MONASH BUSINESS SCHOOL

DEPARTMENT OF ECONOMICS

ISSN 1441-5429

DISCUSSION PAPER 21/16

How fully do people exploit their bargaining position? The effects of bargaining institution and the 50–50 norm

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Abstract:

A recurring puzzle in bargaining experiments is that individuals under–respond to changes in their bargaining position, compared to the predictions of standard bargaining theories. This result has been observed in a variety of settings, but there has been little systematic study of the factors associated with higher or lower responsiveness.We conduct a complete–information bargaining experiment using two institutions – the Nash demand game (NDG) and a related unstructured bargaining game (UBG) – and with bargaining power varied via the disagreement outcome. Importantly, in about one–fourth of bargaining pairs, one player's disagreement payoff is more than half the cake size; in these cases, 50–50 splits are not individually rational. We find that subjects are least responsive to changes in bargaining position in the NDG with both disagreement payments below half the cake size. Responsiveness is higher in the UBG, and in the NDG when one disagreement payment is more than half the cake, but in both cases it is still less than predicted. It is only in the UBG with a disagreement payment more than half the cake that responsiveness reaches the predicted level. Our results imply that the extent to which actual bargaining corresponds to theoretical predictions will depend on (1) the institutions within which bargaining takes place, and (2) the distribution of bargaining power, in particular, whether the 50–50 norm yields a plausible focal point. We construct and analyse a simple model that characterises our main results.

Journal of Economic Literature classifications: C78, C72, D81.
Keywords: Nash demand game; unstructured bargaining; real effort; equal split; experiment.

*Corresponding author. Financial support from Deakin University is gratefully acknowledged. Some of this research took place while Feltovich was at University of Aberdeen. We thank John Boyd III, Emin Gahramanov, Lata Gangadharan, Philip Grossman, Glenn Harrison, H°akan Holm, Sobei H. Oda, Randy Silvers, Robert Slonim, and participants at several conferences and seminars for helpful suggestions,with special thanks to Lata Gangadharan for providing the z–Tree program that we modified to create our real–effort task.

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1 Background

Bargaining is pervasive. Even in Western societies, where haggling over small purchases has been de–emphasised, the selling prices of large goods (e.g., new and used cars, houses) are often determined at by bargaining. Employees' compensation packages are also frequently the result of bargaining at either the group level (for unionised jobs) or the individual level (in many professional labour markets). In order to understand how markets work – especially whether, and at what price(s), trade takes place – we must understand bargaining.[1]

A fundamental principle of bargaining is that outcomes depend on bargaining power. Even before bargaining settings were thought of as leading to precise predictions, it was generally understood that the division of surplus would depend on the two parties' relative bargaining positions (Edgeworth, 1881). Later axiomatic bargaining solution concepts (e.g., Nash, 1950; Kalai and Smorodinsky, 1975) formalised this dependence and quantified it by specifying a precise outcome – the bargaining solution – based on the most important features of the environment. Even non–cooperative game–theoretic approaches to bargaining, which may yield a multiplicity of theoretical predictions, can narrow these down to a unique prediction with only minor additional assumptions. With a unique prediction comes a well–defined comparative–static relationship between features of the bargaining environment and that prediction. In particular, specified changes to the bargaining position of one player relative to the other will have particular implications for the bargaining outcome.

Whether these theoretical implications are seen in real bargaining is an empirical question. Previous experimental work suggests that bargainers are less responsive to changes in bargaining position than predicted, and in particular, the social norm of 50–50 splits of the "cake" (the amount being bargained over) seems to exert a powerful pull on outcomes. (See Section 3 for a review of the relevant literature.) While the extent of this under–responsiveness varies widely across studies, there has been surprisingly little systematic examination of the factors associated with it: in what settings do people tend to exploit their bargaining power to a greater or lesser degree, how much impact do individual aspects of the bargaining setting have, and are there any settings where theoretically predicted levels of exploitation should be expected?

The goal of the current paper is to improve understanding of how bargaining outcomes are shaped by players' bargaining positions. We use a laboratory experiment, allowing us to maintain, in two important ways, a high degree of control over the environment relative to observational studies from the field. First, we are able to standardise the rules under which bargaining takes place, in contrast to field studies that must aggregate bargaining outcomes from heterogeneous and perhaps imperfectly understood bargaining institutions. Second, we give the subjects complete information about the cake size and *disagreement payoffs* (the amounts they get if bargaining is unsuccessful), so that we, and the subjects, know the theoretical prediction for any particular bargaining pair.

We implement differences in bargaining position via the disagreement outcome, so that it can vary nearly continuously over a wide range of possible levels, in contrast to many earlier studies that varied bargaining power in lumpier ways (e.g., first– versus second–mover, number of stages of bargaining, endogenous versus random breakdown). Bargaining theory displays a remarkable amount of consensus regarding the predicted effect of the disagreement outcome. All of the most common axiomatic bargaining solutions – as well as those non–cooperative techniques that yield unique solutions – have exactly the same implication for this setting: a unit increase in one's own disagreement payoff implies a one–half unit *increase* in one's own payoff as a result of bargaining, while a unit

[1]As an example of the importance of bargaining in determining market outcomes, many researchers have suggested that male–female wage gaps are at least partly due to sex differences in willingness or ability to bargain; see, e.g., Stuhlmacher and Walters (1999), Small et al. (2007) and Fortin (2008).

increase in one's opponent's disagreement payoff implies a corresponding one–half unit *decrease*.[2] We call these the *own–disagreement–payoff effect* and *opponent–disagreement–payoff effect*, and their sum – a measure of overall responsiveness to bargaining position – the *combined [disagreement–payoff] effect*.

Subjects in our experiment bargain under one of two bargaining institutions, both widespread in bargaining experiments and in theoretical modelling of the bargaining process. In the *Nash (1953) demand game* (NDG), bargaining consists of a single pair of simultaneously–made demands. If these total the cake size or less, then each bargainer receives the amount demanded; otherwise they receive their disagreement payoffs. In the *unstructured bargaining game* (UBG), bargainers are given a known time interval, during which either one can make proposals for splitting the cake; the first accepted proposal is implemented. If no proposal is accepted before the time runs out, the bargainers receive their disagreement payoffs.

Although the distribution of bargaining power in our experiment is typically asymmetric due to the bargainers having different disagreement payoffs, the two institutions themselves are symmetric in the sense that neither bargainer is given a structural advantage (in contrast, for example, to the ultimatum game or Rubinstein (1982) bargaining, both of which favour the first mover). However, the two institutions have markedly different levels of strategic uncertainty, resulting in a much more severe coordination problem in the NDG than the UBG; previous research (Feltovich and Swierzbinski, 2011) has found this not only leads to fewer agreements in the NDG, but for agreements to gravitate toward 50–50 splits of the cake. Because of this, we hypothesise that subjects will be less responsive to changes in their bargaining power in that game than in the UBG. That is, disagreement–payoff effects should be *higher in the UBG than in the NDG*.

Our variation of the disagreement outcome gives rise to another set of hypotheses involving the 50–50 split. About one–fourth of the time, one of the bargainers has a disagreement payoff more than half of the cake size; we call this *dominant bargaining power*. When an individual has dominant bargaining power, agreeing to a 50–50 split involves an actual monetary sacrifice, which should make it much less attractive compared to situations where neither bargainer has dominant bargaining power (in which case a 50–50 split may still involve accepting a smaller gain relative to the disagreement payoff than one's co–bargainer, but not an outright money loss). With the focal power of the 50–50 split gone, we expect that subjects will be drawn toward alternative focal points like equal sharing *of the surplus* (the remainder of the cake after both disagreement payoffs are subtracted) that entail disagreement–payoff responsiveness equal to the theoretically predicted level. That is, disagreement–payoff effects are expected to be *higher with dominant bargaining power than without it*.

A notable feature of our experimental procedures is the use of earned bargaining power. Specifically, subjects' disagreement payoffs, rather than being assigned by the experimenter, are based on performance on a simple but repetitive "real effort" task (described in Section 4.1). We conjecture that this has two advantages. First, it is probably more realistic: a disagreement payoff in real bargaining – being the value of the best alternative to agreement – is often the result of past decisions, effort, and intrinsic abilities. Second, making subjects earn their bargaining power ought to nudge them toward more fully exploiting it, reducing the attraction of the 50–50 split and increasing responsiveness to disagreement payoffs. Our experiment is novel, as there have been very few bargaining studies that vary bargaining power nearly continuously through a large range of levels, few in which bargaining power depends on skill and effort, few where individually rational 50–50 splits can be ruled out, and to our knowledge, none with all of these features.

Our main result is that responsiveness to earned disagreement payoffs indeed depends on: (1) the bargaining

[2] Thomson (1987) analyses how various axiomatic bargaining solutions vary with the disagreement outcome for more general bargaining problems with two or more agents.

institution; and (2) whether either subject has dominant bargaining power. When subjects bargain in the NDG and neither of them has dominant bargaining power, we observe severe under–responsiveness. In the UBG with no dominant bargaining power, subjects are substantially more responsive than in the NDG, but still less so than theory predicts. When one bargainer does have dominant bargaining power, by contrast, own– and opponent–disagreement–payoff effects are significantly larger. In the NDG, this increase still leaves responsiveness below the theoretically predicted level. In the UBG, however, the increase leads to a level of responsiveness in line with the theory. Thus it takes the combination of a bargaining institution with low levels of strategic uncertainty and elimination of the 50–50 "security blanket" for bargaining behaviour to yield outcomes like those predicted by the theory.

We close the paper by describing an alternative theoretical model in which the population comprises two behavioural types that have been considered in the literature before: one group that strongly dislikes disadvantageous payoff inequity, and another group that strongly dislikes failing to improve payoff beyond the disagreement outcome. We show (see Section 6 for details) that this model is capable of characterising our two main results. Because the model is quite stylised, we make no claims as to its literal truth. However, it serves to illustrate the extent to which compelling focal points (in this case, 50–50 splits) can limit exploitation of bargaining power.

2 The bargaining environment

There is a fixed sum of money (a *cake*) available to the players, which we normalise to one. Negative payments are not possible, so a feasible agreement is a non–negative pair totalling one or less. If bargaining is unsuccessful, the players receive *disagreement payoffs*; the *favoured player* receives d_f and the *unfavoured player* receives d_u, with $d_f \geq d_u \geq 0$ and $d_f + d_u < 1$. The values of d_f and d_u (and the cake size of one) are assumed to be common knowledge.

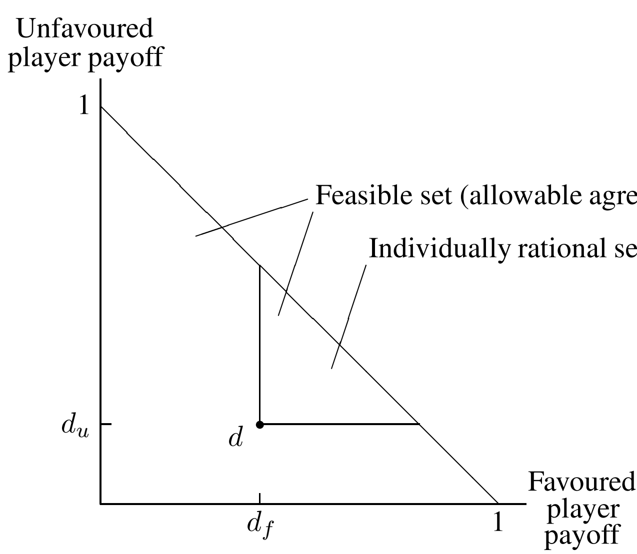

Figure 1: The bargaining environment

2.1 Nash demand game (NDG)

In the Nash (1953) demand game, bargaining consists of a single pair of simultaneously made demands x_f and x_u by the favoured and unfavoured players respectively. If the demands are compatible ($x_f + x_u \leq 1$), then each player receives the amount demanded (with any remainder left "on the table"). If the demands are incompatible ($x_f + x_u > 1$), then they receive their disagreement payoffs.

The NDG is simple enough to be analysed by standard non–cooperative techniques, but the result is not a unique prediction. Rather, if Nash equilibrium is the solution concept used, there is a large number of solutions, including (a) efficient pure–strategy equilibria in which $x_f \geq d_f$, $x_u \geq d_u$ and $x_f + x_u = 1$, leading to payoffs (x_f, x_u); (b) inefficient pure–strategy equilibria in which $x_f > 1 - d_u$ and $x_u > 1 - d_f$, with resulting payoffs (d_f, d_u); and (c) inefficient mixed–strategy equilibria with expected payoffs totalling less than 1 but more than $d_f + d_u$.

Equilibrium selection criteria such as payoff dominance or efficiency can reduce the set of equilibria, eliminating the inefficient equilibria mentioned above. Harsanyi and Selten's (1988) criterion of *risk dominance*, as well as their general solution concept for non–cooperative games, go even further. Both make the unique prediction that players split the surplus (the remainder after disagreement payoffs are subtracted from the cake) evenly: $x_f = \frac{1}{2}(1+d_f-d_u)$ and $x_u = \frac{1}{2}(1 - d_f + d_u)$.[3] The same prediction is entailed by combining payoff dominance (or efficiency) with a notion of symmetry defined relative to the individually rational set (rather than the entire bargaining set).

2.2 Unstructured bargaining game (UBG)

In the unstructured bargaining game, players have a fixed, known amount of time available to negotiate a mutually agreeable division of the cake. Either player can propose any feasible payoff pair. There is no constraint (other than the time available) on the number, ordering and timing of proposals that can be made, and the cake size remains the same until the time runs out. Either player can accept any opponent proposal (i.e., proposals cannot be withdrawn); the first accepted proposal is implemented. (In case both players accept proposals at the same instant, each is implemented with probability one–half.) If no proposal is accepted before the time limit, the disagreement outcome is imposed.

The UBG is too complex to be analysed by standard non–cooperative game–theoretic methods unless additional assumptions are imposed.[4] Instead, we make use of techniques from cooperative game theory. These techniques say little about the precise strategies used by the two players, but they have implications about what the outcome of bargaining is. The *core* predicts that the division of the cake corresponds to an efficient Nash equilibrium outcome ($x_f \geq d_f$, $x_u \geq d_u$ and $x_f + x_u = 1$), but makes no sharper prediction. Axiomatic bargaining solution concepts can refine this multiplicity of predicted outcomes to a unique one; however, they require an assumption about the relationship between monetary payments and payoffs. If the relationship is proportional (risk neutrality), then the outcome of every well–known axiomatic bargaining solution (including the Nash and Kalai–Smorodinsky solutions) coincides, with $x_f = \frac{1}{2}(1 + d_f - d_u)$ and $x_u = \frac{1}{2}(1 - d_f + d_u)$.

[3] Risk dominance (Harsanyi and Selten, 1988) formalises the intuitive notion that when players have little information about the choices others will make, they will prefer strategies that are (in some sense) less risky. In the simplest case of a symmetric game with exactly two symmetric strict Nash equilibria (s, s) and (t, t), (s, s) is risk dominant if the threshold probability of the opponent choosing s at which s becomes a best response is lower than the corresponding threshold probability for t. In their text, Harsanyi and Selten extend this intuition for general non–cooperative games. Their general solution concept (presented in the same text), while different in that payoff dominance is prioritised over risk dominance, yields the same result here, since the risk dominant outcome is efficient and hence not payoff dominated by any feasible outcome.

[4] See Simon and Stinchcombe, 1989; Perry and Reny, 1993, 1994; and de Groot Ruiz et al., 2010 for non–cooperative game–theoretic analyses of unstructured bargaining using various additional assumptions.

2.3 Disagreement–payoff effects

So, the prediction of Nash equilibrium (with the additional assumptions of either risk dominance or efficiency and symmetry) for the NDG, and the predictions of the well–known axiomatic bargaining solutions for both the NDG and the UBG, all imply the same outcome:

$$x_f = \frac{1}{2}(1 + d_f - d_u) \quad \text{and} \quad x_u = \frac{1}{2}(1 - d_f + d_u). \tag{1}$$

This solution implies

$$x_f - x_u = d_f - d_u \tag{2}$$

(the difference in the bargainers' payoffs from bargaining is equal to the difference between their disagreement payoffs), or equivalently, $x_f - d_f = x_u - d_u$ (bargainers gain equal amounts over their disagreement payoffs). Also, it implies a sharp theoretical prediction concerning the relationship between the individual disagreement payoffs and the bargaining outcome:

$$\frac{\partial x_f}{\partial d_f} = \frac{\partial x_u}{\partial d_u} = \frac{1}{2} \tag{3}$$

$$\frac{\partial x_f}{\partial d_u} = \frac{\partial x_u}{\partial d_f} = -\frac{1}{2}. \tag{4}$$

That is, both the "own–disagreement–payoff effect" and the "opponent–disagreement–payoff effect" have magnitudes of 0.5.

An obvious corollary is that the sum of these magnitudes (the "combined [disagreement–payoff] effect") is one:

$$\left|\frac{\partial x_f}{\partial d_f}\right| + \left|\frac{\partial x_f}{\partial d_u}\right| = \left|\frac{\partial x_u}{\partial d_f}\right| + \left|\frac{\partial x_u}{\partial d_u}\right| = 1. \tag{5}$$

Indeed, even some bargaining solutions that do not imply own– and opponent–disagreement–payoff effects of one–half still imply that their combined effect is exactly one (e.g., the generalised Nash solution that maximises the expression $[x_f - d_f]^\theta [x_u - d_u]^{1-\theta}$ for given $\theta \in [0, 1]$). Also, Anbarci and Feltovich (2013) show that when bargainers are risk averse with (possibly different) constant absolute risk aversion preferences, both risk dominance and the Nash bargaining solution imply a combined effect of exactly one, and if either has constant relative risk aversion preferences instead, the combined effect is at least one.

3 Related literature

We will not go into detail here regarding the huge literature on bargaining experiments in general (for surveys, see Roth, 1995 and Camerer, 2003, pp. 151–198). Despite this expansive literature, there has been very little research into the effects of disagreement outcomes in particular.[5] What previous work there has been has usually varied disagreement outcomes as a "side–treatment", in conjunction with some other manipulation intended to address the

[5] In addition to the research discussed here, there is also a small literature (Kahn and Murnighan, 1993; Binmore et al., 1998; Oosterbeek, Sonnemans and van Velzen, 2003; Feltovich and Swierzbinski, 2011) looking into the effects of varying *outside options* in bargaining settings. Outside options differ from disagreement payoffs in that they must be chosen in lieu of bargaining, rather than being available afterwards in the event bargaining fails; they therefore represent less bargaining power than a comparable disagreement payoff. Despite this distinction, typical findings in this literature are similar to those found in experiments with disagreement payoffs. Subjects often make minimal use of their bargaining power, with 50–50 splits common except when the outside option is larger than half of the cake, in which case the favoured player receives the outside option or slightly more (the "deal me out" outcome).

primary research question. Hoffman and Spitzer (1982) examined unstructured bargaining games with (in essence) a fixed, known cake size and one of two randomly chosen disagreement outcomes.[6] Disagreement outcomes were very asymmetric: approximately (0.79, 0) and (0, 0.83) in their "Decision 1" and (0.81, 0.08) and (0, 0.85) in their "Decision 2". Hoffman and Spitzer found a substantial frequency of equal splits of the cake, even though such splits require some bargainers to agree to payments well below their disagreement payoffs. Their results taken at face value would suggest that dominant bargaining power has little influence on bargaining outcomes; however, this may carry little implication for our experiment, due to the lack of anonymity in their procedures (not only did their experiment use face–to–face bargaining, but subjects reaching agreement were required to jointly sign a record sheet).

With equal splits frequently occurring even in settings like Hoffman and Spitzer's, where they are not individually rational (and thus not an equilibrium outcome), it is perhaps not surprising that a strand of the literature has been devoted specifically to the focal nature of equal splits in bargaining. Besides the well–known phenomena of 50–50 splits in ultimatum and dictator games (Roth, 1995, pp. 254–292; Camerer, 2003, pp. 48–59) and in symmetric bargaining games (see Note 10), there have been several recent experiments showing large differences in behaviour according to whether 50–50 splits are available. Güth, Huck and Müller (2001) considered binary ultimatum games where proposers have only two pure strategies: a demand of 85% of the cake and, depending on the treatment, 45%, 50% or 55%. They found that demands of 85% were substantially less frequent when the alternative was 50% (a proposal of an equal split) than when the alternative was either of the other two demands. Falk, Fehr and Fischbacher (2003), also looking at binary ultimatum games, found that responders reject demands of 80% of the cake much more often when the proposer's alternative was a 50% demand than when the alternative was a 100% demand, a 20% demand or another 80% demand. Levati, Nicholas and Rai (2014) elicit preference orderings over outcomes for second movers in a trust game, and dictators in a dictator game, and find that when 50–50 splits are an available option, these subjects are much more likely to submit preferences that are non–single–peaked (and thus inconsistent with own–monetary–payoff maximisation as well as nearly all standard models of other–regarding preferences). Janssen (2006) discusses 50–50 splits as a focal point in both the ultimatum game and the Nash demand game, while Andreoni and Bernheim (2009) present examples of the 50–50 norm in the field and report experimental results suggesting that subjects conform to this norm more closely when deviations can be attributed to themselves (rather than luck).

There is also a rich theoretical literature examining the effects of introducing a small amount of incomplete information into the environment: namely, a low but positive probability that one's opponent is "irrationally" or "obstinately" unwilling to accept any offer below some threshold amount.[7] (See, for example, Myerson, 1991; Abreu and Gul, 2000; Compte and Jehiel, 2002; and Atakan and Ekmekci, 2012, all of which involve obstinate types who are "born" with their non–negotiable demands.) Such a model involving obstinate types, applied to our bargaining environment, predicts a preponderance of roughly 50–50 splits (and more generally, lower responsiveness to disagreement payoffs than under common knowledge of more standard preferences), as long as neither side has dominant bargaining power.

The first bargaining experiment with "earned" bargaining power was Hoffman and Spitzer's (1985) follow–up

[6]In their setup, an agreement involved bargainers settling on one of a small number of payment pairs, but side–payments were allowed; thus, under some weak assumptions, one can consider their bargaining set to have a fixed cake size. Rather than directly implementing disagreement outcomes, Hoffman and Spitzer assigned one of the bargainers the role of "controller"; in the case of disagreement, the controller unilaterally imposed one of the payment pairs. Assuming that controllers in this situation would always choose the most favourable payment pair, this was equivalent to randomly choosing one of two disagreement outcomes.

[7]Here, "irrational" is used in the popular sense, to indicate extreme obstinacy. It is not meant to imply that such behaviour is inconsistent with economic rationality, since clearly, refusal to accept less than a threshold amount can satisfy completeness and transitivity.

to their 1982 study. In some of their cells, favourable bargaining position was assigned randomly, while in others, it was assigned based on performance in a game of skill. Perhaps surprisingly, the way favoured status was assigned had only a minor effect; rather, their data indicate that in order for subjects to exploit their bargaining position, it must be that both (1) bargaining power is perceived by subjects to be earned (their "game trigger" treatment), and (2) instructions make clear that exploiting bargaining power is acceptable behaviour (their "moral authority" treatment), with the latter more important than the former. However, even with *both* a game trigger and moral authority, the favoured player's average payoff from bargaining was still less than her disagreement payoff, though as before, the lack of subject anonymity in the experiment may limit applicability to our study.

Since Hoffman and Spitzer, effort and/or skill have been used in several papers to allocate bargaining roles, typically for ultimatum or dictator games (Hoffman et al., 1994; Schurter and Wilson, 2007; Bolton and Karagözoğlu, 2014). In these bargaining settings, under–responsiveness to changes in bargaining position arises naturally from theoretical predictions being on opposite endpoints of the outcome space, but even so, the evidence is fairly mixed about the impact of earned bargaining power. For example, Schurter and Wilson (2007) found dictator–game offers were *lower* when the dictator position is assigned via a quiz than via a die roll, but they were lower still when it was assigned on the basis of seniority (number of credit hours completed or attempted). Other experiments have used effort and/or skill for reasons other than allocating bargaining power: e.g., to determine the cake size (Ruffle, 1998; Konow, 2000; Cherry et al., 2002; Parrett, 2006; Oxoby and Spraggon, 2008; Karagözoğlu and Riedl, 2013; Birkeland, 2011; Corgnet et al., 2011) or to give one bargainer "moral authority" to receive a larger share of the cake (Gächter and Riedl, 2005; Karagözoğlu and Riedl, 2013; Bolton and Karagözoğlu, 2014). It is worth noting that much of the recent work in this strand of the literature did not explicitly test tasks versus luck (as we also do not). Rather, at this point the consensus seems fairly well established that subjects take their decisions more seriously when some aspect of the setting has been "earned", and real–effort tasks (and related devices like quizzes) have now become part of the experimental economist's tool–box, without the need to re–evaluate them in every new setting.

Separately, a small literature has emerged looking at how bargaining outcomes depend on bargaining positions based on exogenous disagreement outcomes, varied systematically through multiple values.[8] Fischer, Güth and Pull (2007) examine a variant of the NDG, where players simultaneously submit an ambitious demand x_i and a (typically smaller) fallback demand g_i. They receive their ambitious demands if they are compatible; if not, they each get their fallback demand if these are compatible, or disagreement payoffs d_i if not. (We alter their notation somewhat, to parallel ours.) Their main research question was how behaviour in this game compared with behaviour in an ultimatum game, but they used eleven disagreement outcomes with perfect negative correlation between own and opponent disagreement payoffs. This correlation prevents separate measurement of own– and opponent–disagreement–payoff effects, but one can still compute the combined effect. On average, their NDG results imply that $|\partial x_i/\partial d_i| + |\partial x_i/\partial d_{-i}| \approx 0.38$ and $|\partial g_i/\partial d_i| + |\partial g_i/\partial d_{-i}| \approx 0.41$: that is, observed responsiveness to disagreement outcomes was roughly two–fifths of the theoretical prediction.[9]

[8]There is an earlier literature in which bargaining position was varied; see, for example, Binmore et al. (1991) and Ochs and Roth (1989). Like Hoffman and Spitzer (1982), these studies tended to manipulate bargaining power only through a small number of discrete cells (though "small" is a relative term, since Kahn and Murnighan's (1993) 2x2x2x2x2 design had 16 different equilibrium payoff predictions). A consistent result is that subjects fail to fully exploit their bargaining power, though the extent to which they do so varies tremendously across experiments. For example, a one–unit increase in a subject's predicted payoff was associated with only a 0.07–unit increase in her observed payoff in Ochs and Roth's experiment, as compared to an increase of two–thirds of a unit in Binmore et al.'s.

[9]Harrison (1987) also varies disagreement payoffs in an unstructured bargaining game, but with perfect *positive* correlation between disagreement payoffs; his "Type 1 game" has a disagreement outcome of (0, 0), while in his "Type 3 game", both players receive equal positive payments in case of disagreement.

Finally, Anbarci and Feltovich (2013) had subjects bargaining in either the NDG or the UBG, with disagreement payoffs varying from 5% to 45% of the cake, and drawn randomly in each round. They found that in the NDG, the own–disagreement–payoff effect $|\partial x_i/\partial d_i|$ was about 0.2 and the opponent–disagreement–payoff effect $|\partial x_i/\partial d_{-i}|$ was slightly lower, yielding a combined effect roughly comparable to Fischer, Güth and Pull's (2007). In the UBG, both effects were about 0.3 – significantly more than in the NDG, but still only about 60% of the predicted level.

4 The experiment

In our experiment, subjects' disagreement payoffs were determined based on their performance on a real–effort task. The task itself is described next, with some details of its implementation and other aspects of the experimental procedures discussed in Section 4.2, followed by hypotheses in Section 4.3.

4.1 The real–effort task

The task, adapted from the one used by Erkal et al. (2011) to suit our design, was computerised and qualitatively similar for all subjects in the experiment. A sample screen–shot is shown in the appendix. The basic unit of the task was the encoding of a sequence of 2–9 letters (a "word") into numerals, based on a key displayed on the computer screen for the entirety of the task. Below each letter was a blank space; to encode the word, the subject needed to type the numeral corresponding to each letter in the space below it, then click a button once the word was finished. If the word was encoded correctly, it was accepted and the word was replaced by a new word. If the word was encoded incorrectly, an error message stated the incorrectly–encoded letter (or the first, if there were multiple errors), and the subject could go back and make changes as desired.

At the beginning of a round, a sequence of 400 letters was randomly drawn (with replacement); each letter had an equal chance of being chosen for any given place in the sequence. At the same time, the key – a permutation of $(1, 2, ..., 26)$ – was randomly chosen from the set of all such permutations. Thus, both the key and the sequence of letters changed from round to round, though both were common to all subjects within a round of a session. Our use of a random sequence of letters means that the vast majority of our "words" were not actual words (in contrast with Erkal et al.'s task, which used a deterministic list of English words); this was done in order that subjects would not be privileged based on their ability to read English. Drawing a new key and sequence of letters in each round of each session was done in order to minimise differences across rounds due to memorisation.

Variation in task difficulty across rounds and subjects was accomplished by varying the lengths of the words. Each subject in each round was given words of changing lengths, drawn i.i.d. from a distribution that was fixed for that subject and round. At the beginning of a session, each subject was assigned a type (advantaged or disadvantaged) that remained fixed throughout the session. Both types of subject faced an easy and a hard version of the task; the four distributions are shown in Table 1. Note that for each type, the hard version of the task contained longer words, in the sense of first–order stochastic dominance, than the easier version. However, the advantaged player was always advantaged; even the disadvantaged/easy distribution contained longer words than the advantaged/hard distribution.

Assigning an easier version of the task to one subject in a pair than the other serves an important function in the experiment: it decreases the likelihood that the subjects will have equal or nearly equal disagreement payoffs. This matters because many previous experiments have shown symmetric bargaining games to have an extremely strong tendency toward 50–50 splits of the cake, and even when a small amount of asymmetry is present, the 50–50

Table 1: Real–effort task – distributions of word lengths

Type	Task version	Probability of word length 2	3	4	5	6	7	8	9	Expected word length
Advantaged	Easy	0.2	0.4	0.2	0.1	0.1	0	0	0	3.5
	Hard	0	0.2	0.4	0.2	0.1	0.1	0	0	4.5
Disadvantaged	Easy	0	0	0.1	0.1	0.2	0.4	0.2	0	6.5
	Hard	0	0	0	0.1	0.1	0.2	0.4	0.2	7.5

norm provides a powerful focal point that can affect what outcome the pair does reach.[10] Varying the difficulty within–subject allows a greater degree of variability of disagreement payoffs for individual subjects.

Relatedly, this design feature allows the difficulty of the task to be set so that one bargainer has a reasonable chance of earning a disagreement payoff more than 50% of the cake (so that equal splits are not individually rational, and hence not consistent with equilibrium) without a corresponding risk that both bargainers will do so (meaning that there would be no gains to agreement). We go even further by dividing the subjects into two fixed types, advantaged and disadvantaged players, with the former *always* having an easier version of the task, and thus likely to have a higher disagreement payoff than their opponents in *every* bargaining round. If subjects expected to have a favourable bargaining position in some rounds but not in others, they might be amenable to more equal splits of the cake in rounds where they have the better position, on the grounds that they expect to make up for this in rounds where they have the worse position.[11]

Except for an initial one–minute practice round, subjects were allotted five minutes in each round for the task. At the beginning of this time, a word length k_i^1 was drawn randomly from the relevant distribution for subject i. That subject's first word would be made up of letters 1 through k_i^1 of the sequence that had been drawn for that round. When that word was correctly encoded, a new word length k_i^2 was drawn, independently of the previous word length, and the subject's second word would comprise letters $k_i^1 + 1$ through $k_i^1 + k_i^2$ of the sequence. In a similar way, the subject's j–th word was made up of the first k_i^j letters that had not been used yet. Thus, all subjects in a session faced the same sequence of letters; it was only the way the sequence was broken up into words that varied across subjects.

We would like to remark that implementing disagreement outcomes via real–effort tasks rather than exogenously – while possibly having the advantage that subjects internalise them to a greater extent – is not costless. One obvious cost of having disagreement payoffs depend on performance in the task is that the experimenter loses a modicum of control over these disagreement payoffs. Fischer, Güth and Pull (2007) and Anbarci and Feltovich (2013) were able to specify the exact disagreement outcomes subjects faced (in the former paper) or the exact distribution from which these outcomes were drawn (in the latter). In the current paper, we are unable to do so, since the outcomes depend on subjects' behaviour. Indeed, even with the substantial difference in difficulty between the advantaged player's and disadvantaged player's tasks, we cannot guarantee that within a bargaining pair, the advantaged player will have

[10] See Nydegger and Owen (1975) and Roth and Malouf (1979) for experimental comparisons of symmetric and asymmetric bargaining.

[11] On the other hand, Binmore, Shaked and Sutton (1985) found the opposite effect – giving subjects experience in both bargaining roles can mitigate other–regarding preferences – while Bolton (1991) found no difference in behaviour between sessions with changing roles and those with fixed roles. Brandts and Charness (2011, pp. 393–394) provide a brief survey of "role reversal" in general experimental settings, and conclude that there is little evidence of any systematic effect.

the favoured bargaining position.

A second disadvantage concerns the time subjects spend on the real–effort task, which is time they are not spending on the bargaining game. The five minutes in each round allocated to the task itself, along with another half–minute for related aspects such as feedback, carry an opportunity cost of two to three rounds of bargaining in the UBG, or four to five rounds in the NDG. This has two negative implications: fewer data points of bargaining for a given length of session (and thus, roughly speaking, for a given budget for subject payments), and less opportunity for subjects to acquire experience in the bargaining task, leading to a higher variance in the data and more outliers (though on the plus side, the smaller number of rounds in our experiment implies higher stakes per bargaining round, so that subjects might be expected to take their decisions more seriously). Both of these implications complicate comparisons to previous studies that used endowed bargaining power.

Finally, there is no guarantee that our use of a real–effort task will succeed in getting subjects to view their bargaining power as earned. As we will discuss in the next section, we made the differences in task difficulty (within and between subjects) as opaque as possible, in an attempt to get subjects to view their bargaining power as arising from skill and effort rather than luck. However, it is possible that especially clever subjects could infer the role that luck played in determining their disagreement payoffs. It is also possible that some subjects may have considered the task itself to be sufficiently contrived that bargaining power based on performance on it would never be viewed as being earned. However, since we do not vary whether disagreement payoffs are earned, neither of these potential issues would result in a loss of control. At worst, our experiment would reduce to a test of bargaining institution and dominant bargaining power with *endowed* rather than earned bargaining power.

4.2 Experimental design and procedures

Sessions consisted of ten rounds, plus an initial practice round (round 0) with no bargaining and no effect on subjects' payments. Rounds 1–10 were split into five two–round blocks; within each block, one round comprised task followed by bargaining, while the other consisted of the task only but was otherwise identical, allowing for a comparison of task performance with and without a subsequent bargaining round (see Appendix A). In half of the sessions, bargaining took place in the even–numbered non–practice rounds, and in the other half of sessions, bargaining took place in the odd–numbered rounds (see Table 2). The cake size was always £10, and a subject's disagreement payoff

Table 2: Experimental design and session information

Cell	Bargaining game	Rounds in which bargaining took place	Matching–group sizes	Subjects
NDG–odd	NDG	1, 3, 5, 7, 9	6, 6, 6, 6, 8, 8	40
NDG–even		2, 4, 6, 8, 10	6, 6, 6, 8, 10, 12	48
UBG–odd	UBG	1, 3, 5, 7, 9	6, 6, 8, 8, 8, 10	46
UBG–even		2, 4, 6, 8, 10	6, 6, 6, 8, 8, 8	42

in all bargaining rounds was £0.15 for each word correctly encoded in that round. (In rounds with no bargaining, this amount became the subject's payoff for the round.)

Each session comprised one or more *matching groups* that were closed with respect to interaction (advantaged subjects in a particular group interacted only with disadvantaged subjects in the same group), so that data from different matching groups can be considered statistically independent of each other. Random assignment to roles (advantaged/disadvantaged) and matching groups took place before the practice round; these were fixed for the entire session.

Sessions took place at the Scottish Experimental Economics Laboratory (SEEL) at the University of Aberdeen. Subjects were primarily undergraduate and masters–level students from University of Aberdeen, and were recruited using the ORSEE software (Greiner, 2015) from a database of people expressing interest in participating in economics experiments. No one took part more than once. The experiment was run on networked personal computers, and was programmed using the z–Tree software package (Fischbacher, 2007). Subjects were asked not to communicate with other subjects except via the computer program.

At the beginning of a session, subjects were seated in a single room and given written instructions; these instructions were also read aloud in an attempt to make the rules of the game common knowledge.[12] Once the instructions were read and questions answered, subjects were given a few demographic questions to answer.[13] After all subjects had submitted their answers, the practice round began.

Subjects were randomly paired in each bargaining round, with each opposite–type subject in the same matching group equally likely (a two–population protocol). No identifying information was given about opponents, in an attempt to minimise incentives for reputation building and other supergame effects. Also, to reduce demand effects, rather than using terms like "opponent" or "partner" for the other player, we used the neutral though somewhat cumbersome "player matched to you" and similar phrases.

Each round began with a screen displaying instructions for the real–effort task, which were also shown during the task itself. After a few seconds, the task would begin. The task difficulties in each round are shown in Table 3. Notably, while we used no deception in the experiment, we did not provide specific information to subjects about

Table 3: Real–effort task difficulty by round

Round(s)	Task difficulty		Time allotted
	Advantaged player	Disadvantaged player	(seconds)
0 (practice)	Hard	Hard	60
1–2	Hard	Hard	300
3–4	Hard	Easy	300
5–6	Easy	Easy	300
7–8	Easy	Hard	300
9–10	Hard	Easy	300

how task difficulty varied within– or between–subjects. The only information they received was the sequence of words they faced in each round, and in bargaining rounds, the opponent's number of words encoded (from which clever subjects might have been able to infer some information about others' task difficulty).

Rounds without bargaining ended after the time allotted for the task had run out, with a feedback screen displaying the number of words the subject had correctly encoded, as well as the subject's payoff of £0.15 per word.

[12]Sample instructions are shown in Appendix B. The remaining sets of instructions, as well as the raw data from the experiment, are available from the corresponding author upon request.

[13]We do not use the responses to these questions in our analysis of bargaining outcomes, but in Appendix A we look at their ability to explain performance in the real–effort task.

In rounds with bargaining, after the task finished, subjects were informed of the number of words they and their opponent had encoded, and the corresponding disagreement payoffs of £0.15 per word; they were also reminded of the cake size of £10. After viewing their disagreement outcome, subjects in the NDG treatment were prompted to choose their demands. Demands were required to be whole–number multiples of £0.01, between zero and the cake size inclusive.[14] End–of–round feedback comprised own and opponent words encoded and disagreement payoffs, own and opponent demands, whether agreement was reached, and own and opponent payoffs. Previous rounds' results were collected into a history table at the top of the computer screen; this could be reviewed at any time. After all subjects clicked a button on the screen to continue, the session proceeded to the next round.

In the UBG cells, subjects were given a 120–second "negotiation stage" (130 seconds in the first block) to reach agreement on a division of the cake. (See the appendix for a sample screen.) Subjects could make as many or as few proposals as they wished during the 120 seconds; a proposal consisted of a nonnegative multiple of £0.01 for the sender and one for the receiver, adding up to the cake size or less. There were no other constraints on proposals; e.g., later proposals did not have to be more generous than earlier ones, and it was not necessary to wait for the opponent to counter before making the next proposal. Proposals could not be withdrawn once made, and no messages were possible apart from the proposals.[15] Both own and opponent proposals were displayed on the subject's screen (in separate areas); it was not possible to view proposals for other pairs of subjects. As long as the negotiation stage hadn't ended, a subject could choose to accept any of the opponent's proposals, at which time that proposal would become binding. The opponent's proposals were listed in order of increasing payoff to the subject, so there was almost no cognitive effort required to determine the most favourable opponent proposal (it was always at the bottom of the list), though subjects were free to accept less favourable proposals if they wished. The negotiation stage ended if a proposal was accepted, if either subject in a pair chose to end it (by clicking a button on the screen), or if the time had expired without an accepted proposal; in these latter two cases, the disagreement outcome was imposed. In either case, end–of–round feedback comprised own and opponent words encoded and disagreement payoffs, whether agreement was reached, and own and opponent payoffs. As in the NDG, previous results were also available in a history table.

At the end of round 10, the session ended and subjects were paid, privately and individually. For each subject, two bargaining rounds and two task–only rounds were randomly chosen, and the subject was paid his/her earnings in those four rounds. There was no show–up fee. Total earnings averaged £19.40 for favoured subjects (with a standard deviation of £2.96) and £13.34 for unfavoured subjects (with a standard deviation of £2.17), for a session that typically lasted about 90–100 minutes (including about 10 minutes devoted to instructions, and another 10 minutes for other administration such as collecting consent forms).

[14]Our restriction of NDG demands and UBG proposals to hundredths of a pound, necessitated by the discreteness of money, has minor effects on theoretical predictions. In particular, when the sum of disagreement payoffs is an odd number of pence, there is no longer a unique prediction according to symmetry, risk dominance and the axiomatic bargaining solutions; instead, there will be two distinct predictions, differing by one penny, and instead of each player receiving exactly half of the surplus, each receives half of the surplus plus/minus £0.005. For example, for a disagreement outcome of (£3.00, £3.15), all of these concepts predict agreements of either (£4.93, £5.07) or (£4.92, £5.08).

[15]Our prohibition of cheap talk, and the restriction of negotiation to computers rather than face–to–face interaction, were intended to maintain anonymity between bargainers in the experiment. This is important, as removing this anonymity opens up the possibility of side–payments or threats outside the laboratory. However, we acknowledge that lack of anonymity can be an important feature of some real bargaining situations. We also note that a side consequence of both of these design choices is they keep the level of social distance between the bargainers relatively high. Some research (e.g., Hoffman, McCabe and Smith, 1996; Bohnet and Frey, 1999; Rankin, 2006) has found that lower levels of social distance are associated with a greater prevalence of other–regarding behaviour.

4.3 Hypotheses

Our null hypotheses can be summarised as follows:

Hypothesis 0 *For both games, and irrespective of the distribution of bargaining power between the players, demands and payoffs respond fully to changes in the disagreement outcome.*

That is, a one–unit increase in a player's *own* disagreement payoff is associated with a one–half–unit increase in that player's demand and payoff, and a one–unit increase in the player's *opponent's* disagreement payoff is associated with a one–half–unit decrease in that player's payoff. These are the implications of standard theory, as described in Section 2.3 (see Equations 3 and 4). The obvious alternative hypothesis, based on the usual finding in the literature of under–responsiveness to bargaining power (see Section 3), is

Hypothesis 1 *For both games, and irrespective of the distribution of bargaining power between the players, demands and payoffs under–respond to changes in the disagreement outcome.*

That is, a one–unit increase in a player's own disagreement payoff is associated with a *smaller–than*–one–half–unit increase in that player's demand and payoff, and a one–unit increase in the opponent's disagreement payoff is associated with a *smaller–than*–one–half–unit decrease in that player's payoff.

In addition, we conjecture about the effects of the bargaining institution and the distribution of bargaining power. In regard to the former, some researchers (e.g., Skyrms, 1996; Binmore, 2007) have argued that the NDG already captures the important features of bargaining environments, which would imply that the more complex structure of the UBG adds nothing of strategic importance; that is, outcomes ought to be similar under the two institutions. On the other hand, Feltovich and Swierzbinski (2011) argued that the higher level of strategic uncertainty in the NDG should lead to different outcomes compared to the UBG, and in their experiment they find some differences in the types of agreements reached, with more agreements close to the 50–50 split in their analogue to the NDG than in their analogue to the UBG. This result implies the following hypothesis for the current study:

Hypothesis 2 *Responsiveness to changes in the disagreement outcome will be* higher *in the UBG than in the NDG.*

Regarding the latter, we conjecture that while the attraction of the 50–50 split tends to be strong in bargaining experiments, this power will be sharply reduced when the favoured player has a disagreement payoff more than one–half of the cake size (*dominant bargaining power*). In this case, the 50–50 split is no longer an equilibrium outcome, and is therefore lost as a potential focal point. As a result, the power of alternative focal points – most notably, the theoretical prediction – should increase correspondingly. This gives rise to our last hypothesis:

Hypothesis 3 *Responsiveness to changes in the disagreement outcome will be* higher *when the favoured player has dominant bargaining power than when neither player does.*

5 Experimental results

We had twenty–four matching groups – six for each cell (NDG–odd and –even; UBG–odd and –even) – with a total of 176 subjects (see Table 2).[16] Hence, our experimental design is perfectly counterbalanced at the group level, so we are able to pool the –odd and –even cells within each game when we use group–level data. However, due

[16]Three pilot sessions were conducted earlier, in order to test the program, verify the instructions were understandable, and calibrate the real–effort task. The results from the pilots are not discussed here.

to variability in show–up rates across sessions, not all matching groups were the same size, so our design is not counterbalanced at the individual level, and we will have to include controls for game and ordering when we use individual–level data.

As in Section 2, we express quantities like demands, payoffs, and disagreement outcomes as fractions or percents of the cake size. We concentrate on four sub–samples of the experimental data–set. In the NDG, each subject makes a single demand, which may or may not lead to agreement. Our first sub–sample will comprise all bargaining pairs in the NDG (we will often call this "NDG–all") – giving us one demand for each member of the pair, for all NDG pairs over all rounds. Our second sub–sample is a subset of the first, comprising only the demands of those pairs reaching agreement; this is our "NDG–agreements" sub–sample. (Note that in both NDG and UBG, demand conditional on agreement is by definition equal to payoff conditional on agreement.)

In the UBG, each subject may make a single proposal, multiple proposals, or no proposals at all. Each proposal made by a subject could be interpreted as a demand by that subject. Moreover, a subject's acceptance of an opponent proposal, and even failure to accept a proposal, can be construed as carrying information about demands. Inferring a single demand from all of a subject's behaviour in a UBG round thus necessarily carries a big subjective element. To minimise this subjectivity in analysing our data–set, we classify UBG demands based on unambiguous rules. Our "UBG–agreements" sub–sample is straightforward. We interpret each accepted proposal in the UBG as a pair of compatible demands; if a pair does not reach an agreement, it is left out of this sub–sample. Our "UBG–all" sub–sample includes these demands, but additionally, in cases where agreement was not reached, we examine the sequence of proposals and counter–proposals to find the *lowest* amount each bargainer proposed for him/herself. If this lowest amount exists (i.e., if the subject made at least one proposal), this was taken to be the demand. If a subject made no proposals and did not accept an opponent proposal, that subject was left out of this subsample. (This happened only once in 440 UBG observations.) Our use of both "–all" and "–agreements" sub–samples is mainly for robustness's sake; in nearly all of the following analysis, results are qualitatively and quantitatively very similar whichever sub–sample is used.

5.1 Preliminaries

Table 4 presents some statistics about the real–effort task, and hence disagreement outcomes. In about 5.5% of pairs,

Table 4: Real–effort task statistics (bargaining rounds)

		Task difficulties (advantaged/disadvantaged player)				
		Easy/Easy	Easy/Hard	Hard/Easy	Hard/Hard	Total
Number of pairs	in total	88	88	176	88	440
	with d_i lower for advantaged player	3	1	15	5	24
		(3.4%)	(1.1%)	(8.5%)	(5.7%)	(5.5%)
	with d_i lower or equal for advantaged player	3	1	22	8	34
		(3.4%)	(1.1%)	(12.5%)	(9.1%)	(7.7%)
	with $d_f > 0.5$	43	47	12	3	105
		(48.9%)	(53.4%)	(6.8%)	(3.4%)	(23.9%)
	with $d_f + d_u \geq 1$	0	0	0	0	0
		(0.0%)	(0.0%)	(0.0%)	(0.0%)	(0.0%)

the advantaged player (the subject with the easier task) becomes the unfavoured player by encoding fewer words and thus earning a lower disagreement payoff than the disadvantaged player. In another 2.2%, bargaining is symmetric (disagreement payoffs are equal).[17] In just under one–quarter of pairs, the advantaged player encodes enough words in a bargaining round to earn a disagreement payoff larger than £5, giving her dominant bargaining power. Finally, bargainers' disagreement payoffs never totalled the cake size or more, so there were always gains to be made from agreement.

5.2 Aggregate behaviour

Aggregate bargaining results are presented in Table 5. The first row shows that agreements (compatible demands in the NDG, accepted proposals in the UBG) are more frequent in the game (UBG) with less strategic uncertainty. The remainder of the table shows, for both games, the mean disagreement payoff for both advantaged and disadvantaged subjects; the fraction of observations with dominant bargaining power (a disagreement payoff larger than half the cake size); and both types' mean demands, both unconditional and conditional on agreement. The table also shows

Table 5: Aggregate statistics – bargaining outcomes

Game:	NDG		UBG	
Subject type:	advantaged/ disadvantaged	favoured/ unfavoured	advantaged/ disadvantaged	favoured/ unfavoured
Agreement frequency	0.618		0.800	
Mean disagreement payoff (d_i)	0.426/0.258	0.433/0.253	0.424/0.263	0.430/0.259
Frequency of $d_i > 0.5$	0.241/0.000	0.241/0.000	0.236/0.000	0.236/0.000
Mean demand, unconditional	0.563/0.482	0.563/0.483	0.562/0.453	0.569/0.446
Mean demand, given agreement	0.504/0.442	0.507/0.440	0.553/0.447	0.560/0.439

the corresponding statistics for favoured and unfavoured subjects. As results are not extremely sensitive to whether we categorise by disadvantaged/advantaged or favoured/unfavoured status, we will concentrate on the latter.

One result suggested by Table 5 is that the favoured player makes some, but only limited, use of her better bargaining position. In the NDG, favoured subjects' disagreement payoffs are higher than their opponents' by an average of 17% of the cake (i.e., 17 percentage points), but overall, they demand only 8% more of the cake, and conditional on agreement, the difference is only about 6% of the cake. This under–exploitation of bargaining power is less stark in the UBG, but still present: on average, despite having a higher disagreement payoff by over 16% of the cake, the favoured player demands only 11% more of the cake, and the difference is the same in agreements.

Table 6 reports corresponding non–parametric test results.[18] The first row shows that favoured subjects do take

[17] The ten observations of symmetric bargaining, out of 440 total observations, constitute too small a sample to draw any definitive conclusions, but they are consistent with our rationale for trying to impose unequal disagreement payoffs. All four of the symmetric pairs in the UBG treatment, and five of the six in the NDG treatment, reached agreement (well above the overall agreement frequencies reported in Table 5). Three of the four agreements in the UBG were for even splits of the cake, and seven of the twelve demands in the NDG were for 50% of the cake (with three of the remaining five between the subject's disagreement payoff and 50%, perhaps reflecting responses to the high degree of strategic uncertainty in the NDG).

[18] See Siegel and Castellan (1988) for descriptions of the non–parametric statistical tests used in this paper, as well as for tables of critical values. Some critical values for the robust rank–order test are from Feltovich (2005). We note that in implementing these tests, we err on the side of conservatism in two ways. First, we use group–level data rather than more disaggregated data, so that we ignore the information that can be gained by looking at individuals separately. (While individuals within a matching group should not be assumed to be statistically independent of each other, neither are they perfectly correlated.) Second, we pool data from cells with bargaining in even– and odd–numbered

account of their stronger bargaining power, demanding significantly more than unfavoured subjects do. On the

Table 6: Aggregate statistics – p–values from non–parametric tests

Within–game tests	NDG (all)	NDG (agreements)	UBG (all)	UBG (agreements)
$x_f > x_u$	$p \approx 0.001$	$p \approx 0.005$	$p < 0.001$	$p < 0.001$
$x_f - x_u < d_f - d_u$	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p \approx 0.002$
Between–game tests	NDG (all) vs. UBG (all)		NDG (agreements) vs. UBG (agreements)	
$(x_f - x_u) - (d_f - d_u)$ smaller in NDG	$p < 0.01$		$p \approx 0.02$	

Wilcoxon signed–ranks test used for within–game tests, robust rank–order test used for between–game tests. Both use group–level data and two–tailed rejection regions.

other hand, the second row shows that they significantly under–exploit their bargaining power; the difference is demands between favoured and unfavoured players is significantly smaller than the difference in their disagreement payoffs. Finally, the bottom row gives evidence of systematic differences between the UBG and NDG treatments. Specifically, the difference $(x_f - x_u) - (d_f - d_u)$, the extent to which subjects exploit their bargaining power, is significantly less in the NDG than in the UBG. This means that while favoured subjects do not fully exploit their status in either game, they exploit it *more* in the UBG than in the NDG.

5.3 Parametric statistical analysis

We next use panel Tobit regressions to disentangle the effect of the disagreement outcome from other various factors that might influence bargaining outcomes. (Linear regressions, available from the corresponding author, yield similar results.) We estimate models with demands (as fractions of the cake) as the dependent variable, separately for all pairs and agreements only, with pooled NDG and UBG for both, and leaving out the observations with a symmetric bargaining game (and thus no favoured or unfavoured player). For each sub–sample, we estimate an unrestricted model and a restricted model. The primary explanatory variables are the own and opponent disagreement payoffs (d_i and d_{-i}), a UBG indicator, and their interactions. To measure whether bargaining behaviour is different when there is dominant bargaining power, we also include interactions between these variables and an indicator for dominant bargaining power. Our restricted models include only these variables and a constant term.

Our unrestricted models use these variables and additional ones. We add the block number (1–5), an indicator for bargaining taking place in odd–numbered rounds, and a favoured–player indicator – along with its interaction with the dominant–bargaining–power indicator, to allow for a shift as well as a change in slope at 50% of the cake. Finally, we include two variables meant to capture skill and effort in the real–effort task unconnected with advantaged status: own and opponent letters encoded (the total number of letters in all words encoded). Each model is estimated using Stata (version 12).

Table 7 presents average marginal effects and standard errors for each variable, and log likelihoods for each model. For both pairs of models, f–tests fail to reject the null that all of the extra coefficients in the unrestricted model are zero ($\chi^2_5 = 7.50, p \approx 0.19$ in Model 2; $\chi^2_5 = 2.63, p > 0.20$ in Model 4).[19] Because of this, and since the results are robust to which specification we use, we focus on the restricted models.

rounds. We did this because we did not find systematic differences between these cells within either game, but to the extent that differences are indeed present, this will add a source of variance that will reduce the apparent significance of our test statistics.

[19] We report p–values between 0.001 and 0.20 to two significant figures. Those outside this interval are reported as inequalities ($p > 0.20$

Table 7: Tobit results: average marginal effects, standard errors in parentheses

Sub–sample:	NDG/UBG (all)		NDG/UBG (agreements)	
Equation:	[1]	[2]	[3]	[4]
Own disagr. payoff (d_i)	0.331^{***}	0.365^{***}	0.320^{***}	0.289^{***}
	(0.047)	(0.093)	(0.040)	(0.070)
Opp. disagr. payoff (d_{-i})	-0.184^{***}	-0.186^{**}	-0.269^{***}	-0.299^{***}
	(0.046)	(0.094)	(0.038)	(0.070)
UBG	-0.016^{**}	-0.017^{**}	0.031^{***}	0.032^{***}
	(0.008)	(0.008)	(0.008)	(0.009)
Dominant barg. power	–0.010	–0.007	–0.005	–0.005
	(0.019)	(0.019)	(0.016)	(0.016)
Block		-0.006^{**}		0.003
		(0.003)		(0.002)
Order (bargaining in odd rounds)		0.006		–0.002
		(0.008)		(0.009)
Favoured		–0.003		–0.003
		(0.018)		(0.013)
Letters encoded		–0.0001		0.0001
		(0.0003)		(0.0002)
Opp. letters encoded		0.0002		–0.0000
		(0.0003)		(0.0002)
Constant term?	Yes	Yes	Yes	Yes
N	859	859	606	606
$\|ln(L)\|$	686.44	690.17	756.90	758.21

* (**,***): *Marginal effect significantly different from zero at the 10% (5%, 1%) level.*

The main result here is that when we do not distinguish between situations with and without dominant bargaining power, we replicate the finding from earlier work that subjects under–respond to disagreement payoffs. The own–disagreement–payoff effect, which is simply the marginal effect of the own–disagreement–payoff variable, varies across models from about 0.29 to 0.37, while the opponent–disagreement–payoff effect varies from about 0.18 to 0.30; all of these are clearly well below the predicted magnitude of 0.5.

Table 8 shows additional results based on Models 1 and 3. This table reports point estimates and 95% confidence intervals for the combined disagreement–payoff effect, taken at values of 0 and 1 for the UBG and dominant–bargaining–power indicators. This gives us the effects for all four combinations of NDG vs. UBG and with vs. without dominant bargaining power; reported for all observations (Model 1) and for agreements only (Model 3). Chi–square tests strongly reject the null hypothesis of equal effects across the four combinations ($\chi^2_3 \approx 36.36$ for all observations and 53.76 for agreements, $p < 0.001$ in both); therefore we also report p–values for the corresponding ceteris paribus pair–wise comparisons. These show that subjects are least responsive to their bargaining power in the NDG with no dominant bargaining power; the combined effect of 0.222 (all bargaining pairs) or 0.300 (agreements only) is far below the theoretical prediction of 1, and indeed 1 is well outside either of the corresponding confidence intervals. Responsiveness is much higher – and significantly so – in the UBG without dominant bargaining power, with point estimates of 0.649 and 0.709. However, this is still well below one, which again is outside both of the corresponding confidence intervals.

When the bargaining situation is one with dominant bargaining power, responsiveness to bargaining power in-

or $p < 0.001$).

Table 8: Point estimates and confidence intervals for combined disagreement–payoff effects, from Models 1 and 3

		All bargaining pairs			Agreements		
		NDG	UBG	sig. diff.?	NDG	UBG	sig. diff.?
No d.b.p.	Point estimate	0.222	0.649	$p < 0.001$	0.300	0.709	$p < 0.001$
	95% CI	(0.066, 0.377)	(0.483, 0.814)		(0.162, 0.437)	(0.560, 0.857)	
d.b.p.	Point estimate	0.690	0.824	$p \approx 0.17$	0.786	0.913	$p \approx 0.17$
	95% CI	(0.560, 0.820)	(0.685, 0.963)		(0.649, 0.922)	(0.794, 1.032)	
Point estimates sig. diff.?		$p < 0.001$	$p \approx 0.09$		$p < 0.001$	$p \approx 0.01$	

Notes: d.b.p. = dominant bargaining power. CI = confidence interval. sig. diff. = significantly different

creases, sometimes drastically. In the NDG, the difference is especially striking – a rise from 0.222 to 0.690 (over all observations) or from 0.300 to 0.786 (over agreements) of the theoretically–predicted level – and is significant, though even so, this leaves disagreement–payoff responsiveness still well below one. In the UBG, responsiveness increases from 0.649 to 0.824 (all observations), or from 0.709 to 0.913 (agreements), under dominant bargaining power compared to without it; these changes are also significant (though only at the 10% level in the case of all observations). In the case of agreements, the corresponding confidence interval contains one, meaning that we cannot reject the null hypothesis that subjects fully respond to changes in their bargaining power, while in the case of all observations, one lies just above the upper limit of the corresponding confidence interval.

6 A theoretical explanation

In this section, we provide a stylised theoretical model that characterises our two main results: higher responsiveness to bargaining power in UBG than in NDG, and higher responsiveness when one bargainer has dominant bargaining power. As in our experiment, the cake size is normalised to 1, and the favoured and unfavoured bargainers have disagreement payoffs d_f and d_u respectively. We consider two types of agents: *equity* (E) types which make up a fraction $\alpha \in (0, 1)$ of the population, and *net gain* (N) types which constitute the remainder. E types have the utility function

$$U_E(x_i) = \begin{cases} x_i, & x_i \geq 0.5 \\ -\infty, & x_i < 0.5. \end{cases}$$

That is, they will never demand less than half of the cake, nor will they agree to a proposal that gives them less than half the cake. (In case of disagreement, we assume $U_E(d_i) = d_i$, even if $d_i < 0.5$.) N types have lexicographic preferences; they care firstly about making a certain gain relative to the disagreement payoff ($x_i > d_i$) and secondly about the expectation of this gain. Both types are risk neutral.

While both of our types are idiosyncratic – in the sense of preferences differing from the standard self–regarding agents typically used in theoretical models, the assumptions underlying them can be seen frequently in the literature. Our E types are similar to the "obstinate" types found in Myerson (1991), Abreu and Gul (2000), Compte and Jehiel (2002) and Atakan and Ekmekci (2012). The lexicographic preferences of our N types can be viewed as a requirement for ex post individual rationality (see, e.g., Jackson, 2003). The criterion that net gain should be positive rather than zero is in the spirit of *strict individual rationality* (Roth, 1977). Other models using types like our N players can be found in Matthews and Postlewaite (1989), Forges (1999) and Olivier and Jehiel (2009).

In NDG, the players will make simultaneous demands, so we assume that neither knows the other's type. As before, we will appeal to risk dominance as a selection criterion when multiple Nash equilibria exist. In UBG, we will assume that both bargainers know the other's type. (This can be justified by having players incur a severe psychological misrepresentation cost as in Kartik (2009), or by supposing they can figure out the other's type at the beginning of the bargaining period as in Gul and Sonnenschein (1988).) We assume a simplified UBG bargaining process with two steps. First, each bargainer makes at most a single proposal: namely, if there is any feasible split that is at least weakly preferred by both bargainers to disagreement, a bargainer proposes her most preferred such proposal. Second, if both bargainers have made proposals, the bargaining outcome is their midpoint (motivated, perhaps, by each accepting the other's proposal as time expires, with one of the two randomly implemented). If at least one did not make a proposal, this means that there is no mutually preferable proposal to the disagreement outcome, and hence they disagree.

For conciseness, let the bargaining outcome x^* be defined by $x_i^* = \frac{1}{2}(1 + d_i - d_j)$, where (i, j) is either (f, u) or (u, f); this is simply the standard theoretical prediction discussed in Section 2. Also, let $e^* = (0.5, 0.5)$: the equal split of the cake. Finally, we use E_f, E_u, N_f and N_u refer to favoured and unfavoured versions of each type.

We begin with the straightforward but somewhat tedious task of characterising the bargaining result for each possible pair of bargainers, in each game and with/without dominant bargaining power. For UBG, we focus on demands conditional on agreement, since our model does not specify what "final demands" players choose in the event of disagreement.

Observation 1 *In UBG, when two E types bargain, the result will be e^* if $d_f \leq 0.5$, while they will disagree if $d_f > 0.5$.*

In other words, E types will agree on an equal split when there is no dominant bargaining power (as this is the only mutually acceptable split), but will disagree if there is dominant bargaining power.

Observation 2 *In UBG, when two N types bargain, the outcome (whether or not $d_f \leq 0.5$) will be x^*.*

Thus, the N types will always agree on the Nash solution (since each offers the other exactly their disagreement payoff).

Observation 3 *In UBG, when E_f bargains with N_u, the outcome will be $(0.75 - 0.5d_u, 0.25 + 0.5d_u)$ if there is no dominant bargaining power, or x^* if there is dominant bargaining power.*

This is because E_f offers N_u his disagreement payoff, while N_u offers E_f half of the cake.

Observation 4 *In UBG, when N_f bargains with E_u, the outcome will be $(0.25 + 0.5d_f, 0.75 - 0.5d_f)$ if there is no dominant bargaining power, while they will disagree if there is dominant bargaining power.*

If there is no dominant bargaining power, N_f offers E_u half of the cake and E_u offers N_f her disagreement payoff.

Lemma 1 *In UBG if neither bargainer has dominant bargaining power, the bargainers always reach agreement, and the favoured player's expected share of the cake is $0.5\alpha + (1 - \alpha)x_f^*$. If the favoured player has dominant bargaining power, they reach agreement with probability $1 - \alpha$, and the favoured player's expected share of the cake, conditional on agreement, is x_f^*. The unfavoured player receives the remainder of the cake in any agreement (i.e., all agreements are efficient).*

Proof: this follows from Observations 1 – 4, and noting that the probabilities of two E types, a favoured E type and unfavoured N type, a favoured N and unfavoured E, and two N types are α^2, $\alpha(1-\alpha)$, $\alpha(1-\alpha)$, and $(1-\alpha)^2$ respectively.

Now, we turn to NDG. N types know that with some probability they will be paired with an E type, so that demands of more than half of the cake will lead to disagreement with positive probability. So, if there is no dominant bargaining power, N_f will demand just half the cake as the lexicographic nature of her preferences makes her avoid disagreement if possible. However, if N_f has dominant bargaining power, disagreement with E_u is certain so N_f bargains as if she is facing a N_u type – with whom agreement is still possible. In this case, and for N_u either with or without dominant bargaining power, the set of efficient equilibrium bargaining outcomes is nearly the same as under standard preferences (we need $x_i > d_i$ instead of $x_i \geq d_i$ if i is an N type), so the bargaining result will be as in this standard case. So we have:

Observation 5 *In NDG, N types demand 0.5 if favoured but without dominant bargaining power, x_f^* otherwise.*

Given this behaviour by N types, an E_u type will demand 0.5 if there is no dominant bargaining power – agreeing if paired with N_f and possibly if paired with E_f (we will see below what E_f does, but we know that he will demand at least 0.5, and if he demands strictly more, disagreement is the best E_u can do) – while when there is dominant bargaining power, any demand at least 0.5 ensures disagreement, so demanding 0.5 is weakly optimal. An E_f type with dominant bargaining power will certainly disagree if matched with E_u, so will demand x_f^*, which is risk dominant if matched with N_u. Finally, if there is no dominant bargaining power, E_f can get 0.5 for sure by demanding 0.5, or x_f^* with probability $(1-\alpha)$ by demanding x_f^*. The latter maximises expected payoff if

$$\alpha \leq \bar{\alpha} \equiv 1 - \frac{1}{1 + d_f - d_u}. \tag{6}$$

Thus, we have:

Observation 6 *In NDG, there exists a cutoff value $\bar{\alpha}$ such that when $d_f \leq 0.5$ and $\alpha > \bar{\alpha}$, E types always demand 0.5, and if either $\alpha < \bar{\alpha}$ or $d_f > 0.5$, they demand 0.5 if unfavoured and x_f^* if favoured.*

As noted above, $\bar{\alpha}$ is given by (6).

As in our analysis of the experimental data, for NDG we can distinguish between all demands and those demands leading to agreement. Lemmas 2 and 3 below characterise these respectively.

Lemma 2 *In NDG if neither bargainer has dominant bargaining power, the favoured player demands 0.5 for sure if $\alpha > \bar{\alpha}$, while her expected demand is $\alpha x_f^* + (1-\alpha)0.5$ if $\alpha < \bar{\alpha}$. If she has dominant bargaining power, she demands x_f^* for sure. The unfavoured player's expected demand is $\alpha(0.5) + (1-\alpha)x_f^*$ for any α and irrespective of dominant bargaining power.*

Lemma 3 *In NDG if neither bargainer has dominant bargaining power and $\alpha > \bar{\alpha}$, the bargainers always agree, the favoured player gets 0.5 for sure, and the unfavoured player's expected share of the cake is $\alpha(0.5) + (1-\alpha)x_f^*$. If neither bargainer has dominant bargaining power and $\alpha < \bar{\alpha}$, they disagree with probability α^2; conditional on agreement, expected payoffs are*

$$\frac{\alpha x_f^* + 0.5}{1+\alpha} \quad \textit{and} \quad \frac{0.5\alpha + x_u^*}{1+\alpha}$$

for the favoured and unfavoured players respectively. Finally, if the favoured player has dominant bargaining power, they reach agreement with probability $1-\alpha$, in which case each player receives 0.5.

The proofs of both lemmas are straightforward, and are based on Observations 5 and 6, as well as the probabilities of each of the four possible meetings (E versus E, etc.).

Next, we calculate disagreement–payoff responsiveness in UBG agreements, NDG demands, and NDG agreements. As earlier, we define disagreement–payoff responsiveness as $\left|\frac{\partial x_i}{\partial d_i}\right| + \left|\frac{\partial x_i}{\partial d_j}\right|$, where (i, j) is either (f, u) or (u, f). Lemma 4 follows directly from calculation of these derivatives.

Lemma 4 *In UBG (conditional on agreement), average disagreement–payoff responsiveness is* $(1-\alpha)$ *when neither player has dominant bargaining power, and 1 when the favoured player has it. In NDG without dominant bargaining power, average disagreement–payoff responsiveness is* $(1-\alpha)/2$ *when* $\alpha > \bar{\alpha}$ *and* $1/2$ *when* $\alpha < \bar{\alpha}$ *(for both all demands and demands conditional on agreement), while with dominant bargaining power, it is* $1 - \alpha/2$ *for all demands and 1 for demands conditional on agreement (irrespective of* α*).*

From Lemma 4, our main results follow immediately.

Proposition 1 *Disagreement–payoff responsiveness is higher under dominant bargaining power than without dominant bargaining power, holding the game (NDG or UBG) constant.*

Proposition 2 *Suppose* $\alpha < 0.5$. *Then disagreement–payoff responsiveness is weakly higher in UBG than in NDG, holding the presence or absence of dominant bargaining power constant.*

A few remarks are warranted here. First, note that a population consisting entirely of N types would behave in the same way as a population of agents with standard preferences (i.e., as in Section 2.3), and in particular such a population would exhibit full responsiveness to changes in bargaining position. It is the existence of E types that reduces disagreement–point responsiveness (indeed, a population of only E types would not respond to changes in bargaining position at all).

Second, both propositions follow in an intuitive way from the assumptions about individual behaviour made by the model. Dominant bargaining power leads to increased responsiveness to changes in bargaining power because the main reason for a favoured player to accept an equal split – agreement with an E type – disappears. That is, it is not that unfavoured subjects give up on the 50–50 focal point once it is no longer individually rational, but rather, favoured subjects stop accommodating their opponents' attachment to that focal point. Responsiveness is higher in the UBG than in the NDG, as long as α is relatively low, because in the latter, favoured players shy from exploiting their bargaining power due to the possibility that this leads to disagreement (in case they are matched with an E type). While we have no strong argument to justify any particular value for α, the obstinacy of E types – in their refusal to countenance any share less than half the cake, no matter how small their disagreement payoff – makes it reasonable to suppose that their share of the population is smaller than that of N types.

Third, we acknowledge that this model is quite stylised, with realism traded away for tractability. Nonetheless, it is not difficult to see that our qualitative results are robust to including in the population an additional group: standard self–regarding agents (S types). Note that S types will behave just like E types without the 0.5 threshold agreement payoff, and like N types without the requirement of gaining relative to the disagreement payoff. For example, note Observation 2 will hold for bargaining in the UBG between S types, as well as between S and N types, while bargaining between N and E types will be governed by the results in Observations 3 and 4. We have left these types out of the analysis above for reasons of tractability and parsimony.

Finally, even though the model was designed only to explain our main results, others of its implications are seen in our data. For example, agreement frequencies are higher in UBG than in NDG, and higher without dominant bargaining power than with it – both in our model and in the experiment.

7 Discussion and concluding remarks

Our experimental findings confirm our conjectures about the effects of bargaining institution and the existence of equilibrium equal splits. Observed responsiveness to disagreement payoffs increases as we move from the NDG to the UBG, likely due to the lower amount of strategic uncertainty and resultant less severe coordination problem (thus reducing the attractiveness of the 50–50 split) in the latter. Responsiveness is also higher with than without dominant bargaining power, as when 50–50 splits are no longer individually rational, they are no longer focal, so that bargainers have to rely on alternative focal points. Both of these treatment effects are not only significant, but large in magnitude. Moving from the NDG without dominant bargaining power either to the UBG or to a situation with dominant bargaining power increases disagreement–payoff responsiveness by roughly 40 percentage points. From there, adding the other increases responsiveness by a further 12–20 percentage points. Indeed, in the UBG with dominant bargaining power, responsiveness approaches the theoretically predicted level (100 percent), and if we restrict consideration to agreements, the corresponding 95% confidence interval includes this point prediction. Thus in this case at least, we would not be able to reject the null hypothesis that subjects fully exploit their bargaining position. We acknowledge that this is a fairly weak claim, since it's based on a failure to reject a null hypothesis that the claim is true (we equally couldn't reject a null that responsiveness is only 80% of predicted), and the corresponding confidence interval for all demands does not include full responsiveness. However, even granting this caveat, our result is noteworthy, as we are unaware of any other finding of approximately full exploitation of bargaining power in the literature.

We close with some implications for applied theorists and experimenters. First, our finding of a general under–responsiveness to disagreement payoffs, and the sensitivity of this responsiveness to the presence or absence of dominant bargaining power, highlight the importance of framing in bargaining experiments. We conjecture that our results would have been quite different if our experiment had involved bargainers (a) being given their disagreement payoffs immediately, and (b) bargaining over the remainder. This setting is nearly isomorphic to ours (the only difference is that we allow individually irrational agreements), but we would expect outcomes in such a hypothetical experiment to cluster around 50–50 splits of the *remainder*, which would correspond to 100% responsiveness to disagreement payoffs in our actual experiment. If this is true, then the standard modelling technique of normalising the bargaining problem so that the disagreement outcome is (0, 0) is clearly not innocuous: absolute payoff amounts matter, not just payoffs relative to the disagreement point.

Second, the differences we find between NDG and UBG suggest that the way bargaining is modelled matters. Applications of bargaining in theoretical models tend to assume a bargaining process similar to our UBG (typically applying the Nash solution or a generalisation of this), while experimental tests of such models tend to use more highly abstracted bargaining games like the NDG, or even more commonly, the ultimatum game. Implementing bargaining this way carries the risk that the experimental results will not be generalisable back to the original strategic setting, above and beyond any other concerns about the external validity of lab experiments. This may actually be good news for theorists, since experimental results that seem inconsistent with standard theory may be at least partly an artifact of how the theory was implemented in the experiment, rather than owing to any intrinsic weakness of the theory itself.

Third, our results cast some light on how a *descriptive* theory of bargaining might look. Normative solution concepts that assume *translation invariance*, such as Nash's (1950) and Kalai and Smorodinsky's (1975), will have difficulty explaining the under–responsiveness to the disagreement outcome that we have observed. Anbarci and Feltovich (2013) showed that this kind of under–responsiveness cannot be attributed to risk aversion, but that it is consistent with some models of other–regarding preferences. However, our different results for NDG and UBG suggest that other–regarding preferences are at best only part of the explanation, as we can see no plausible reason for individuals' distastes for inequality to differ according to the bargaining institution. If other–regarding preferences are to have an impact, it may be an indirect one, via their influence on focal points. Indeed, the model we examine in Section 6 works by positing a fraction of agents firmly attached to the focal point of equal splits. As we illustrate there, richer models, such as the ones that additionally incorporate self–regarding agents, could also generate results like ours. We welcome future theoretical work in this direction.

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A Do subjects consider under–responsiveness when choosing effort?

In our experiment, each non–practice block comprises two rounds, identical except that one has a bargaining stage and one is task–only. A natural question is whether subjects behave differently in task–only rounds, where the number of words encoded directly determines the payoff, compared with bargaining rounds, where payoff is based indirectly on words encoded, through the latter’s effect on the bargaining outcome. Even if subjects fully exploit their bargaining power, an additional word encoded in a bargaining round will yield only half as much revenue as one from a task–only round (assuming bargainers reach agreement). Since subjects actually under–respond, the difference in revenue per word between bargaining and task–only rounds will be even larger. (In the extreme case where bargaining outcomes were completely insensitive to disagreement payoffs – for example, if bargainers always agreed on 50–50 splits – encoding words in bargaining rounds would confer no extra revenue at all.) If subjects recognise this difference in marginal benefits, they ought to expend less effort in bargaining rounds than in task–only rounds. But do they?[20]

We address this question with a linear panel regression, using letters encoded (a measure of performance less sensitive than words to task difficulty) as our dependent variable. Our main explanatory variable is an indicator (“Bargain”) for a bargaining round. Additional variables are indicators for UBG, advantaged player, hard task, and bargaining in odd–numbered rounds (“Order”), as well as the block number (1–5). We also include all interactions amongst these six variables. Finally, we include the following demographic variables: Female (indicator), Age (positive integer), Econ (integer number of economics classes taken at university, bounded at 0 and 4) and Residence (ordinal variable for number of years living in the United Kingdom, with categories 0–1, 1–2, 2–5, 5–10 and 10+ coded as 0, 1, 2, 3 and 4).

Table 9 displays the main results. The negative overall marginal effect of “Bargain” is consistent with shirking, but its size is small. In the NDG, the effect is significantly different from zero, but its magnitude is less than two letters per round, as compared to the average of 110 letters encoded per subject. In the UBG the effect is even less, and not significantly different from zero. The apparent (though insignificant) difference in effect size between games makes sense, since subjects under–react more to disagreement payoffs in the NDG, yielding a lower expected payoff per word encoded and implying more shirking. However, their *absolute* magnitudes seem puzzling, as they suggest that subjects barely respond to the substantially lower expected returns in bargaining rounds compared to task–only rounds. There are several possible explanations for why this might be happening.

[20] One subject in the NDG treatment clearly understood this logic. After encoding 14, 15 and 16 words in the first three bargaining rounds, he encoded zero in each of the last two – in both cases demanding £4 in the subsequent bargaining game and getting it. For sake of comparison, he encoded 12 and 16 words in the task–only rounds in those two blocks.

Table 9: Regression results (marginal effects and standard errors) – letters encoded, non–practice rounds

Marginal effects at means (std. errors)		*Marginal effects by game (std. errors)*	
Bargain (round with bargaining)	-1.220^{***}	Bargain (in NDG)	-1.630^{***}
	(0.418)		(0.592)
UBG	2.484	Bargain (in UBG)	–0.757
	(2.916)		(0.592)
Advantaged	–4.663	p–value, significance of differences	$p \approx 0.30$
	(2.955)		
Hard task	–0.722		
	(0.496)		
Order (bargain in odd–numbered rounds)	-6.476^{**}		
	(2.934)		
Block	3.491^{***}		
	(0.227)		
Constant term?	Yes		
Demographic variables?	Yes		
N	1760		
$-ln(L)$	6657.43		

* (**,***): *Coefficient significantly different from zero at the 10% (5%, 1%) level.*

1. **Cognitive limits** Subjects may not understand that returns to encoding words are lower in bargaining rounds than task–only rounds, since the underlying logic is fairly subtle.

2. **Optimism/overconfidence** Subjects might overestimate the effect of their disagreement payoff on their bargaining outcome, either through overconfidence in their ability to negotiate, or through an optimistic assessment of the likelihood of being matched with a poor negotiator.

3. **Pessimism** Following a disagreement, subjects receive their disagreement payoffs, so in this case, the return to an additional word encoded is the same as in a task–only round. Overall, if α is a subject's subjective probability of reaching agreement in a bargaining round, the expected return to a word encoded in that round is £0.15 multiplied by $1-\alpha+\alpha\frac{\partial x_i}{\partial d_i}$ ($i = f, u$), compared with £0.15 in a task–only round. If the subject's α is close to zero (versus actual agreement frequencies of about 0.6 in NDG and 0.8 in UBG), then this multiplier will be close to one, so that the returns to encoding will be similar in bargaining and task–only rounds.

4. **Backward–bending labour supply** Some subjects' labour supply curves might be negatively sloped over the relevant range of per–word rates, so that on average, the effect of a change in this piece rate is no discernible change in effort. Charness and Kuhn (2011) note that the observation of a backward–bending labour supply curve in lab experiments is puzzling, since it would imply an income effect large enough to outweigh the substitution effect (which on its own would imply a positive slope), even though the amounts at stake in lab experiments are typically small compared to subjects' wealth levels. However, Andersen et al. (2012) have argued that subjects only partially integrate their lab earnings with their wealth outside the lab; if so, large wealth effects within the lab can be consistent with sensible behaviour outside the lab.

5. **Inelastic labour supply** It might simply be that subjects' labour supply curves are very inelastic, so that the effect of changes in the per–word rate is so small that even a halving of the per–word rate would lead to a

barely perceptible change in behaviour. This could be due to a corner solution in the labour–supply problem; either because the disutility of effort is very low, or because intrinsic motivation raises the benefits of effort, subjects could run out of time allocated for the task before they get tired of performing it.

These explanations are not mutually exclusive, and still other explanations may exist. Our experiment was not designed to test among these, but future work may try to do so.

B Instructions from the experiment

Below is the text of instructions for our UBG treatment with bargaining in even-numbered rounds, followed by the text of instructions for our NDG treatment with bargaining in odd-numbered rounds. The instructions for the other two treatments are analogous, and available from the corresponding author upon request.

[UBG instructions]

You are about to participate in a study of decision making. Please read these instructions carefully, as your payment may depend on how well you understand them. If you have any questions, please feel free to ask the experimenter. We ask that you not talk with the other participants – or anyone else – during the experiment.

The main part of this experiment consists of ***ten*** rounds. In each round, you will perform an ***encoding task***. Your computer screen will display a “word” – a sequence of 1-10 letters of the alphabet – along with a key showing the number that corresponds to each letter. Below each letter on your screen will be a blank space. ***Inside each space, you should type the number that corresponds to the letter above it.*** Once you have encoded the entire word, click the “OK” button. If you have encoded the word correctly, the computer will accept it and display a new word. The key will stay the same for all words during a round, but may change from round to round.

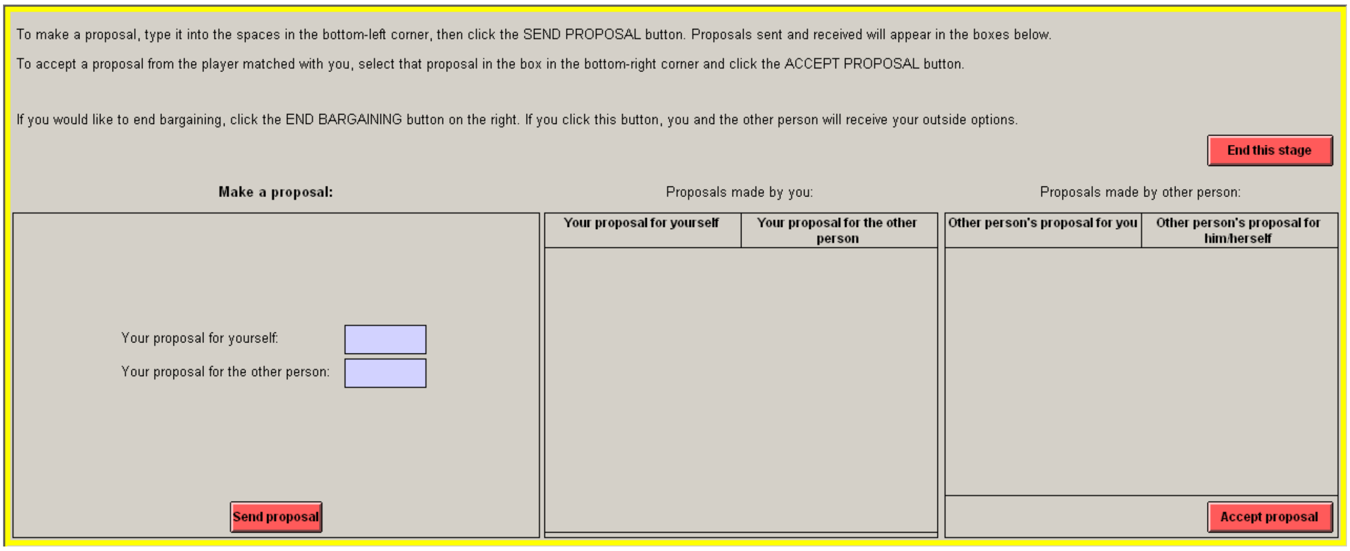
Example: Suppose the key is as follows (this is just an example; the actual key might be different):

A	B	C	D	E	F	G	H	I	J
1	9	5	4	10	6	7	3	8	2

Suppose the word you are given is G – A – J – F – J. The code for G is 7 (below G in the table), and the codes for A, J, F and J are 1, 2, 6 and 2. So, you would encode this word as 7 – 1 – 2 – 6 – 2, then click “OK”.

In each round of the experiment, you will have ***five minutes*** to encode as many words as you wish. In ***rounds 1, 3, 5, 7 and 9***, the round ends after the five minutes have finished, and your profit is *15p (£0.15)* for each word you correctly encoded.

In ***rounds 2, 4, 6, 8 and 10***, there is another stage after the encoding task is over. ***In this stage, you have the opportunity to bargain with a randomly chosen participant, over a prize of £10***. The way you bargain is by ***sending and receiving proposals*** for dividing the £10. Below is an example of how the bottom portion of your computer screen will look during this bargaining stage.



To send a proposal to the other person, type the amounts for yourself and the other person in the "Make a proposal" box, then click "Send proposal". ***The amounts you enter must be between 0 and 10 (inclusive), and can have 0, 1 or 2 decimal places.*** The two amounts together must add up to £10 or less. All of your proposals will appear in the box in the bottom-centre of your screen, and all of the proposals made by the other person will appear in the box in the bottom-right. The person paired with you will see these proposals as well, but no one else will be able to see your proposals, nor will you be able to see theirs.

You may accept ***any one*** of the proposals from the person paired with you, ***or none*** of them. To accept a proposal, highlight the one you wish to accept and click "Accept proposal". ***If either you or the other person accepts a proposal, then you have reached an agreement, and the prize is divided according to the accepted proposal.***

The bargaining stage lasts for up to ***2 minutes***; you may send as many or as few proposals as you wish during that time. You may end the bargaining stage before the 2 minutes are over, by clicking on the button labelled "End this stage" on the right of your screen. ***Once you or the person matched with you has clicked this button, it is not possible to send or accept proposals.***

If you or the other person ends the bargaining stage early, or if the time available for proposals ends without you reaching an agreement, then you receive an ***outside option*** equal to ***15p*** for each word you had encoded, and the other person receives an ***outside option*** equal to 15p for each word he/she had encoded. Both you and the person paired with you are informed of ***both*** outside options at the beginning of the bargaining stage.

Organisation of the experiment: This experimental session has three parts.
(1) We will begin with a short questionnaire, where you will answer some demographic questions.
(2) Next, there will be a ***one-minute practice round***, so that you can familiarise yourself with the encoding task. After the one minute has ended, the computer screen will show the number of words you correctly encoded. The results of this practice round will ***not*** affect the amount you are paid.
(3) Then, the main part of the experiment will begin. Each round proceeds as follows:

- (a) You perform the encoding task. In odd-numbered rounds, you earn 15p for each word correctly encoded. In even-numbered rounds, this amount becomes your outside option for the bargaining stage.
- (b) If it is an even-numbered round, the computer randomly pairs you with another participant, and your screen displays both of your outside options. You can send proposals for dividing the £10.00 prize. The other person can also send proposals for dividing the £10.00 prize; you can accept one of these proposals or none of them.
- (c) The round ends. Your computer screen displays the number of words you encoded and your profit. In even-numbered rounds, it also displays whether or not you reached an agreement, and the other person's profit.

Payments: The amount you are paid will depend on the results of the experiment. The computer will randomly select ***four rounds*** out of the ten you played. You will be paid the total of your profits from those selected rounds. Payments are made privately and in cash at the end of the session.

[NDG instructions]

You are about to participate in a study of decision making. Please read these instructions carefully, as your payment may depend on how well you understand them. If you have any questions, please feel free to ask the experimenter. We ask that you not talk with the other participants – or anyone else – during the experiment.

The main part of this experiment consists of ***ten*** rounds. In each round, you will perform an ***encoding task***. Your computer screen will display a "word" – a sequence of 1-10 letters of the alphabet – along with a key showing the number that corresponds to each letter. Below each letter on your screen will be a blank space. ***Inside each space, you should type the number that corresponds to the letter above it.*** Once you have encoded the entire word, click the "OK" button. If you have encoded the word correctly, the computer will accept it and display a new word. The key will stay the same for all words during a round, but may change from round to round.

Example: Suppose the key is as follows (this is just an example; the actual key might be different):

A	B	C	D	E	F	G	H	I	J
1	9	5	4	10	6	7	3	8	2

Suppose the word you are given is G – A – J – F – J. The code for G is 7 (below G in the table), and the codes for A, J, F and J are 1, 2, 6 and 2. So, you would encode this word as 7 – 1 – 2 – 6 – 2, then click "OK".

In each round of the experiment, you will have ***five minutes*** to encode as many words as you wish. In ***rounds 2, 4, 6, 8 and 10***, the round ends after the five minutes have finished, and your profit is *15p (£0.15)* for each word you correctly encoded.

In ***rounds 1, 3, 5, 7 and 9***, there is another stage after the encoding task is over. ***In this stage, you have the opportunity to bargain with a randomly chosen participant, over a prize of £10.*** The way you bargain is by each making ***simultaneous*** claims for shares of the £10.

- If your claim and the other person's claim add up to ***£10 or less***, you receive your claim, and the other person receives his/her claim.
- If the claims add up to ***more than £10***, you receive an ***outside option*** equal to ***15p*** for each word you had encoded, and the other person receives an outside option equal to 15p for each word he/she had encoded.

Both you and the person paired with you are informed of ***both*** outside options before choosing your claims.

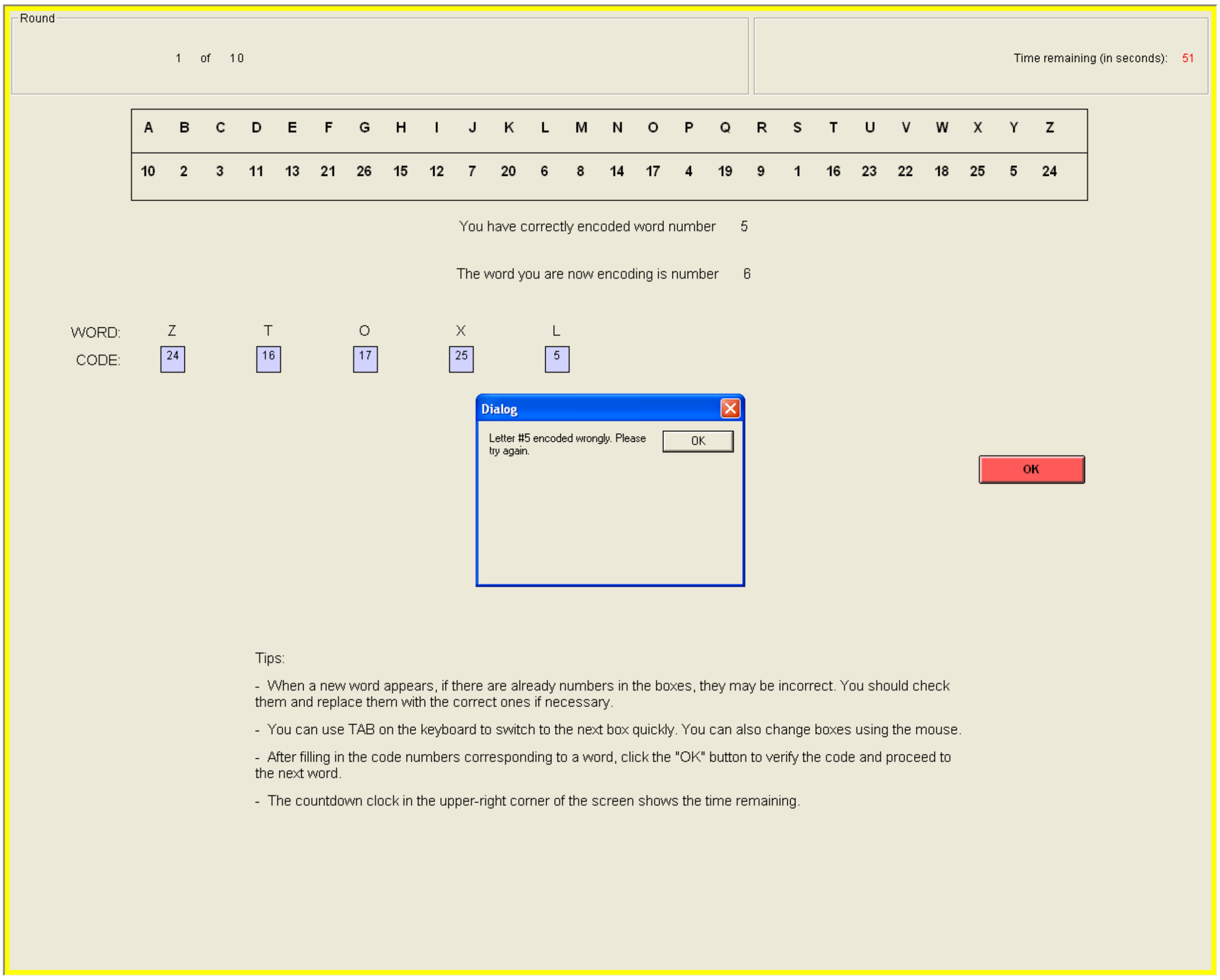
Organisation of the experiment: This experimental session has three parts.

(1) We will begin with a short questionnaire, where you will answer some demographic questions.
(2) Next, there will be a ***one-minute practice round***, so that you can familiarise yourself with the encoding task. After the one minute has ended, the computer screen will show the number of words you correctly encoded. The results of this practice round will ***not*** affect the amount you are paid.
(3) Then, the main part of the experiment will begin. Each round proceeds as follows:
  (a) You perform the encoding task. In even-numbered rounds, you earn 15p for each word correctly encoded. In odd-numbered rounds, this amount becomes your outside option for the bargaining stage.
  (b) If it is an odd-numbered round, the computer randomly pairs you with another participant, and your screen displays both of your outside options. You choose a claim for your share of the £10.00 prize. The other person chooses a claim for his/her share. ***Your claim can be any multiple of 0.01, between 0.00 and 10.00 inclusive.*** Be sure to enter your claim before the allotted time runs out, or the computer will enter a claim of zero for you.
  (c) The round ends. Your computer screen displays the number of words you encoded and your profit. In odd-numbered rounds, it also displays your claim, the claim made by the person paired with you, and the other person's profit.

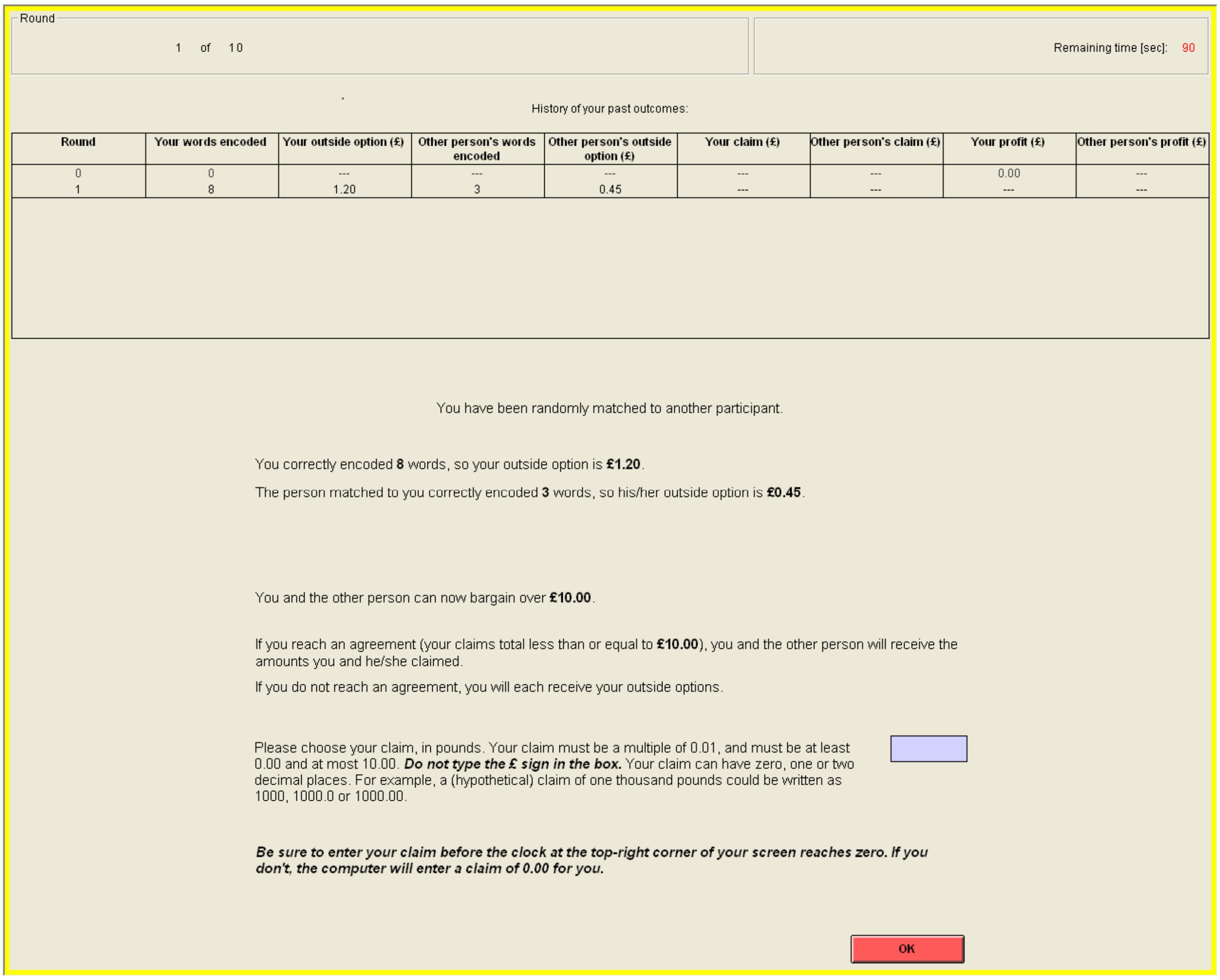
Payments: The amount you are paid will depend on the results of the experiment. The computer will randomly select ***four rounds*** out of the ten you played. You will be paid the total of your profits from those selected rounds. Payments are made privately and in cash at the end of the session.

C Additional screenshots from experiment

Error screen from real-effort task:



Decision screen, NDG treatment:



Round

1 of 10

Remaining time [sec]: 90

History of your past outcomes:

Round	Your words encoded	Your outside option (£)	Other person's words encoded	Other person's outside option (£)	Your claim (£)	Other person's claim (£)	Your profit (£)	Other person's profit (£)
0	0	---	---	---	---	---	0.00	---
1	8	1.20	3	0.45	---	---	---	---

You have been randomly matched to another participant.

You correctly encoded **8** words, so your outside option is **£1.20**.

The person matched to you correctly encoded **3** words, so his/her outside option is **£0.45**.

You and the other person can now bargain over **£10.00**.

If you reach an agreement (your claims total less than or equal to **£10.00**), you and the other person will receive the amounts you and he/she claimed.

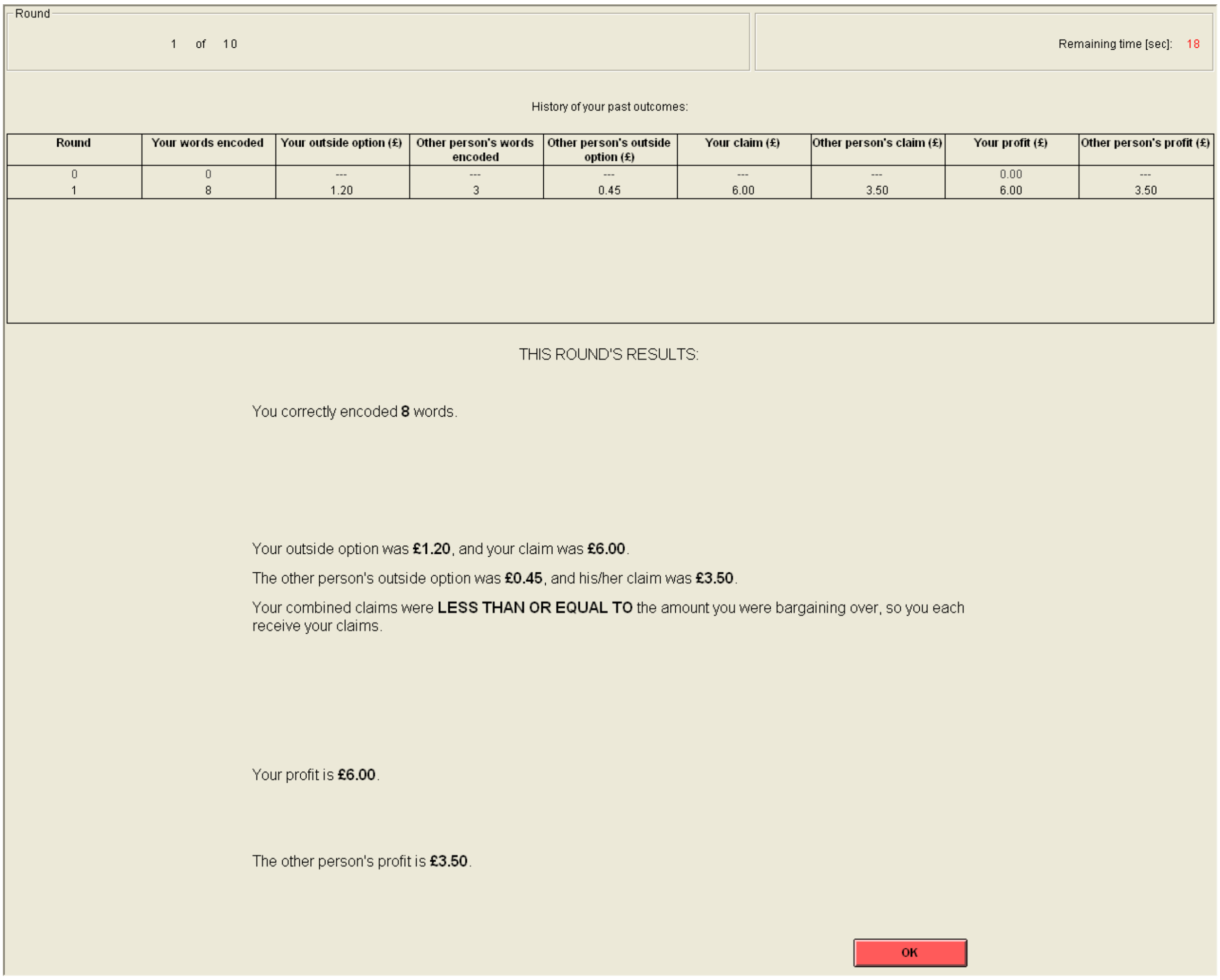
If you do not reach an agreement, you will each receive your outside options.

Please choose your claim, in pounds. Your claim must be a multiple of 0.01, and must be at least 0.00 and at most 10.00. ***Do not type the £ sign in the box.*** Your claim can have zero, one or two decimal places. For example, a (hypothetical) claim of one thousand pounds could be written as 1000, 1000.0 or 1000.00.

Be sure to enter your claim before the clock at the top-right corner of your screen reaches zero. If you don't, the computer will enter a claim of 0.00 for you.

OK

Feedback screen, NDG treatment:



Round

1 of 10

Remaining time [sec]: 18

History of your past outcomes:

Round	Your words encoded	Your outside option (£)	Other person's words encoded	Other person's outside option (£)	Your claim (£)	Other person's claim (£)	Your profit (£)	Other person's profit (£)
0	0	---	---	---	---	---	0.00	---
1	8	1.20	3	0.45	6.00	3.50	6.00	3.50

THIS ROUND'S RESULTS:

You correctly encoded **8** words.

Your outside option was **£1.20**, and your claim was **£6.00**.

The other person's outside option was **£0.45**, and his/her claim was **£3.50**.

Your combined claims were **LESS THAN OR EQUAL TO** the amount you were bargaining over, so you each receive your claims.

Your profit is **£6.00**.

The other person's profit is **£3.50**.

OK

Feedback screen, UBG treatment:

Round

1 of 10

Remaining time [sec]: 15

History of your past outcomes:

Round	Your words encoded	Your outside option (£)	Other person's words encoded	Other person's outside option (£)	Was agreement reached?	Your profit (£)	Other person's profit (£)
0	0	---	---	---	---	0.00	---
1	11	1.65	2	0.30	YES	6.20	3.80

THIS ROUND'S RESULTS:

You correctly encoded **11** words.

Your outside option was **£1.65**, and the other person's outside option was **£0.30**.

You and the other person **DID** reach an agreement.

Your profit is **£6.20**.

The other person's profit is **£3.80**.

OK