Balance of power and the propensity of conflict*

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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

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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, Wagner 2000, Alsharabati and Kugler 2008, Chadefaux 2011; 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. 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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1 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 Tannen 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 parties to the conflict 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.2

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 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 agree-

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2This type of mediator is not a real player but acts more like a automated device. The survey by Kydd (2010) highlights that a mediator may have several roles and may also be a player with own objectives.
ment. 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. 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.

In all treatments, we observe a significant probability of resource wasteful conflict. Increasing the imbalance of power has no effect on the likelihood of conflict in case of the exogenous division mechanism. However, increasing the imbalance of power significantly increases the likelihood of conflict in case of endogenous demands. In case of an exogenous division, the disadvantaged player consistently rejects the proposed division more often than the advantaged player. In case of endogenous demands, the stronger a player’s disadvantage in the contest the lower is the peaceful share this player demands. 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. This suggests that with endogenous demands players are better able to implement divisions that reflect their subjective win probabilities. In other words, if power is balanced, exogenous mediation proposals even lead to more conflict than own demand choices in the negotiations. With large power asymmetry, the players’ total demands chosen are too high and the 50-50 split is no longer 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.

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

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3For 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.
when players are symmetric, concentrating on differences in the imposed discount factors of the future. Ke et al. (2014) 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 heterogenous 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 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 fighting for a prize in a contest. Two papers that consider asymmetries between players in a bargaining context are Anbarci and Fel-tovich (2013a, 2013b), 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, starting out with Shogren and Baik (1992);
for a recent survey on contest experiments see Dechenaux et al. (2012). 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.\footnote{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.} 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.\footnote{DeScioli and Wilson (2011) consider players who interact as avatars in a virtual environment and find that large avatars are not necessarily more likely to defeat small avatars.} 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 $B$. 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, as explained below. The players compete in a two-stage game about a prize that has monetary value $V$.

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.

Turn now to stage 2 that is reached if the players have failed to divide the prize peacefully in stage 1. 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.\footnote{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} 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 from conflict is equal to

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

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.** Consider first the **SPLIT** game. A division $(s_A, s_B)$ of the prize is exogenously proposed with $s_A$ being the solution to

$$\max_{s_A} (s_A - \pi_A^*)(V - s_A - \pi_B^*) = \frac{c_B}{c_A + c_B} V$$

(1)

The solution to (1) yields

Table 1: Characterization of the equilibrium.

<table>
<thead>
<tr>
<th>Effort $x_i^*$</th>
<th>Player $A$</th>
<th>Player $B$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\frac{c_B}{(c_A + c_B)^2} V$</td>
<td>$\frac{c_A}{(c_A + c_B)^2} V$</td>
<td></td>
</tr>
</tbody>
</table>

| Win probability $p_i^*$ | $rac{c_B}{c_A + c_B}$ | $\frac{c_A}{c_A + c_B}$ |

| Expected payoff $\pi_i^*$ | $(\frac{c_B}{c_B + c_A})^2 V$ | $(\frac{c_A}{c_B + c_A})^2 V$ |
\[(s_A, s_B) = \left( \frac{c_B}{c_A + c_B} V, \frac{c_A}{c_A + c_B} V \right) \tag{2} \]

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.\(^8\) The choice of this division rule has intuitive appeal, not only because it is the solution to (1).\(^9\)

For the experimental setup, we follow this rule and 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, a 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.\(^{10}\)

**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

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\(^8\)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 \((s_A, s_B)\).

\(^9\)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.

\(^{10}\)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.
**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.

Note: **Split**: exogenously proposed shares (Nash bargaining solution); **Demand**: Nash demand game.

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

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 \(V - s_A < \pi_B^*\) 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). 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. In the treatments with large asymmetry, we increase the cost spread to \(c_A = 2\) and \(c_B = 7\), keeping the average cost parameter constant. In all treatments, the prize value is equal to \(V = 549\). Table 2 summarizes the treatments.

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11Importantly, 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.

12Choosing 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.
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 3 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 four 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, the 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.\textsuperscript{13} 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.\textsuperscript{14} 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.\textsuperscript{15} 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

\textsuperscript{13}See appendix B for a sample of the instructions.
\textsuperscript{14}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.
\textsuperscript{15}In all treatments, in order to help subjects with computing winning probabilities, the lower part of the screen displayed a calculator. Subjects could enter hypothetical effort levels and compute the cost of effort and the probability of winning as often as they wished.
### Stage 1: bargaining shares

<table>
<thead>
<tr>
<th></th>
<th>Player $A$</th>
<th>Player $B$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Split</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>$s_A = 305$</td>
<td>$s_B = 244$</td>
</tr>
<tr>
<td>Large</td>
<td>$s_A = 427$</td>
<td>$s_B = 122$</td>
</tr>
<tr>
<td><strong>Demand</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>$s_A \in [169.4, 440.5]$</td>
<td>$s_B \in [108.4, 379.6]$</td>
</tr>
<tr>
<td>Large</td>
<td>$s_A \in [332.1, 521.9]$</td>
<td>$s_B \in [27.1, 216.9]$</td>
</tr>
</tbody>
</table>

### Stage 2: conflict behavior

<table>
<thead>
<tr>
<th></th>
<th>Player $A$</th>
<th>Player $B$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effort cost $c_i$</td>
<td>SMALL</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>LARGE</td>
<td>2</td>
</tr>
<tr>
<td>Contest effort $x_i^*$</td>
<td>SMALL</td>
<td>33.9</td>
</tr>
<tr>
<td></td>
<td>LARGE</td>
<td>47.4</td>
</tr>
<tr>
<td>Effort cost $c_i x_i^*$</td>
<td>SMALL</td>
<td>135.6</td>
</tr>
<tr>
<td></td>
<td>LARGE</td>
<td>94.9</td>
</tr>
<tr>
<td>Expected conflict payoff $\pi_i^*$</td>
<td>SMALL</td>
<td>169.4</td>
</tr>
<tr>
<td></td>
<td>LARGE</td>
<td>332.1</td>
</tr>
</tbody>
</table>

Note: Shares proposed in **Split** are outcomes of a Nash bargaining game with equal bargaining power. For **Demand**, shares are choices in efficient equilibria only. In the experiment, choice of shares in **Demand** and effort levels are restricted to integers.

Table 3: Theory prediction for bargaining shares and conflict behavior.
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 characteristics 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 the peaceful 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.16

The two approaches lead to two competing hypotheses:17

16 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.

17 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.
**Hypothesis 1a (Wittman):** The likelihood of conflict is independent of whether players are almost symmetric (Small) or asymmetric (Large) in terms of fighting strengths.

**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 3 shows that the 50-50 split of the prize is not an equilibrium in case of large asymmetry (A should rationally demand at least $\pi_A^* = 333 > 549/2$). Hence, 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.\(^\text{18}\) 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 and LARGE, then the hypothesis might no longer be fulfilled.

\(^{18}\) A considerable amount of theory and empirical evidence supports this hypothesis. Seminal work is by Hirsch (1976) and Frank (1984a, 1984b, 1985a, 1985b).
concerns. This is most evident for the case of ordinal relative standing preferences. The disadvantaged player $B$ can reverse the payoff ranking only by entering into the contest. 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 3). 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 2013a,b). 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. Moreover, 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 analyze average choices at the bargaining and the conflict stage. The analysis in Sections 5.1 - 5.3 is based on non-parametric tests, while the results in Section 5.4 are based on a regression analysis of individual-level data.

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19 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.

20 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 is the average probability that a game proceeds to the contest stage (panel a) and the average total payoffs of A and B (panel b). Standard errors in parentheses (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 demands.

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.

5.2 Stage 1 decisions

5.2.1 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 2. 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.\(^{21}\) This effect is particularly strong when comparing the advantaged player A and the disadvantaged player B, both for small and for large asymmetry.\(^{22}\)

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\(^{21}\) Recall that, in Figure 2a, the exogenous share offered to the players becomes lower when moving clockwise from A-LARGE to A-SMALL to B-SMALL to B-LARGE.

\(^{22}\) Since the roles of subjects were randomly assigned in each round, the observations of behavior as player A and B are not independent. Therefore, we use the Wilcoxon signed rank test to test differences between
Figure 2: Probability of rejection of the exogenous split and endogenous demands in the Nash demand game.

Note: The numbers show the average probability that a player rejects the exogenous division in SPLIT (panel a) and the average demand (as % of the prize) in DEMAND (panel b). Standard errors in parentheses (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% level.

**Result 3** The rejection probability is higher for the disadvantaged player than for the advantaged player.

The result on the higher rejection probability of disadvantaged players is in line with preferences on relative standing.\(^{23}\)

### 5.2.2 On sharing in the DEMAND treatments

The right panel of Figure 2 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.\(^{24}\) 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).

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\(^{23}\) 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.

\(^{24}\) In Figure 2b, relative fighting strength decreases clockwise from A-LARGE to A-SMALL to B-SMALL to B-LARGE.
Result 4 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 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. 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 a successful 50-50 split was achieved in less than 1% of the observed pairs (compared to 46% in Small). Given that the 50-50 split loses its property as a focal point in the case of a large asymmetry, coordination becomes seemingly more difficult. Figures 3 and 4 depict the distributions of bargaining outcomes with Small and Large asymmetry, separately for compatible and incompatible demand choices.

More specifically, consider the players’ actual payoff if they can reach a peaceful division in stage 1. In Small, conditional on bargaining being successful, A receives 269.4 points and B receives 268.6 points (see Figure 7a in the appendix) and, hence, almost the same payoff. Players may 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. If they consider the case with a small asymmetry as a basically symmetric situation, the asymmetric exogenous division in Split-Small (305 for A and 244 for B) may be seen as too asymmetric, and this may be the reason for the higher conflict rates in Split compared to Demand if power is almost balanced (recall Result 2). In any case, the results suggest a correlation between the subjective fighting strengths and the peaceful sharing rule that is considered appropriate.

With an imbalance of power in Large, successful peaceful agreements in Demand allocate 311.3 points to the advantaged player and 179.0 points to the disadvantaged player (see again Figure 7a in the appendix). Upon peaceful division, the advantaged player A ends

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25 For the distribution of individual demand choices see the figures in Appendix A.2.

26 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.)

27 Also compare Anbarci and Feltovich (2013b) who observe that outcomes crucially depend on whether the 50-50 split is a viable split.

28 These shares in successful agreements are considerably below the players’ average demands in Large (Figure 2b). Further indication that coordination is more difficult to obtain 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 3: Stage 1 demands \((s_A, s_B)\) with SMALL asymmetry; the dashed lines are the average observed conflict payoffs.

Figure 4: Stage 1 demands \((s_A, s_B)\) with LARGE asymmetry; the dashed lines are the average observed conflict payoffs.
up with an average share that is even slightly lower than his empirically observed average conflict payoff (which is 318.3; see Figure 7b 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 1.3 and, hence, even much less than predicted by theory). Thus, in the Nash demand game with large asymmetry, on average, 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 5**  
(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. If bargaining is successful, the division of the peace dividend (bargaining surplus) is biased in favor of the disadvantaged player.

A peaceful outcome is more likely if the asymmetry in fighting strengths of the two players is small. 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. We turn to the results on rent dissipation in the conflict in the next section.

5.3 Stage 2 decisions: on fighting

Consider individual choices in the contest if the players cannot peacefully split the prize in stage 1. Figure 5 summarizes individual effort levels in the stage 2 contest.\(^{29}\) 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.\(^{30}\) Second, from Figure 5, we can directly compute the effort 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 (159.1) than with a large asymmetry (140.8). Similarly, with endogenous demands in Demand, total effort cost with a small

\(^{29}\)In all treatments, there is overdissipation, which is a standard result in experimental contests.

\(^{30}\)The decrease in effort for player $B$ with large asymmetry is weaker for Split than for Demand; in the latter treatment, since the contest stage is reached more often, learning is facilitated. This may explain the difference.
Figure 5: Effort choice $x_i$ in the stage 2 contest.

Note: Calculated is the average effort level conditional on reaching the contest in stage 2. Standard errors in parentheses (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%, 10%) level.

asymmetry is higher (153.1) than with a large asymmetry (113.9). The difference in rent dissipated between SMALL and LARGE 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 6** 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.

### 5.4 Regression analysis

A panel regression analysis confirms the findings of the non-parametric tests on the summary statistics. Table 4 presents results of three random-effects regressions: (1) a logistic regression of the individual choice whether to reject the exogenous division in SPLIT, (2) a Tobit regression of the individual demand chosen in DEMAND, and (3) a Tobit regression of the individual effort choice in the stage 2 contest. All regressions include an individual’s effort cost parameter as the main independent variable (assuming for simplicity a linear effect of

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31 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.

32 Estimation 3 pools stage 2 effort levels from both the SPLIT and the DEMAND treatment.
<table>
<thead>
<tr>
<th></th>
<th>Stage 1 (SPLIT or DEMAND)</th>
<th>Stage 2</th>
</tr>
</thead>
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<tr>
<td><strong>Dependent variable</strong></td>
<td>Choice of &quot;reject&quot;</td>
<td>Demand $s_i$ (in %)</td>
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<td><strong>constant</strong></td>
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<td>72.5***</td>
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<td></td>
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<td><strong>cost $c_i$</strong></td>
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<td><strong>Nash_Demand</strong></td>
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<td>(=1 if DEMAND treatment)</td>
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<td>(2.29)</td>
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<td><strong>risk_general</strong></td>
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<td>0.533</td>
</tr>
<tr>
<td></td>
<td>(0.089)</td>
<td>(0.434)</td>
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<tr>
<td><strong>risk_lottery</strong></td>
<td>0.556***</td>
<td>2.37**</td>
</tr>
<tr>
<td></td>
<td>(0.198)</td>
<td>(1.06)</td>
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<tr>
<td><strong>prosocial</strong></td>
<td>0.027</td>
<td>-5.03**</td>
</tr>
<tr>
<td></td>
<td>(0.446)</td>
<td>(2.11)</td>
</tr>
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<td>(1.78)</td>
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<td><strong>ambiguity_aversion</strong></td>
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<td></td>
<td>(0.327)</td>
<td>(1.63)</td>
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</tr>
<tr>
<td><strong>Obs</strong></td>
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</tr>
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</table>

Note: Estimation (1) is a random-effects logistic regression of the rejection probability in SPLIT (144 individuals); the dependent variable is equal to one if a subject chose rejection and 0 otherwise. Estimation (2) is a random effects Tobit regression of the share in DEMAND (144 individuals); the dependent variable is the percentage points demanded (truncated at 0 and 100). Estimation (3) is a random effects Tobit regression of stage 2 effort (truncated at 0; 287 individuals). Standard errors in parentheses. ***(***) significant at the 1% (5%) 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 4: Regression of rejection probabilities, Nash demands, and conflict efforts.
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 a larger disadvantage (marginal effort cost) leads to a significantly increased probability to reject the exogenous split (column 1 in Table 4) and to a significantly lower demand choice in the Nash demand game (column 2 in Table 4). Moreover, we find that effort is significantly lower if a player is more disadvantaged (column 3 in Table 4). In terms of individual-specific characteristics, we find that the more risk loving a subject is, the higher is the probability of rejection in Split and the share demanded in Demand and the higher is the contest effort. Across the three estimations in Table 4, the explanatory power of the measures for distributional preferences is mixed.33

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 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 coordination more difficult. 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 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. An even split may serve as a focal point in this case and facilitate coordination. With larger asymmetry, however, the strategic uncertainty in the Nash demand

33 Allocation decisions characterized as pro-social behavior lead to significantly lower demands in the Nash demand game, and "envy" causes efforts in the stage 2 contest to be significantly higher; the other included variables are not significant. Among the socio-economic variables, the probability to accept the exogenous split is significantly higher for older subjects and the more siblings a subject has.
game becomes 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. 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.

From a game-theoretic point of view, our results suggest that players use backward induction. 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 reputational concerns which may make players less willing to compromise. But even a context of perfect information can make it difficult to agree if the institutional bargaining environment involves strategic uncertainty.

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 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. Hence, 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 the players’ subjective relative conflict strength.
Appendix

A.1 Average payoffs conditional on whether bargaining was successful

Figure 6: Average payoffs if a peaceful agreement has been reached in stage 1 (panel a) and if conflict takes place (panel b): SPLIT treatment with the exogenous division mechanism.

Figure 7: Average payoffs if a peaceful agreement has been reached in stage 1 (panel a) and if conflict takes place (panel b): DEMAND treatment with the Nash demand game.
A.2 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).
References


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 Taler 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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1 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 Taler 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 A. 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!