Set Contractions and Bargaining Outcomes: An Experiment*

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Abstract

Although several allocation rules (such as the Kalai-Smorodinsky solution) have been proposed that allow for possible violations of the *'independence of irrelevant alternatives' (IIA)* axiom in the context of cooperative bargaining games, there is no conclusive evidence on how contractions of feasible sets exactly affect bargaining outcomes. We have been able to conclusively identify a definite way through which such contractions actually determine the outcomes of negotiated bargaining. We report that the direction and the extent of changes in bargaining outcomes, due to feasible set contraction, respond to the level of (given) agent-asymmetry with a remarkable degree of regularity. Alongside, we conclude that the validity of the *IIA* axiom is only limited to symmetric games. The results imply that a mere introduction of a minimum wage law, or maximum retail price (each of which makes for a contraction) may significantly alter bargaining outcomes, even if none is binding. So far, no theoretical allocation rule is associated with a set of axioms that account for the results we report.

Keywords :Experimental bargaining, exogenous asymmetry, contraction axiom.

JEL Classification : C71, C78, C90.

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1 Introduction

Whether a mere introduction of a minimum wage law affects the bargaining position of laborers, is often a question of primary importance in developing countries. The introduction of a legal fare on three-wheeler (auto-rickshaw) services in India, has witnessed negotiations between individual customers and three-wheeler drivers who eventually settle on fares that are significantly higher than those prescribed by regulation. Another interesting question that relates to the above examples is, if consumers stand to gain out of a mere introduction of a maximum retail price (MRP) on a product ... even if the said MRPs significantly exceed the prices that would occur under bargaining. As it turns out, all the examples above can be understood as bargaining problems subject to contractions of the feasible set. It is also worth noting that the two parties involved in each example (e.g. consumers and sellers) need not be symmetric (say, because of 'status gaps' owing to different backgrounds and so on).

In this paper we revisit the validity of Nash's (1950) axiom of *independence of irrelevant alternatives* (IIA hereafter) with the introduction of asymmetries in the context of his bargaining solution. This axiom can be explained as follows: the equilibrium outcome of the bargaining problem for a given feasible set (of outcomes) will also be the equilibrium outcome of the bargaining problem for any subset of that original feasible set, provided that such a subset has the initial outcome as one of its elements. The Nash solution was subsequently criticized (Raiffa (1953), Yu (1973), Kalai and Smorodinsky (1975), and Perles and Maschler (1981)) because of this axiom. The criticism, as Thomson (1994) puts it, was that, "the crucial axiom on which Nash had based his characterization requires that the solution outcome be unaffected by certain contractions of the feasible set, corresponding to the elimination of some of the options initially available ... but this independence is often not fully justified".[1]

This axiom, however, witnessed its first experimental validity when Nydegger and Owen (1975), found evidence against the Kalai-Smorodinsky (KS) solution (where contraction matters) in favor of the Nash solution in their controlled experimental set up. There was, however, one concern which related to the *random selection* of the individual in the advantageous position against his counterpart (due to the contraction). As Hoffman et al. (1994) point out, "randomization may not be neutral, since it can be interpreted by subjects as an attempt by the experimenter to treat them fairly ... thus experimenters may unwittingly induce 'fairness'. A subject may feel that, since the experimenter is being fair to them, they should be fair to each other." They could explain why first movers in *ul-*

[1]For more detailed discussions on axiomatic approaches to bargaining theory, see Moulin (1988, 2003) and Roth (1979, 1985).

timatum games offered significantly more to their counterparts than noncooperative game theory would suggest. Hence, because of randomization, the axiom was only validated under *symmetric bargaining*[2] in the Nydegger and Owen (1975) framework. The goal of this paper is to check if their results would survive in an asymmetric setting, so we borrow ideas from ultimatum games.[3]

In the experiment of Hoffman et al. (1994), the roles of sender and receiver were assigned randomly in the control group, and in the treatment group, the right to be the first mover was earned by scoring high on a general knowledge quiz (rights were reinforced by the instructions as being earned). To that effect, the role of the trivia test was to eradicate potential interpretation of fairness by the subjects that arises from randomization. The modal offer observed in the treatment group was significantly less than that made in the control group.[4] We borrow this idea to address the concern above by replacing randomization by a trivia test to generate self-regarding behavior and extend the research of Nydegger and Owen (1975) to test for contraction effects under asymmetric bargaining (with one individual having a status advantage) - an open question so far. The central motivation of this experiment is thus, to test contraction effects under asymmetry, when the experiment does not oblige the subjects to be fair.[5]

2 The formulation

In the discussion that follows on the (theoretical) effects of contraction, the Kalai-Smorodinsky (KS hereafter) solution is used only as a representative example of allocation rules that violate the IIA axiom, many of which have been mentioned in the previous (introductory) section. While the KS solution itself is not central to the main theme (that is, effects of contraction) of this paper, it will be useful for the understanding of how set contractions may alter bargaining outcomes (contrary to the Nash solution).[6] Throughout the discussion, we assume that the agents involved in bargaining gain nothing when there is a disagreement

[2]This should not be confused with the *axiom of symmetry* in the context of cooperative bargaining. Here, by 'symmetry' we only mean that the individuals involved in bargaining are identical in every respect.

[3]For more examples, see the discussions in Bardsley et al, 2009; Chaudhuri, 2009; Smith, 2008; Henrich and Henrich, 2007; and Camerer, 2003 (and the papers cited therein).

[4]Cardenas and Carpenter (2008), for example, also point out that the perception of how *deserving* recipients are, could be a strong predictor of altruism. Ball et al. (2001) interprets this (significant) effect of test performance as a 'status effect'.

[5]For more literature on bargaining with fairness considerations, see Birkeland and Tungodden (2014), Bruyn and Bolton (2008), Burrows and Loomes (1994), and Buchan et al (2004). The 50%-50% outcome may also be seen as a focal point (see Crawford et al, 2008).

[6]Only the intuitions behind the Nash and the Kalai-Smorodinsky solutions have been employed in the subsections that follow. I thank Profs. Ariel Rubinstein, Arunava Sen and Debasis Mishra for helping me finalize this entire section to appeal to a wider audience.

(that is, the disagreement payoff is zero for each agent). In general, disagreement payoffs may play an important role in the determination of bargaining outcomes (See Anbarci and Feltovich, 2013).

2.1 Symmetric bargaining in the absence of contraction

Two individuals X and Y (both from the same homogenous population[7]) get to share a pie of size z. Their respective shares are x and y (both non-negative), so that $x + y = z$. We normalize z to be equal to unity so that x and y may be interpreted as the percentages (proportions/fractions) of the pie that X and Y (respectively) get, from which they derive utilities $v(x)$ and $v(y)$.[8] Figure I shows the feasible set (following a normalizing utility transformation u, explained in Appendix 4). While, both the Nash and the KS solutions are formally presented in Appendix 4, for now, for the non-specialist, it suffices to say that the (symmetric) KS solution requires that X and Y share the pie in proportion to the maximum each can get in the absence of the other. Similarly, the (symmetric) Nash solution requires that X and Y share the pie such that the product of their utilities is maximized. The axioms of *symmetry* and *efficiency* together, in the Nash and the Kalai-Smorodinsky bargaining framework, are sufficient to guarantee that X and Y get 50% each (of the pie). This is verified in Appendix 4.

2.2 Asymmetric bargaining in the absence of contraction

Coming to the case of *asymmetric* individuals, let X now, be the individual with a measurably higher bargaining power β (> 0) over individual Y.[9] Both the Nash and the Kalai-Smorodinsky solutions suggest that X will get a higher (than 50%) share. To provide an intuition here, for the (asymmetric) Nash solution, we maximize the product of the utility of agent Y and that of agent X after raising the latter to the power of $(1 + \beta)$; and for the KS solution, we 'pretend' that agent X would be entitled to $(1 + \beta)$ times the utility that he would otherwise get in the absence of agent Y (before deciding on the final proportion in which both the agents share the pie). The asymmetric Kalai-Smorodinsky solution is explained in Figure II. The derivations are deferred to Appendix 4.

[7]Hence X and Y are symmetric by our definition.

[8]That the functional form v of the utility of individual X is identical to that of Y, is consistent with X and Y being from a homogeneous population (and therefore X and Y are 'symmetric').

[9]While there is no immediate interpretation of β, it suffices, for now, to say that for any allocation rule, the bargaining power β is a determinant of the (positive) quantity by which x exceeds y.

2.3 Symmetric bargaining in the presence of contraction

Now, we assume that X and Y share the pie subject to the requirement that X gets at least α (< 1), fraction of the total pie size. This puts a cap on individual $Y's$ utility. We have a truncation of the feasible set which is shown in Figure III. For $\alpha \leq 1/2$, the (symmetric) Nash Bargaining solution remains the same as before (since contraction does not matter). The Kalai-Smorodinsky solution, however, suggests a higher share for individual X, (contraction matters) and has been derived in Appendix 4.

For example, if we want individuals X and Y to split \$1 amongst themselves (with $v(x) = x$), subject to the constraint that Y gets to keep no more than 50 cents (so that $\alpha = 0.5$), then the Nash solution will still predict a split where each individual gets 50 cents, but the Kalai-Smorodinsky solution will predict a split where X gets to keep two-thirds and Y one-third of the pie (the axiom of *independence of irrelevant alternatives* has been violated since the truncated set now still has the point (0.5, 0.5) as its element, but the final outcome is different).

2.4 Asymmetric bargaining in the presence of contraction

Theoretically, asymmetry in the Nash bargaining model accompanied by a contraction of the feasible set leads to the same solution in the asymmetric Nash framework without contraction (since contraction does not matter in the Nash setting). The Kalai-Smorodinsky solution, however shifts further in favor of individual X (details in Appendix 4). Now we will summarize the results of a previous study.

Nydegger and Owen (1975) had a control group of pairs of individuals that were required to split \$1 amongst themselves over face-to-face negotiations. In the treatment group, one of the randomly assigned individuals was to get at least 40 cents (i.e. $\alpha = 0.4$) subject to which both the individuals negotiated. On observing that all the pairs of individuals in both the treatment and control groups, had chosen on an equal split of 50 cents each, the study did not reject Nash's axiom of *independence of irrelevant alternatives* (in the symmetric case). The very process of *randomly* selecting the individual in the treatment group, who gets to keep at least 40% of the split, however, may have induced both the individuals to be fair to each other (since at the first place, each individual had an equal chance of capitalizing on the constraint), which may have led to the observed equal splits. The aim of our experiment is to eradicate the effects of randomization that induce fairness by replacing randomization by a test and thereby introducing asymmetry in the setting.

3 Key features of the experimental design

The subject pool consisted of undergraduate and MBA students at institutions in New Delhi. Each individual was randomly assigned to either the control group, or one of three treatment groups. Subjects were grouped into pairs in each treatment. Each individual received a show-up fee of Rs. 125. In addition, they retained the part of Rs. 600 that was negotiated with their respective partners under relevant treatment conditions. In each treatment, if a pair did not agree on any split of Rs. 600, each individual got nothing (i.e. the disagreement payoff was zero), otherwise they took away the amounts as negotiated. The key features of the experiment are *anonymity* (to generate asymmetry) and *dialogue* (a key element of any negotiation process).

The control group in this experiment receives the symmetric bargaining treatment of Nydegger and Owen (1975). In one of the treatments, the feasible set of bargaining outcomes, is restricted or contracted by stipulating that a randomly chosen individual of a bargaining pair must at least receive a payoff greater than a minimum. The minimum is so chosen that the contracted set includes all the bargaining outcomes observed in the control group (without the contraction of the feasible set). This treatment is called 'random contraction'. Nydegger and Owen showed that such a random contraction did not alter the bargaining outcome thus validating the axiom of independence of irrelevant alternatives.

As mentioned before, the goal of the experiment is to test for the axiom of independence of irrelevant alternatives in asymmetric bargaining. The challenge was to generate asymmetry among otherwise similar individuals. To achieve that, subjects were given a test. While the test was administered to all the treatment groups to ensure uniformity, it was immaterial to the control group and to the random contraction treatment. In the 'rank bargaining' treatment, individuals were informed about their ranks in the test. Although the ranks were randomly assigned, subjects were told that they were assigned on the basis of their performances in the test.[10] Higher ranked subjects were matched with lower ranked subjects for the bargaining experiment. Subjects had full knowledge of their own ranks and the ranks of the subjects they were paired with. In a variant of this treatment, called the 'rank

[10] This (fortunately mild) form of deception is very important for our experiment. Although the results from pilot studies (available on request), that in fact, do assign ranks based on the subjects' actual test performances, are qualitatively very similar to those that we report in this paper, one would raise immediate concerns with such pilot analyses. This is because, although the assignment to this treatent group would still remain exogenous, the experimental effect itself will be correlated with unobserved subject ability - that is, we will not be sure if the smarter subjects get higher shares simply because they are smarter, or because of the treatment effect (in this case, status effect), or both. In order to make our form of the (already mild) form of deception even milder, nowhere do we explicitly suggest (or impose) that the higher ranked subjects, should in fact, receive more than their lower ranked counterparts. Ball et al. (2001) employ a similar strategy.

contraction', the feasible set was contracted. The stipulation that governed the contraction was that the higher ranked individual of a bargaining pair must at least receive a payoff greater than a minimum. Once again, the minimum payoff guaranteed to the higher ranked subject (in the event of agreement) was so chosen that the contracted set included all the bargaining outcomes of the rank bargaining treatment. The details of all the treatments are summarized in Table I.

Overall, 130 subjects (69 males and 61 females) participated in the experiment. 58 subjects were from the Fore School of Management, and the remaining 72 were from the University of Delhi (44 from St. Stephen's College and 28 from Hansraj College).

4 The experiment

The Baseline Treatment (Control Group, T0): This baseline treatment replicates the standard Nash-bargaining protocol. Subjects were randomly paired. In each pair, the subjects were given a set of instructions (shown in the appendix) to split Rs. 600 among themselves. Negotiation happened over Skype, and a maximum of ten minutes were allotted to both the candidates in each pair to arrive at an agreement.[11] The negotiated outcomes in this treatment were then observed before introducing others to make sure that each outcome in this treatment was also an element in the feasible sets of all the other treatments that followed. Based on the Nydegger and Owen (1975) experiment and the existing theory on symmetric bargaining, one might expect the highest frequency of equal splits (i.e. Rs. 300 each) in this treatment. The control group was assigned a sample size of ten pairs. In the appendix, it is shown that such a sample size has reasonable power for testing the null hypothesis of equal split.

Rank-Based Bargaining Treatment (T1): Subjects were told that they were ranked according to their test performances. In reality, the ranks were *randomly* assigned and the subjects did not know this.[12] Each member ranked in the top half was randomly paired with a member in the bottom half. Subjects in each pair knew their own and each others' ranks prior to negotiation (this is how we exogenously imposed asymmetry) which happened over Skype with a time limit of ten minutes.[13] The feasible set remained just as that of the

[11] Candidates were not allowed to disclose their names/identity in the chat conversations (which were saved) violating which, entailed a penalty of the full amount earned (including the show-up fees) for both the individuals in the pair. This ensured anonymity. The login names used for this treatment were Candidate.001, Candidate.002 and so on. The sufficiency of ten minutes was observed from the pilot studies.

[12] Ball et al. (2001) employ a similar approach in their paper titled "Status in Markets."

[13] As before, the negotiation happened over Skype, but this time with rank-defining usernames such as Rank.001, Rank.002 etc.

control group (as in Figure I). 19 pairs of subjects were randomly put into this treatment. One could expect a departure from the 50% solution predicted in symmetric bargaining if the test (as discussed above) has the effect of preventing individuals from behaving in a fair manner (i.e. $\beta > 0$ in (A4.2) of Appendix 4, so the higher ranked individual gets a share greater than 50%).[14]

Random Contraction Treatment (T2): Subjects were randomly paired. Individuals in each pair divided Rs. 600 in any way they wished, but with the additional constraint that one of the *randomly assigned* individuals in each pair received no more than 60% (i.e. Rs. 360, or $\alpha = 0.4$) of the total pie size (subject to negotiation agreement). α was chosen so as to ensure that each outcome in the control group remained in the (contracted) feasible set of this treatment group (as in Figure III). Negotiation happened over Skype with a maximum permissible limit of ten minutes to reach an agreement.[15] All the remaining instructions remained the same as in the baseline treatment above. 17 pairs of subjects were randomly put into this treatment. This treatment, together with the baseline treatment replicate the Nydegger and Owen experiment covering symmetric bargaining. In this treatment one might again expect a high frequency of equal splits for issues pointed out by Hoffman et al. (1994) - the very process of randomization may induce them to act in a fair manner (as witnessed in the Owen and Nydegger experiment).

Rank-Based Contraction Treatment (T3): This treatment looks at the combined effects of contraction and asymmetry. It followed all the other treatments to ensure that the observed average outcomes of all the above treatments remained within the feasible set of this treatment (as in Figure III). Each member among the top half rankers was randomly paired with a member in the bottom half (again, these ranks were assigned randomly). Subjects in each pair knew their own and each others' ranks prior to negotiation which happened over Skype with a time limit of ten minutes.[16] The lower-ranked subjects in each pair could not receive more than 60% (i.e. Rs. 360, just like the randomly selected individuals in T2 above) of the total Rs. 600 (subject to negotiation agreement). 19 pairs of subjects were randomly put into this treatment. The treatment groups 1 and 3 above, extend Nydegger and Owen's framework to the asymmetric case. One might expect self-regarding behavior on the part of individuals ranked in the top half in this treatment as well ($\beta > 0$ in both (A4.2) and (A4.6) of Appendix 4).

[14]See Dahl (1957), Frank (1985), Babcock et al. (1996) and Harsanyi (1962a, 1962b, 1966) for discussions on how status effects matter in bargaining, resulting in asymmetric outcomes. For more recent literature on the role of entitlements, see Bruce and Clark (2012), Croson and Johnston (2000), Gächter and Riedl (2005), Gächter and Riedl (2006) and Karagözoğlu (2014) among others.

[15]The usernames were the same as in the baseline treatment.

[16]As in the Rank-Based Bargaining Treatment above, the Skype usernames were rank-defining (Rank.001, Rank.002 etc.).

4.1 A discussion

The Nydegger and Owen framework depended on face-to-face negotiations. Since students come from similar backgrounds, it is highly probable that those involved in a given pair would know each other or even be friends. This will tend to mitigate the intended effect of the test: to generate *self-regarding behavior* and *asymmetry*. Thus, we would like to preserve anonymity in our protocol. However, we also need to maintain the crucial feature of any negotiation - *dialogue between the individuals*, as was the case with the Nydegger and Owen experiment. The very idea of making individuals of a given pair chat over Skype has the dual effect of preserving anonymity (since those chatting only knew the user IDs and were not supposed to disclose their own identities) and dialogue (saved in the chat history) thereby making our results comparable with those of Nydegger and Owen.

In treatment 3 we observe the combined effects of treatments 1 and 2 (Figure IV explains how). We account for the possibility that the effect of contraction need not be independent of that of asymmetry. We allow for contraction to have different effects under the symmetric and asymmetric bargaining conditions. One can think of 'asymmetry-effect' as the movement from the control group to T1 (or T2 to T3), and 'contraction-effect' as the movement from the control group to T2 (or T1 to T3).

5 Empirical strategy

For the treatments involving contraction of the feasible set, we say that individual j (in pair i) has a contraction advantage, if the contraction specifies this individual j must receive the minimum share (α). Then the following dummy is defined.

$$ContrAdv_j = \begin{cases} 1, & \text{if } j \text{ has a contraction advantage} \\ -1, & \text{if } j \text{ is paired with a subject who has a contraction advantage} \end{cases}$$

Similarly, for treatments involving rank, we define another dummy as follows.

$$HighRank_j = \begin{cases} 1, & \text{if } j \text{ has a higher rank than the subject he/she is paired with} \\ -1, & \text{if } j \text{ has a lower rank relative to the subject he/she is paired with} \end{cases}$$

We finally define a variable ($RelPos$) which summarizes the *relative position* of any subject with his/her pair in terms of rank and contraction.

$$RelPos_j = \begin{cases} ContrAdv_j, & \text{if } j \text{ belongs to a pair in a treatment involving contraction} \\ HighRank_j, & \text{if } j \text{ belongs to a pair in a treatment involving asymmetry} \\ 0, & \text{if } j \text{ belongs to a pair in the control group} \end{cases}$$

In other words, $RelPos_j$ is a ternary dummy that takes the value 1 for subjects who are either high ranked or with a contraction advantage (or both); -1 for subjects who are either low-ranked or are paired with individuals with contraction advantage (or both); and 0 for subjects in the control group. The regression equation we are interested in is

$$Share_{ij} = \alpha_0 + \alpha_1 RankBarg_i \cdot RelPos_j + \alpha_2 RandmContr_i \cdot RelPos_j + \alpha_3 RankContr_i \cdot RelPos_j + \mathbf{X}_{ij}\boldsymbol{\beta} + \varepsilon_{ij} \tag{1}$$

where, $Share_{ij}$ represents the share of the jth individual in the ith pair. $RelPos_j$ is defined as above. α_0 is the constant of regression. $RankBarg$, $RandmContr$ and $RankContr$, are the treatment dummies that respectively represent if the ith pair belongs to treatment groups 1, 2 or 3. $\mathbf{X}_{ij}$ is a vector of other observed covariates (gender of involved individuals, background, institution, income etc.) with the coefficient vector $\boldsymbol{\beta}$. ε_{ij} is the random error term.[17] Thus, the (average) outcome in the control group can be represented by α_0; the share of the higher-ranked individual (on an average) in the rank-based bargaining treatment (T1) is represented by $\alpha_0 + \alpha_1$; the (average) share of the individual with contraction advantage in the random contraction treatment (T2) is represented by $\alpha_1 + \alpha_2$; and that of the high-ranked individual (also with the contraction advantage) in the rank-based contraction treatment (T3) is represented by $\alpha_0 + \alpha_3$.[18]

5.1 Testable hypotheses

Testing for asymmetry: We start with the following hypothesis

$$Hypothesis\ 1 : \alpha_1 = 0$$

[17]Note that for α_0, to represent the average share of the control group, each variable included in $\mathbf{X}_{ij}$ needs to be appropriately normalized to have mean zero.

[18]Note that the regression specification in (1) is different from the following specification

$Share_{ij} = \alpha_0 + \alpha_1 RankTreatment_i \cdot RelPos_j + \alpha_2 ContrTreatment_i \cdot RelPos_j + \mathbf{X}_{ij}\boldsymbol{\beta} + \varepsilon_{ij}$,

where $RankTreatment_i$ is a dummy for a treatment involving rank-based bargaining and $ContrTreatment_i$ is a dummy for a treatment involving a contraction. In such a specification, the (expected) share of the high-ranked individual in the rank-based contraction treatment will be represented by $\alpha_0 + \alpha_1 + \alpha_2$. This specification therefore, clearly imposes a restriction that rank effects and contraction effects are additive (which may not be true). The specification in (1), clearly does not impose this additivity, and is thus, less restrictive.

against the alternative that α_1 is significantly greater than zero ($\alpha_1 > 0$). The rejection of the above hypothesis, means that the average observed outcome in the Rank-bargaining treatment deviates from the symmetric $(\frac{1}{2}, \frac{1}{2})$ solution in favor of the higher-ranked individuals. If *Hypothesis* 1 is not rejected, then the rank bargaining treatment does not lead to significantly asymmetric outcomes.

The effect of contraction in the symmetric case: We test the following hypothesis that

contraction does not matter in the symmetric bargaining setting.

$$Hypothesis\ 2 : \alpha_2 = 0$$

against the alternative that $\alpha_2 > 0$. If *Hypothesis* 2 above, is not rejected, then we infer that the introduction of contraction in the baseline treatment does not significantly matter. Recall that in the baseline treatment, the individuals were not subject to any contraction or the assignment of ranks. Rejecting *Hypothesis* 2 above, leads to the inference that the axiom of independence of irrelevant alternatives is violated significantly. Such a result would be inconsistent with the symmetric Nash bargaining solution.

The effect of contraction in the asymmetric case: If *Hypothesis* 1 is rejected in favor of $\alpha_1 > 0$, then the following hypothesis comes to be of interest.

$$Hypothesis\ 3 : \alpha_1 = \alpha_3$$

against the alternative that $\alpha_1 < \alpha_3$. *Hypothesis* 3 means that the observed outcomes in treatment groups T1 and T3 are statistically identical. Since both the treatments involve assignment of ranks (leading to asymmetric bargaining outcomes), the observed differences (if any) between their average behaviors can only be attributed to contraction. Thus, if we do not reject the above hypothesis, then we conclude that contraction does not significantly matter in the asymmetric case. But if we reject *Hypothesis* 3, then we conclude that contraction matters significantly in the asymmetric case.

6 Results

6.1 Descriptive statistics

From the rows in Table IIa, that report the minimum and the maximum shares of all the treatment groups, we learn that all the outcomes observed in the control group belong to the feasible sets of the remaining treatments. We also learn that the feasible set of the Rank

Contraction treatment allows for all the outcomes observed in all the other treatments. Thus, we are in a position to test the validity of the IIA axiom for both symmetric and asymmetric bargaining. For the purposes of this paper, we are primarily interested in the figures reported in the rows named 'Mean Share (RelPos = 1)' and 'Mean Share (RelPos = -1)' in Table IIa. Since the variable RelPos is defined to be zero for observations in the control group, no figure is reported under the same. In the Rank-based bargaining treatment (T1), 'Mean Share (RelPos = 1)' represents the average share of the high-ranked subject in a pair. We learn that the high-ranked subjects in this treatment received, on an average, about 59% of the pie, leaving the remaining 41% (the corresponding figure listed in 'Mean (RelPos = -1)' under the same treatment), for their lower-ranked counterparts. Similarly, it is seen that subjects with a contraction advantage in the Random contraction treatment (T2), received, on an average, 52% of the pie, leaving about 48% for their counterparts without the advantage. In the Rank-based contraction treatment (T3), those with high-ranks (and hence with the contraction advantage) received, on an average, close to 64% of the pie-size, leaving only about 36% for their lower-ranked counterparts. These figures, suggest that while the effect of contraction of the feasible set is insignificant in symmetric bargaining settings, it is not insignificant in asymmetric settings.[19]

Table IIb displays the average shares received by subjects, based on their personal characteristics. Both female and male subjects receive, on an average, very close to 50% of the pie-size, suggesting that gender does not significantly determine bargaining outcomes. This is contrary to the findings of Sutter et al, 2009; and Castillo et al, 2013, among still others. Similarly it did not (significantly) matter if a subject came from a family with a background in business (or shop-ownership), although such families are more accustomed to negotiation on a daily basis, and could therefore, be thought to possess certain negotiation-specific skills to settle on more favorable outcomes. Students who experienced hostel lives did not get significantly higher shares than those who did not. Parents' education are not significant determinants of bargaining either. A regression of observed share on family income level suggests that the latter is not a significant determinant of the former (p-value is 0.31). The fact that none of the personal or intrinsic characteristics discussed above (possibly known by the subjects about each other owing to daily interaction) were strong determinants of observed shares, potentially explains the strength of anonymity in our experimental setting.

[19]T-test results for a simple test of means for individuals with $RelPos = 1$, in the rank-bargaining treatment against those in the rank-contraction treatment, yield a t-statistic (d.f. = 36) with a value of 1.59 and an associated p-value of 0.06, suggesting some evidence of significance. A similar comparison between all the observations in the control group and those with $RelPos = 1$, in the random-contraction treatment, shows no significant difference (p-value of 0.23, for a t-statistic (d.f. = 35) with a value of 1.22).

6.2 Key findings

Table IIIa shows the results of regression equation (1). As we will immediately see, these results are consistent with the observations made in Table IIa. In Column 1, we see that the effect of rank-bargaining leads to asymmetric outcome, i.e.a significant departure from the 50-50 solution (therefore we reject *Hypothesis 1,* that rank bargaining does not lead to asymmetry). The regression estimate suggests that on an average, the high-ranked subject in any pair, managed to get a share of close to 59% (over Rs. 350 out of Rs. 600). The effect of contraction in symmetric bargaining is only marginally significant. The effect of contraction in asymmetric bargaining can be understood by testing for the equality of the coefficients of RankBargaining*RelPos and RankContraction*RelPos (Hypothesis 3). The regression result suggests that the high-ranked subject in a pair gets, on an average, close to 64% of the total pie size in the rank-contraction treatment. This treatment differs from the rank-bargaining treatment, only in the allotment of contraction-advantage to the high-ranked individual. The F-Statistic for the test (of *Hypothesis 3*) is 5.16 (with a p-value of 0.02). We therefore, reject *Hypothesis 3* and conclude that contraction matters in asymmetric bargaining. In Column 2, we run the same regression with the introduction of institution dummies,[20] and in Column 3, we introduce controls for gender.[21] In both these specifications, the effect of asymmetry remains (we reject *Hypothesis 1*, since the high-ranked subject of any pair, gets on an average, over 56% of the total pie-size). The effect of contraction, however, in symmetric bargaining is no longer significant (we therefore do not reject *Hypothesis 2).* The F-Statistics for the test of *Hypothesis 3* in both the specifications of Columns 2 and 3 (5.10 and 5.01 respectively) suggest that the effect of contraction in asymmetric bargaining is significant.[22] These results verify Nydegger and Owen's conclusion that contraction does not matter in the symmetric setting, and demonstrates the invalidity of the IIA axiom in asymmetric bargaining settings. We reject *Hypotheses 1* and *3*, and do not reject *Hypothesis 2*.

It should be noted that regression equation (1) above has been estimated using least

[20]Note that there is no institution dummy for St. Stephen's College in our specification. This is because, the following linear relation always holds:

RankBargaining*RelPos + RandomContraction*RelPos + RankContraction*RelPos = FORE*RelPos + HansRaj*RelPos + Stephens*RelPos.

[21]Female subjects may behave differently from male subjects. See Andreoni and Vesterlund (2001), Chaudhuri and Gangadharan (2007) for examples.

[22]These results persist when we introduce further controls for: education levels attained by the subjects' parents; subjects' home income levels; whether subjects belong to business families; subjects' age; whether subjects lived in hostel etc. The introduction of institution dummies only confirms that subjects from different institutions reacted to treatments with some variation. Students from Hansraj College, for instance were perhaps more serious about the tests than those from the other institutions. In any given pair, the two subjects belonged to the same institution.

squares and includes both sides of the bargaining table in the data set.[23] This violates the assumption that the errors are uncorrelated, and therefore the reported standard errors become questionable. Thus, the inferences drawn so far, are at best naïve. To correct this, we do fixed-effects regression by differencing the data at the pair level. Specifically, for each pair i, if we subtract the share (s_{il}) of the individual without the contraction or a rank advantage from that of the individual (s_{ih}), with either (or both) of those advantages, then the left hand side of the regression equation (1) equals: $\Delta^j Share_{ij} = s_{ih} - s_{il} = s_{ih} - (1 - s_{ih}) = 2s_{ih} - 1$.[24] The right hand side equals: $\alpha_1 RankBarg_i \cdot \Delta^j RelPos_j + \alpha_2 RandmContr_i \cdot \Delta^j RelPos_j + \alpha_3 RankContr_i \cdot \Delta^j RelPos_j + (\Delta^j \mathbf{X}_{ij})\boldsymbol{\beta} + \Delta^j \varepsilon_{ij}$. Now we know that $\Delta^j RelPos_j \equiv 2$, for every pair in each treatment except the in control group.[25] The differenced equation (after some algebraic steps) becomes

$$s_{ih} = 0.5 + \alpha_1 RankBarg_i + \alpha_2 RandmContr_i + \alpha_3 RankContr_i + (\Delta^j \mathbf{X}_{ij})\boldsymbol{\gamma} + u_i \qquad (2)$$

where $u_i = (\Delta^j \varepsilon_{ij}/2)$, and $\boldsymbol{\gamma} = (1/2)\boldsymbol{\beta}$. Note that there is no α_0 in the above regression equation, the constant of which equals 0.5. The fixed-effects regression equation above, therefore expresses the share of the individual (in excess of 0.5) with a rank or a contraction advantage (or both) in terms of which treatment group he/she is a part of. The hypotheses of interest remain the same and Table IIIb presents the results.[26] The results are similar, and for all the specifications, we can conclusively reject *Hypotheses 1* and *3*. We do not reject *Hypothesis 2*. We now have more conclusive evidence that contraction matters only when there is bargaining asymmetry, and not otherwise - but this is not the end of the story.

6.3 The central story

The regressions reported in Tables IIIa and IIIb only suggest that the IIA axiom holds in symmetric bargaining settings and not in asymmetric settings. However, so far, no underlying

[23] That is, if subjects agree on a 62% and 38% split, we include both 0.62 and 0.38 in the regression. Thus, the errors associated with both the subjects in any given pair, will be correlated with each other.

[24] Putting Δ^j before a variable indcates differencing that variable over the index j for any given pair (that is, by holding that pair i, fixed).

[25] This is true since $RelPos = 1$ for the subject with a higher rank or a contraction advantage, and $RelPos = -1$, for his/her partner, and we are looking at the difference between the two.

[26] I am extremely grateful to Prof. Martin Cripps for this entire discussion on looking beyond least-squares regressions. On a closer look, this is one of the rare instances, where using fixed-effects regressions actually eradicates problems related to autocorrelation (rather than contributing to them). Random effects regressions (that account for autocorrelation) and tobit regressions also produce almost identical results to those reported in this paper (with similar test results, and almost identical coefficient values for the significant variables of this paper) and can be made available on request (although neither adds significantly more to the existing discussion on our already established conclusions - we continue to reject Hypotheses 1 and 3, and as before do not reject Hypothesis 2).

mechanism that explains these results has been put forward. Now we turn to this main theme. The regressions ignore a crucial aspect of our experimental bargaining framework that relates to the differences in rankings. To check if the absolute ranks or the rank differences matter, we define a variable RD_i as the (absolute) rank difference between the two subjects in the ith pair. The difference in ranks could be thought of as a measure of the degree of asymmetry between two individuals in a pair. We therefore, define $RD_i = 0$ for pairs belonging to the Control Group and the Random Contraction treatment group. One would expect close to equal splits in pairs with subjects who are very close in rank, and more unequal splits in pairs with subjects who are far apart in rank.[27] Table IV, tests this intuition. Column 1 reports the regression of subjects' observed shares on their individual ranks and Column 2 reports the regression of observed shares on the rank differences between the subjects and the individuals they are paired with. While individually they are significant determinants of observed shares, the effect of individual ranks goes away when we regress observed shares on both (Column 3). We learn that the individual ranks do not matter as much as the differences in ranks (between the two individuals in any given pair) do in the determination of final shares received by individuals. We need to account for this effect of rank differences in our specification.[28] So we modify (1) as under.

$$\begin{aligned} Share_{ij} &= \alpha_0 + \\ &\alpha_1 RankBarg_i \cdot RelPos_j \cdot RD_i + \alpha_2 RandmContr_i \cdot RelPos_j + \\ &\alpha_3 RankContr_i \cdot RelPos_j \cdot RD_i + \mathbf{X}_{ij}\boldsymbol{\beta} + \varepsilon_{ij} \end{aligned} \tag{3}$$

Table Va reports the naïve (least squares) results, and Table Vb reports the fixed-effects regression results for the above equation (for reasons pointed out in the previous section).[29] Column 1 in each reports the basic results, Column 2 controls for institution dummies and Column 3 controls for some personal characteristics. We are interested in the same set of hypotheses (1, 2 and 3).

[27]See for example Dubey and Geanakoplos (2005). Bohnet and Zeckhauser (2004) also provide evidence for social comparisons.

[28]Note that in Panels 1 and 3, there are only 76 observations, whereas in Panel 2, there are 130 observations. This is because only 76 individuals belonged to the treatments that involved ranks and therefore had individual ranks (for the remaining 54, it was missing data). However, rank difference is defined to be zero for those in treatments that did not involve ranks (consistent with our definition of symmetry).

[29]The share of the higher-ranked individual (on an average) in the rank-based bargaining treatment (T1) will be represented by $\alpha_0 + \alpha_1$ if he is only one position ahead of the subject he is paired with. It is $\alpha_0 + 2\alpha_1$ if he is two positions ahead and so on. The idea is exactly the same for the rank-based contraction treatment. The maximum observed rank difference for both the treatments (involving ranks) was 13.

After accounting for rank differences, we see that rank-bargaining still generates asymmetry (as before, we reject *Hypothesis 1* in the specifications of Columns 1, 2 and 3). We also conclude that contraction does not significantly matter in symmetric bargaining. As before, we do not reject *Hypothesis 2* for any of the specifications. Further, we continue to reject *Hypothesis 3*, suggesting that contraction does matter when there is bargaining asymmetry (with F-Statistics equal to 19.80, 28.39, and 14.98 respectively in columns 1, 2 and 3 of Table Vb, and negligible p-values for each just like in the reported chi-squared tests that follow). In fact, the effect of contraction seems to interact with the degree of asymmetry (which we capture in our rank-differences - putting RD_i equal to zero, takes us back to the zero asymmetry condition, where contraction does not matter). We conclude that Nydegger and Owen (1975) established the validity of the axiom of *independence of irrelevant alternatives* in a restricted setup involving no asymmetry. The axiom fails to hold when there are bargaining asymmetries, in the sense that contraction begins to matter. Clearly, from the results of Column 3, we see that when there is no contraction advantage, then the high-ranked individual is expected to get 51.7% of the total pie if he is only one position ahead of his low-ranked partner; he is expected to get 53.3% of the total pie if he is two positions ahead of his low-ranked partner; he is expected to get 55.0% when he is three ranks ahead and so on. The corresponding figures for the high-ranked subject when there is contraction advantage are 53.4%, 56.8% and 60.2% and so on. These simulations for a complete set of observed rank differences are presented in Figure Va (and in Figure Vb, along with 95% confidence intervals). For any given rank difference, the vertical distance between the two lines represents the effect of contraction. We see that the effect of contraction grows with greater degrees of asymmetry (i.e. higher rank differences).

Interestingly, subjects who had to wait for their bargaining session towards the end (since the order in which we ran the treatments was important), tended to gravitate toward more equal splits. This effect has been captured by the significantly negative coefficient of the variable SessionTiming*RelPos in Columns 2 and 3. The experimental lab could only accommodate a limited number of students at one go. The variable $SessionTiming$ takes the value 1 for all the subject-pairs who were the first to be made to bargain in the experimental lab; it takes the value 2 for all subject-pairs who bargained after the previous set of subject-pairs and so on. There is a concern that, due to the not-so-large sample size, observed ranks could be possibly correlated with unobserved ability. This may cause our results to be biased. To account for the possibility of a bias, the math-tests were graded to assign *actual ranks* to subjects who took the test based on their *actual* performance. Figure VI shows that there is no significant correlation between the assigned and the actual ranks.

The variable ARD_i (Column 3) stands for the *actual rank difference* between the subjects in the ith pair. This variable can be thought of as a measure of smartness (and therefore an individual characteristic). One may reason that the generally smarter individuals would tend to get better deals out of their bargaining (simply because they are smarter). The fact that the interaction of the treatment dummies with ARD_i has no significant impact on the final shares leads us to infer that the status effects that generate the asymmetries are in fact, *pure status effects* (actual ranks were not determining final shares).[30] The fact that observed shares are not being determined by actual ranks supports our valid randomization, thereby making our results robust.

Overall, the reported test results display remarkable levels of significance, and all regression models presented in Tables Va and Vb (accounting for rank differences), perform significantly better than those reported in Tables IIIa and IIIb (with much higher values of R-squared). The high values of R-squared are reflective of the level control in the experimental setting.[31] Both the models in Tables III (a and b) and V (a and b) convey the same message about the effects of contraction in symmetric and asymmetric settings.

7 Conclusion

We have established that contraction on its own, has no effect on the bargaining outcome. The effect of contraction, however, emerges with the introduction of asymmetry, and increases with rising degrees of asymmetry. The results established may be relevant to the ideas behind MRPs since they can be thought of a contraction in some cases ... and should therefore matter because consumers and sellers are not necessarily symmetric. The legal fare in the auto-rickshaw market in India could also be thought of as such a contraction. In general, such contractions matter because buyers and sellers are not regarded similar in status (i.e. asymmetries remain). Therefore, from our conclusions, it can be argued that laborers could stand to gain in negotiating wages with firms when they are backed with a minimum wage law (See Comay et al. (1974) for other examples). It must be noted that this paper looks at the effects of only horizontal contractions under asymmetric conditions. There could, in general, be other types of contraction, the effects of which have not been analyzed in this paper. Such contractions may respond differently to different degrees of asymmetry.

To sum up, no asymmetry implies no contraction effect, and the higher the degree of asymmetry, the higher would be the contraction effect. The results of the Nydegger and

[30] Making individuals bargain, based on the disclosure of actual ranks could have given us biased results since actual ranks are correlated with unobserved factors such as ability etc.

[31] As before, random effects and tobit regressions that report almost identical results can be made available on request.

Owen (1975) experiment are subsumed in the results that we report, although with the exact opposite conclusion on the effect of contraction. So far, no theoretical bargaining solution predicts the results we report. An immediate area of theoretical research, therefore, could be towards finding a set of axioms to construct an allocation rule that could possibly explain the observations made in the lab. While, a complete axiomatization accounting for all possible types of contraction may, at the moment, be very difficult, any theoretical construct allowing for the interaction of some forms of contraction with asymmetry effects could be seen as a potential value addition to the existing literature.

8 Appendices

8.1 Appendix 1: Thought experiment

Name:

Group:

Gender:

Please read carefully and answer the questions that follow (you have TEN minutes)

Suppose you were a judge required to split a prize money totalling Rs. 600 among two individuals A and B who took the test you have just taken. You are given information about the performances of A and B in the test. How would you split Rs. 600 if

1. A's rank in the test is 4 and B's rank in the test is 16?

A gets Rs. ______________/- B gets Rs. ______________/-

2. A's rank in the test is 7 and B's rank in the test is 9?

A gets Rs. ______________/- B gets Rs. ______________/-

8.2 Appendix 2: Test Details

A Test of Puzzles

Instructions: You have 25 minutes to complete this test. **There are 10 questions**. Each question (marked 1, 2, 3, etc.) is immediately followed by four options (marked a, b, c, and d). Only one of the options correctly answers the associated question. Your task is to **mark a tick on what you believe to be the correct answer and maximize your score**. Each correct entry carries one point. There is no negative marking. You may begin. All the best.

Name:

Gender (M/F):

Course:

Please leave the following spaces blank.

Time:

Score:

Experimental Reference ID:

1. A three-man jury has two members, each of whom independently has a 60% chance of making the correct decision and a third juror who flips a coin for each decision (majority rules). A one man jury has a 60% chance of making the correct decision. Which of the following is true?

   (a) The three-man jury is better than the one-man jury

   (b) The one-man jury is better than the three-man jury

   (c) Both of them are equally good

   (d) There is no conclusive answer

   This is just a sample question for this draft (in order to comply with the instructed word limit). The complete test can be made available on request.

(a)

8.3 Appendix 3: Working of sample size for the control group

Let the ith pair of shares be (x_1^i, x_2^i), where $x_1^i + x_2^i = 1$. Since $|x_1^i - 0.5| = |x_2^i - 0.5|$, we can define, without loss of generality $Z_i = |x_1^i - 0.5|$. Then let $\bar{Z} = \frac{Z_1 + \ldots + Z_n}{n}$ (where n is the number of observed pairs). $\bar{Z}$ measures the average deviation of the negotiated shares from the equal division solution $(0.5, 0.5)$. Suppose that the population mean of this variable is μ_0. Now, consider the test of the null hypothesis that $\mu_0 = 0$ (i.e. the equal division solution is the population mean). The question is: what would be the minimum sample that is required for such a test to have reasonable power against an alternative hypothesis that the population mean is $\mu_1 > 0$? We consider the alternative hypothesis to be $\mu_1 = 0.02$. It is clear that the sample size that has reasonable power for this alternative hypothesis would also have at least that much power for any $\mu_1 > 0.02$. We make no assumption(s) on the distribution of Z_i (and therefore $\bar{Z}$) under the null or the alternate hypothesis.

Let α be the size of the type-I error. Let c be a non-negative constant such that $P(\bar{Z} - \mu_0 > c | \mu = \mu_0) \leq \alpha$. In other words, the null is rejected whenever $\bar{Z} > \mu_0 + c$. To determine c as a function of α and n, we note the following inequalities.

$$P(\bar{Z} \leq \mu_0 + c) \geq P(\mu_0 - c < \bar{Z} < \mu_0 + c); \ \{\because \text{ LHS spans more values}\}$$

$$P(\mu_0 - c < \bar{Z} < \mu_0 + c) = P(|\bar{Z} - \mu_0| < c) \geq 1 - \frac{\sigma_Z^2}{nc^2}; \ \{\because \text{ Chebyshev's inequality}\}$$

We combine the two inequalities above as follows

$$P(\bar{Z} \leq \mu_0 + c) \geq 1 - \frac{\sigma_Z^2}{nc^2}$$

$$\implies P(\bar{Z} - \mu_0 > c | \mu = \mu_0) \leq \frac{\sigma_Z^2}{nc^2}$$

$$\implies P(\text{Type I error}) \leq \frac{\sigma_Z^2}{nc^2} = \alpha$$

$$\implies c = \frac{\sigma_Z}{\sqrt{\alpha n}} \tag{A3.1}$$

Thus, the probability of a Type I error does not exceed α when $c = \frac{\sigma_Z}{\sqrt{\alpha n}}$. Now we turn to Type II error (which should not exceed β).

$$P(\text{Type II error}) = P(\bar{Z} < \mu_0 + c | \mu = \mu_1)$$

Now $\mu_0 = 0$, and we substitute for c from (A3.1), we get

$$P(\text{Type II error}) = P(\bar{Z} < \frac{\sigma_Z}{\sqrt{\alpha n}} | \mu = \mu_1)$$

Note that for any k, we know from Chebyshev's inequality that

$$P(\mu_1 - k < \bar{Z} < \mu_1 + k | \mu = \mu_1) \geq 1 - \frac{\sigma_Z^2}{nk^2}$$

We now take $k = \mu_1 - \frac{\sigma_Z}{\sqrt{\alpha n}}$ in the above inequality to get

$$P(\underbrace{\frac{\sigma_Z}{\sqrt{\alpha n}}}_{\mu_1 - k} < \bar{Z} < \underbrace{2\mu_1 - \frac{\sigma_Z}{\sqrt{\alpha n}}}_{\mu_1 + k} | \mu = \mu_1) \geq 1 - \frac{\sigma_Z^2}{nk^2} \tag{A3.2}$$

But

$$P(\bar{Z} \geq \frac{\sigma_Z}{\sqrt{\alpha n}} | \mu = \mu_1) \geq P(\underbrace{\frac{\sigma_Z}{\sqrt{\alpha n}}}_{\mu_1 - k} < \bar{Z} < \underbrace{2\mu_1 - \frac{\sigma_Z}{\sqrt{\alpha n}}}_{\mu_1 + k} | \mu = \mu_1); \ \{\because \text{ LHS spans more values}\} \tag{A3.3}$$

On combining the inequalities (A3.2), and (A3.3), we get

$$P(\bar{Z} \geq \frac{\sigma_Z}{\sqrt{\alpha n}} | \mu = \mu_1) \geq 1 - \frac{\sigma_Z^2}{nk^2}$$

$$\implies P(\bar{Z} < \frac{\sigma_Z}{\sqrt{\alpha n}} | \mu = \mu_1) \leq \frac{\sigma_Z^2}{nk^2}$$

$$\implies P(\text{Type II error}) \leq \frac{\sigma_Z^2}{nk^2} = \beta \tag{A3.4}$$

Thus, the probability of a Type II error does not exceed β when $\frac{\sigma_Z^2}{nk^2} = \beta$. Substituting for $k = \mu_1 - \frac{\sigma_Z}{\sqrt{\alpha n}}$, and solving for n we get

$$\implies n = \frac{\sigma_Z^2}{(\mu_1 - \mu_0)^2} \left(\frac{1}{\sqrt{\alpha}} + \frac{1}{\sqrt{\beta}} \right)^2 \tag{A3.6}$$

In this expression, we fix the probabilities of type - I error (α) and type - II error (β) to be 0.05 and 0.10 respectively. We take $\mu_1 = 0.02$. The only limitation is that we do not know the value of σ_Z. To estimate σ_Z, we use a pilot study that had 14 subjects (7 pairs) in the control group. In this sample, $\hat{\sigma}_Z = 0.0075592$. Using this value gives us $n^* = 8.33 \ \approx 9$ pairs (18 subjects). Note that c equals 0.01 for this value of n. In other words, with just 18 subjects, we can be 95% confident that the average outcome is the 50%-50% split (and not a 51%-49% split).

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8.4 Appendix 4: Derivations of the bargaining solutions

The axioms of *symmetry* and *efficiency* together, in the Nash and the Kalai-Smorodinsky bargaining framework, are sufficient to guarantee that X and Y get 50% each (of the pie). To verify this with a specific example, in what follows, we assume that X and Y have utilities $v(x)$ and $v(y)$, with $v \geqq 0$, $v' > 0$ and, $v'' < 0$.[32] Finally, with a transformation $u = v - v(0)$, so that $u(0) = 0$, I assume a zero disagreement-payoff vector. The feasible set of interest is shown in the shaded region of Figure I.

The symmetric Nash solution: This is formulated as follows (ignoring the non-negativity constraint)

$$\begin{aligned} Maximize &: u(x)u(y) \\ Subject\ to &: x + y = 1 \end{aligned}$$

which is the same as the following problem (following a monotonic transformation of the objective function and feeding the constraint into the same)

$$Maximize : \ln[u(x)u(y)] = \ln u(x) + \ln u(1-x)$$

The first order condition is

$$\frac{u'(x)}{u(x)} = \frac{u'(1-x)}{u(1-x)} \tag{A4.1}$$

Now, defining $w(x) = \ln\left(\frac{u'(x)}{u(x)}\right) = \ln u'(x) - \ln u(x)$, so that, w (and hence e^w) is monotonic for $x > 0$, the above equation (A4.1) can be written as $e^{w(x)} = e^{w(1-x)}$. Finally, from the monotonicity of e^w, we get $x = 1 - x$, giving us $x = y = 1/2$.

The symmetric Kalai-Smorodinsky solution: For ease of notation, we write $u(x) = a$, and $u(y) = b$, to transform the (x, y)-plane to the (a, b)-plane. The boundary $x + y = 1$ is therefore, transformed to $u^{-1}(a) + u^{-1}(b) = 1$. The coordinates of the *maximal point* on this plane are given by $(u(1), u(1))$. The equation of the line joining the disagreement payoff $(u(0), u(0)) = (0, 0)$ and the *maximal point* is given by

$$\frac{a-0}{u(1)-0} = \frac{b-0}{u(1)-0} \Rightarrow u(x) = u(y)$$

[32]The functional form of X's utility is identical to that of Y's. This captures the feature that X and Y come from a homogenous population.

feeding the constraint ($y = 1 - x$) into which gives us $u(x) = u(1-x)$, or $x = y = 1/2$ (from the monotonicity of u).

The asymmetric Nash solution: For individual X with a higher bargaining power β, this allocation rule (that puts more weight on agent X's utility), is formulated as follows (ignoring the non-negativity constraint)

$$\begin{aligned} Maximize &: u(x)^{(1+\beta)}u(y) \\ Subject\ to &: x + y = 1 \end{aligned}$$

The first order condition is

$$(1+\beta)\frac{u'(x)}{u(x)} = \frac{u'(1-x)}{u(1-x)}$$

Now, defining $w(x)$ as before, the above condition can be written as $(1+\beta)e^{w(x)} = e^{w(1-x)}$. Since $(1+\beta) > 1$, it follows that $e^{w(x)} < e^{w(1-x)}$. Finally with $w' < 0$, we conclude that $x > 1 - x$, or $x > 1/2$. Thus, the person with a higher bargaining power gets the higher share.

The asymmetric Kalai-Smorodinsky solution: Here, agent X's higher bargaining power

(β) is captured in a different way. This solution concept is explained in Figure II. Transforming the (x, y)-plane to the (a, b)-plane and using the equation of the line joining the disagreement payoff and the *maximal/ideal point* given by

$$\frac{a-0}{(1+\beta)u(1)-0} = \frac{b-0}{u(1)-0} \Rightarrow u(x) = (1+\beta)u(y)$$

leads us to conclude that $u(x) > u(y)$, or $x > y$ (from the monotonicity of u). The constraint $y = 1 - x$ gives us $x > 1 - x$, or $x > 1/2$.

In the specific case where $u(x) = x$, it is well known that both the Nash and the Kalai-Smorodinsky solutions will be given by

$$\arg\max_x x^{1+\beta}(1-x) = \frac{1+\beta}{2+\beta} > \frac{1}{2}. \tag{A4.2}$$

This is a more general solution to the bargaining problem, since if $\beta = 0$ (in (A4.2)), then we get back the symmetric solution.

The symmetric Kalai-Smorodinsky solution with contraction: There is a cap on individual $Y's$ utility equivalent to $u(1-\alpha)$. The coordinates of the *maximal point* on the (a, b)-plane (see Figure III) are given by $(u(1), u(1-\alpha))$. The equation of the line that intersects this point with the disagreement payoff is given by

$$\frac{a-0}{u(1)-0} = \frac{b-0}{u(1-\alpha)-0} \Rightarrow \frac{u(x)}{u(y)} = \frac{u(1)}{u(1-\alpha)} > 1; \ \{\because 1 > 1-\alpha \text{ and } u' > 0\}$$

which gives us $u(x) > u(y)$ or $x > y$. Finally, the constraint $y = 1-x$ gives us $x > 1/2$. That the solution is unique is verified as follows

$$\frac{u(x)}{u(y)} = \frac{u(x)}{u(1-x)} = \frac{u(1)}{u(1-\alpha)}. \tag{A4.3}$$

Now, we define $w(x) = \ln[u(x)/u(1-x)] = \ln u(x) - \ln u(1-x)$, so that w is monotonic for $x > 0$ and (A4.3) can be written as $e^{w(x)} = u(1)/u(1-\alpha)$. The uniqueness of x is immediately verified from the monotonicity of w. It is interesting that the Kalai-Smorodinsky solution is insensitive to power transformations under contraction. To explain this point, let α be a fixed parameter and u be such that $u(x) = x^\gamma$ (with $0 < \gamma < 1$). so that the basic assumptions i.e. $u \geqq 0, u' > 0, u'' < 0$, and, $u(0) = 0$ hold. A well-known property that $\frac{u(x)}{u(y)} = u\left(\frac{x}{y}\right)$ is satisfied. Thus, (A4.3) can be written as

$$u\left(\frac{x}{1-x}\right) = u\left(\frac{1}{1-\alpha}\right)$$

which leads us to the unique solution $x = 1/(2-\alpha)$ given the monotonicity of u, for this general class of utility functions including $u(x) = x$, in which case, the Nash solution is given as

$$Nash : x_N = \begin{cases} 0.5 & ; \text{ for } 0 \leq \alpha < 0.5 \\ \alpha & ; \text{ for } 0.5 \leq \alpha \leq 1 \end{cases} \tag{A4.4}$$

The Kalai-Smorodinsky solution (written below) is, therefore, different from Nash when there is feasible set contraction

$$\textit{Kalai-Smorodinsky} : x_{KS} = \frac{1}{(2-\alpha)}; \forall \alpha \in [0,1] \tag{A4.5}$$

Asymmetric Bargaining in the Presence of Contraction: The Nash solution, with $u(x) = x$ remains as in (A4.2) but the Kalai-Smorodinsky solution changes. Specifically, with $u(x) = x$, it changes to

$$x_{KS} = \frac{1+\beta}{2+\beta-\alpha}. \tag{A4.6}$$

Note again that in the absence of asymmetry ($\beta = 0$), the Kalai-Smorodinsky solution above is identical to the one involving only contraction.

8.5 Instructions to candidates

GENERAL INSTRUCTIONS

Hello and welcome to this experiment. You will receive a sum total of Rs. 125 as a show-up fee for this experiment. This is the minimum amount you will get (provided you stick to the rules of this experiment). In today's session you have to bargain over a sum of Rs. 600 with individuals you will be paired with. Any amount you earn here will be additional earnings. For purposes of confidentiality you will be identified only by your identity (ID) numbers which will be provided to you.

You will be given a form that requests your consent for participating in the experiment. You will have to sign it and return it to us. The amount that is due to you will be filled in after the experiment when we can determine your winnings.

Please raise your hands if you have any questions, otherwise we are ready to move on to the main part of the experiment.

You will now be divided into different groups.

Please come one by one to the computer screen and press 'enter'; and give your names.

(We run the command one by one, on R for each student to hit enter and record their names in the reference sheet T0, T1, T2 or T3 depending on the output.)

Stay in this room (if the output is 0 or 2, signifying T0 or T2 respectively).

Go to the next room (if the output is 1 or 3, signifying T1 or T3; the research assistants guide them to the room).

INSTRUCTIONS TO THE BASELINE TREATMENT GROUP (T0)

Instructions in the waiting room **before** the test

1. Please read the instructions carefully and fill in your details.
2. Your goal is to direct all your efforts towards scoring as high as possible.
3. Do you have any questions? Please raise your hands.
4. You may begin now.

(Test begins.)

(Test is over and answer scripts are collected.)

Instructions in the waiting room **after** the test

1. Each candidate in this group will now be randomly paired with another candidate in this room.
2. You will move to the experimental lab in groups of six (three pairs per session).
3. Once just outside the experimental lab, you will be called in one by one by your names and seated on your allotted workstations.
4. On your workstations, you will get to know your Candidate ID number and the related Skype Username.

5. You will have to **chat** in **English** on **Skype** with the candidate you have been paired with to decide on how to split Rs. 600 between yourselves.

6. You will have only **ten minutes** to complete this conversation.

7. Should you disagree or not reach an agreement in ten minutes, you will be given nothing but the show-up fee; otherwise, you will be given your share in Rs. 600, as negotiated, plus, the show-up fee.

8. You will be asked to report your negotiated amounts and some other details about yourself in the pages that appear after your chat conversation.

9. Do you have any questions? Please raise your hands.

10. More instructions will be given to you once you are in the lab.

Instructions **in the lab**

(Candidates find that the 'Consent and Cash Receipts' are already kept on their workstations. They also see that they have already been logged in to Skype and the chat-windows of the subjects they have been paired with, are also open.)

(Candidates are taken through the first part of the presentation (they retain the hard copies till they have filled in their details) and the following instructions are given.)

1. **Do not disclose your identities**. Any implicit or explicit attempt to do so will lead to the **cancellation** of both the show-up fee and the negotiated amount. Remember your chat histories are saved by us.

2. **Do not misreport your negotiated amounts** in the pages that appear after the chat conversation. Any attempt to do so will lead to the **immediate cancellation** of both the show-up fee and the negotiated amount.

3. Please remember that your responses are confidential and the raw data collected from this experiment will not be given to anyone outside this project.

4. Do you have any questions? Please raise your hands.

5. You may begin now.

(Chatting commences and the candidates finalize their negotiations over Skype.)

(Chatting ends.)

Please fill in your details patiently now.

(The candidates go through the second part of the presentation as they fill in their details - at this stage, the candidates already know their own (negotiated) shares/earnings.)

(Once the total amount is displayed on the candidates' screens, we make them fill up, and sign the receipts, and pay them accordingly.)

INSTRUCTIONS TO THE RANK BARGAINING TREATMENT GROUP (T1)

Instructions in the waiting room **before** the test

1. Please read the instructions carefully and fill in your details.
2. Your goal is to direct all your efforts towards scoring as high as possible.
3. Do you have any questions? Please raise your hands.
4. You may begin now.

(Test begins.)

(Test is over and answer scripts are collected.)

Instructions in the waiting room **after** the test and **before** the thought experiment

1. Your tests will now be evaluated.
2. You will all now do a thought experiment which you have ten minutes to complete.

(Subjects individually work on their thought experiments.)

(The thought experiment sheet are collected.)

Instructions in the waiting room **after** the thought experiment

1. Your tests have now been evaluated.
2. Based on your test performances, you have all been ranked.
3. Each candidate in the top half will be randomly paired with a candidate in the bottom half.

(instructions 4-12 below are the same as 2-10 in the baseline treatment above.)

4-12. (can be made available on request)

Instructions **in the lab**

(Candidates find that the 'Consent and Cash Receipts' are already kept on their workstations. They also see that they have already been logged in to Skype and the chat-windows of the subjects they have been paired with, are also open.)

(Candidates are taken through the first part of the presentation (they retain the hard copies till they have filled in their details) and the following instructions are given.)

1. **Do not disclose your identities**. Any implicit or explicit attempt to do so will lead to the **cancellation** of both the show-up fee and the negotiated amount. Remember your chat histories are saved by us.
2. **Do not misreport your negotiated amounts** in the pages that appear after the chat conversation. Any attempt to do so will lead to the **immediate cancellation** of both the show-up fee and the negotiated amount.
3. Please remember that your responses are confidential and the raw data collected from this experiment will not be given to anyone outside this project.
4. Do you have any questions? Please raise your hands.
5. You may begin now.

(Chatting commences and the candidates finalize their negotiations over Skype.)

(Chatting ends.)

Please fill in your details patiently now.

(The candidates go through the second part of the presentation as they fill in their details - at this stage, the candidates already know their own (negotiated) shares/earnings.)

(Once the total amount is displayed on the candidates' screens, we make them fill up, and sign the receipts, and pay them accordingly.)

INSTRUCTIONS TO THE RANDOM CONTRACTION TREATMENT GROUP (T2)

Instructions in the waiting room **before** the test

(these are same as the instructions in the baseline treatment.)

Instructions in the waiting room **after** the test

(these are same as the instructions in the baseline treatment.)

Instructions **in the lab**

(Candidates find that the 'Consent and Cash Receipts' are already kept on their workstations. They also see that they have already been logged in to Skype and the chat-windows of the subjects they have been paired with, are also open.)

(Candidates are taken through the first part of the presentation (they retain the hard copies till they have filled in their details) and the following instructions are given.)

1. In each pair, one of the **randomly selected** subjects has been awarded a star. The subject he/she (i.e. the starred individual) is paired with cannot get more than 60% (i.e. Rs. 360) of the total Rs. 600. The starred individual can get any amount provided there is agreement (we remind Point No. 7 in the instructions after the test for the control group).

(We then discuss two examples.)[33]

2. If you have a star on your workstation, then you are the starred subject in your pair. Otherwise, your partner is the starred subject in your pair.

3. **Do not disclose your identities**. Any implicit or explicit attempt to do so will lead to the **cancellation** of both the show-up fee and the negotiated amount. Remember your chat histories are saved by us.

[33] Let us discuss a few examples to make this clear. Are the following splits acceptable?

Rs. 200 for the starred individual and Rs. 400 for his/her partner?

Rs. 400 for the starred individual and Rs. 200 for his/her partner?

4. **Do not misreport your negotiated amounts** in the pages that appear after the chat conversation. Any attempt to do so will lead to the **immediate cancellation** of both the show-up fee and the negotiated amount.

5. Please remember that your responses are confidential and the raw data collected from this experiment will not be given to anyone outside this project.

6. Do you have any questions? Please raise your hands.

7. You may begin now.

(Chatting commences and the candidates finalize their negotiations over Skype.)

(Chatting ends.)

Please fill in your details patiently now.

(The candidates go through the second part of the presentation as they fill in their details - at this stage, the candidates already know their own (negotiated) shares/earnings.)

(Once the total amount is displayed on the candidates' screens, we make them fill up, and sign the receipts, and pay them accordingly.)

INSTRUCTIONS TO THE RANK CONTRACTION TREATMENT GROUP (T3)

Instructions in the waiting room **before** the test

(these are same as the instructions in the rank bargaining treatment)

Instructions in the waiting room **after** the test and **before** the thought experiment

(these are same as the instructions in the rank bargaining treatment)

Instructions in the waiting room **after** the thought experiment

(these are same as the instructions in the rank bargaining treatment)

Instructions **in the lab**

(Candidates find that the 'Consent and Cash Receipts' are already kept on their workstations. They also see that they have already been logged in to Skype and the chat-windows of the subjects they have been paired with, are also open.)

(Candidates are taken through the first part of the presentation (they retain the hard copies till they have filled in their details) and the following instructions are given.)

1. In each pair, the **higher-ranked** subject has been awarded a star. The subject he/she (i.e. the starred individual) is paired with cannot get more than 60% (i.e. Rs. 360) of the total Rs. 600. The starred individual can get any amount provided there is agreement (we remind Point No. 7 in the instructions after the test for the control group).

(We then discuss two examples)[34]

[34] Let us discuss a few examples to make this clear. Are the following splits acceptable?

2. If you have a star on your workstation, then you are the starred subject in your pair. Otherwise, your partner is the starred subject in your pair.

3. **Do not disclose your identities**. Any implicit or explicit attempt to do so will lead to the **cancellation** of both the show-up fee and the negotiated amount. Remember your chat histories are saved by us.

4. **Do not misreport your negotiated amounts** in the pages that appear after the chat conversation. Any attempt to do so will lead to the **immediate cancellation** of both the show-up fee and the negotiated amount.

5. Please remember that your responses are confidential and the raw data collected from this experiment will not be given to anyone outside this project.

6. Do you have any questions? Please raise your hands.

7. You may begin now.

(Chatting commences and the candidates finalize their negotiations over Skype.)

(Chatting ends.)

Please fill in your details patiently now.

(The candidates go through the second part of the presentation as they fill in their details - at this stage, the candidates already know their own (negotiated) shares/earnings.)

(Once the total amount is displayed on the candidates' screens, we make them fill up, and sign the receipts, and pay them accordingly.)

Rs. 200 for the starred individual and Rs. 400 for his/her partner?
Rs. 400 for the starred individual and Rs. 200 for his/her partner?

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9 Tables

Table I: Summary of the treatments

	Control Group	Rank Bargaining	Random Contraction	Rank Contraction
Test	Yes	Yes	Yes	Yes
Asymmetry/Rank	No	Yes	No	Yes
Contraction	No	No	Yes	Yes
Feasible Set	Figure I.	Figure I.	Figure III.	Figure III.
Zero-Disagreement	Yes	Yes	Yes	Yes

Table IIa: Descriptive statistics by treatment

	Control Group	Rank- Based Bargaining	Random Contraction	Rank Contraction
Observations	20	38	34	38
Mean Share	0.500	0.500	0.500	0.500
Standard Deviation	0.027	0.117	0.053	0.176
Minimum Share	0.417	0.250	0.300	0.125
Maximum Share	0.583	0.750	0.700	0.875
Mean Share (RelPos = 1)	n.a.	0.587	0.516	0.636
Mean Share (RelPos = -1)	n.a.	0.413	0.484	0.364
No. of Males	13	21	19	16

Table IIb: Share distribution by personal characteristics

	No. of Observations	Mean Share	Standard Deviation	Minimum Share	Maximum Share
Female	61	0.504	0.120	0.233	0.767
Male	69	0.496	0.115	0.125	0.875
Business Background	51	0.502	0.095	0.125	0.767
Other Background	79	0.498	0.145	0.167	0.875
Low Income ($<$ Rs. 2.5 Lakhs)	19	0.500	0.108	0.250	0.700
High Income ($>$ Rs. 10.0 Lakhs)	39	0.507	0.085	0.233	0.767
Post Graduate Father	53	0.517	0.109	0.250	0.875
Post Graduate Mother	46	0.501	0.121	0.167	0.875
Hostel Experience	67	0.513	0.087	0.300	0.833

Table IIIa: The effect of contraction on bargaining outcomes

Dependent Variable: Share	(1)	(2)	(3)
	Least Squares	Least Squares	Least Squares
RankBargaining*RelPos	0.0868***	0.0652***	0.0651***
	(0.0126)	(0.0163)	(0.0164)
RandomContraction*RelPos	0.0162*	-0.0108	-0.0109
	(0.0087)	(0.0131)	(0.0132)
RankContraction*RelPos	0.1364***	0.1098***	0.1101***
	(0.0178)	(0.0175)	(0.0177)
FORE*RelPos		0.0235	0.0232
		(0.0160)	(0.0162)
HansRaj*RelPos		0.0676***	0.0682***
		(0.0204)	(0.0208)
Gender (Male = 1)			0.0022
			(0.0133)
GenderOfOpponent (Male = 1)			-0.0022
			(0.0133)
Constant	0.500***	0.500***	0.500***
	(0.0068)	(0.0066)	(0.0118)
F ($\alpha_1 = \alpha_3$)	F(1, 126) = 5.16	F(1, 90) = 5.10	F(1, 88) = 5.01
(P-Value for F-Statistic)	(0.0248)	(0.0257)	(0.0270)
Observations	130	130	130
R-squared	0.567	0.605	0.605

Notes: Least squares estimates. Robust standard errors are in parentheses.

***, ** and * indicate significance at the 1, 5 and 10% levels respectively.

Table IIIb: The effect of contraction on bargaining outcomes

Dependent Variable: Share	(1)	(2)	(3)
	Fixed Effects	Fixed Effects	Fixed Effects
RankBargaining*RelPos	0.0868***	0.0652***	0.0651***
	(0.0126)	(0.0146)	(0.0147)
RandomContraction*RelPos	0.0162	-0.0108	-0.0109
	(0.0134)	(0.0168)	(0.0132)
RankContraction*RelPos	0.1364***	0.1098***	0.1101***
	(0.0126)	(0.0166)	(0.0168)
FORE*RelPos		0.0235	0.0232
		(0.0167)	(0.0169)
HansRaj*RelPos		0.0676***	0.0682***
		(0.0197)	(0.0200)
Gender (Male = 1)			0.0022
			(0.0135)
Constant	0.500***	0.500***	0.500***
	(0.0068)	(0.0066)	(0.0118)
Chi-Squared test for ($\alpha_1 = \alpha_3$)	$\chi^2(1) = 7.68$	$\chi^2(1) = 6.45$	$\chi^2(1) = 6.39$
(P-Value for χ^2-Statistic)	(0.0056)	(0.0111)	(0.0114)
Observations	65	65	65
R-squared	0.567	0.605	0.605

Notes: Fixed effects estimates. Robust standard errors are in parentheses.
***, ** and * indicate significance at the 1, 5 and 10% levels respectively.

Table IV: Effect of individual ranks and rank differences

Dependent Variable: Share	(1)	(2)	(3)
	Least Squares	Least Squares	Least Squares
IndividualRank	-0.0224***		2.42e-11
	(0.0038)		(0.0042)
RD*RelPos		0.0187***	0.0187***
		(0.0019)	(0.0028)
Constant	0..640***	0.500***	0.500***
	(0.0251)	(0.0063)	(0.0245)
Observations	76	130	76
R-squared	0.402	0.630	0.671

Notes: Least squares estimates. Robust standard errors are in parentheses.
***, ** and * indicate significance at the 1, 5 and 10% levels respectively.

Table Va: Effect of contraction accounting for rank differences

Dependent Variable: Share	(1)	(2)	(3)
	Least Squares	Least Squares	Least Squares
RankBargaining*RelPos*RD	0.0128***	0.0171***	0.0166***
	(0.0018)	(0.0024)	(0.0024)
RandomContraction*RelPos	0.0162*	0.0196	0.0164
	(0.0087)	(0.0136)	(0.0138)
RankContraction*RelPos*RD	0.0270***	0.0363***	0.0340***
	(0.0018)	(0.0018)	(0.0033)
SessionTiming*RelPos		-0.0179***	-0.0175***
		(0.0039)	(0.0039)
FORE*RelPos		0.0427***	0.0433***
		(0.0151)	(0.0159)
HansRaj*RelPos		0.1206***	0.1219***
		(0.0193)	(0.0191)
Stephens*RelPos		0.0204	0.0242
		(0.0230)	(0.0231)
Gender (Male = 1)			0.0019
			(0.0087)
GenderOfOpponent (Male =1)			-0.0019
			(0.0087)
RankBargaining*RelPos*ARD			0.0008
			(0.0013)
RankContraction*RelPos*ARD			-0.0024
			(0.0028)
Constant	0.500***	0.500***	0.500***
	(0.0055)	(0.0041)	(0.0088)
F ($\alpha_1 = \alpha_3$)	F(1, 126) = 31.22	F(1, 122) = 68.22	F(1, 118) = 28.59
(P-Value for F-Statistic)	(0.0000)	(0.0000)	(0.0000)
Observations	130	130	130
R-squared	0.723	0.846	0.848

Notes: Least squares estimates. Robust standard errors are in parentheses.
***, ** and * indicate significance at the 1, 5 and 10% levels respectively.

Table Vb: Effect of contraction accounting for rank differences

Dependent Variable: Share	(1)	(2)	(3)
	Fixed Effects	Fixed Effects	Fixed Effects
RankBargaining*RelPos*RD	0.0128***	0.0171***	0.0166***
	(0.0021)	(0.0029)	(0.0031)
RandomContraction*RelPos	0.0162	0.0196	0.0164
	(0.0152)	(0.0208)	(0.0216)
RankContraction*RelPos*RD	0.0270***	0.0363***	0.0340***
	(0.0024)	(0.0038)	(0.0051)
SessionTiming*RelPos		-0.0179***	-0.0175***
		(0.0056)	(0.0058)
FORE*RelPos		0.0427*	0.0433*
		(0.0248)	(0.0254)
HansRaj*RelPos		0.1206***	0.1219***
		(0.0295)	(0.0302)
Stephens*RelPos		0.0204	0.0242
		(0.0352)	(0.0362)
Gender (Male = 1)			0.0037
			(0.0184)
RankBargaining*RelPos*ARD			0.0008
			(0.0016)
RankContraction*RelPos*ARD			-0.0024
			(0.0035)
Constant	0.500***	0.500***	0.498***
	(0.0078)	(0.0060)	(0.0115)
F ($\alpha_1 = \alpha_3$)	F(1, 62) = 19.80	F(1, 58) = 28.39	F(1, 55) = 14.98
(P-Value for F-Statistic)	(0.0000)	(0.0000)	(0.0003)
Chi-Squared test for ($\alpha_1 = \alpha_3$)	$\chi^2(1) = 40.24$	$\chi^2(1) = 59.72$	$\chi^2(1) = 32.15$
(P-Value for χ^2-Statistic)	(0.0000)	(0.0000)	(0.0000)
Observations	65	65	65
R-squared	0.723	0.846	0.848

Notes: Fixed effects estimates. Robust standard errors are in parentheses.
***, ** and * indicate significance at the 1, 5 and 10% levels respectively.

Figure I: The Feasible Set

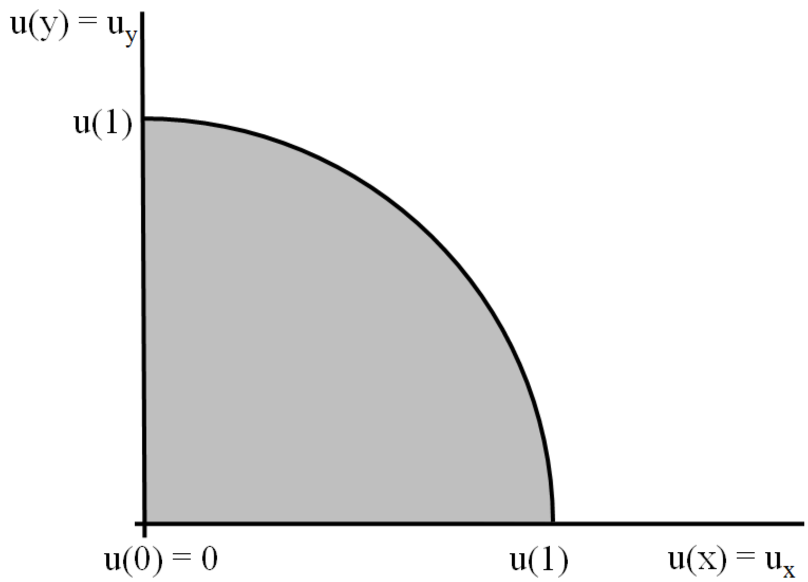

Figure II: The Asymmetric Kalai-Smorodinsky Solution

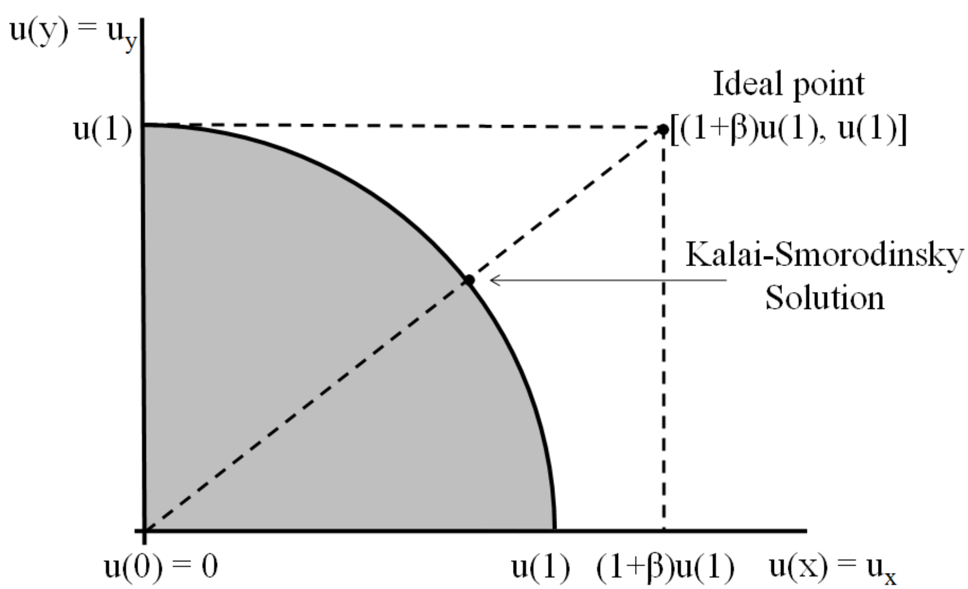

Figure III: The Feasible Set with Contraction

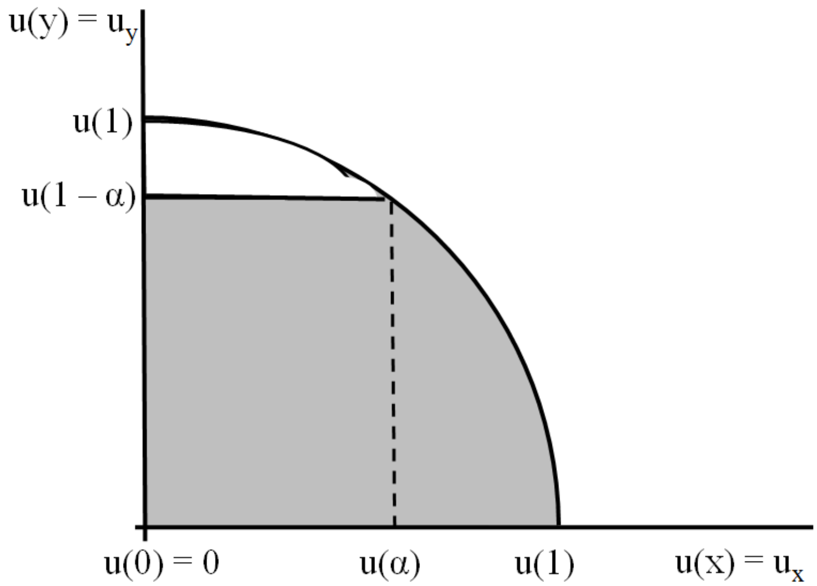

Figure IV: A Summary of Treatments

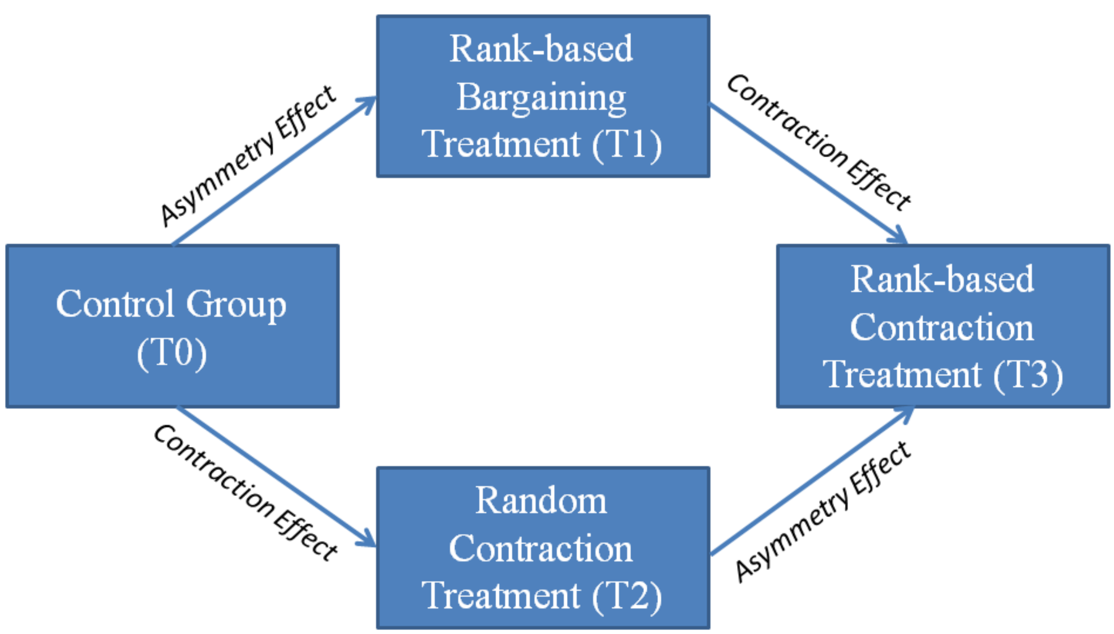

Figure Va: A Simulation

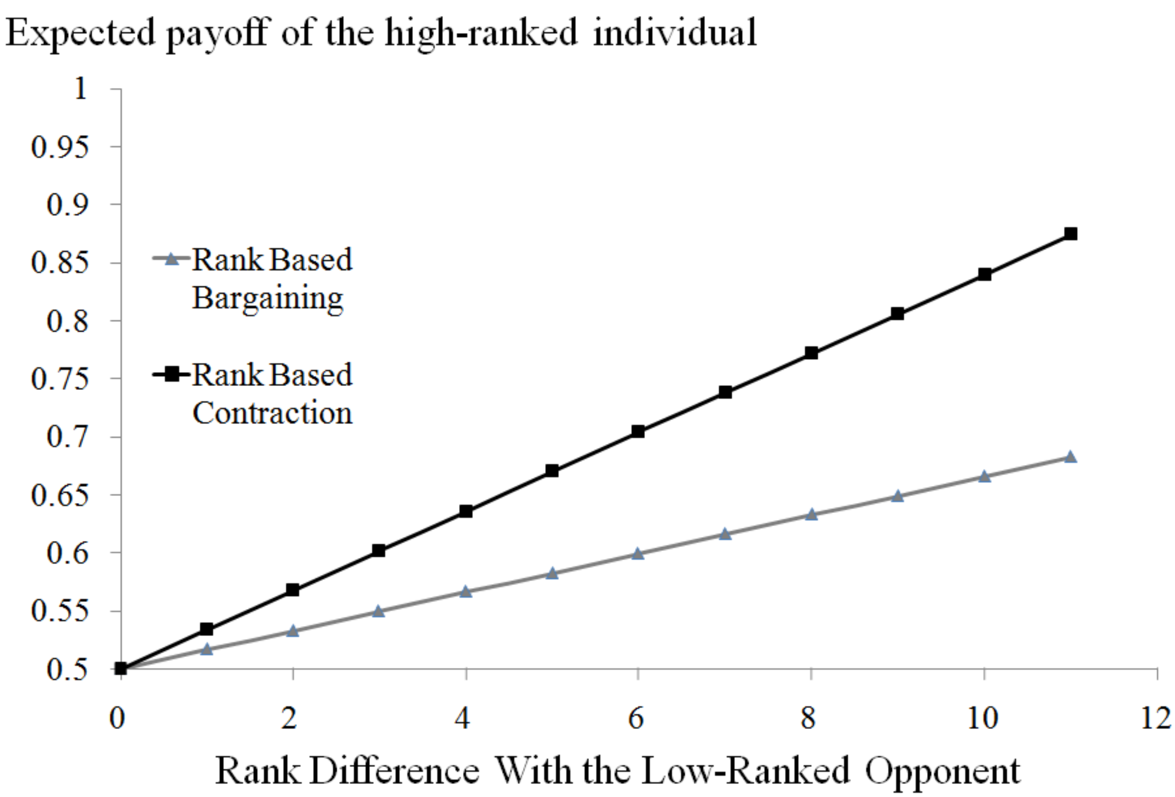

Figure Vb: A Simulation

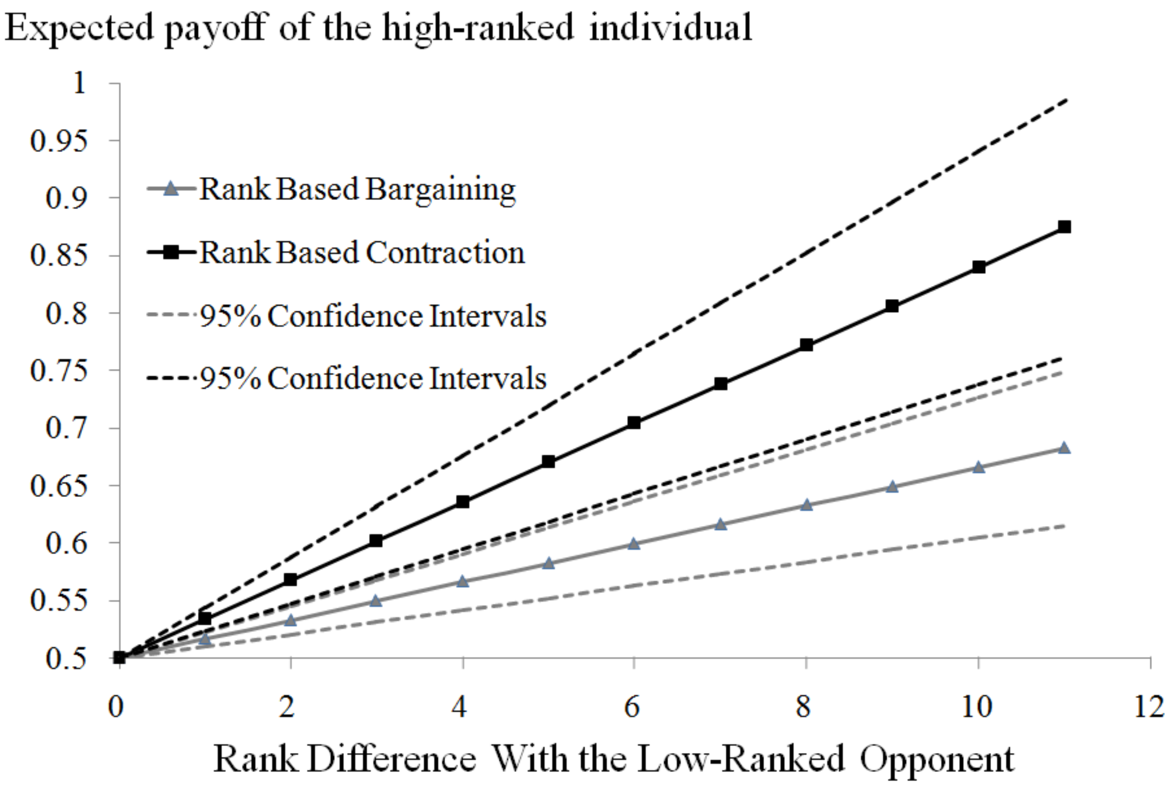

Figure VI: Relation between Actual Rank and Assigned Rank