The contractor game: a theoretical and experimental analysis

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Abstract

We introduce the contractor game, related to the ultimatum game (UG). The proposer makes an offer, and simultaneously sends a cheap talk message, indicating (possibly falsely) the amount of the offer. The responder observes the message with certainty and the offer with probability $p$ before accepting or rejecting the offer. We theoretically examine versions with $p = 0$ and $p = 0.5$ along with the UG, played by some standard economic agents and others who are averse to inequity, lies and lying. The equilibria yield intuitive predictions, which are supported by our experimental results. Offers are higher when they might be seen by the responder. Messages over–state offers, but less so when the offer might be seen. Responders are more likely to accept an unseen offer if it might have been seen. When offers are seen, responders reward truthful messages, rather than punishing lies, compared to when no message is sent.

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1 Introduction

A motorist’s car breaks down on a deserted section of highway. He gets out of his car and, after walking for a while, manages to find a service station (the kind that might have “last gas for 200 miles” written on a sign). After telling the station’s owner, who is also the mechanic, about his problem, the mechanic quotes a price to tow his car to the station and repair it, and the motorist must choose whether to accept the quote, in which case the work will be done, or reject it and continue looking – most likely for a long time – for another mechanic.

We have just described an example of the ultimatum game (Güth, Schmittberger and Schwarze, 1982). However, in this case the story hasn’t ended yet, because the mechanic’s quote may not be the price ultimately charged for the mechanic’s service. Indeed, the mechanic chooses the actual price along with the quote, but the motorist knows only the quote until he’s decided whether or not to accept it. If the motorist accepts, the work is done, but the motorist pays the mechanic the actual price, not the quoted price.

This adaptation of the ultimatum game is called the contractor game.1 Like the ultimatum game, there is a fixed sum of money (a “cake”), known to both players, and one player (the proposer) chooses an amount to offer the other player (the responder). Unlike the ultimatum game, the proposer also sends a message to the responder of the form, “I have offered you X”. The message is cheap talk in the game-theoretic sense – costless and non-binding – and in particular lies are quite possible.

Our contractor game – where one player has private information about the proposed distribution of a surplus whose size is common knowledge – has been the subject of much less theoretical and experimental study than a related class of models where there is asymmetric information about the size of the surplus. However, our game deserves attention in its own right, as it may serve as a model for many buyer–seller interactions where one side has an informational advantage regarding the ultimate transaction price of a good. This may be fairly common in service markets; the game between a traveller who hires a taxi in an unfamiliar city and the taxi driver is an example, as is the “hidden cost” game played by a bank or utility company with its customers. Such information asymmetries might also arise in labour markets; for example, workers in a firm may have private information about how much employee theft (which may be thought of as a “top–up” of compensation beyond the amount contracted with the firm) they intend to carry out.

In the basic contractor game, the responder is informed of the message but not the offer, and must therefore decide to accept or reject based only on the message. As in the ultimatum game, acceptance means the responder receives the amount offered – irrespective of the message – and the proposer receives the remainder, while rejection means both receive zero. We also consider a modified contractor game which is identical except that the responder is able to observe the offer with probability one-half (thus still receiving the message with certainty).

This paper is an investigation of these three games: the ultimatum game, the basic contractor game and the modified contractor game, which we denote UG, CG(0) and CG(0.5) respectively (the latter two indicating probabilities of 0 and 0.5 of seeing the offer). We begin with a theoretical analysis of these games. Of course, such an analysis is trivial under the usual Homo economicus assumption of pure own–money–payment maximisation: as in the ultimatum game, responders in either version of the contractor game should accept any positive offer (and are indifferent about accepting a zero offer), and therefore proposers should offer either zero or the smallest monetary unit, while the message itself is irrelevant. However, our analysis takes a step in the direction of increased realism by relaxing the assumption of pure own–money–payment maximisation to allow for (1) “inequity aversion”, a

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1Lang and Rosenthal (1991) and Cadsby et al. (2013) examine other strategic environments motivated by contractors, unrelated to the game we investigate.
distaste for either favourable or unfavourable inequality of money payoffs, and (2) “deception aversion”, a distaste for either lying or being lied to. A substantial body of experimental–economics research suggests that a non–trivial fraction of people are inequity averse, and a smaller but rapidly growing literature provides evidence of deception aversion. (See Section 2 for a short survey.) We construct a model where both proposers and responders are one of two types: self–regarding, who behave as typical Homo economicus, and other–regarding, whose preferences include both inequity aversion and deception aversion. Our model is simple and tractable, but nonetheless provides clear comparative–static predictions about how behaviour varies across these three games and across contingencies within the games.

We test these implications with a laboratory experiment. As is commonly the case for experimental tests of theory, the model’s point predictions have limited success in describing behaviour; however, the main qualitative features of the data are quite striking in their resemblance to the model’s directional predictions. First, we find that proposers’ offers are highest in the UG and lowest in CG(0); that is, offers become smaller as their likelihood of being seen decreases. Second, while lying (in the sense of sending a message that over–states the corresponding offer) is commonplace, with the average message in both contractor games 50–100 percent higher than the average offer, it is not universal (about one–fifth of messages are truthful, and another one–tenth actually under–state the offer), and its extent varies with the game: about 40 percent of messages are either truthful or under–statements in CG(0.5), versus about 20 percent in CG(0). Third, responders are significantly more likely to accept an unseen offer in CG(0.5) than in CG(0) – that is, when the offer was made knowing it might be observable versus when it could never have been – and in CG(0.5), unseen offers are more likely than seen ones to be accepted. Fourth, in those cases of CG(0.5) where responders observe the offer as well as the message, acceptance is substantially less likely when the message under–states the offer (i.e., the proposer is seen to have lied about the offer); however, comparison to the UG (where no message is sent) suggests that responders are actually rewarding truth–telling rather than punishing lying.

2 Other relevant research

Our study contributes to two related but distinct segments of the theory and experimental literature: (1) variants of the ultimatum game with incomplete information and/or cheap talk, and (2) deception in general strategic settings (not necessarily the UG) where cheap–talk messages are sent. Here, we describe some of the relevant literature. This is not an exhaustive review, and in particular, we discuss additional relevant work as we develop our theoretical model (Section 3) and elsewhere.

Early experiments involving incomplete information and cheap talk in the ultimatum game tended to find subjects opportunistically taking advantage of their extra information, and using messages to deceive their opponents about the nature of their information, but seldom to the extent predicted by standard game theory with self–regarding players. A typical example is from one of the first papers we know of in this literature. Mitzkewitz and Nagel (1993) study a version of the ultimatum game where the cake size (between 1 and 6) is determined by a die roll and the realisation is told to the proposer but hidden from the responder. In their “offer game”, the responder is informed of the proposer’s offer, while in their “demand game”, the responder is instead informed about the proposer’s demand (i.e., the cake size minus the offer). They find significant differences in behaviour between the two games, but it is the nature rather than the existence of these differences that is most interesting. In the offer game, proposers drawing

2There is also an earlier literature on incomplete information and cheap talk in unstructured bargaining; see, for example, Roth and Murnighan (1982, 1983).
a large cake size tried to pool with those drawing a smaller cake size: the modal offer for cake sizes of 1–4 is half of the cake, but for cake sizes of 5–6 is only 2. In the demand game, the reverse happened, with proposers most frequently demanding half of a cake size of 6, but 3 when the cake size is 3, 4 or 5, and the entire cake when it is 1 or 2.

Later studies have found mixed results. Kagel, Kim and Moser (1996) found no difference in offers according to whether proposers or responders are informed of the other’s exchange rate between tokens – which the subjects bargain over – and real money.) Croson (1996) manipulated whether the responder knows the cake size and whether offers are made in money units or percents of the cake, and observed that in the money–unit treatment, proposers made significantly higher offers when responders knew the cake size than when they did not. Kriss et al. (2013) examine ultimatum games where only the proposer is informed about the cake size, and distinguish between implicit deception (e.g., making offers that would be “fair” if the cake had been smaller than it actually is) and explicit deception (sending a message containing a lie about the cake size). They find increased misrepresentation when explicit deception is possible compared to when only implicit deception is.

Gehrig et al. (2007) introduce a variant of the ultimatum game similar to our contractor game; in their “yes/no game”, the responder decides whether to accept or reject the proposer’s offer knowing the cake size, but not the offer itself, and with no message from the proposer (in contrast to our CG(0)). Gehrig et al. find that offers in the yes/no game are comparable to those in a dictator game (an ultimatum–game variant where the responder has no move, and the proposer’s proposal is automatically implemented), and substantially lower than in an ultimatum game. Interestingly, responders tend not to use their veto power, even though they were very likely to have received a small offer. Güth and Kirchkamp (2012) compare Gehrig et al.’s results to those from several field experiments with the same game and varying subject pools (e.g., business executives) and forms of interaction (playing by post or Internet rather than in the lab). Broadly, proposer behaviour is indistinguishable from the original lab experiment, but responders reject much more often in all of the new experiments.

Several studies focus on sender–receiver games, where players’ payoffs depend on the actions of the receiver, to whom the sender can transmit costless messages. Gneezy (2005) classifies lies into four types, depending on whether they help or harm the sender and whether they help or harm the receiver. He concentrates on one of these cases – where lying helps the sender at the expense of the receiver – and varies the size of these potential gains and losses. He finds that raising the sender’s benefit from lying, or reducing the harm imposed on the receiver, is associated with more lying. In Lundquist et al. (2009) subjects designated as sellers obtain scores on a general knowledge test and then send messages about their score to the buyer with whom they are matched. Buyers decide, upon receiving the message but without observing the score itself, whether to engage in a contract which is profitable if and only if the buyer’s actual score is above a commonly–known threshold. Lundquist et al. find substantial but not universal deception: depending on the treatment, 40 to 76 percent of subjects with scores below the cutoff over–state their scores. Interestingly, they also report evidence of an aversion to lying by sellers that increases in the “size” of the lie (i.e., the difference between the true and reported scores), even though the monetary cost to the buyer from such a lie is always the same. They also find that free–form communication implies a lower frequency of lies compared to pre–specified communication. López-Pérez and Spiegelman (2012) examine a setting where the informed sender cannot affect the uninformed receiver’s payoffs. A random draw determines the colour of a circle (blue or green), and the sender sends the receiver a message indicating the colour. The sender receives a payoff of 15 by sending a green message, versus 14 from sending blue, while the receiver gets a constant 10. Even though lying doesn’t harm the receiver, nearly half of senders report truthfully when the circle is blue.

The common result that subjects lie less often than predicted by standard theory has led some researchers to pro-
pose theoretical models assuming that individuals incur some cost to lying, but otherwise act according to standard game theory. Many of these models consider a related, but distinct, concept of honesty to ours. Rather than having a taste for correctly reporting a piece of private information (e.g., the cake size, or one’s offer), these models consider honesty to be a taste for honouring past agreements or promises about one’s own subsequent behaviour. This can be considered a cost of lying – in the event that a player entered an agreement while intending to violate it – but also means that players can incur the cost even when they entered the agreement with the intention of honouring it (e.g., if it was only afterward, upon further introspection or the receipt of new information, that the player decided not to honour the agreement).

Ellingsen and Johannesson (2004) examine this form of honesty using a game between a buyer and a seller, where the seller acts first and decides whether to pay a fixed cost to generate a surplus. After surplus generation, they play an ultimatum game with the buyer as proposer (so that after rejection, the seller loses the fixed cost). They consider a “promises” treatment where buyers can send pre-play messages, a “threats” treatment where sellers can send messages along with their decision, and a baseline with no messages. They report that either kind of communication increases offers – from an average of about 50 percent of the cake in the baseline to about 63 percent under seller messages and 70 percent under buyer messages (an offer of 60 percent is needed to cover the seller’s fixed cost) – and this is anticipated by sellers, who are more likely to incur the fixed cost under either type of communication. Ellingsen and Johannesson develop a model combining Fehr and Schmidt’s (1999) inequity aversion and a lump-sum disutility of lying, and use it to explain their main experimental results.

López-Pérez (2012) introduces a model with three types of player: self-regarding types, “H” players who incur a disutility by violating norms of honesty (proportional to the strength of the norm), and “EH” players who are motivated by a norm of equity/efficiency as well as the honesty norm. He shows that this model can explain many patterns of behaviour found in social-dilemma experiments with pre-play communication, and that an analogous model with H types but no EH types could not do so. Miettinen (2013) studies a model where the cost of reneging on pre-play agreements is increasing in the level of harm inflicted on others, and shows that the extent to which such “guilt” improves welfare depends on the game’s structure. Games with strategic substitutes give rise to a conflict between efficiency and incentives to honour the agreement; this conflict does not arise when the strategies are strategic complements.

The closest theoretical model to ours is the one proposed by Besancenot et al. (2013) for the UG with asymmetric information about the cake size. Like Ellingsen and Johannesson (2004) above, they posit inequity aversion and a disutility of lying, though unlike Ellingsen and Johannesson, their disutility–of–lying function is linear in the size of the lie, and lying itself refers to misrepresenting information rather than a subsequent action. Besancenot et al. show theoretically that the presence of some truth-tellers makes it worthwhile for other proposers to lie, and in an experiment verify that lying is rampant (nearly 90 percent of proposers under-state the cake size).

The work discussed above has tended to concentrate on whether message senders will lie when given the opportunity. However, there is also a literature looking at message receivers’ response to being lied to. Sánchez-Pagés and Vorsatz (2007) consider a sender–receiver game with multiple possible states of the world, where only the sender knows the true state. They observe that senders send truthful messages about the state significantly more often than the theoretical prediction. Notably, though, they also find that receivers will expend resources to punish lying senders when this option is available, suggesting an aversion to being lied to. Peeters, Vorsatz and Walzl (2008) show, using similar games, that a non-negligible fraction of receivers will choose to reward senders when the oppor-

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3Sánchez-Pagés and Vorsatz (2009) argue that this pattern of behaviour is consistent with an aversion to lying, rather than a preference for truth-telling.
portunity is available, suggesting that some people receive a benefit from being told the truth. However, these rewards are found to have no significant effect on the overall truth–telling levels of senders (indeed, truth–telling seems to decrease). Brandts and Charness (2003) find evidence of both rewarding truth–telling and punishing lies in a 2x2 game preceded by cheap talk.

Finally, while our notion of deception aversion involves lies specifically, it is related to several other notions of disutility from bad treatment more generally. A disutility of lying is in the spirit of “guilt aversion” (Charness and Dufwenberg, 2006; Ellingsen et al., 2010) or “letting–down aversion” (Dufwenberg and Gneezy, 2000), while a disutility from being lied to is similar to “betrayal aversion” (Bohnet and Zeckhauser, 2004; Aimone, J.A. and D. Houser, 2012; Aimone, Ball and King-Casas, 2013).

3 Theory

The experiment uses two versions of the contractor game (CG), which we describe below, in addition to the standard ultimatum game (UG). In all three games, the two players bargain over a fixed sum of money (“cake”); this sum will be 20 Turkish liras (TL) in the experiment, so for convenience we will set it to 20 here as well. In the UG, the proposer makes an offer \( x \in \{0, 1, 2, ..., 20\} \) to the responder. The responder sees \( x \) (with certainty) and chooses a response: Accept or Reject. If the responder accepts, monetary payoffs are \( 20 - x \) for the proposer and \( x \) for the responder; after a rejection, each receives a monetary payoff of 0. In either case, the game ends with no opportunity for subsequent renegotiation.

In the basic contractor game, which we will abbreviate as CG(0), the proposer sends a message \( m \in \{0, 1, 2, ..., 20\} \) in addition to the offer \( x \). The message and offer spaces are identical by design; messages are meant to indicate the amount offered, and in the experiment are framed explicitly in this way. The responder observes \( m \) but not \( x \), and then chooses Accept or Reject, after which monetary payoffs are determined as in the UG; in particular, \( m \) has no direct effect on either player’s monetary payoff. The modified contractor game, which we abbreviate as CG(0.5), is similar, except that with probability 0.5, the responder does see the offer \( x \) (along with the message \( m \)) before choosing a response. Importantly, the proposer chooses \( x \) and \( m \) before knowing whether \( x \) will be seen by the responder. (The variant CG(1), where both message and offer are seen by the responder with certainty, is just the UG with a presumably redundant message.)

3.1 Self–regarding players

We will use the term “self–regarding” to describe players of either type (proposer or responder) who seek only to maximise their own expected monetary payoff. If both players are self–regarding, solving these games is simple. A self–regarding responder will accept any positive offer, is indifferent between accepting and rejecting a zero offer, and is unaffected by messages. Since \( x \geq 0 \) in all three games, the responder weakly prefers to accept even without observing the offer, in CG(0) and CG(0.5). Given this, backward induction implies that a self–regarding proposer will offer either nothing or almost nothing.

The pure–strategy perfect Bayesian equilibria (PBE) are thus as follows.\(^4\) In UG, the proposer will offer zero, and this will be accepted, or she will offer one, and this will be accepted while a zero offer would have been rejected. In CG(0), the proposer will offer zero and choose any message, and the responder will accept irrespective of the

\(^4\)There are also equilibria in which the responder mixes, but not enough to change proposer behaviour from one of the pure–strategy equilibria. For example, in either UG or CG(0) the proposer can offer zero and the responder can accept with probability above 0.96.
message (based on no information about the offer). In CG(0.5), there is an equilibrium where the proposer offers one and the responder accepts, and will also accept when not knowing the offer, but rejects when he sees a zero offer; there is also an equilibrium where the proposer offers zero and the responder always accepts. As in CG(0), the proposer can choose any message in any PBE, and the responder ignores the message when he decides to accept or reject.

To summarise, the three games’ equilibria are very similar. The proposer never offers more than 1, and positive offers are always accepted. In the UG, there are no messages, but even in CG(0) and CG(0.5), messages are only cheap talk, and are irrelevant to equilibrium.

3.2 Other–regarding players

In this section, we will begin examining the implications of two types of departure from own–money–payoff maximisation: aversion to inequity and aversion to deception. Both of these departures have been useful in explaining previous experimental results, as discussed in Section 2. Both departures will exist in two forms, one corresponding to each type of player (proposer or responder). Because some players will value aspects of outcomes other than their own monetary payoff, for expository purposes we will henceforth drop the term “monetary” and distinguish between payoffs, which are money amounts, and utilities, which comprise all aspects of an outcome that matter to players.

Fehr and Schmidt (1999) propose a model of inequity aversion, where players dislike both advantageous inequity (getting a higher payoff than others) and disadvantageous inequity (getting a lower payoff than others). Under the two–player version of their model, an inequity–averse player’s utility function is given by

$$ U_i(x) = x - \alpha_i \cdot \max\{x_j - x_i, 0\} - \beta_i \cdot \max\{x_i - x_j, 0\}, $$

where $x_i$ is the own payoff and $x_j$ is the opponent payoff, $\alpha_i \geq \beta_i \geq 0$, and $\beta_i < 1$. The values of $\alpha_i$ and $\beta_i$ represent the player’s aversion to disadvantageous and advantageous inequity, respectively.

In the remainder of this section (but of course not in the experiment), we restrict consideration to offers of 50% or less of the cake. In ultimatum game experiments, proposers seldom offer more than half the cake to responders, and we conjecture that such offers will be no more common in the contractor game. Similarly, we restrict consideration to messages of 50% or less of the cake; since offers are unlikely to be outside this range, we expect that messages would be viewed as obviously incredible if they indicated such a high offer.

These restrictions imply that proposers’ aversion to disadvantageous inequity, and responders’ aversion to advantageous inequity, are irrelevant. Thus, the two players’ utility functions can be written

$$ U_p(x) = 20 - x - \beta_p(20 - 2x); $$
$$ U_r(x) = x - \alpha_r(20 - 2x). $$

In the ultimatum game, where there are no messages, these will be the utility functions we use.

For the contractor game, we also consider players who dislike deception; for proposers, this is an aversion to lying, while for responders it is an aversion to being lied to. Distastes for lying are increasingly becoming incorporated in theoretical models (see, for example, Chen, Kartik and Sobel, 2008; Kartik, 2009; and Besancenot et al., 2013), and while aversion to being deceived is less common in these models, it is in the spirit of experimental findings that people dislike being lied to (e.g., Brandts and Charness, 2003).\footnote{We are agnostic about the psychological underpinnings of aversion to inequity and deception, though we note that there has been substantial work attempting to disentangle various explanations for individuals forgoing monetary gains in order to tell the truth or to punish liars (see, e.g., Charness and Dufwenberg, 2006, 2010).} We will define a message $m$ to be a
lie if it over–states the offer \( x \), and truthful if \( m \leq x \). While we admit that this abuses terminology to some extent (messages that under–state the offer are, in a literal sense, just as untrue as over–statements), we use this definition because it captures the common moral distinction between lies that benefit the proposer at the responder’s expense and other kinds of untruth, which are typically viewed as either more benign or irrelevant (see, e.g., Gneezy, 2005).

When \( m > x \) (i.e., the message over–states the offer) and the responder accepts, the proposer receives a disutility of \( \gamma_p(m – x) \) and the responder receives a disutility of \( \delta_r(m – x) \), on top of any money payoff and inequity aversion.\(^6\) When \( x \geq m \), disutility from deception is zero, as it is in the UG (where there are no messages). Disutility from deception is also zero when the responder rejects; in that case, we suppose either that the deception was disbelieved by the responder or that there was no harm done. Adding deception aversion to the utility functions (1) and (2) gives us the general utility functions for our model:

\[
U_p(x, m) = \begin{cases} 
20 – x – \beta_p(20 – 2x) – \gamma_p \cdot \text{Max}\{0, m - x\} & x \text{ accepted}; \\
0 & x \text{ rejected}; 
\end{cases}
\]

\[
U_r(x, m) = \begin{cases} 
x – \alpha_r(20 – 2x) – \delta_r \cdot \text{Max}\{0, m - x\} & x \text{ accepted}; \\
0 & x \text{ rejected}; 
\end{cases}
\]

with \( x, m \leq 10 \). Note that these utility functions are simply the ones specified by Fehr and Schmidt (1999), augmented to allow deception aversion in addition to inequity aversion.

### 3.3 A simple model of behaviour in the UG and CG games

We now make several assumptions, in an attempt to simplify the general model while still yielding non–trivial predictions to test in the experiment. We begin by assuming that the population comprises both self–regarding and other–regarding people, with \( \phi_s \in (0, 1) \) the fraction of self–regarding proposers and \( \rho_s \in (0, 1) \) the fraction of self–regarding responders (with complements \( \phi_o = 1 – \phi_s \) and \( \rho_o = 1 – \rho_s \)). All self–regarding people are obviously identical, with \( \alpha = \beta = \gamma = \delta = 0 \), but we also assume that all of the other–regarding people are identical, with \( \alpha = \beta = \gamma = \delta = 0.5 \); in other words, there is perfect correlation between inequity aversion and deception aversion for both proposers and responders. Such an assumption is clearly strong, but perhaps justifiable by an argument that individuals either value “fair play” or they do not, and those who value fair play ought to dislike both greed and lying, while those who don’t are indifferent toward both.\(^7\) The values of \( \phi_s \) and \( \rho_s \) are assumed to be common knowledge.

The common value of one–half for all of the parameters is also an obvious simplification, though in the case of inequity aversion, it is close to the median values reported by Blanco, Engelmann and Normann (2011), and some of our results are robust to relaxing this assumption.\(^8\) Let \( P_s \) and \( P_o \) stand for self– and other–regarding proposers respectively, and similarly \( R_s \) and \( R_o \) for responders. Define \( \mu_s(m) \) to be the responder’s belief that a given proposer is self–regarding based on observing \( m \) in either version of the contractor game, and let \( \mu_o(m) = 1 – \mu_s(m) \) be the corresponding belief that the proposer is other–regarding.

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\(^6\)Clearly, one can easily generalise these functional forms and those from inequity aversion to nonlinear cases which might be more realistic, but our goal is not to find the best model of inequity– and deception–aversion. We only seek to construct a simple and tractable model that yields testable hypotheses for our experiment.

\(^7\)Indeed, this simplification may not be totally unrealistic. For example, Hurkens and Kartik (2009) argue that the data from Gneezy’s (2005) lying experiment are explained well by a model that has only two types of player: those who lie whenever it benefits them, and those who never lie.

\(^8\)For example, other–regarding proposers’ behaviour in all three games would be unaffected by increasing the values of any of the four parameters.
We next make three tie-breaking assumptions. First, if an other-regarding proposer is indifferent between multiple messages, she will choose the one that minimizes over-statement \( \text{Max} \{0, m-x\} \), and if multiple messages obtain this minimum (as is the case when \( x > 0 \)), she will choose the most truthful one (i.e., the closest to \( x \)). Second, if a proposer is indifferent between multiple offers, all of which are less than or equal to half of the cake, she will send the highest offer. Third, if a responder is indifferent between accepting or rejecting a proposal, then he will accept it.

Under these assumptions, the basic contractor game \( \text{CG}(0) \) becomes a signaling game with multiple sender and receiver types, in contrast to standard signalling games that have multiple sender types but just one receiver type. The modified contractor game \( \text{CG}(0.5) \) is a semi-signalling game in which nature reveals information about the sender’s type to the receiver with probability one-half but does not reveal the receiver’s type to the sender.

The UG is straightforward to solve, though the presence of other-regarding players alters the solution from what we saw before. The solution, like those of \( \text{CG}(0) \) and \( \text{CG}(0.5) \) below, will depend partly on the population proportions of self-regarding proposers and responders (to which we will refer as simply “model parameters”, since we have fixed the values of all other parameters).

**Proposition 1** The UG has a unique PBE. Other-regarding responders will accept offers of at least 5, and self-regarding responders will accept all offers. Other-regarding proposers will offer 10, and self-regarding proposers will offer either 0 (if \( \rho_o < 0.25 \)) or 5 (otherwise).

Proof: See Appendix A.

Like the UG, the equilibria of \( \text{CG}(0) \) depend on model parameters, but unlike the UG, \( \text{CG}(0) \) has no equilibrium in which self-regarding proposers make positive offers.

**Proposition 2** In \( \text{CG}(0) \), no separating PBE exists. There always exists a pooling PBE, with all proposers sending the same message, other-regarding proposers offering 10, and self-regarding proposers offering 0. When \( \phi_o \geq 0.6 \), there is a pooling PBE where all offers are accepted, and any message between 0 and 10 is consistent with equilibrium. When \( \phi_o < 0.5 \), there is a pooling PBE where only messages of 10 are sent, and only self-regarding responders accept offers. For \( \phi_o \in [0.5, 0.6) \), both of these PBE exist.

Proof: See Appendix A.

In solving \( \text{CG}(0.5) \), we introduce some additional terminology. An equilibrium in which both proposer types send the same message and make the same offer is a pooling equilibrium, one where both proposer types send the same message but make different offers is a semi-pooling equilibrium, and one where both proposer types send different messages and make different offers is a separating equilibrium.

**Proposition 3** In \( \text{CG}(0.5) \), no pooling PBE exist. There always exists a semi-pooling PBE with other-regarding proposers offering 10, but for a small subset of parameter values \( (\rho_o \in [0.4, 0.5] \text{ and } \phi_o < 0.5) \) there is none where everyone chooses pure strategies. For \( \rho_o \geq 0.5 \), both semi-pooling and separating PBE exist, with messages between 0 and 10, self-regarding proposers offering 5 or 6 (depending on model parameters and the message(s)), and all offers being accepted. For \( \rho_o < 0.5 \) and \( \phi_o \geq 0.5 \), a semi-pooling PBE exists, with all proposers sending the same message, self-regarding proposers offering 0, and all offers being accepted except 0 offers by other-regarding responders who see both the message and the offer. For \( \rho_o < 0.4 \) and \( \phi_o \leq 0.6 \), a semi-pooling PBE exists with all proposers sending a message of 10, self-regarding proposers offering 0, self-regarding responders always accepting, and other-regarding responders accepting only when they see the offer of 10.

Proof: See Appendix A.
3.4 Implications for the experiment

From Propositions 1, 2 and 3, we see that equilibrium behaviour depends on the values of $\phi_o$ and $\rho_o$ – that is, the proportions of other–regarding proposers and responders – and even for specific parameter values, there can be multiple perfect Bayesian equilibria. We therefore need to make two additional assumptions in order to arrive at the predictions we will test in the experiment.

Our first assumption is that, since subjects in the experiment were randomly assigned to be either proposer or responder, the role should be uncorrelated with subjects’ types, and so the proportion of other–regarding proposers should be the same as that of other–regarding responders: $\phi_o = \rho_o$. Given this assumption, the set of equilibria can be described as a function of the proportion of other–regarding players, and the implied expected values of behavioural variables can be calculated. As an example, in UG when $\rho_o < 0.25$, self–regarding proposers offer 0 and other–regarding proposers offer 10. Then, for a given $\rho_o < 0.25$, the expected offer from the proposer population is $10\rho_o + 0(1 - \rho_o) = 10\rho_o$. Similarly, when $\rho_o > 0.25$ self–regarding proposers offer 5 and other–regarding proposers offer 10, so the expected offer for a given $\rho_o > 0.25$ is $10\rho_o + 5(1 - \rho_o) = 5 + 5\rho_o$. In cases where there are multiple equilibria, each class of equilibria is chosen with equal probability, and if some class permits multiple messages or offers, the arithmetic mean of these is chosen.

The second assumption we make is that since types are unobservable, and since neither we nor the subjects have information about the distribution of types in the population, expected behaviour in the experiment is simply the unconditional expectation given a uniform distribution over $\rho_o$. For example, the expected offer in UG is given by

$$E(x) = \int_0^{0.25} 10\rho_o \, d\rho_o + \int_{0.25}^1 (5 + 5\rho_o) \, d\rho_o,$$

which evaluates to approximately 6.406, or equivalently just over 32% of the cake. The resulting point predictions for offers and overall acceptances in all three games, and messages, the amount of “over–statement” (message minus offer), and the probability of acceptance of an unseen offer in both CG games, are shown in Table 1, with monetary amounts (offers, messages and over–statements) expressed as percents of the cake size. As usual in experiments based on theory, however, our focus is not on the narrow question of whether actual behaviour in the experiment is characterised by the point predictions we have derived. Rather, we are interested in the qualitative implications of these point predictions: how a statistic varies across games, or how two statistics compare within a game. These comparative statics give us our first seven hypotheses.

Table 1: Characteristics of equilibria of UG, CG(0.5), CG(0), based on the model in Section 3.3 and with the same proportion of other–regarding types for both proposers and responders

<table>
<thead>
<tr>
<th>Game</th>
<th>Expected Offer</th>
<th>Expected Message</th>
<th>Expected Over–Statement</th>
<th>Prob(Unseen Offer Accepted)</th>
<th>Overall Acceptance Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>UG</td>
<td>32.0</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>0.974</td>
</tr>
<tr>
<td>CG(0.5)</td>
<td>28.7</td>
<td>34.6</td>
<td>5.9</td>
<td>0.900</td>
<td>0.839</td>
</tr>
<tr>
<td>CG(0)</td>
<td>25.0</td>
<td>39.0</td>
<td>14.0</td>
<td>0.848</td>
<td>0.848</td>
</tr>
</tbody>
</table>

Note: offers, messages and over–statements expressed as percents of the cake.

This assumption may be restrictive if individuals adopt self–serving notions of fairness (e.g., Babcock et al., 1995; Binmore et al., 1998).
Hypothesis 1 Offers are higher in UG than CG(0.5), and higher in CG(0.5) than CG(0).

Hypothesis 2 In both CG(0) and CG(0.5), messages are higher than offers.

Hypothesis 3 Messages are higher in CG(0) than CG(0.5).

Hypothesis 4 The amount that messages over-state offers is higher in CG(0) than CG(0.5).

Hypothesis 5 Overall acceptance rates are higher in UG than CG(0.5), and higher in CG(0.5) than CG(0).

Hypothesis 6 Message-offer pairs in which the responder does not observe the offer are more likely to be accepted in CG(0.5) than CG(0).

Hypothesis 7 Acceptance rates in CG(0.5) are higher when the offer is not observed than when it is observed.

Our final hypothesis does not come from the table or propositions, but rather from the specification of the model itself: in particular, the preferences of other-regarding responders.

Hypothesis 8 In CG(0.5) when responders do observe the offer \( x \), responders are more likely to accept \( x \) when the message \( m \) is truthful.

While our hypotheses arise mathematically as implications of the model described above, including the assumptions we made in deriving its solution, for the most part they also reflect common (and we believe uncontroversial) intuition about how people would play the three games. Hypothesis 1 simply states that the more likely a proposer’s offer is to be seen by the responder, the more generous it ought to be, and Hypothesis 5 predicts that responders will understand this and react accordingly. Hypotheses 2–4 state that messages, which are cheap talk, will be more “generous” than actual offers (which of course are costly), and that the amount that they will over-state the offers will be higher when the offer cannot be observed than when it might be; Hypothesis 6 states that responders understand this. Hypothesis 8 arises naturally from the deception aversion of a positive fraction of responders. So, only Hypothesis 7 is a consequence of the specific model we use.

4 Experimental design and procedures

Each experimental session involved ten subjects playing one game (UG, CG(0) or CG(0.5)) for five rounds, followed by a questionnaire containing attitudinal and demographic questions. Each subject was randomly assigned a role – proposer or responder – that was fixed for the entire session, and was matched once to each of the five subjects of the opposite role.

The sessions took place at the Social Sciences Laboratory at TOBB University of Economics and Technology in Ankara, Turkey in January 2013. Subjects, primarily undergraduate students, were invited by a school-wide email and registered online for a session; no one took part more than once. The experiment was run on networked personal computers, and programmed using the z–Tree experiment software package (Fischbacher, 2007). Subjects

10English translations of the instructions (which, along with the other materials, were written in Turkish) for the CG(0.5) treatment are in Appendix B, translations of the post–experiment questionnaire are in Appendix C, and sample screen–shots (also translated) are in Appendix D. Other experimental materials such as instructions from the other treatments, the raw data and computer programs are available from the corresponding author upon request.
sat in individual carrels in a single room and were visually isolated from each other, and were asked to turn off their mobile phones and not to communicate with each other except via the computer program. All sessions were run by the same experimenter.

At the beginning of a session, subjects were given written instructions, which were also read aloud in an attempt to make them common knowledge. After this, the first round begun. Each round began with a reminder of the subject’s role. After that, the proposer was prompted to choose an offer, which could be any whole number between 0 and 20 Turkish liras (TL). In CG(0) and CG(0.5) the proposer decided at the same time what message she would send to the responder. This message was elicited with the phrasing, “In your message to player A, how much out of 20 TL will you tell him/her that you sent to him/her”. The responder observed the offer in UG, the message in CG(0), and – with equal probability – either only the message or both the message and the offer in CG(0.5). After receiving this information, the responder decided whether to accept or reject the proposer’s offer, after which payoffs were determined and subjects received feedback: the offer, the message (in CG(0) and CG(0.5)), the responder’s decision and the subject’s payoff. Subjects weren’t told the opponent payoff, but were given enough information to make that calculation if desired.

At the end of the last round, subjects completed the questionnaire, then were paid in cash, privately and individually. For each session, one round was randomly chosen for payment, and subjects additionally received a show–up fee of 8 TL. Total earnings averaged just under 16 TL and ranged from 8 TL to 28 TL, for a session that typically lasted about 25–30 minutes.

5 Experimental results

There were seventeen experimental sessions, 5 each of the UG and CG(0) treatments, and 7 of the CG(0.5) treatment, for a total of 170 subjects. (We had more CG(0.5) sessions in order partly to offset the fact that in each session, half of observations have a seen offer and half have an unseen offer.) In order to facilitate comparison of our results with previous ultimatum–game experiments, we express all monetary quantities (e.g., offers) as percents of the cake size, as we did with the theoretical predictions in Table 1, unless stated otherwise.

5.1 Aggregate descriptive statistics

Table 2 shows some aspects of aggregate proposer behaviour in the experiment – offers, messages and over–statements (message minus offer, censored at zero) averaged over all rounds – along with results of non–parametric tests of significance of differences across treatments or statistics. Figure 1 provides some additional information about these variables, with non–parametric kernel densities used to estimate the underlying distributions of offers and messages. Offers in our UG treatment are fairly typical for ultimatum games; nearly all are between 20 and 50 percent of the cake, and averaging a bit over 40 percent. As predicted by the model – and consistent with Hypothesis 1 – offers in both versions of the contractor game are lower than those in the ultimatum game, with offers in

11 At the time of the experiment, 1 TL corresponded to USD 0.56 at market exchange rates. However, the lower cost of living in Turkey compared to many developed countries made the stakes correspondingly higher. For comparison, the minimum hourly wage in Turkey is 4.5 TL, and a lunch at the school cafeteria costs about 6 TL.

12 A 3–sample Jonckheere test is used for comparison of offers across all three treatments (because the alternative hypothesis is directional), while a 2–sample robust rank–order test is used for the comparison of messages between the CG treatments. Within either treatment, a Wilcoxon signed–ranks test for matched samples is used for the comparison of offers and messages. All non–parametric statistical tests in this paper use session–level data. See Siegel and Castellan (1988) for descriptions of these tests, and see Feltovich (2005) for a table of critical values for the robust rank–order test.
Table 2: Aggregate proposer data

<table>
<thead>
<tr>
<th></th>
<th>UG</th>
<th>CG(0.5)</th>
<th>CG(0)</th>
<th>Significantly different?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean offer (% of cake)</td>
<td>41.5</td>
<td>31.5</td>
<td>20.1</td>
<td>( p &lt; 0.005 )</td>
</tr>
<tr>
<td>Mean message (% of cake)</td>
<td>—</td>
<td>46.5</td>
<td>46.6</td>
<td>n.s.</td>
</tr>
<tr>
<td>Significantly different?</td>
<td>( p \approx 0.008 )</td>
<td>( p \approx 0.03 )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean over–statement (% of cake)</td>
<td>17.7</td>
<td>29.8</td>
<td></td>
<td>( p \approx 0.01 )</td>
</tr>
</tbody>
</table>

See text for descriptions of significance tests. n.s. = not significant.

Figure 1: Distribution of offers and messages, as shares of the cake size, by treatment (kernel densities)

CG(0) even lower than those in CG(0.5). There is substantial variance in offers in both CG treatments, with positive but small mass on the equal split. Nonetheless, the treatment effects in offers are highly significant: the null hypothesis of no difference across the three treatments is rejected in favour of the alternative hypothesis of highest offers in UG and lowest offers in CG(0) (Jonckheere test, \( J = 87 \), sample sizes (5, 5, 7), \( p < 0.005 \)). Further evidence of differences across treatments comes from pairwise robust rank–order tests, which find significantly higher offers in UG than in CG(0) (\( \hat{U} = +\infty \), sample sizes (5, 5), \( p \approx 0.004 \)) and CG(0.5) (\( \hat{U} = 6.07 \), sample sizes (5, 7), \( p \approx 0.005 \)), and significantly higher offers in CG(0.5) than in CG(0) (\( \hat{U} = 2.42 \), sample sizes (5, 7), \( p \approx 0.03 \)).

The relationships between offers and messages in the two CG treatments also support the model. Consistent with Hypothesis 2, we see in Table 2 and Figure 1 that messages, the vast majority of which are close to 50 percent of the cake, are higher than offers in both CG(0) and CG(0.5), and these differences are significant (Wilcoxon signed–ranks tests, \( T^+ = 15, N = 5 \), \( p \approx 0.031 \) for CG(0), \( T^+ = 28, N = 7 \), \( p \approx 0.008 \) for CG(0.5)). Also, consistent with Hypothesis 4, the amount that messages over–state offers (i.e., the extent to which proposers lie on average) is significantly higher in CG(0) than in CG(0.5) (robust rank–order test, \( \hat{U} = 4.25 \), \( p \approx 0.01 \)). However, we find no significant difference between treatments in the messages themselves, in contrast to Hypothesis 3’s prediction of higher–valued messages in CG(0) (robust rank–order test, \( \hat{U} = 0.07 \), \( p > 0.20 \)).

Figure 2 shows average offers and messages round–by–round. Offers in the UG show a slight upward time trend that is suggestive but not significant at conventional levels (two–tailed Wilcoxon signed–ranks test between round 1 and round 5 on session–level data, \( T^+ = 10, n = 4 \), \( p \approx 0.125 \)). Offers in CG(0) also don’t change significantly
over time ($T^+ = 11, n = 5, p > 0.20$), while those in CG(0.5) show a significant downward trend ($T^+ = 27, n = 7, p \approx 0.03$). As with offers, messages don’t change significantly over time in CG(0) ($T^+ = 8, n = 5, p > 0.20$) but there is a weak downward tendency in CG(0.5) ($T^+ = 25, n = 7, p \approx 0.08$).

Figure 3 shows every individual proposer (message, offer) pair in the CG(0) and CG(0.5) treatments. For each (message, offer) combination, the figure shows the number of times that combination was sent by proposers in the CG(0) treatment as the area of the dark circle, and the number of times it was sent in the CG(0.5) treatment as the area of the light circle (or ring surrounding a dark circle). Given the aggregate descriptive statistics already seen, Figure 3: Proposer messages and offers – CG(0) and CG(0.5) treatments (The area of each circle is proportional to the number of observations with that (message, offer) pair. Within each circle, the dark circle has area proportional to the number of observations in the CG(0) treatment, and the light circle/ring has area proportional to the number of observations in the CG(0.5) treatment.)
it is not surprising that the modal message is clearly 10 (50 percent of the cake), or that there is little apparent correlation between offers and messages in either CG treatment. However, it is arguably noteworthy that there is any correlation at all between offers and messages – and thus that messages are informative to some extent. The figure shows OLS trend lines for the two treatments separately; both are positively sloped (though only the CG(0.5) slope is significantly different from zero).

Another somewhat surprising feature of the figure is the frequency of truthful messages. Proposers send a message exactly equal to their offer 13% of the time in the CG(0) treatment and 27% of the time in the CG(0.5) treatment. Further, a non–negligible fraction of incorrect messages are in the “wrong” direction, with the proposer’s offer higher than the corresponding message 8% of the time in the CG(0) treatment and 13% of the time in the CG(0.5) treatment.

Table 3 reports results on proposer behaviour from four pairs of Tobit regressions. Models 1–4 have the offer as the dependent variable, using either all proposer data (Models 1–2) or the proposer data from the CG(0) and CG(0.5) treatments (Models 3–4). Models 5 and 6 also use the proposer data from the two CG treatments, but have the message as the dependent variable, while Models 7 and 8 use a new variable, “Over–state”, defined as the message minus the offer, truncated at zero on the left side (and hence equalling the extent to which the message is an over–statement of the offer), as the dependent variable. Within each pair of models, there is a restricted model with only the main treatment variables, and an unrestricted model with additional explanatory variables. The main treatment variables in Models 1 and 2 are indicators for two of the three treatments (with UG as the baseline), the round number, and its product with the two treatment indicators. Models 3 and 4 use the CG(0.5) indicator (so that CG(0) is the baseline), the round number, the message, and all products of these variables (including the three–way product); Models 5–8 use the CG(0.5) indicator, the round number, and their product. The additional variables used in the unrestricted models (2, 4, 6 and 8) are an indicator for female; the subject’s age (to the nearest year); indicators for living with family, with friends, or alone (living in a dorm is the baseline); indicators for economics student and business (non–economics) student; number of younger siblings; number of older siblings; indicator for being an only child; number of economics classes completed (up to a maximum of 4); the 15 attitudinal variables from the questionnaire (see Appendix C); and the subject’s decision time (i.e., the time from the beginning of the stage until the subject enters her choices). All eight models were estimated using Stata (version 12), and include a constant term and individual–subject random effects.

The table shows marginal effects (at variables’ means), standard errors, and level of significance for the main treatment variables. To save space, we leave the demographic and attitudinal variables, none of which were significant once a correction for multiple comparisons was made (Benjamini and Hochberg, 2005), out of the table – though we do keep these variables in the models themselves. Comparison of each pair of models suggests that our main treatment variables are largely unaffected by whether these additional variables are included.

In Models 1 and 2, the marginal effects of the CG(0) and CG(0.5) dummies show that offers are significantly higher in the UG treatment than in either CG treatment, and further tests show that offers are also higher in CG(0.5) than in CG(0) ($p \approx 0.002$ and $p \approx 0.003$ in Models 1 and 2, respectively), consistent with Hypothesis 1. Model 3 further confirms the difference in offers between CG(0) and CG(0.5), though in Model 4, the difference misses significance ($p \approx 0.12$). Models 3 and 4 also show the positive correlation between messages and offers that was apparent from Figure 3, though calculations of the treatment–specific marginal effects show that this relationship is significant only for CG(0.5) ($p \approx 0.003$ and $p \approx 0.009$ in Models 3 and 4 respectively), and is insignificant and nearly zero for CG(0) ($p > 0.20$ in both models). The marginal effect of the round number is negative and significant in all four of these models, indicating the tendency of offers to decline over time on average, though this
Table 3: Proposer behaviour – Tobit marginal effects, with standard errors in parentheses

<table>
<thead>
<tr>
<th>Model</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample:</td>
<td>All proposers (N = 425)</td>
<td></td>
<td></td>
<td>CG(0) and CG(0.5) proposers (N = 300)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dependent variable:</td>
<td>Offer</td>
<td>Offer</td>
<td>Offer</td>
<td>Offer</td>
<td>Message</td>
<td>Message</td>
<td>Over-state</td>
<td>Over-state</td>
</tr>
<tr>
<td>CG(0) treatment</td>
<td>$-0.220^{***}$</td>
<td>$-0.232^{***}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.041)</td>
<td>(0.041)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CG(0.5) treatment</td>
<td>$-0.096^{***}$</td>
<td>$-0.089^{**}$</td>
<td>$0.125^{***}$</td>
<td>$0.099$</td>
<td>$-0.001$</td>
<td>$0.001$</td>
<td>$-0.124^{***}$</td>
<td>$-0.113^{*}$</td>
</tr>
<tr>
<td></td>
<td>(0.043)</td>
<td>(0.043)</td>
<td>(0.045)</td>
<td>(0.063)</td>
<td>(0.023)</td>
<td>(0.026)</td>
<td>(0.047)</td>
<td>(0.060)</td>
</tr>
<tr>
<td>Round</td>
<td>$-0.012^{***}$</td>
<td>$-0.012^{**}$</td>
<td>$-0.018^{***}$</td>
<td>$-0.018^{***}$</td>
<td>$-0.007$</td>
<td>$-0.013^{**}$</td>
<td>$0.017^{***}$</td>
<td>$0.013^{**}$</td>
</tr>
<tr>
<td></td>
<td>(0.005)</td>
<td>(0.005)</td>
<td>(0.005)</td>
<td>(0.006)</td>
<td>(0.005)</td>
<td>(0.006)</td>
<td>(0.005)</td>
<td>(0.006)</td>
</tr>
<tr>
<td>Message</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant term?</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Additional RHS variables?</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>$</td>
<td>\ln(L)</td>
<td>$</td>
<td>43.76</td>
<td>64.26</td>
<td>2.87</td>
<td>38.23</td>
<td>161.32</td>
<td>205.02</td>
</tr>
</tbody>
</table>

Notes: RHS variables included but not displayed in Models 2, 4, 6 and 8: Living with family, Living with friends, Living alone, Older siblings, Younger siblings, Only child, Economics student, Business student, Number of economics classes completed, Age, Female, Decision time, 15 attitudinal variables (see Appendix C).

Offer, message, over-state as proportion (not percent) of cake size.

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

average masks differences across treatments: positive and insignificant time trend for UG, negative and significant for CG(0.5), negative and insignificant for CG(0).

Models 5 and 6 show that there is no treatment effect on messages, confirming the results of the non-parametric tests earlier in this section, and failing to support Hypothesis 3. Given the lack of treatment effect on messages and the significant treatment effects on offers seen in Models 1–4, we would expect over-statement to be larger in CG(0) than CG(0.5); this is confirmed by Models 7 and 8, again consistent with Hypothesis 4.

5.2 Responder behaviour

Table 4 shows some descriptive statistics for responders’ behaviour (i.e., acceptances) in four conditions: UG, CG(0.5) in observations where the offer was seen by the responder, CG(0.5) in observations where the offer was not seen, and CG(0) (not shown, but easily calculated, is the overall acceptance frequency of 75% for CG(0.5)). In the first two of these conditions, acceptance frequencies are broken down by intervals; in the last two, where offers were not observable, only overall acceptance frequencies are relevant. The relationships between acceptance frequencies and either offers (in UG) or messages (in the CG treatments) are also estimated using lowess smoothers (a non-parametric curve-fitting technique), with the results displayed in Figure 4.

The left panel of Figure 4 suggests that responder behaviour in the UG is fairly typical: they accept equal splits almost always, reject near-zero offers nearly always, and 70–30 proposals are accepted about half the time. Table 4 shows, consistent with Hypothesis 5, that the overall (unconditional) acceptance frequency in CG(0) is lower than that in either CG(0.5) or UG; however, only the difference between UG and CG(0) is significant, and only weakly so (robust rank-order test, $\hat{U} = 1.56$, $p \approx 0.09$ for UG vs. CG(0), $\hat{U} = 1.22$, $p \approx 0.12$ for CG(0.5) vs. CG(0)). Similarly, a Jonckheere three-sample test cannot reject the null hypothesis that all three acceptance rates are equal ($J = 62.5$, $p \approx 0.10$). On balance, then, the support for Hypothesis 5 is fairly weak.

By contrast, the right panel of Figure 4 provides some evidence consistent with Hypotheses 6 and 7. For a given
message, acceptance in CG(0.5) is more likely when the offer is not seen than when it is seen. Also, acceptance of an unseen offer in CG(0.5) is more likely than in CG(0). At the aggregate level, both of these differences are highly significant (robust rank–order test, $\hat{U} = 6.07$, $p \approx 0.005$ for unseen offers in CG(0.5) versus CG(0); Wilcoxon signed–ranks test, $T^+ = 21$, $n = 7$, $p \approx 0.008$ for unseen offers versus seen offers in CG(0.5)).

Table 5 shows acceptance frequencies in those observations of CG(0.5) where the offer was seen by the responder, disaggregated according to whether the message was greater than the corresponding offer, or alternatively less than or equal to the offer; we continue to call a message a “lie” in the former case and “truthful” in the latter. These frequencies are also shown at a less aggregated level in Figure 5. The bottom row of the table shows that in aggregate, offers are much more likely to be accepted when the accompanying message was truthful versus when it was a lie. This difference is significant (Wilcoxon signed–ranks test, $p \approx 0.008$), and consistent with Hypothesis 8. Moreover, the figure shows that the higher acceptance frequency after truthful messages than after lies is discernible even conditioning on the offer, though as noted in Table 5, finding significant differences here is difficult due to the paucity of directly comparable observations (most truthful messages involve higher offers, while most lies involve lower offers, so there is little overlap). In the one range of offers with sample sizes large enough to detect a difference (between 5 and 9 inclusive), the corresponding $p$–value just misses statistical significance (Wilcoxon signed–ranks test, $U = 71$, $n = 5$, $p = 0.08$).

Figure 4: Acceptance frequencies by offer (UG) and message (CG), lowess smoother (non–parametric curve fit)
Table 5: Responders in CG(0.5) – offer observed

<table>
<thead>
<tr>
<th>Message &gt; Offer</th>
<th>Offers</th>
<th>Acceptances</th>
<th>Frequency (%)</th>
<th>Message ≤ Offer</th>
<th>Offers</th>
<th>Acceptances</th>
<th>Frequency (%)</th>
<th>Signif. of diff.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–20%</td>
<td>8/28</td>
<td>29</td>
<td></td>
<td>0–20%</td>
<td>1/1</td>
<td>100</td>
<td></td>
<td>n.s.</td>
</tr>
<tr>
<td>25%–45%</td>
<td>23/32</td>
<td>72</td>
<td></td>
<td>25%–45%</td>
<td>12/13</td>
<td>92</td>
<td></td>
<td>$p \approx 0.11$</td>
</tr>
<tr>
<td>50%+</td>
<td>0/0</td>
<td>–</td>
<td></td>
<td>50%+</td>
<td>19/20</td>
<td>95</td>
<td></td>
<td>–</td>
</tr>
<tr>
<td>All</td>
<td>31/60</td>
<td>52</td>
<td></td>
<td>All</td>
<td>32/34</td>
<td>94</td>
<td></td>
<td>$p \approx 0.008$</td>
</tr>
</tbody>
</table>

See text for descriptions of significance tests. n.s. = not significant.

Figure 5: Acceptance frequencies by offer in CG(0.5) conditional on offer being seen by responder, lowess smoother (non-parametric curve fit)

Not only is acceptance more likely in CG(0.5) after a truthful message than after a lie, but it is also more likely than in the UG; that is, when no message at all accompanied the offer. This can be seen by comparison between Tables 4 and 5 or between Figures 4 and 5. Moreover, the difference in aggregate acceptance frequencies is significant (robust rank–order test, $\hat{U} = 17.85$, $p \approx 0.003$ for UG versus seen offers with truthful messages in CG(0.5)).

We continue examining responder behaviour with five probit regressions, all with an Accept choice as the dependent variable. The models differ in which right–hand–side variables are included, which also determines the sub–sample used. All five models include a constant term and the round number (though the latter turns out never to have a significant effect). Model 9 uses all of the responder data, and includes the offer and dummies for the CG(0) and CG(0.5) treatments (so that the baseline is UG). Model 10 uses the subset of the CG(0) and CG(0.5) data in which the offer was unseen (i.e., all observations in CG(0) and about half in CG(0.5)), and includes a CG(0) dummy along with the message. Model 11 uses the subset of the UG and CG(0.5) data in which the offer was seen, and includes the offer and dummy variables for a truthful message (taking a value of 1 if $m \leq x$) and a lie (equal to 1 if $m > x$); the baseline is thus the UG, where no message was sent. Model 12 uses the CG(0.5) data, and includes the message and a dummy for whether the offer was seen. Model 13 uses the subset of the CG(0.5) data in which the
offer was seen, and includes the message and offer, along with the dummy variable for truth–telling. Each model additionally includes all relevant two– and three–way interaction variables, though we leave out the demographic and attitudinal variables since we found no evidence that their inclusion in the proposer regressions (Table 3) had any significant effect on the results, and because the smaller sample sizes in some of these models leads to concerns about over–fitting. These models were estimated using Stata (version 12), and included individual–subject random effects. Table 6 reports the results: estimated marginal effects and standard errors for each variable, and log–likelihoods for each model.

Table 6: Responder behaviour – probit marginal effects (dependent variable = Accept), standard errors in parentheses

<table>
<thead>
<tr>
<th>Model</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample:</td>
<td>All responders</td>
<td>Both CG, offer unseen</td>
<td>UG and CG(0.5), offer seen</td>
<td>CG(0.5), all offers</td>
<td>CG(0.5), offer seen</td>
</tr>
<tr>
<td>CG(0) treatment</td>
<td>0.162*</td>
<td>−0.192***</td>
<td>(0.093)</td>
<td>(0.065)</td>
<td></td>
</tr>
<tr>
<td>CG(0.5) treatment</td>
<td>0.274***</td>
<td>(0.092)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Offer (frac. of cake)</td>
<td>1.278***</td>
<td>2.052***</td>
<td>1.445</td>
<td>(0.289)</td>
<td>(0.742)</td>
</tr>
<tr>
<td>Message (frac. of cake)</td>
<td>0.256</td>
<td>−0.269</td>
<td>0.982</td>
<td>(0.219)</td>
<td>(0.273)</td>
</tr>
<tr>
<td>Round</td>
<td>0.009</td>
<td>0.017</td>
<td>−0.011</td>
<td>0.030</td>
<td>0.010</td>
</tr>
<tr>
<td>Offer seen</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Truth</td>
<td>0.166**</td>
<td>0.365***</td>
<td>(0.076)</td>
<td>(0.142)</td>
<td></td>
</tr>
<tr>
<td>Lie</td>
<td>0.063</td>
<td>(0.083)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant term?</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>N</td>
<td>425</td>
<td>206</td>
<td>219</td>
<td>175</td>
<td>94</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ln(L)</td>
<td>218.40</td>
<td>105.47</td>
<td>86.44</td>
<td>88.59</td>
<td>35.31</td>
</tr>
</tbody>
</table>

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

Model 9 shows a positive and significant marginal effect of the offer on the probability of acceptance. Such a result may seem unsurprising given the strong correlation between offers and acceptance probabilities throughout the literature on experiments involving ultimatum games and related games; however, our finding of a similarly significant correlation is somewhat noteworthy, given that roughly half of all offers were not observable to the responder. This model also shows positive and significant marginal effects for the CG(0) and CG(0.5) treatment dummies. This means that controlling for the offer, responders were on average more agreeable in these games than in the UG; the lower overall acceptance rate in CG(0) and roughly equal one in CG(0.5) seen earlier in the aggregate responder data are thus attributable mainly to lower offers by proposers, rather than to stricter responders.

Model 10 provides additional evidence consistent with Hypothesis 6; the negative and significant marginal effect of the CG(0) dummy implies that when an offer is not observed by the responder, it is more likely to be accepted if there was a chance that it could have been observed. Model 11 shows that controlling for the offer, the likelihood of acceptance following a lie in the CG(0.5) treatment is not significantly different from that in the UG, while acceptance is actually more likely after a truthful message.
In Model 12, the negative and significant marginal effect of the “offer seen” dummy indicates that responders are less likely to accept when they observe the offer than when they cannot observe it, consistent with Hypothesis 7. The message itself has no significant effect on the likelihood of acceptance, despite the positive correlation with the offer seen in Figure 3 and Table 3. In Model 13, we further see that in cases where both offer and message are observed, not only the message, but also the offer has no significant effect on acceptance, except via the “truth” dummy. The positive and significant marginal effect of this last variable implies that responders like being told the truth, or alternatively dislike being lied to (consistent with Hypothesis 8), though the result for Model 11 suggests the former interpretation is correct. By contrast, the lack of significance of either the message or the offer suggest that responders do not distinguish between big and little lies (or between big and little under–statements of the offer).

5.3 Payoffs

Table 7 shows the monetary payoffs of both player types in each cell of our experiment, along with p–values from Kruskall–Wallis tests of equal versus unequal payoffs across the three cells. The payoffs given acceptance illustrate

<table>
<thead>
<tr>
<th></th>
<th>UG</th>
<th>CG(0)</th>
<th>CG(0.5)</th>
<th>Significantly different?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Proposer payoff</strong></td>
<td>(overall)</td>
<td>41.7</td>
<td>55.5</td>
<td>50.1</td>
</tr>
<tr>
<td></td>
<td>(given Accept)</td>
<td>55.4</td>
<td>80.7</td>
<td>66.4</td>
</tr>
<tr>
<td><strong>Responder payoff</strong></td>
<td>(overall)</td>
<td>33.5</td>
<td>13.3</td>
<td>25.3</td>
</tr>
<tr>
<td></td>
<td>(given Accept)</td>
<td>44.6</td>
<td>19.3</td>
<td>33.6</td>
</tr>
</tbody>
</table>

*p ≈ 0.005*

*p ≈ 0.004*

*p ≈ 0.011*

*p ≈ 0.004*

Note: Significance of differences based on Kruskall–Wallis 3–sample test.

how gains from bargaining are shared between the proposer and responder. These are most equitable in the UG, with proposers receiving just over half of the gains. Proposers’ share rises to about two–thirds of gains in CG(0.5), and higher still (about 81 percent of gains) in CG(0). Despite the differences in acceptance rates across treatments, focusing on absolute payoffs yields the same relationships across treatments, with proposer payoffs lowest in UG and highest in CG(0), and the reverse ordering for responder payoffs. The Kruskall–Wallis tests confirm the significance of the differences across treatments.\(^{13}\)

6 Discussion

We have introduced a new game: the contractor game. This game preserves the notable features of the ultimatum game – simple rules and an extremely asymmetric distribution of structural bargaining power – and incorporates a monetary incentive to lie, along with limited ability to detect a lie. We theoretically and experimentally examine the contractor game under two parameter specifications, along with the closely–related ultimatum game. These specifications result in three different environments: (i) CG(0), where the responder receives a message about the offer from the proposer, but not the offer itself; (ii) CG(0.5), where the message is received, while the offer is

\(^{13}\)Since we did not have ex ante hypotheses regarding payoffs, it is not appropriate to use the Jonckheere test which tests the null of no difference versus a directional alternative hypothesis. However, if the ordering observed in Table 7 is used for the alternative hypothesis, this test would yield a p–value of less than 0.005 for all four sets of payoffs.
observed with probability strictly between zero and one; and (iii) UG, where the offer is observed for sure, making it very similar to a CG(1) game, as noted already.

If all proposers and responders have standard *Homo economicus* preferences, there should be no differences in behaviour across the three games: in each one, responders will accept any positive offer and perhaps even a zero offer, so proposers will offer nothing or nearly nothing. Our theoretical model generalises beyond this trivial case; it builds on Fehr and Schmidt’s (1999) framework to allow not only “self–regarding” (*Homo economicus*) agents, but also “other–regarding” agents with aversion to advantageous and disadvantageous inequality of monetary payments (inequity aversion), and to lying and being lied to (deception aversion). This simple heterogeneous–agent model implies clear differences in behaviour across the three games, and in some cases across contingencies within a game.

To a large extent, the key differences predicted by the model are indeed observed in our experiment. Our most important results shed light on how individuals behave when they face monetary incentives to lie, and when they must interact with others who face such incentives. We find that lying by proposers is rampant, but not universal: even in our CG(0) treatment, where lying cannot be detected until after all decisions are made, and even though our experimental procedures mean that subjects never face each other a second time, proposers choose not to over–state their offers about one–fifth of the time. Allowing the possibility for lying to be detected (our CG(0.5) treatment) doubles this frequency of “truth–telling”. More generally, increasing the likelihood that an offer is observed results in higher offers and a decrease in the extent to which they are over–stated by messages.

Responders, for their part, behave in a way that combines an understanding of their own and their opponents’ monetary incentives with preferences over non–monetary aspects of outcomes. They frequently accept unseen offers, but do so more often when they know the offer was made with the recognition that it might be seen (the CG(0.5) treatment versus CG(0)). When offers are seen, higher offers are of course more likely to be accepted, but the likelihood of accepting a given offer depends also on what message was sent. In particular, comparison of all observed offers – in both UG and CG(0.5) treatments – shows that truthful messages are actually rewarded, in that they are more likely to be accepted than either lies or offers unaccompanied by a message. By contrast, lies do not appear to be punished (in comparison to offers with no message). This last result is similar in spirit to results from other recent experimental studies showing that people are willing to sanction those who deceive them (see Section 2), relative to those who don’t. However, unlike most of this earlier work, we find that responders are actually providing a bonus for good behaviour, rather than punishing bad behaviour.

At this point, it is important to clarify what can be learned from our study. Even though the data are mostly consistent with our theoretical model’s implications, our objective is not to garner evidence in favour of this particular model. Indeed, we hasten to acknowledge that it is difficult to take the model seriously as a literal description of reality. The type space we use for aversion to inequity and deception (everyone has either no such aversion or a single common level of aversion to both) and the functional form we assume utility takes (linear in the amount of inequity and deception) are restrictive and clearly unrealistic, and the data clearly show more heterogeneity (see, e.g., Figure 3) than our model predicts. But absolute realism was not our goal; rather, our model was developed with an eye toward simplicity and tractability, moving (we believe) the minimum distance away from standard self–regarding preferences that would allow a positive fraction of non–negligible offers and informative messages to arise, thus leaving room for non–trivial comparative statics. We anticipate that many other models incorporating aversion to both inequity and deception (or perhaps affinity for truth–telling) will make similar qualitative predictions as the one we used, and our interest is not in conducting a “horse race” among the various models that do. Instead, we see our results as supporting a more general claim: a non–negligible fraction of subjects have other–regarding concerns, and thus the incentives they face are not strictly monetary, but they nonetheless react to changes in these incentives

20
Several potential extensions of our study immediately suggest themselves. One obvious possibility would be to give some responders a positive benefit from being told the truth, to complement or replace the disutility of being lied to. Other theoretical extensions include broadening the type space to allow more heterogeneity in attitudes toward inequity and deception, along with relaxing the assumption that individuals are affected in the same way from each of these – either by modifying the parameterisation of our model or within a different model. While there is limited scope for variations of our model to improve in characterising the main results of this paper, it’s possible that such variations can better describe other aspects of the data, such as the shapes of the distributions of offers and messages.

Other extensions would incorporate both theory and experiments. One would look at different versions of CG(p) from those examined here. How does the behaviour of proposers and responders change as p varies between 0 and 1? Does a truth–telling premium exist for all p, or only for p sufficiently low that proposers could reasonably expect to “get away” with lying, so that truth telling could be attributed to personal ethics rather than a fear of getting caught? A second extension would investigate the contractor game with proposer competition. If responders can choose among proposers based on the messages they receive – and with some known probability, the true offers – how will they choose, and how will this choice impact on the offers and messages proposers choose? Still another set of extensions could examine how behaviour in the contractor game is affected by institutions such as repetition with fixed pairings, reputation mechanisms, second– or third–party punishment, or legal remedies.

There are likely many other interesting extensions. We expect the contractor game will become useful as a milieu for understanding how individuals trade off between honesty and monetary gain when providing information to others, and how they react to information that might be fraudulent in order to deter dishonest information and encourage truth–telling. Such situations are ubiquitous in economic (and other) settings.

References


A Proofs

A.1 Proof of Proposition 1

The PBE of the UG can be found by backward induction. Self–regarding responders will accept any offer. The utility function of an other–regarding responder is given by

$$U_{ro}(x) = x - 0.5(20 - 2x) = 2x - 10$$

if he accepts the proposer’s offer, and 0 if he rejects. So, he will accept any offer of at least 5. Thus, proposers know that any offer $x \geq 5$ will be accepted for sure, and any lower offer will be accepted with probability $\rho_s$ (the fraction of self–regarding responders in the population).

A self–regarding proposer will offer either 5 or 0, depending on $\rho_s$. If $\rho_s > 0.75$, she will offer 0; otherwise she will offer 5 (by our second tie–breaking rule when $\rho_s = 0.75$). An other–regarding proposer has the utility function

$$U_{po}(x) = 20 - x - 0.5(20 - 2x) = 10$$

so prefers to offer 10 (by our second tie–breaking rule) as long as it is accepted (which it is).

A.2 Proof of Proposition 2

Part 1: no separating equilibrium

Suppose by contradiction there does exist a separating equilibrium, where self–regarding proposers choose $(x_s, m_s)$ and other–regarding proposers choose $(x_o, m_o)$, with $m_o \neq m_s$. Then responder beliefs after $m_s$ or $m_o$ are given by $\mu_s(m_s) = 1$ and $\mu_s(m_o) = 0$. Also, self–regarding responders will always accept, and self–regarding proposers will offer 0, so that other–regarding responders will reject after receiving $m_s$.

In a potential separating equilibrium, if other–regarding responders accept after observing $m_o$ then the payoff for other–regarding proposers is

$$(20 - x_o) - 0.5(20 - 2x_o) - 0.5 \cdot \text{Max}(0, m_o - x_o) = \begin{cases} 10 - 0.5(m_o - x_o) & x_o \leq m_o \\ 10 & x_o > m_o. \end{cases}$$

On the other hand, if they reject after observing $m_o$ the payoff for other–regarding proposers is

$$[(20 - x_o) - 0.5(20 - 2x_o) - 0.5 \cdot \text{Max}(0, m_o - x_o)]\rho_s = \begin{cases} [10 - 0.5(m_o - x_o)]\rho_s & x_o \leq m_o \\ 10\rho_s & x_o > m_o. \end{cases}$$

By assumption, $m_o \leq 10$. Based on this and the payoff functions specified above, other–regarding proposers will choose $x_o = 10$ in this potential separating equilibrium regardless of the strategy of other–regarding responders. Hence, in this equilibrium, other–regarding responders must accept after observing $m_o$. But then, self–regarding proposers will deviate and choose $(x_s, m_s) = (0, m_o)$ breaking the equilibrium. So, we conclude that such an equilibrium can not exist.
Part 2: pooling equilibrium

Consider a pooling equilibrium, where both types of proposer send message $m^*$ and other–regarding proposers offer $x^*$. Then responder beliefs after seeing $m^*$ must be $\mu_s = \phi_s$; other messages are sent with probability zero, so we can assume $\mu_s(m) = 1$ for $m \neq m^*$. Self–regarding responders will accept after any message. Self–regarding proposers will offer 0, irrespective of what message they send.

Given the equilibrium behaviour of proposers, an other–regarding responder receiving a message $m^*$ believes he is getting expected utility

$$\phi_o\left[x^* - 0.5(20 - 2x^*) - 0.5 \cdot \text{Max}(0, m^* - x^*) + (1 - \phi_o)[0 - 0.5(20) - 0.5(m^*)]\right]$$

if he accepts the proposer’s offer, and 0 if he rejects. He will accept if $x^* \leq m^*$ and $x^* \geq \frac{(1 - \phi_o)m^* + 20}{4\phi_o}$, or equivalently if $x^* \geq \text{Max}\left\{\frac{m^* + 20}{5\phi_o}, \frac{(1 - \phi_o)m^* + 20}{4\phi_o}\right\}$. After any other message, he would believe he is facing a self–regarding proposer who offered zero, and would reject (since the utility from accepting is $-0.5m - 10$, worse than the zero utility from rejecting).

First, we look for pooling PBE in which other–regarding responders accept after observing $m^*$. In this case, the other–regarding proposer’s utility is equal to $10 - 0.5(m^* - x_o)$ if $x_o \leq m^*$, or 10 if $x_o > m^*$. Given that $m^* \leq 10$, an other–regarding proposer will choose $x_o = 10$, by our second tie–breaking rule. Then, the condition of acceptance by other–regarding responders will hold if $10 \geq \text{Max}\left\{\frac{m^* + 20}{5\phi_o}, \frac{(1 - \phi_o)m^* + 20}{4\phi_o}\right\}$, which holds if $\phi_o \geq \frac{20 + m^*}{40 + m^*}$. As Table 8 shows, as long as $\phi_o \geq 0.5$, there exists a combination of $m^*$ and $\phi_o$ that supports a pooling PBE in which other–regarding responders accept after observing $m^*$. For $\phi_o < 0.5$, it must be that $10 < \text{Max}\left\{\frac{m^* + 20}{5\phi_o}, \frac{(1 - \phi_o)m^* + 20}{4\phi_o}\right\}$.

Table 8: Minimum proportion of other–regarding responders needed to support a given message in a PBE

<table>
<thead>
<tr>
<th>$m^*$:</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\phi_o$:</td>
<td>0.5</td>
<td>0.512</td>
<td>0.524</td>
<td>0.535</td>
<td>0.545</td>
<td>0.556</td>
<td>0.565</td>
<td>0.574</td>
<td>0.583</td>
<td>0.592</td>
<td>0.6</td>
</tr>
</tbody>
</table>

so there is no PBE in which other–regarding responders accept following any message.

Finally, we look for pooling PBE in which other–regarding responders reject irrespective of the message. In that case, self–regarding proposers will offer 0 and other–regarding proposers will offer 10 (by the second tie–breaking rule) and send a message of 10 (by the first), while self–regarding responders will still accept irrespective of the message. As long as $\phi_o < 0.6$, other–regarding responders do prefer to reject after a message of 10 (by the same reasoning that yielded Table 8), completing the equilibrium.

A.3 Proof of Proposition 3

Part 1: no pooling equilibrium

Suppose that a pooling equilibrium does exist; that is, both types of proposer send message $m^*$ and offer $x^*$. Then self–regarding respondents will always accept, and other–regarding responders will accept after receiving any combination $(x, m)$ such that $x \geq \text{Max}\{5, 4 + \frac{m^*}{4}\}$, and will accept $(\emptyset, m^*)$ if $x^* \geq \text{Max}\{5, 4 + \frac{m^*}{4}\}$.

In a potential pooling equilibrium, if other–regarding responders accept after observing $m^*$ then the payoff for
other–regarding proposers is

\[
(20 - x^*) - 0.5(20 - 2x^*) - 0.5 \cdot \max(0, m^* - x^*) = \begin{cases} 
10 - 0.5(m^* - x^*) & x^* \leq m^* \\
10 & x^* > m^*.
\end{cases}
\]

On the other hand, if they reject after observing \(m^*\) the payoff for other–regarding proposers is

\[
[(20 - x^*) - 0.5(20 - 2x^*) - 0.5 \cdot \max(0, m^* - x^*)]_{\rho_s} = \begin{cases} 
(10 - 0.5(m^* - x^*))\rho_s & x^* \leq m^* \\
10\rho_s & x^* > m^*.
\end{cases}
\]

As long as \(m^* \leq 10\); this is maximised when \(x^* \geq m^*\), so by the second tie–breaking rule, we have \(x^* = 10\). However, a self–regarding proposer would earn 10 by following this strategy, and would earn \(20(1 - \rho_o/2) > 10\) by offering zero instead, breaking the potential equilibrium.

**Part 2: separating equilibrium**

In a separating PBE, self–regarding proposers choose \((x_s, m_s)\) and other–regarding proposers choose \((x_o, m_o)\), with \(m_s \neq m_o\). Self–regarding responders always accept, and other–regarding responders accept after seeing \((x, m)\) if \(x \geq \max\{5, 4 + \frac{m_o}{\rho_o}\}\), after \((\emptyset, m_o)\) if \(x_o \geq \max\{5, 4 + \frac{m_o}{\rho_o}\}\), and after \((\emptyset, m_s)\) if \(x_s \geq \max\{5, 4 + \frac{m_s}{\rho_o}\}\).

First, there is no separating PBE where other–regarding responders reject after \((\emptyset, m_o)\). Since self–regarding proposers are choosing a different message, this could only happen if \(x_o < \max\{5, 4 + \frac{m_o}{\rho_o}\}\), but in this case, then other–regarding proposers would offer 10 (by the second tie–breaking rule) instead, making other–regarding responders prefer to accept.

Second, there is no separating PBE where other–regarding responders reject after \((\emptyset, m_s)\) but accept after \((\emptyset, m_o)\). In this case, the best that a self–regarding proposer could do in such a PBE is by offering zero (maximising payoff in case she is matched with a self–regarding responder, since she earns nothing from being matched with an other–regarding responder). This would give her \(20\rho_s = 20(1 - \rho_o)\). But deviating to message \(m_o\), while still offering zero, would lead to acceptance except when matched with an other–regarding responder who saw the offer (since outside this case, he would infer that it was an other–regarding proposer), yielding payoff \(20\left(1 - \frac{1}{2}\rho_o\right)\), which is strictly larger, breaking the equilibrium.

Third, consider a separating equilibrium where other–regarding responders accept after both \((\emptyset, m_o)\) and \((\emptyset, m_s)\). Then other–regarding proposers will offer 10. Self–regarding proposers will offer the lowest amount that gets accepted. From \(x_s \geq \max\{5, 4 + \frac{m_o}{\rho_o}\}\) above, it follows that \(x_s = 5\) if \(m_s \leq 5\), and \(x_s = 6\) if \(m_s \geq 6\). It remains to confirm that this is actually a best response for them; that is, it wouldn’t pay to deviate by offering 0. Offering 0 earns \(20\left(1 - \frac{1}{2}\rho_o\right)\), while offering 5 (6) earns 15 (14) for sure; the latter is higher if \(\rho_o \geq 0.5\) (\(\rho_o \geq 0.6\)). Thus, it is an equilibrium for other–regarding proposers to choose \((10, m_o)\) and self–regarding proposers to choose \((5, m_o)\) if \(m_o \neq m_o, m_s \leq 5\) and \(\rho_o \geq 0.5\), and it is an equilibrium for other–regarding proposers to choose \((10, m_s)\) and self–regarding proposers to choose \((6, m_o)\) if \(m_s \neq m_o, m_s \geq 6\) and \(\rho_o \geq 0.6\). If \(\rho_o < 0.5\), there is no equilibrium of this type.

When a separating equilibrium exists, it is supported by beliefs that the proposer is self–regarding and offered zero after any out–of–equilibrium (offer, message) pair \((\emptyset, m)\).

**Part 3: semi–pooling equilibrium**

In a semi–pooling equilibrium, both proposers choose message \(m^*\); self–regarding proposers offer \(x_s\) and other–regarding proposers offer \(x_o\), with \(x_o \neq x_s\). Self–regarding responders always accept, and other–regarding responders accept after seeing \((x, m)\) if \(x \geq \max\{5, 4 + \frac{m_o}{\rho_o}\}\). Then, other–regarding proposers will choose \(x_o = 10\).
Given (offer, message) pair \((0, m^*)\), an other–regarding responder will get a payoff of 0 from rejecting, and accepting will yield \((1 - \phi) + \phi s(2x_s - 10)\) if \(x_s \geq m^*\), or \((1 - \phi) + \phi s(2.5x_s - 10 - 0.5m^*)\) if \(x_s < m^*\). So, he will accept if \(x_s \geq \text{Max} \{10 - \frac{5}{\phi s}, 8 - \frac{4}{\phi s} + \frac{m^*}{\phi s}\}\). Note that this is a strictly weaker condition than \(x_s \geq \text{Max} \{5, 4 + \frac{m^*}{\phi s}\}\), since \(\phi < 1\).

Given that other–regarding responders accept following \((0, m^*)\), a self–regarding proposer has two possible optimal offers. Offering 0 earns an expected payoff of \(20 - 10\rho_o\), and offering the minimum \(x\) that satisfies \(x \geq \text{Max} \{5, 4 + \frac{m^*}{\phi s}\}\) (either 5 or 6, depending on \(m^*\)) earns \(20 - x\). For \(m^* \leq 5\), this minimum \(x\) is 5, which is payoff–maximising if \(\rho_o \geq 0.5\). For \(m^* \geq 6\), this minimum \(x\) is 6, which is payoff–maximising if \(\rho_o \geq 0.6\). Note that other–regarding responders will accept following \((0, m^*)\) if \(x_s \geq 5\), \(m^* \leq 5\) or if \(x_s \geq 6\), \(m^* \geq 6\). In other cases, self–regarding proposers will offer 0, which might still be consistent with equilibrium, as long as other–regarding responders accept, which happens if \(0 \geq \text{Max} \{10 - \frac{5}{\phi s}, 8 - \frac{4}{\phi s} + \frac{m^*}{\phi s}\}\), that is, \(\phi s \leq \frac{20}{40 + m^*}\).

Alternatively, suppose \(x_s < \text{Max} \{10 - \frac{5}{\phi s}, 8 - \frac{4}{\phi s} + \frac{m^*}{\phi s}\}\), so that other–regarding responders will reject following \((0, m^*)\). Then, it must be that they reject following all \((0, m)\) (otherwise, proposers would choose a message that led to acceptance). So, other–regarding proposers will choose \((10, 10)\), so that it must be that \(m^* = 10\). If self–regarding proposers make an offer acceptable to other–regarding responders, this will break the equilibrium, so it must be that they offer 0, along with sending message 10. This earns \(20(1 - \rho_o)\), while deviating to an offer of 5 (the lowest possible acceptable offer, when combined with a message of 5 or less) earns \(15(1 - \rho_o/2)\). The offer of 0 is payoff–maximising if \(\rho_o \leq 0.4\), and consistent with rejection by other–regarding responders if \(\phi s > 0.4\).

For \(\phi < 0.5\) and \(\rho_o \in [0.4, 0.5]\), there is no pure–strategy equilibrium, but there are semi–pooling PBE where some players mix. For example, it is easily verified that there is an equilibrium where both types of proposer send message \(m^* \leq 5\), other–regarding proposers offer 10, self–regarding proposers mix between offering 0 and 5, self–regarding responders always accept, and other–regarding responders accept following \((5, m^*)\) or \((10, m^*)\), reject following \((0, m^*)\), and mix between accepting and rejecting following \((0, m^*)\).

When a semi–pooling equilibrium exists, it is supported by beliefs that the proposer is self–regarding and offered zero after any out–of–equilibrium (offer, message) pair \((0, m)\).

Figures 6 and 7 show how the PBE of the three games depend on the proportions of other–regarding players in the proposer and responder populations.

![Figure 6: Equilibrium behaviour in UG and CG(0), conditional on \(\phi_0\) and \(\rho_0\)](image-url)
**B English translation of experimental instructions – CG(0.5) treatment**

**Welcome,**

Thank you for your participation. The aim of this study is to understand how people make decisions in certain situations. From now on, talking to each other is prohibited. Please also turn off your cell phones.

If you have a question please raise your hand. We will come to you and answer your question. Please do not hesitate to ask questions, since it is very important that all participants understand the rules in this study. The experiment will be conducted on the computer and you will make all your decisions using the computer. You will earn a monetary reward in the game you will play during the experiment. The amount you will earn depends on your decision and the decisions of other participants. This amount and the participation fee will be paid to you in cash at the end of the experiment.

**The Roles and the Groups:**

At the beginning of the experiment, you will be randomly assigned to one of these roles: Player A or Player B. This role is fixed.

The game you will play will last for 5 periods and at every period you will be matched in groups of 2 players. In your group, there will be another player whose role is different than yours. Therefore in each group there will be a Player A and a Player B. This matching is randomly determined and you will never be matched with the same person more than once.

You will not learn the identities of people that you’re matched with. Similarly, other players who are matched with you will not learn your identity.

At every period you will play the following game:
The Game:

There are 20 TL to be split between Player A and Player B. Player A proposes how much of this 20TL to offer to Player B. At the same time, Player A chooses a message to be sent to Player B. In his message Player A will tell Player B how much his offer is. This message can be accurate or not.

After this, Player B will see Player A’s message. With probability 50%, Player B will also see Player A’s actual offer, and with probability 50%, Player B will not see Player A’s offer.

Player B will then decide whether to accept the offer of Player A or not.

If Player B accepts the offer, the earnings of the players will be determined according to the actual offer of Player A. That is, the earnings of players will be as follows:

- **Player A:** 20 – offer
- **Player B:** offer

If Player B rejects the offer of Player A the earnings of both players will be 0. In either case, Player A’s message has no effect on either player’s earnings.

At the end of each period, a summary of the current period (offer, message, acceptance decision, earnings) will be presented to both players. We will randomly select one of the 5 periods and your earnings from this part of the experiment will be equal to your earnings in the selected period. Each period is equally likely to be selected, therefore it is in your best interest to decide carefully during each period.

C Questionnaire questions (English translation)

**Attitudinal questions (all answered on a scale from 1=absolutely wrong to 6=absolutely right):**

q1: I won’t hesitate to ask my boss for a pay rise.
q2: I might invest in risky assets.
q3: Lying is difficult for me.
q4: I can choose someone as a roommate without knowing that person well.
q5: I don’t hesitate to wear unconventional clothes.
q6: I might argue with a friend who has a very different opinion on an issue.
q7: If I lose my wallet, I believe that the person who finds it will bring it to me with the things in it.
q8: I trust my friends in money issues.
q9: I can spend money without thinking about the consequences.
q10: I can admit it easily when my tastes are different from my friends.
q11: I won’t hesitate to move to a different city.
q12: If I would have an unexpected money windfall, the first thing I would do would be to share with people I know.
q13: I can take a job at which I will get paid on commission only.
q14: If I am rich enough, I can lend high amounts of money to my friends.
q15: My verdicts about others’ trustworthiness generally turn out to be correct.

**Demographic questions:**
Age: age of the subject (in years).
Sex: gender of the subject (1=female, 0=male).
Living: living arrangement for the subject (0=student housing, 1=with family, 2= with friends, 3=alone).
Siblings: number of siblings of subject.
Older siblings: number of siblings who are older than the subject.
Major: subject’s major (2=economics, 1=other business, 0=other).
Econ: number of economics classes (censored at 4).
D  Sample screen-shots from the experiment

Below are sample screen-shots, typical of those that would have been seen in the CG(0.5) cell of the experiment. Screen-shots from the other cells are similar, and can be obtained from the corresponding author upon request.

Proposer decision screen – CG(0.5)

Responder decision – CG(0.5), offer not observed
Based on the random draw of the computer, you will see both the message and the actual offer of Project A.

Player A informed you that he/she is offering \( 10 \) TL out of \( 20 \) TL.

The actual offer of Player A is \( 7 \) TL out of \( 20 \) TL.

What you like to accept the decision of \( 20 \) TL/\( 7 \) TL out of the actual offer decision?

\( ^{No} \)
\( ^{Yes} \)

Continue