of the individual-specific characteristics is mixed. For example, a higher willingness to take risks is positively correlated with the reject probability and the effort choice.

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<sup>36</sup>For simplicity the estimation of stage 2 effort choices pools the data from all treatments.

<sup>37</sup>Pooling the data from DEMAND and DEMAND-FOCAL and using an interaction model we find that the demand of the advantaged player significantly increases and the demand of the disadvantaged player significantly decreases when comparing DEMAND-FOCAL to DEMAND.

	Stage 1 (SPLIT or DEMAND)				Stage 2
	(1) SPLIT	(2) SPLIT -50-50	(3) DEMAND	(4) DEMAND -FOCAL	(5) pooled
Dependent variable	Choice of “reject”		Demand $s_i$ (in %)		Effort $x_i$
constant	-5.74*** (1.14)	-6.57*** (2.34)	72.5*** (5.50)	82.2*** (4.36)	60.3*** (6.58)
cost $c_i$	0.54*** (0.03)	-2.65*** (0.17)	-5.94*** (0.10)	-7.02*** (0.11)	-8.80*** (0.21)
risk_general	0.33*** (0.00)	0.36*** (0.14)	0.53 (0.43)	0.63** (0.31)	1.72*** (0.50)
risk_lottery	0.57*** (0.20)	0.83*** (0.31)	2.37** (1.06)	0.66 (0.71)	1.15 (1.15)
prosocial	0.03 (0.45)	0.39 (0.59)	-5.03** (2.11)	-2.71* (1.59)	-0.24 (2.45)
prosocialcostly	-0.17 (0.37)	-1.54*** (0.57)	2.45 (1.78)	1.36 (1.24)	-1.48 (2.04)
envy	0.21 (0.44)	1.07* (0.60)	-0.90 (1.84)	-1.46 (1.60)	-0.48 (2.36)
envycostly	0.34 (0.41)	-0.26 (0.64)	-2.58 (2.02)	-2.13 (1.57)	4.98** (2.40)
ambiguity_aversion	0.33 (0.33)	0.12 (0.55)	-1.52 (1.63)	1.99* (1.21)	-0.13 (1.88)
Socioeconomics	yes	yes	yes	yes	yes
Obs	4320	2160	4320	4320	5824

Note: Estimation (1) is a random-effects logistic regression of the rejection probability in SPLIT (144 individuals); Estimation (2) is a random-effects logistic regression of the rejection probability in SPLIT-50-50 (72 individuals); the dependent variable is equal to one if a subject chose rejection and 0 otherwise. Estimation (3) is a random effects Tobit regression of the share in DEMAND (144 individuals); Estimation (4) is a random effects Tobit regression of the share in DEMAND-FOCAL (144 individuals); the dependent variable is the percentage points demanded (truncated at 0 and 100). Estimation (5) is a random effects Tobit regression of stage 2 effort (truncated at 0; 503 individuals). Standard errors in parentheses. \*\*\*(\*\*, \*) significant at the 1% (5%, 10%) level. “Socioeconomics” controls for age, gender, field of study, semester and number of siblings. “risk\_general” is a self-reported measure for the willingness to take risk on an increasing scale from 0-10; “risk\_lottery” measures the number of investments in lotteries with different win probabilities (on a scale from 0-5). “prosocial”, “prosocialcostly”, “envy”, and “envycostly” are dummy variables indicating individual decisions in two-person allocation choices. “ambiguity\_aversion” is a dummy variable derived from the choice between lotteries with known vs. unknown win probabilities.

Table A.2: Regression of rejection probabilities, Nash demands, and conflict efforts.

### A.3 Payoffs conditional on whether bargaining was successful

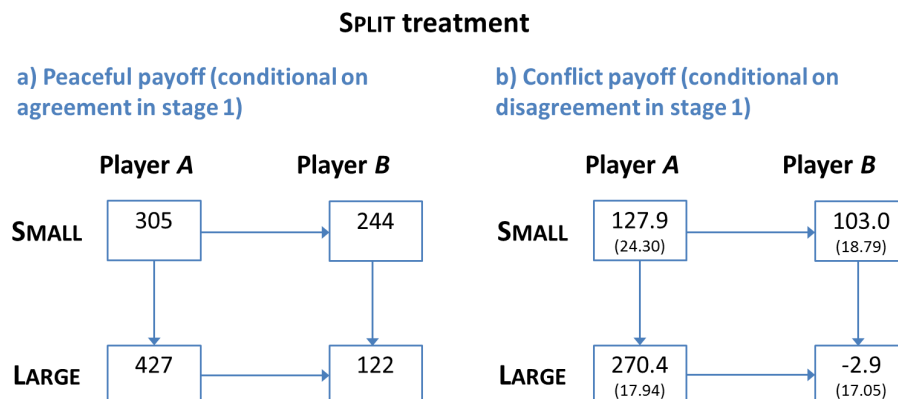


Figure A.1: Average payoffs in the SPLIT treatment.

Note: Calculated are mean and standard error (in parentheses) of payoffs in SPLIT if agreement has been reached in stage 1 (panel a) and if conflict takes place (panel b). Values based on matching group averages (8 subjects over 30 rounds per matching group).

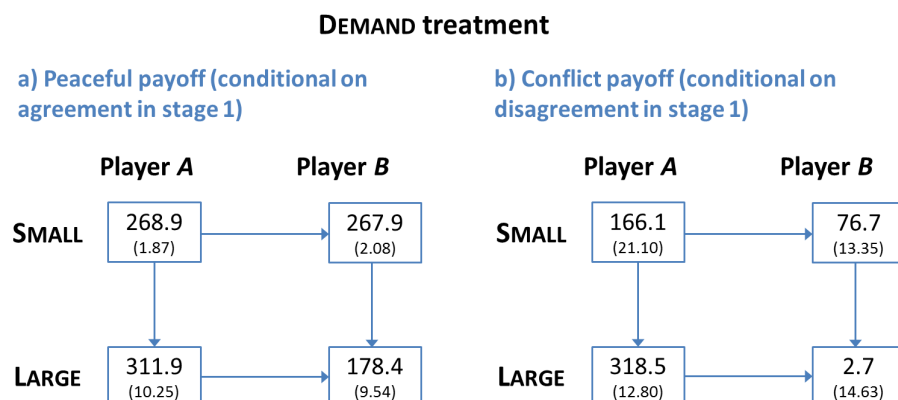
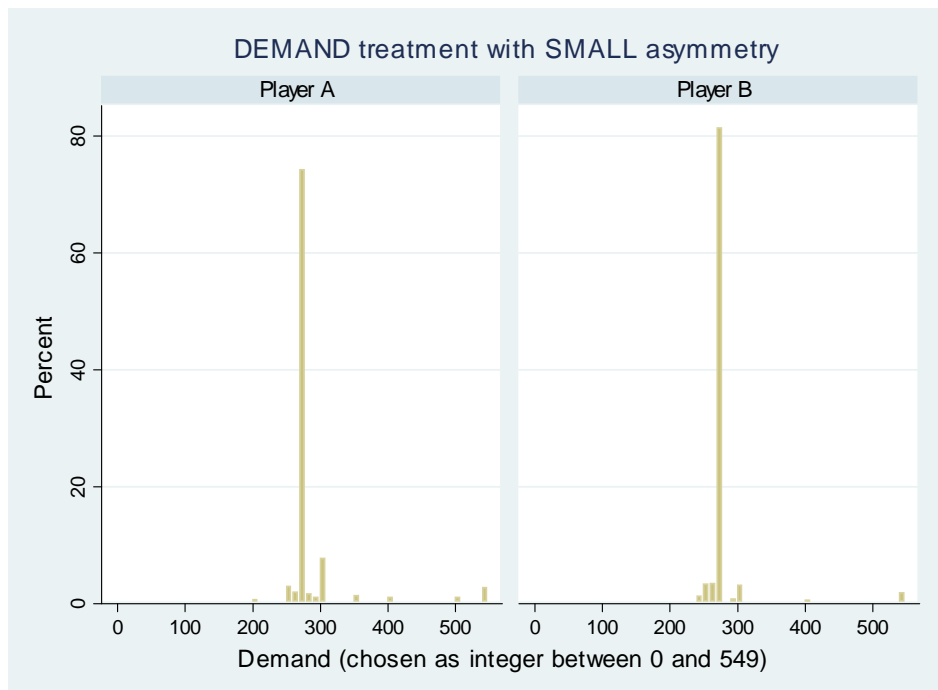


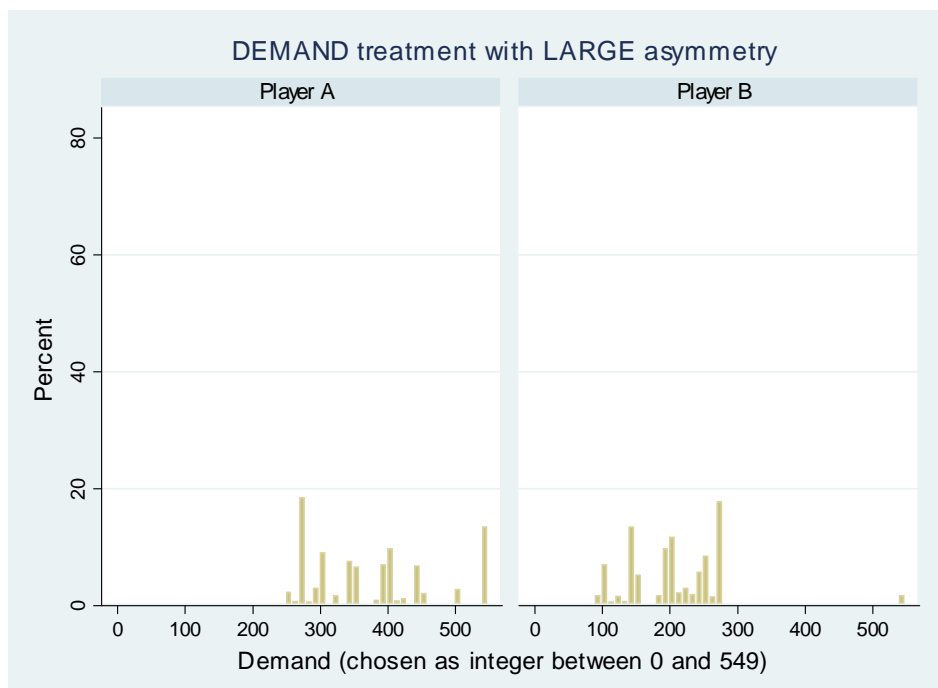
Figure A.2: Average payoffs in the DEMAND treatment.

Note: Calculated are mean and standard error (in parentheses) of payoffs in DEMAND if agreement has been reached in stage 1 (panel a) and if conflict takes place (panel b). Values based on matching group averages (8 subjects over 30 rounds per matching group).

## A.4 Distribution of individual demands (stage 1)



Histogram of stage 1 choices with SMALL asymmetry (by player A and B).



Histogram of stage 1 choices with LARGE asymmetry (by player A and B).

## A.5 Rejection probabilities in SPLIT 50-50 (stage 1)

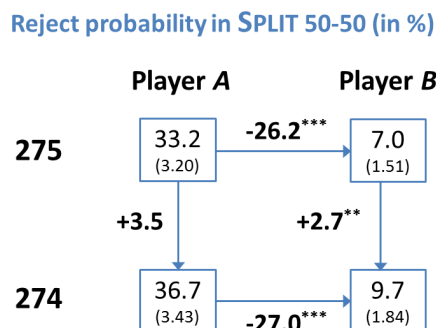


Figure A.3: Rejection probabilities in the SPLIT-50-50 treatment.

Note: Calculated are mean and standard error (in parentheses) of the probability that a player rejects the exogenous division in SPLIT-50-50, depending on whether the player is allocated 274 or 275 points in the exogenous division. Values based on matching group averages (8 subjects over 30 rounds per matching group). Differences are tested using Wilcoxon signed rank tests on the matching-group level (18 observations per test), \*\*\*(\*\*) significant at the 1% (5%) level.

## A.6 Demands in DEMAND and DEMAND-FOCAL (stage 1)

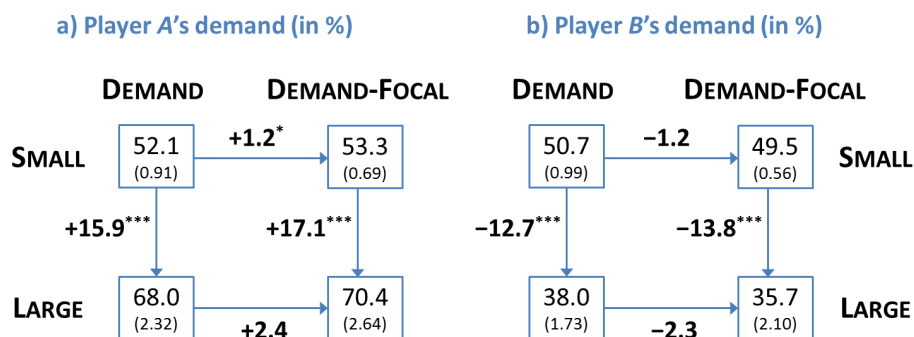


Figure A.4: Endogenous demands in the Nash demand game with and without focal point.

Note: Calculated are mean and standard error (in parentheses) of the demand (in % of the prize) for player A (panel a) and player B (panel B) in DEMAND-FOCAL (compared to DEMAND). Values based on matching group averages (8 subjects over 30 rounds per matching group). Differences between SMALL and LARGE and between DEMAND and DEMAND-FOCAL are tested using Mann Whitney U tests; tests on the matching-group level (18 observations per test), \*\*\*(\*) significant at the 1% (10%) level.

## B Experimental instructions<sup>1</sup>

**Welcome!** Please read the following instructions carefully and completely. Properly understanding them might help you to earn more money.

Your earnings in this experiment will be measured in Talers. At the end of the experiment we will convert the Talers you have earned to cash and pay you in private. For each 50 Talers you earn you will be paid 1 Euro in cash. In addition, each participant will receive a show-up-fee of 4 Euros.

Please keep in mind that you are not allowed to communicate with other participants during the entire experiment. If you do not obey this rule, you will be asked to leave the laboratory and will not be paid. Whenever you have a question, please raise your hand and we will help you.

**Your task** In the main part of today’s experiment, two participants each will make a decision on how to split 549 Talers. The two participants in such a pair are called “participant A” and “participant B”. The division of the 549 Talers between participant A and participant B takes place in several stages.

**Stage 1** <<version of the **SPLIT** treatment>> Both participants choose simultaneously and independently of each other whether they want to split the 549 Talers in the following way: A receives 305 Talers and B receives 244 Talers.

Subsequently, the choices of A and B are displayed on the screen.

- If both participants A and B decide in favor of the proposed split, then the 549 Talers are split as proposed and the division is completed.
- If both decide against the proposed split, then the division of the 549 Talers is decided in “stage 2.”
- If one of the two participants decides in favor of the proposed split and the other decides against it, then there will be a random draw: In 9 out of 10 cases, the division of the 549 Talers is decided in “stage 2,” and in 1 out of 10 cases, the 549 Talers will be split as proposed.

**Stage 1** <<version of the **DEMAND** treatment>> Each participant decides how many of the 549 Talers he/she wants to receive. To do so, both participants choose simultaneously and independently of each other an integer between 0 and 549, that is, 0, 1, 2, ..., 549.

Subsequently, the choices of A and B are displayed on the screen.

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<sup>1</sup>This section contains a translation of the set of instructions for the SPLIT and for the DEMAND treatment, both for the case of SMALL asymmetry. Note that the instructions in these two treatments only differ in subsection “Stage 1” and in subsection “Summary,” as indicated below.



- If the sum of the amounts chosen by A and B is smaller than or equal to 549, then both get exactly the amount (in Talers) they have chosen for themselves and the division is completed.
- If the sum of the amounts chosen by A and B is greater than 549, then the division of the 549 Talers is decided in “stage 2.”

**Stage 2** Stage 2 of the experiment will be reached only if the 549 Talers have not been divided in stage 1. In stage 2, the two participants A and B can buy “tokens.” Both participants A and B simultaneously and independently choose an integer as their respective number of tokens, that is, 0, 1, 2, 3, etc. These tokens decide who gets the 549 Talers. The more tokens a participant buys, the more likely it is that he gets the 549 Talers.

Buying tokens is costly. Participant A has to pay 4 Talers per token, and participant B has to pay 5 Talers per token. Hence, participant A pays less per token than does participant B.

After both participants have chosen how many tokens to buy, it will be displayed on the screen how many tokens A and B have bought. The computer assigns the 549 Talers to one of the participants. The probability that A gets the 549 Talers is exactly equal to the share of his tokens in the tokens bought by A and B together:

$$\text{Success probability of A} = \frac{\text{Tokens of A}}{\text{Tokens of A} + \text{tokens of B}}.$$

Participant B receives the 549 Talers with the corresponding probability:

$$\text{Success probability of B} = \frac{\text{Tokens of B}}{\text{Tokens of A} + \text{tokens of B}}.$$

If one of the two participants did not buy any Tokens, the other participant receives the 549 Talers. If none of the players bought any token, then each participant’s success probability is 50%.

Note that the more tokens a player buys, the more likely it is for him to get the 549 Talers in stage 2, but the more Talers have to be paid as cost of the tokens. On the computer screen it will be possible to compute the Talers to be paid for arbitrary choices of tokens. Moreover, you can compute success probabilities for any number of tokens potentially chosen by you and your co-player.

In the experiment the success probabilities are illustrated by a circular area on the screen. The area is divided into two colors: the red segment represents the success probability of A and the blue segment represents the success probability of B. An arrow on the circular area will first rotate and then stop randomly. Depending on where the arrow stops (in the red or the blue segment), A or B will get the 549 Talers.

**Summary** <<version of the SPLIT treatment>> The division of the 549 Talers between two participants A and B takes place in up to two stages.

- In stage 1, both A and B choose whether they want to split the 549 Talers as proposed by the laboratory.

- Stage 2 is reached only if the division was not completed in stage 1. If stage 2 is reached, both A and B can buy tokens. The number of tokens bought determines whether A or B gets the 549 Talers.

**Summary** <<version of the DEMAND treatment>> The division of the 549 Talers between two participants A and B takes place in up to two stages.

- In stage 1, both A and B choose how many Talers to receive for themselves.
- Stage 2 is reached only if the division was not completed in stage 1. If stage 2 is reached, both A and B can buy tokens. The number of tokens bought determines whether A or B gets the 549 Talers.

**Procedure** The main part of the experiment will consist of 30 identical and independent rounds. In each of these rounds, 549 Talers will be divided between two participants each, according to the rules described above.

In each round, the co-player will be randomly and newly assigned to you; hence, your co-player will typically vary across rounds. You will not know the identity of your respective co-player. Any attempt to reveal your identity is prohibited.

Furthermore, it will be randomly decided in each round whether you are participant A or participant B in this round. Hence, in each round, it will be randomly decided who (you or your co-player) is assigned the low (and the high, respectively) cost per token.

At the end of today's experiment, your Talers earned in 3 out of the 30 rounds will be added up and the cost for tokens possibly bought in these rounds will be deducted. The resulting amount will be converted to Euros (50 Talers = 1 Euro). The earnings of the other rounds will not be paid to you. For these other rounds, however, you do not have to pay the cost of tokens bought either. Which 3 out of the 30 rounds are relevant for your payoff will be determined only at the end of this experiment.

In addition, you receive 10 Euros that will be added to your earnings (gain or loss) in the 3 randomly selected rounds. On top of that you will receive the show-up-fee of 4 Euros. The resulting amount will be paid to you in cash.

Before the experiment starts, you will be asked some questions about the experiment on the screen. These questions should illustrate the rules of the experiment by means of different examples. After the experiment, you will be asked for some additional information. All the information you provide will be kept anonymous and strictly confidential.

We would like to thank you in advance for participating and wish you good luck!