

# **Resources for Conflict: Constraint or Wealth?**

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## **Abstract**

We investigate the effects of the availability of resources that can be expended in conflict on conflict intensity. We run a between-subjects Tullock contest in which we vary the contest budget from Low to Medium to High, while keeping the Nash equilibrium bid the same. We find an 'inverted U-shaped' relationship between resource availability and conflict intensity. While standard error correction models can explain the first part of the relationship by attributing resources as constraint, they do not apply in the latter part. We further run a Wealth treatment in which the budget remains Medium, but a fixed payment independent of the contest outcome is provided. The level of conflict in the Wealth and the High treatment are not different, implying a wealth effect through available resources. We conclude that the resources for conflict can have both a constraint as well as a wealth effect. When initial resources are scarce, they act as a constraint. As more resources become available the constraint loosens up and conflict intensity increases. However, when resources are abundant, they are viewed as wealth and conflict intensity decreases. Hence, the availability of additional resources reduces the marginal benefit from winning as well as conflict intensity.

## **JEL classification codes**

C72, C91, D72, D74.

## **Keywords**

Conflict, experiment, wealth effect, resource constraint.

# Resources for Conflict: Constraint or Wealth?

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## Abstract

We investigate the effects of the availability of resources that can be expended in conflict on conflict intensity. We run a between-subjects Tullock contest in which we vary the contest budget from Low to Medium to High, while keeping the Nash equilibrium bid the same. We find an ‘inverted U-shaped’ relationship between resource availability and conflict intensity. While standard error correction models can explain the first part of the relationship by attributing resources as constraint, they do not apply in the latter part. We further run a Wealth treatment in which the budget remains Medium, but a fixed payment independent of the contest outcome is provided. The level of conflict in the Wealth and the High treatment are not different, implying a wealth effect through available resources. We conclude that the resources for conflict can have both a constraint as well as a wealth effect. When initial resources are scarce, they act as a constraint. As more resources become available the constraint loosens up and conflict intensity increases. However, when resources are abundant, they are viewed as wealth and conflict intensity decreases. Hence, the availability of additional resources reduces the marginal benefit from winning as well as conflict intensity.

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# 1. Introduction

Conflicts, in which individuals or groups “*try to hamper, disable, or destroy rivals*” (Hirshleifer, 1995), are ubiquitous. Some examples are warfare, civil disputes, ethnic clashes, terrorism and defense, gang fights, litigation and rent-seeking. Agents make sunk investments of resources in the conflict in order to win a reward which can be winning a war, gaining prestige or taking revenge, to name a few. The availability of such resources is arguably one of the most important elements that determines the intensity of conflicts. Intuitively, the lack of availability of sufficient resources would restrict conflict and as more resources become available, conflict intensity may go up. One way to model conflict is to use standard contest theory models (see Konrad, 2009). In the basic model, conflict intensity is not expected to change with changes in available resources, as long as such resources are above equilibrium conflict intensity.

However, it is seen in the experimental laboratory that resource availability may affect behavior in a variety of situations such as altruism (Chowdhury and Jeon, 2012), cooperation and punishment (Kocher et al., 2008), and risky choices (Bosch-Domènech and Silvestre, 2006). Here we experimentally investigate the effects of resource availability on the intensity of conflict. We find an inverted U-shaped relationship between resource availability and conflict intensity and argue that it is caused by two different effects, each of which is monotonic, but of different sign and size.

The theoretical literature finds a negative relationship between resource availability and conflict intensity. In competition for political influence, Becker (1983) finds that smaller (thus, with lower resources) groups are more aggressive, and therefore more successful. Hirshleifer (1991) is one of the earliest scholars to draw attention to this issue in a contest setting. When players can expend resources on either productive or conflictive activities, he shows that the player with a lower level of resources may expend more on conflict and earn a higher share of the exploit. He terms this phenomenon as the ‘Paradox of Power’. Durham et al. (1998) finds support for this phenomenon in a laboratory experiment. In a setting in which production is not an option, Che and Gale (1997, 1998) show theoretically that restricting the availability of resources may result in a higher level of conflict. Recently, Schroyen and Treich (2013) show that an increase in available resources has two opposing effects. On the one hand, it reduces the marginal cost of expending resources, which encourages conflict. On the other, it reduces the marginal benefit of winning, which discourages conflict. This, in spirit, is supported by Miguel et

al. (2004) who find that a negative income shock (in terms of lack of rainfall) raises conflict intensity in sub-Saharan Africa. Ciccone (2011), however, employs an alternative empirical method and finds no such relationship.

Though a systematic investigation of the effects of resource availability has not been the focus of studies, the experimental literature, on the other hand, has observed a positive effect of resource availability on conflict intensity. Sheremeta (2013) and Morgan et al. (2012) document the general observation that overbidding<sup>1</sup> increases with increases in resources relative to prize value. In closely related work, Price and Sheremeta (2011) find a higher level of conflict when the resources for 20 periods of conflict are given at the start compared to giving them over the 20 periods. Sheremeta (2010, 2011) observe a decrease in conflict due to a decrease in resources but do not test the statistical significance of the effect. Sheremeta (2011) attributes this to the judgment errors of the subjects and employs the Quantal Response Equilibrium (McKelvey and Palfrey, 1995) model to explain the same. He notes that “*when subjects have large endowments then their mistakes are more likely to result in over-dissipation, whereas small endowments are more likely to result in under-dissipation*” (pp. 582).<sup>2</sup>

These experimental studies have focused on very different issues such as multi-stage games (Sheremeta, 2010) and multi-prize games (Sheremeta, 2011), and were not designed to test the effects of resource availability. As a result, observations of correlations between resource availability and bids are incidental and are not tested statistically. Further, existing experimental studies focus on a subset of the parameter space. In particular, the resources available to subjects in contest experiments are typically lower than or equal to the prize value.<sup>3</sup> Thus, the reasons for this divergence between theoretical predictions and experimental observations are still not well understood.

Since conflicts are an integral and often unavoidable part of human life, it is necessary to understand the reasons behind, and the behavioral underpinnings of, the intensity of conflict. In this study we investigate the issue of resource availability for the first time with a specifically designed laboratory experiment. We find that both sides of the argument have merit. When

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<sup>1</sup> There is a large body of evidence on overbidding relative to the equilibrium in contest experiments. This phenomenon is attributed to many possible reasons such as player heterogeneity (Herbst et al., 2014), bounded rationality (Sheremeta, 2011), joy of winning (Sheremeta, 2010), lack of understanding of probability etc. See Dechaunax et al. (2012) and Sheremeta (2013) for surveys on this issue.

<sup>2</sup> Although several studies in contest experiments term the resources as ‘endowment’, we refrain from doing so in order to avoid any confusion with the psychological endowment effect (Thaler, 1980; Kahneman et al., 1991).

<sup>3</sup> An exception is Millner and Pratt (1989) where subjects receive more than the prize value. However, they examine the impact of different contest success functions and do not consider the issue of resource availability.

resources are scarce, they act as a constraint and an increase in resources results in a higher level of conflict. But when resources are abundant, then they are viewed as wealth and a further increase in resources results in a lower level of conflict. Thus, our study serves to reconcile the two sides of the debate.

The rest of the paper is organized as follows. In Section 2 we provide a theoretical benchmark for the experiment. Section 3 elaborates the experimental procedures and Section 4 reports the results. Section 5 concludes.

## 2. Theoretical benchmark

We consider a rent-seeking contest (Tullock, 1980) with  $N$  identical risk-neutral players each with budget  $E$  that they can use in the contest. They each also hold wealth,  $F$ , that cannot be used in the contest. Player  $i$ , for  $i = 1, 2, 3, \dots, N$ , chooses his bid,  $b_i \in [0, E]$ , to win a prize of common value  $V > 0$ . There is no prize for the losers and irrespective of the outcome of the contest players forgo their bids. The probability that player  $i$  wins the prize,  $p_i(b_i, \mathbf{b}_{-i})$ , is represented by a lottery contest success function:

$$p_i(b_i, \mathbf{b}_{-i}) = \begin{cases} b_i / \sum_j b_j & \text{if } \sum_j b_j \neq 0 \\ 1/N & \text{otherwise} \end{cases} \quad (1)$$

That is, the probability of winning depends on player  $i$ 's own bid relative to the sum of all players' bids, where  $\mathbf{b}_{-i}$  is the vector of bids by all players other than player  $i$ . Given (1), the expected payoff for player  $i$ ,  $E(\pi_i)$ , can be written as

$$E(\pi_i) = F + p_i V + (E - b_i). \quad (2)$$

The existence and uniqueness of the equilibrium for this game are proved by Szidarovszky and Okuguchi (1997). Following standard procedures, the unique symmetric interior Nash equilibrium bid is<sup>4</sup>

$$b^* = (N - 1)V/N^2, \quad (3)$$

and the equilibrium payoff is

$$\pi^* = F + E + V/N^2. \quad (4)$$

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<sup>4</sup> We assume that the budget is large enough, i.e.,  $E \geq (N - 1)V/N^2$ , which we ensure in the experimental design.

Note that the equilibrium bid in (3) does not depend on individual budget ( $E$ ) or wealth ( $F$ ), but only on the value of the prize ( $V$ ) and the number of competing players ( $N$ ). Hence, as long as  $E > b^*$ , the equilibrium bid remains unchanged for any level of wealth,  $F$ . We design our experiment to test this particular property of the equilibrium.

### 3. Experimental procedure and hypotheses

To understand the effects of resource availability on conflict intensity, we run three treatments in which we vary the resources available, i.e., the contest budget ( $E$ ), while keeping the equilibrium bid fixed. In each treatment the contest is repeated for 25 periods. In the ‘Low’ treatment, each subject is given 90 tokens per period from which he can bid for a prize. In the ‘Medium’ treatment the budget available per period is 180 tokens whereas in the ‘High’ treatment it is 540 tokens. In each of these treatments players receive no lump-sum payment, i.e.,  $F = 0$ . In all these treatments, players can enter bids up to one decimal place. While players compete in each of 25 rounds, they are paid their earnings in the average of five of these rounds chosen randomly. All subjects in a session are paid for the same five rounds.

In all treatments, three players compete for a prize of 180 tokens, i.e.,  $N = 3$  and  $V = 180$ . Hence, the equilibrium bid ( $b^*$ ) per period is 40 tokens in all treatments and it remains the same in finite repetitions of the one-shot game. Table 1 summarizes the treatment details.

**Table 1. Summary of Treatments**

Treatment	Budget / period ( $E$ )	Fixed Fee ( $F$ )	Players / group ( $N$ )	Prize value ( $V$ )	Eqbm bid ( $b^*$ )	Total no. of subjects
Low	90	0	3	180	40	54
Medium	180	0	3	180	40	54
High	540	0	3	180	40	51

The experiment was computerized using z-Tree (Fischbacher, 2007) and was run in a laboratory of the Centre for Behavioural and Experimental Social Science at the University of East Anglia. The subjects were students at the University and were recruited through the online recruiting system ORSEE (Greiner, 2004). We employed a fixed matching protocol, i.e., in each session three subjects were matched into one group of contestants and the matching did not

change in a session. This was made clear in the instructions, a copy of which is included in the Appendix. We ran three sessions for each treatment with 15 or 18 subjects in a session.<sup>5</sup>

Each subject participated in only one of the sessions and did not participate in any contest experiment before. They might have participated in other economics experiments. Before the contest part, a risk elicitation task *a la* Eckel and Grossman (2008) based on Binswanger (1981) was also run, but the outcome of the task was not revealed until the end of the experiment. Instructions were read aloud by an experimenter, after which subjects answered a quiz before proceeding to the experiment. Before the payment was made, subject demographic information (such as age, gender, study area), and information about their experience in economics experiments were collected through an anonymous survey. Each session took around 1 hour. At the end of each session the token earnings were converted to GBP at the rate of 1 token to 3 Pence. Subjects, on average, earned £13.41.

We denote bids in treatment  $i$  as  $b^i$ , where  $i = L, M, H$ ; i.e., Low, Medium, High. Our hypotheses are given below.

**Hypothesis 1 (Theory).** The observed bids are the same across treatments and are equal to the equilibrium bid, i.e.,  $b^L = b^M = b^H = 40$ .

An alternative hypothesis for this comes from the existing studies that robustly observe overdissipation. Hence, an alternative hypothesis is that there is overbidding in all treatments.

Furthermore, Sheremeta (2010, 2011, 2013) observe an increase in bids when the available resources are increased. These studies employ QRE to state that larger resources are correlated with higher level of mistakes and as a result higher bids. Hence, this explanation essentially interprets resources as constraints. Combining these, we state the second hypothesis.

**Hypothesis 2 (Constraint).** Bids increase with the availability of resources, i.e.,  $b^L \leq b^M \leq b^H$ .

However, the arguments in Hirshleifer (1991), Becker (1988) and Miguel et al. (2004) suggest that subjects with lower levels of resources will have a higher incentive to engage in conflict. This, according to Schroyen and Treich (2013), is because resources are similar to

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<sup>5</sup> Due to lower than expected show-up, a session in the High treatment had only 15 subjects. Hence, we have 18 triples for the Low and the Medium treatments and 17 triples for the High treatment. Given the partner matching design, each triple produces one independent observation.

wealth and an increase in resources implies a reduction in marginal benefit of winning. Hence, the third hypothesis would be the following.

**Hypothesis 3 (Wealth).** Bids decrease with the availability of resources, i.e.,  $b^L \geq b^M \geq b^H$ .

In the following section we test each of the competing hypotheses.

## 4. Results

We proceed by reporting descriptive statistics of bids by subject triples (3-subjects groups), averaged over the 25 periods. We do so since a subject triple constitutes an independent observation. Table 2 presents the summary statistics of individual bids across all rounds in each treatment. At first glance it can be observed that the average bids in all treatments are over the equilibrium prediction of 40. Moreover, bids are lower in the Low and High treatments with average bids of 48.084 and 49.11 respectively, compared to 61.184 in the Medium treatment.

**Table 2. Summary statistics of individual bids per treatment**

Treatment	Independent Observations	Mean	Standard Deviation	Minimum	Maximum
Low	18	48.084	9.459	28.981	62.46
Medium	18	61.184	18.177	18.764	89.109
High	17	49.110	18.556	19.727	85.317

Next we test the observations from Table 2 that bids in all three treatments are greater than the equilibrium bid of 40. The p-values for non-parametric Mann-Whitney Wilcoxon signed rank (z) tests are 0.0038, 0.0012 and 0.0846 for the Low, Medium and High treatments respectively. The tests confirm overbidding in all treatments, though to a lesser extent in the High treatment. This gives our first result reaffirming the findings in the existing literature.

**Result 1.** There exists significant overbidding in all three treatments.

In terms of dispersion, since the strategy space is smaller in the Low treatment compared to the High and the Medium treatment, the standard deviation in the Low treatment is also smaller. In terms of levels, we investigate whether the bids are different across treatments. A Kruskal-Wallis test confirms difference in bids across treatments (chi-sq with 2 df = 7.443, p =



0.0242). Since both Hypotheses 2 and 3 suggest weak inequality, this could support either hypothesis. Hence, we now test for differences in bids between pairs of treatments. Table 3 reports the results from Mann-Whitney Wilcoxon rank-sum tests. It shows that the bids in the Medium treatment are significantly different from bids in both High and Low treatments, but that the bids in the latter two treatments are not significantly different from each other.

**Table 3. Pairwise non-parametric (Wilcoxon rank-sum) tests**

Comparison	z-stat	p-value
Medium vs. Low	-2.753***	0.0059
Medium vs. High	1.914*	0.0556
Low vs. High	0.165	0.8689

We further run one-sided tests to check if bids in the Medium treatment are indeed higher than the ones in other treatments. The results confirm this with a stronger p-value for Medium vs. High ( $p = 0.0269$ ). To summarize, bids in the Medium treatment are different (and higher) than bids in the other two treatments. This is reported in the following result.

**Result 2.** Conflict resources have a non-monotonic effect on the resulting conflict intensity. With an increase in resources, conflict intensity first increases, and then decreases.

Result 2 implies that both Hypotheses 2 and 3 do not generalize for the entire parameter space. As shown in Sheremeta (2011), error corrections models such as QRE can explain the initial increase in bids from Low to Medium. However, a decrease in bids due to an increase in the available resources cannot be explained with such models, as they essentially predict a weak increase in bids with an increase in available resources. . Similarly, the hypothesis that players with lower resource levels engage in greater conflict is also not supported by a comparison of the Low and Medium treatments, but is supported by a comparison of the Medium and High treatments.

The main difference between the existing literature and our treatments is that in the Low treatment the available resources are lower than the prize value whereas in the High treatment they are sufficiently higher than the prize value. Hence, an explanation for the increase in their bids is that the players incur overdissipation by mistake but are constrained by their lack of

resources in the Low treatment. When there are sufficient resources available in the Medium treatment, the constraint is relaxed and subjects raise their bids. Furthermore, according to Schroyen and Treich (2013), an increase in resources may have a wealth effect that reduces the incentive to bid. Hence, when the budget is abundant in the High treatment, it is viewed as wealth and players bid less.

To investigate the existence of a possible wealth effect on the decision to expend resources in a more concrete manner, we introduce one further treatment titled the ‘Wealth’ treatment. This treatment is identical to the ‘Medium’ treatment except that the subjects were given a fixed fee of 360 tokens which is independent of, and in addition to, the payoffs earned otherwise in the session. This was made clear in the instruction. There were 18, 18 and 15 subjects in the three sessions of this treatment. The details of the treatment are included in Table 4 along with the Medium treatment.

**Table 4. Wealth Treatment**

Treatment	Budget / period ( $E$ )	Fixed Fee ( $F$ )	Players / group ( $N$ )	Prize value ( $V$ )	Eqbm bid ( $b^*$ )	Total no. of subjects
Medium	180	0	3	180	40	54
Wealth	180	360	3	180	40	51

We expect bidding behavior to be the same in the High and Wealth treatments since subjects in both treatments receive the same amount of extra resources, over and above the budget in the Medium treatment. This will also support our hypothesis that subjects perceive resources in the High treatment as wealth. Further, since, as in the Medium treatment, the budget per period is the same as the prize value, this treatment will also control for any possible ‘focality’ that the subjects might have in the Medium treatment.

It turns out that the average bid in the Wealth treatment is 53.165 with standard deviation 12.819. The minimum and maximum (average) individual bids in the Wealth treatment in a period are 24.913 and 71.453 respectively. Comparing this information with Table 2 (which shows that the average bids in the Low, Medium and High treatments are 48.084, 61.184, and 49.110) it indeed appears that the average bids are similar in the High and the Wealth treatments.

**Figure 1. Average individual bids by treatment and by periods**

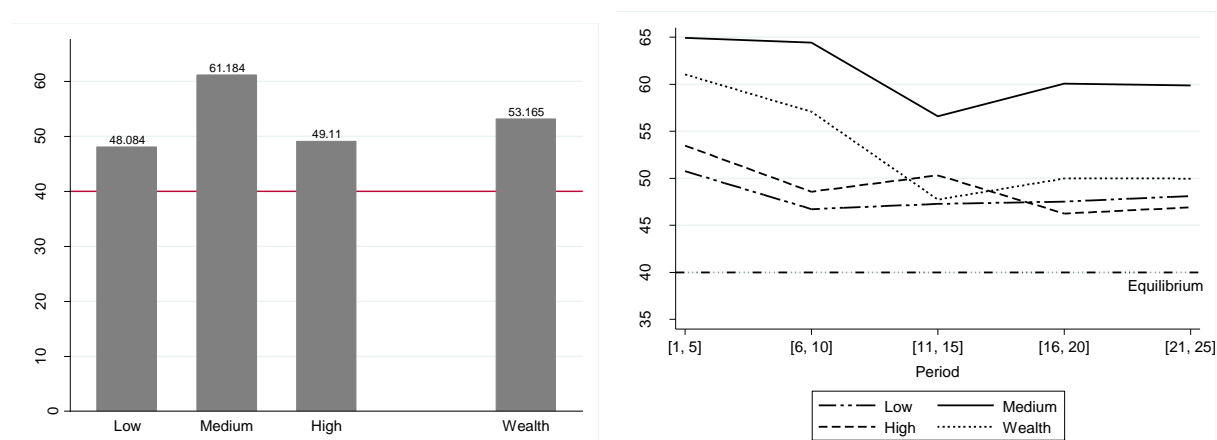


Figure 1 shows the average individual bids across rounds in all treatments. To examine whether the bids are concentrated in some periods, we also plot the average individual bids over periods. Overall it seems to support the existing result from the literature that for all treatments bids go down over time, but still stay over the equilibrium bid. To add to the literature we find that the bids in the Medium treatment are consistently the highest in all periods.

Table 5 reports the results of pairwise Wilcoxon rank-sum tests that investigate whether bids in the Wealth treatment are different from bids in the other treatments. Average bids in the High and Wealth treatments are not different. However, the average bids in the Medium treatment are significantly different than in the Wealth treatment. The significance level becomes stronger when we employ a one-sided test ( $p = 0.0349$ ).

**Table 5. Non-parametric (Wilcoxon rank-sum) tests of pairwise comparison**

Comparison	z-stat	p-value
Medium vs. Wealth	1.815*	0.0695
High vs. Wealth	-1.085	0.2779
Low vs. Wealth	-1.320	0.1868

To test whether the results are robust at the individual level, Tables 6 and 7 present random effects panel regressions of individual bid in a period on treatment dummies, our main variables of interest. However, we also control for other factors. The first set includes the standard controls (see the survey by Dechenaux et al. 2012) for past outcomes within the group: the individual's bid in the previous period, an indicator for whether or not the individual won the

contest in the previous period and the sum of the bids of the others in the group in the previous period. We further control for an individual's demographic characteristics: an indicator for risky behavior,<sup>6</sup> an indicator for a graduate student (i.e., if age  $\geq 21$  years), a female gender dummy and the number of experiments the individual has participated in in the past (experience). We report robust standard errors clustered on independent triples.

The first column in Table 6 reports a regression in which the baseline treatment is Medium. We find that compared to Medium all the treatments significantly reduce individual bids. The next three columns in Table 6 pairwise compare Low-High, Low-Wealth and High-Wealth treatments and find no treatment effect on bids. Columns 1, 2 and 3 show that the result of the non-monotonic effect of conflict resources is robust; whereas Column 4 reinstates that a sufficient increase in conflict resources has the same effect on conflict behavior as wealth.

**Table 6. Comparisons of treatments**

	(1) Baseline: Medium	(2) Baseline: Low	(3) Baseline: Low	(4) Baseline: High
Lag bid	0.509*** (0.039)	0.454*** (0.057)	0.506*** (0.040)	0.468*** (0.054)
Lag win	1.334 (1.524)	3.235 (2.334)	-0.0495 (1.668)	2.815 (2.420)
Lag others bid	0.007 (0.019)	0.0202 (0.031)	-0.0076 (0.021)	0.0292 (0.026)
Period	-0.157** (0.072)	-0.0783 (0.099)	-0.200** (0.092)	-0.172 (0.117)
Low	-4.971* (2.606)			
High	-6.399** (2.960)	-1.392 (2.083)		
Wealth	-4.602* (2.646)		1.037 (2.196)	1.645 (2.498)
Risky Behavior	-0.668	1.649	-5.360**	-0.809

<sup>6</sup> The risk elicitation task had six options (1–6) with increasing order of risk – see Instructions Part 1. The risky behavior indicator takes the value 1 for subjects who chose option 4–6 and 0 otherwise. The results are robust to alternative definitions of the indicator.

	(2.063)	(3.067)	(2.666)	(3.063)
Age $\geq 21$	-0.874 (2.363)	0.254 (2.953)	0.573 (2.773)	-1.423 (3.704)
Female	3.164 (2.329)	3.837 (3.682)	-0.304 (2.871)	4.487 (3.981)
Experience	0.175 (0.160)	0.176 (0.249)	0.0241 (0.156)	0.350 (0.249)
Constant	28.74*** (4.540)	21.31*** (3.976)	29.83*** (4.000)	20.26*** (4.888)
Observations	5040	2520	2520	2448

Dependent variable: Individual bid in each period. Standard errors clustered on independent subject-triples (groups) are in parentheses. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

Finally, Table 7 pairwise compares the bids in Medium vs. Low, Medium vs. Wealth, and Medium vs. High treatments and again finds higher bids in the Medium treatment compared to each of the other treatments. We use the same controls used in the regressions in Table 6 and report standard errors clustered on independent groups.

**Table 7. Pairwise comparison with medium endowment**

	(1) Baseline: Medium	(2) Baseline: Medium	(3) Baseline: Medium
Lag bid	0.555*** (0.0545)	0.500*** (0.0587)	0.550*** (0.0469)
Lag win	-0.439 (1.715)	2.424 (2.469)	-0.379 (1.970)
Lag others bid	-0.0204 (0.0248)	0.0190 (0.0272)	-0.00777 (0.0224)
Period	-0.141 (0.0927)	-0.119 (0.115)	-0.238* (0.106)
Low	-5.942** (2.902)		
High		-6.011** (3.019)	
Wealth			-4.658*

			(2.690)
Risky Behavior	-0.372 (2.638)	3.393 (3.074)	-2.577 (2.839)
Age $\geq 21$	-0.757 (2.824)	-2.641 (3.763)	-2.353 (3.851)
Female	1.772 (2.678)	5.894 (3.622)	3.125 (2.844)
Experience	-0.0202 (0.193)	0.413 (0.329)	0.140 (0.223)
Constant	31.46*** (6.361)	23.19*** (5.748)	31.97*** (6.014)
Observations	2592	2520	2520

Dependent variable: Individual bid in each period. Standard errors clustered on independent subject-triples (groups) are in parentheses. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

The results from Tables 3, 5, 6 and 7 can be combined in the following.

**Result 3.** Conflict resources, when scarce, act as a constraint and with an increase in resources, conflict intensity increases. However, when resources are abundant, they are perceived as wealth and conflict intensity decreases with a further increase in resources.

This result crucially points out that both the existing hypotheses introduced in the literature hold true in different mutually exclusive circumstances. Resource availability has two different effects, constraint and wealth, each of which is monotonic, but of different sign and size. The constraint effect dominates when the resource availability is low, and the wealth effect dominates when the resource availability is high.

## 5. Discussion

We systematically investigate the effects of the availability of conflict resources on conflict intensity. We run a between-subject Tullock (1980) type experiment in which we vary the fixed payment – unrelated to the experimental tasks – paid to the subjects, and the budget that can be used in the experimental task while keeping the Nash equilibrium bid the same.

The results show that, *ceteris paribus*, there is an inverted-U type relationship between the resources available for conflict and conflict intensity. When the level of available resources is

low, then the intensity of conflict is also low. In this case, the lack of resources acts as a constraint. When more resources become available the constraint loosens up and the intensity of conflict goes up, as seen in Sheremeta (2010, 2011), Price and Sheremeta (2011) and the meta-analysis in Sheremeta (2013) who explain this feature with error correction models such as the QRE. However, when the level of available resources is ‘high’, conflict intensity declines, which the error correction models cannot explain.

This apparently puzzling result is explained by comparing the very high resources treatment with the Wealth treatment, in which available resources remained moderate, but the subjects were provided with wealth that could not be used in conflict. It turns out that the conflict intensity is not different from that in the high resources treatment. This further means that when resources are abundant, they have a wealth effect on players. This effect reduces the marginal benefit of winning the conflict and, as a result, conflict intensity declines.

This result is reminiscent of the ‘backward bending supply curve of labor’ (dating back to Pigou, 1920), which suggests that as the wage rate increases, labor supply will first increase and when the wage rate is sufficiently high, the labor supply will decrease. This was later supported in a laboratory experiment by Dickinson (1999). The majority of the literature explains this phenomenon with the diminishing marginal utility of income. In the current study as well, one can explain the inverted-U shaped relationship with a decline in the marginal benefit of winning as a result of an abundance of resources (Schroein and Treich, 2013).

There are many implications of this result. Hirshleifer (1995), in a very different setting, states that conflict is more attractive option for the relatively poor people. We extend this argument by adding that conflict is not a plausible option for the very poor, but it is certainly a more popular option for not-so-poor than it is for the rich. Hence, *ceteris paribus*, the availability of more resources for conflict would not necessarily monotonically escalate the conflict intensity. Also, for the same value of a prize, one would expect to observe more conflict in medium income societies than in poor or rich societies.

It is possible to extend this research in various interesting avenues. Since wealth or resources change symmetrically in our experiment, a natural next step would be to investigate if wealth or budget inequality increases or decreases conflict. It would also be interesting to test the effects of changes in wealth on conflict intensity. Finally, it would be worthwhile investigating these issues with field data.

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# Appendix: Instructions

## GENERAL INSTRUCTIONS

This is an experiment in the economics of decision making. This experiment consists of two unrelated parts. Instructions for the first part are given next and the instructions for the second part will be provided after the first part of the experiment is finished.

The instructions are simple. If you follow them closely and make appropriate decisions, you can earn an appreciable amount of money.

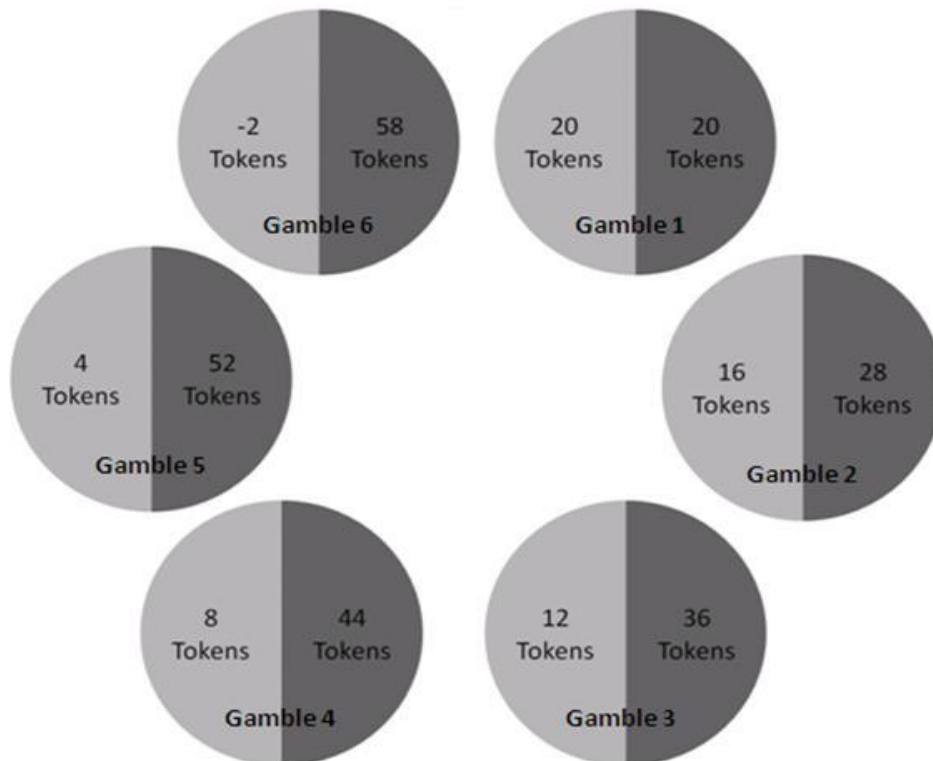
It is very important that you remain silent and do not look at other people's work. If you have any questions, or need assistance of any kind, please raise your hand and an experimenter will come to you. If you talk, laugh, exclaim out loud, etc., you will be asked to leave and you will not be paid. We expect and appreciate your cooperation.

Experimental Currency is used in the experiment and your decisions and earnings will be recorded in tokens. At the end of today's experiment, you will be paid in private and in cash. Tokens earned from both parts of the experiment will be converted to Pound Sterling at a rate of:

1 token to 3 Pence (£0.03).

## INSTRUCTIONS – PART 1

In this task, you will be asked to **choose from six different gambles** (as shown below). Each circle represents a different gamble from which you must **choose the one that you prefer**. Each circle is divided in half, with the number of tokens that the gamble will give you in each circle.



Your payment for this task will be determined at the end of today's experiment. A volunteer will come to the front of the room and toss a coin. If the outcome is heads, you will receive the number of tokens in the light grey area of the circle you have chosen. Alternatively, if the outcome is tails, you will receive the number of tokens shown in the dark grey area of the circle you have chosen. Note that no matter which gamble you pick, each outcome has a 50% chance of occurring.

Please select the gamble of your choice by clicking one of the "Check here" buttons that will appear on each circle in the picture. Once you have made your choice, please click the "Confirm" button at the bottom of the screen.

For your record, also tick the gamble you have chosen in the above picture.

Once everyone has made their decision, this task will end and we will move on to Part 2 of the experiment. Your payment for this task will be decided at the end of today's experiment.

## INSTRUCTIONS (for Medium) – PART 2

### YOUR DECISION

This part of the experiment consists of **25** decision-making periods. At the beginning, you will be randomly and anonymously placed into a group of **3 participants**. The composition of your group will remain the same for all 25 periods. You will **not** know who your group members are at any time.

Each period you will receive an initial endowment of **180** tokens. Each period, you may bid for a reward of **180 tokens**. You may bid any number between **0** and **180** (including 0.1 decimal points). An example of your decision screen is shown below.

The screenshot shows a decision screen with a light gray background and a yellow border. At the top left, it says "Period" followed by "1 of 1". At the top right, it says "Remaining time[sec]: 24". In the center, the text reads: "Your group consists of 3 participants.", "The reward is worth 180 tokens.", "You may bid any number of tokens between 0 and 180 (including 0.1 decimal points).", and "How much would you like to bid?". Below this text is a blue input field with a vertical line cursor. At the bottom right, there is a red "OK" button.

### YOUR EARNINGS

For each **bid** there is an associated **cost** equal to the bid itself. The cost of your bid is:

$$\text{Cost of your bid} = \text{Your bid}$$

The more you bid, the more likely you are to receive the reward. The more the other participants in your group bid, the less likely you are to receive the reward. Specifically, your chance of receiving the reward is given by your bid divided by the sum of all 3 bids in your group:

$$\text{Chance of receiving the reward} = \frac{\text{Your bid}}{\text{Sum of all 3 bids in your group}}$$

You can consider the amounts of the bids to be equivalent to numbers of lottery tickets. The computer will draw one ticket from those entered by you and the other participants, and assign the reward to one of the participants through a random draw. If you receive the reward, your earnings for the period are equal to your endowment of 180 tokens *plus* the reward of 180 tokens *minus* the cost of your bid. If you do not receive the reward, your earnings for the period are equal to your endowment of 180 tokens *minus* the cost of your bid. In other words, your earnings are:

**If you receive the reward:** Earnings = Endowment + Reward – Cost of your bid = 180 + 180 – your bid

**If you do not receive the reward:** Earnings = Endowment - Cost of your bid = 180 – your bid

### An Example (for illustrative purposes only)

Let's say participant 1 bids 30 tokens, participant 2 bids 45 tokens and participant 3 bids 0 tokens. Therefore, the computer assigns 30 lottery tickets to participant 1, 45 lottery tickets to participant 2 and 0 lottery tickets to participant 3. Then the computer randomly draws **one lottery ticket out of 75** (30 + 45 + 0). As you can see, participant 2 has the **highest chance** of receiving the reward: **0.60 = 45/75**. Participant 1 has **0.40 = 30/75** chance and participant 3 has **0 = 0/75** chance of receiving the reward.

Assume that the computer assigns the reward to participant 1, then the earnings of participant 1 for the period are  $330 = 180 + 180 - 30$ , since the reward is 180 tokens and the cost of the bid is 30. Similarly, the earnings of participant 2 are  $135 = 180 - 45$  and the earnings of participant 3 are  $180 - 0$ .

At the end of each period, your bid, the sum of all 3 bids in your group, your reward, and your earnings for the period are reported on the outcome screen as shown below. Once the outcome screen is displayed you should record your results for the period on your **Personal Record Sheet** (page 4) under the appropriate heading.

Period	Remaining time[sec]: 24
1 of 1	
<p>Your bid: <b>75.0</b> tokens.</p> <p>Sum of all 3 bids in your group: <b>135.0</b> tokens.</p> <p>You did not receive the reward.</p> <p>Your reward: <b>0.0</b> tokens.</p> <p><b>Your earnings for this period (= Endowment + Reward - Bid) : 105.0 tokens.</b></p> <p>OK</p>	

## IMPORTANT NOTES

At the beginning of this part of the experiment you will be randomly grouped with another two participants to form a 3-person group. You will not be told which of the participants in this room are assigned to which group.

At the end of the experiment the computer will randomly choose **5 of the 25** periods for actual payment for this part of experiment. You will be paid the average of your earnings in these 5 periods. These earnings in tokens will be converted to cash at the exchange rate of 1 token to 3 Pence (£0.03) and will be paid at the end of the experiment.

**Are there any questions?**

### Personal Record Sheet

(5 periods from here will be randomly chosen for final payments)

Period	Your bid	Sum of all 3 bids in your group	Your reward	Your earnings for this period
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				

### Total Earnings

Period Chosen	Earnings for this period
<b>Total</b>	

Total earnings from table above: \_\_\_\_\_ (1)

Average of above earnings:  $(1) \div 5$  \_\_\_\_\_ (2)

Earnings from Part 1: \_\_\_\_\_ (3)

Total earnings  $(2) + (3)$  \_\_\_\_\_ (4)

Multiply by exchange rate:  $(4) \times \underline{0.03}$

**Total payment for the experiment: £ \_\_\_\_\_**



## QUIZ

1. Does group composition change across periods in the experiment?

Ans.     Yes            No

2. What is the value of 1 token in Pence?

Ans.     3 Pence            6 Pence            9 Pence

### Questions 3 to 7 apply to the following information.

In a given period, suppose the bids by participants in your group are as follows.

Bid of participant 1: 55 tokens

Bid of participant 2: 70 tokens

Bid of participant 3: 10 tokens

3. What is the chance that participant 1 will receive the reward?

Ans.     \_\_\_\_\_ out of \_\_\_\_\_

4. What is the chance that participant 2 will receive the reward?

Ans.     \_\_\_\_\_ out of \_\_\_\_\_

5. What is the chance that participant 3 will receive the reward?

Ans.     \_\_\_\_\_ out of \_\_\_\_\_

6. If you are Participant 1 and you **did not receive** the reward what are your earnings this period?

Ans. \_\_\_\_\_ tokens

7. If you are Participant 2 and you **received** the reward what are your earnings this period?

Ans. \_\_\_\_\_ tokens

## EXPLANATIONS FOR QUIZ ANSWERS

1. Does group composition change across periods in the experiment?

Ans. No

2. What is the value of 1 token in Pence?

Ans. 3 Pence

3. What is the chance that participant 1 will receive the reward?

Ans. 55 out of 135.

4. What is the chance that participant 2 will receive the reward?

Ans. 70 out of 135.

5. What is the chance that participant 3 will receive the reward?

Ans. 10 out of 135.

6. If you are Participant 1 and you **did not receive** the reward what are your earnings this period?

Ans. 125 tokens (= Endowment – bid =  $180 - 55$ )

7. If you are Participant 2 and you **received** the reward what are your earnings this period?

Ans. 290 tokens (= Endowment + Reward – Bid =  $180 + 180 - 70$ )