OTHER-REGARDING PREFERENCES: OUTCOMES, INTENTIONS OR INTERDEPENDENCE?

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Abstract. If preferences and beliefs are appropriately parametrized, different theories of "other-regarding" preferences poses equilibria that are consistent with experimental results in a variety of setting. Our goal is to experimentally separate between those theories, by studying their comparative-static performance in the neighborhood of the classic Ultimatum Game, whose results are extremely robust. In order to perform this exercise, we first characterize all Perfect Bayesian Equilibia in the Ultimatum Game if preferences are interdependent. We then show that in this model, capping the demand a proposer can make may increase the proposer's demand and the responder's acceptance probability. Outcome-based theories and intentions-based models have opposite predictions. We then design and execute an experiment that facilitates almost instantaneous learning and convergence by both proposers and responders. The experimental results are consistent with the predictions of the interdependent-preferences model. Beyond the evident theoretical implications, the economic and social implications of this result are far-reaching: low minimum wage may *lower* wages, and high price cap *may* increase the price a monopolist charges.

1. Introduction

The past twenty years have seen a surge in theories that depart from the benchmark of selfish preferences, motivated mainly by experimental evidence and introspection. Since the work of Levine [36] it has been shown that different theories may have a parametrization that results in equilibria among which there exists an equilibrium that is consistent with the experimental findings. The goal of the current study is to design and execute a simple experimental test that can differentiate among those theories. The Ultimatum Game (Güth et al [27]) is used as a benchmark, since it is a well studied game, with very robust outcomes. The ultimatum game has motivated many of the theories of "other-regarding" preferences, and all of them can account for its

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stylized properties. The experiment we conduct is a small perturbation of the original game: we study how offers made by proposers and responders' acceptance rate change when offers must be higher than some exogenously determined minimum.

The Ultimatum Game describes a simple and natural interactive decision problem that is inherent to almost every bargaining environment: a proposer makes a demand of p (between 0 and $\bar{p}$) to a responder. If the responder accepts, the proposer receives his demand and the responder receives $\bar{p} - p$. If the responder rejects then both receive zero. A well known backwards induction argument predicts that a selfish responder should accept any positive offer and therefore a selfish proposer should make a maximal demand. As is now well known, the experimental evidence refute this prediction. Furthermore, several experimental regularities have emerged: as the demand increases the probability of acceptance decreases; the relation between the proposer's offer and his expected revenue is hump shaped; and there is a substantial variation in demands that are made in experiments: proposers do sometimes demand everything (make low offers) even though these offers are often rejected.

Models of other-regarding preferences that account for the experimental regularities in the ultimatum game and its variants (the dictator game, trust game, gift exchange game) can be broadly classified into three classes: outcome-based models (Fehr and Schmidt [21], Bolton and Ockenfels [11]) assume that a player's utility may be a function of the resources allocated to other agents as well as to herself. These models incorporate heterogeneity across agents. Interdependent preferences models (Levine [36]) allow the agent's preferences to depend not only on her opponent's resources but also on her type. Since players are heterogeneous, the opponent's action affects both the material allocation and the inference the agent makes about the opponent type.[1] Intention-based (reciprocity) models (Rabin [40]) assume the agent cares about her opponent's intentions (beliefs) and motives. The latter models use the "psychological games" (Geanakoplos, Pearce and Stacchetti [25]) framework.[2] There exists some experimental evidence that points to

[1]Gul and Pesendorfer [26] provide a non-strategic foundation for reduce-form behavioral interdependence.

[2]Many hybrid models that combine elements from the above models have been proposed. Cox et al [15] proposed a nonparametric model of preferences defined over own and other's payoffs. In their model, a decision maker will become "more altruistic" if the budget set he is offered to choose from is "more generous". The model has the very nice feature that it naturally extends standard consumer theory to analyze important issues that arise in a variety of experiments. However, it is

the importance of intentions (e.g. Camerer [13] pages 110-113; Blount [10]; Falk et al [17, 18] and McCabe, Rigdon and Smith [39]). However, this evidence only excludes outcome-based models, which have their own appeal in their simplicity. The experimental methodology we employ tests the equilibrium response of the different theories in close proximity to the most standard (and robust) experiment in this field, by investigating the effect of setting a lower bound to the offer a proposer can make.[3] The equilibrium response of outcome and intention-based models to our proposed comparative static is straightforward. In outcome-based models, proposers that otherwise would offer below the minimum should make the minimal offer, while the rest of the offer distribution and the conditional acceptance rates do not change. In intention-based models, the perceived kindness of each offer diminishes. As a result, the conditional acceptance rates decrease and offers should (weakly) increase.

In order to evaluate the implications of the comparative static when preference are interdependent, it is essential to first characterize the equilibrium of the ultimatum game. Following the approach of Levine [36], the game is modeled as a signaling game in which preferences are 'interdependent' in the sense that players' preferences depend on other players' types. Levine [36] assumed that proposers and responders are sampled from an identical distribution and have symmetric utility function. Although Levine was able to calibrate his model, we are not aware of a tight characterization of all equilibria in this framework.[4] We find that the rich variety of behavior observed in the ultimatum game can be accounted for by a simple structure of interdependence, which we term *negative interdependence.* This means that the more eager the proposer is to have his demand accepted, the less interested the responder is to accept that demand.[5] Traditional explanations of behavior in the ultimatum game can be recast in terms of interdependence. For example, the type of the proposer could represent his greed. A responder

not suitable to analyze environments like the ultimatum game where the choice set available to the responder is not convex (although one can consider generalizations of the game, as in Andreoni et al [1] which fit into Cox et al's framework). Other explanations are based on evolutionary arguments and deemphasize backwards induction reasoning (Binmore et al [24, 8, 7, 9]).

[3]An alternative approach would be to suggest a completely new environment, and to study whether the different models can account for equilibrium behavior in that experiment.

[4]Appendix A includes a characterization of equilibrium in an environment similar to Levine's.

[5]Negative interdependence corresponds to Gruocho Marx's philosophy of not belonging to a club who would accept him as a member.

will receive some utility from rejecting an offer from a greedy proposer rather than being concerned per se with the payoff difference. Similarly, the view that subjects employ in simple experimental settings rules of thumb that have developed in more complex but more common environments (as in Aumann [3] and Frank's [23] "rule rationality") can be formalized using the framework of interdependence. For example, responders and proposers may employ in a one-shot ultimatum game rules that were developed in an offer-counteroffer game that they usually play. A rejection of an unfair offer is the response that would work best in everyday bargaining situations in which the rejection would be followed up with a counteroffer. How effective it would be to reject such an offer depends on characteristics of the proposer that the responder can't know - his discount rate for example. The proposer's initial offer signals information about his unknown type. It should be emphasized that the current paper does not take a stand on the interpretation of negative interdependence, but allows a unified treatment of various motivations that have been suggested in the past.

Negative interdependence represents a very simple type of preference interdependence. The responder's preferences depend on the proposer's preference, but not on any higher order consideration since the proposer's preferences don't depend on the responder's preferences at all. Despite the fact that this simple formulation supports the rich set of behavior that has already been observed in ultimatum experiments, it is restrictive enough to provide testable implications. That is, we can provide a comparative static result that differs from the results associated with outcome-based or intention-based models, giving the objective reader an opportunity to compare the performance of our model with some well-known alternatives.

When there is negative interdependence, all perfect Bayesian equilibria of the ultimatum game involve pooling of proposer types who are least eager to have their demands accepted, at the highest possible demand. Different equilibria are characterized only by the degree of separation of the other types. This separation generates the dispersion of demands that is so commonly observed in experimental results. However, there is a strict bound on this dispersion - demands will never be 'too' low (we describe the exact lower bound in what follows). Since the proposers who are eager to have their offers accepted make low demands, high demands must be accepted with lower probability to support incentive compatibility. This supports the declining acceptance probability that is so common in experiments.

However, this declining acceptance probability also presents a puzzle since the expected return (the demand the proposer makes times the probability it is accepted) is not constant as one might expect. Instead, it has a distinct hump shape, making it something of a mystery why proposers make very low and high demands. In our model, proposers differ about the relative value of acceptance and rejection of a demand. Those proposers who are more eager to have their demands accepted, act as if they are punished more heavily by a rejection than the less anxious proposers. As a consequence, the former are willing to accept a lower expected return (and a very high acceptance probability) than the latter.

After characterizing all Perfect Bayesian Equilibria, we perform the comparative static investigation described above: we study how the equilibrium (distribution of offers and conditional acceptance rates) changes if we set an upper bound to the demand made by a proposer. As explained above, outcome and intention-based models predict concentration of offers on the lower bound, and decrease or no change (respectively) in the acceptance rate. We show that the equilibrium with negative interdependence predicts higher demands (lower offers) and higher acceptance rate. The intuition behind this prediction is that if the subset of low types who make high demands will not increase, then responders (who have low marginal utility of rejecting offers made by low types) would accept these high demand in certainty. To maintain an equilibrium, the subset of proposers who make high demands must increase, and in order to satisfy the incentive compatibility constraint of the new pivotal high type proposer - the acceptance probability must increase. We find that the experimental results are consistent with the negative interdependence model proposed here.

One could argue that the experimental results are a consequence of anchoring: once an external bound is set, all agents (proposers and responders) adjust their expectations to that bound. Therefore, if the bound is low - lower offers will be made and they will be accepted more frequently than in the base treatment. This line of reasoning assumes that a lower bound of 0 (as in the standard game) has no such anchoring effect. To test whether the results are a consequence of equilibrium behavior or simply anchoring, we manipulate the presentation of the problem to subjects in the following way: the proposer can make an offer as in the standard ultimatum game, but the payment to the responder, if she accepts, equals the offer plus a certain amount (that is equal to the lower bound set before). This treatment is strategically equivalent to the truncation used above, but does not involve anchoring. We find that the effects on the offer distribution and the conditional acceptance rate are robust and significant, though smaller than in the original treatment we considered.

The economic implications of modeling interdependent preference in a bargaining environment and the comparative statics performed may be very important: consider, for example, wage bargaining. Almost every bargaining model has an ultimatum component, to which we could apply the comparative static result. Our theoretical and experimental results suggest that as a result of setting a minimum wage, the wage distribution may shift to the left. Similarly, prices are determined in a bargaining process which induces price dispersion. Setting a maximum price may shift the price distribution to the right.[6] Evidently, these environments are much more complex than the stylized ultimatum game studied here, but the latter is an important ingredient in the price (including wage) setting process. The current study suggests to apply caution when analyzing such environments, and to further investigate the implications of such policies on prices.

2. The Model

Let P be a finite collection of feasible demands (offers) for the proposer. These are normalized to lie between 0 and 1. Suppose these offers are indexed in such a way that $0 = p_1 < p_2 < \ldots < p_n = 1$. The lowest demand p_1 is assumed to give all the surplus in the experiment to the responder. The highest demand p_n is assumed to give all the surplus from the experiment to the proposer. The proposer is of type $s \in [\underline{s}, \overline{s}] \equiv S$, which affects the payoff of both players.[7] The distribution of types is given by F, and is assumed to be continuous with full support. Let $\alpha \in \{0, 1\}$ denote the action of the responder, $\alpha = 1$ meaning that she accepts the proposal. The payoffs are treated asymmetrically. The payoff to the proposer is given by $u_p(p, \alpha, s)$ where s is his type.

[6] Some empirical evidence to that effect may be found in Knittel and Stango [34] who study the credit market market. Their interpretation is that price ceiling serve as a focal point. Our third treatment shows that the effect may persist even when focal point is not established. Experimental studies by Isaac and Plott [32] and Smith and Williams [49] do not support the hypothesis that price controls away from the competitive equilibrium serve as focal points in a double auction environment, but find that controls close to the equilibrium may affect convergence. Other experimental papers are discussed below in 10.

[7] The case of negative interdependence does not require heterogeneity on the responder side, though it could be added without affecting the main conclusions of the analysis that follows. The case of positive interdependence, studied in Appendix A, required heterogeneity on both sides in order to accommodate the standard experimental results. The Appendix also demonstrates the technical changes required to introduce two-sided heterogeneity.

Assumption 1. *For all $s \in S$:*

(1) $u_p(p', 1, s) > u_p(p, 1, s)$ for all $p' > p$.
(2) $u_p(p', 0, s) = u_p(p, 0, s)$ for all $p, p' \in P$.

The first part of the assumption states that if his demand is accepted, the proposer is better off with higher demand (lower offer). The second part assumes that he is indifferent among all rejected demands. We maintain the monotonicity assumption incorporated in the first part, to minimize the departure from a benchmark of selfish preferences, and to highlight the importance of interdependence in the comparative statics to follow. One natural way to generalize the model is to relax it.

The following assumption is also used repeatedly.

Assumption 2. *Let s' and s be such that*

$$u_p(p, 0, s) - u_p(p, 1, s) < u_p(p, 0, s') - u_p(p, 1, s')$$

and suppose that for some $p_j > p_k$ and $q_j < q_k$,

$$q_j u_p(p_j, 1, s) + (1 - q_j)u_p(p_j, 0, s) \geq q_k u_p(p_k, 1, s) + (1 - q_k)u_p(p_k, 0, s)$$

Then the same inequality holds strictly for type s'.

This "single-crossing" assumption states that if proposer of type s utility loss as a result of being rejected is lower than the utility loss of type s', and if type s expected utility from a high demand (p_j) with probability of acceptance (q_j) is not lower than his expected utility of a lower demand ($p_k < p_j$) with higher probability of acceptance $q_k > q_j$), then proposer of type s' strictly prefers the higher demand.

The payoff to the responder also depends on the proposer's type. This payoff function is given by $u_r(p, \alpha, s)$. We assume that:

Assumption 3. *The function $u_r(p, 0, s) - u_r(p, 1, s)$ is monotonically increasing and supermodular in p and s. For every s there is a $p > 0$ such that $u_r(p, 0, s) - u_r(p, 1, s) < 0$; $u_r(p, 0, \overline{s}) - u_r(p, 1, \overline{s}) > 0$ for some p, and $u_r(p, 0, \underline{s}) - u_r(p, 1, \underline{s}) < 0$ for all $p \in P$.*

The assumption is made on the responder's marginal utility of rejection, if she knew the proposer's type s. It is assumed that the marginal utility of rejection is increasing and supermodular in the proposer's demand and type. That is, if the responder would know the proposer's type, for higher proposer's type the change in the marginal utility of rejecting a higher demand is higher. No matter what are the responder's beliefs about the proposer's type, there is some demand the responder would accept. A responder who believes the proposer's type is $\overline{s}$ will reject some offer, while a responder who believes the proposer's type is $\underline{s}$ will accept any offer.

This game has many equilibrium outcomes. The nature of these outcomes depends on the function $u_p(p,0,s) - u_p(p,1,s)$. In Appendix A we analyze the case where this function is strictly increasing. Since this function is always increasing for the responder, we refer to this as a situation of *positive interdependence.* Since in the case were there is no responder heterogeneity the equilibrium can contain no more than two distinct demands, we characterize in the Appendix a similar model with responder heterogeneity. We show that for every sequence of demands, there exist distributions of subjects that will support that sequence as a perfect Bayesian equilibrium. Since this model cannot be refuted, we turn below to analyze an alternative structure of interdependence.

2.1. **Equilibrium with Negative Interdependence.** We now consider the case where $u_p(p,0,s) - u_p(p,1,s)$ is monotonically decreasing in s. We refer to this as negative interdependence. Without committing to a specific interpretation, the higher the proposer's type, the greater is the utility loss due to a responder's rejection. The responder's marginal utility of rejection continues to increase in the proposer's type. As discussed in the Introduction, this formulation unifies the fairness and "rule-rationality" interpretations. Roughly speaking, the proposer now has an incentive to try to hide his information from the responder because their interests are not aligned.

The following assumption is required to construct an equilibrium:

Assumption 4. *For any demand p let s be such that $u_r(p',1,s) < u_r(p',0,s)$ for each $p' > p$. Then*

$$u_p(p,1,s) > u_p(p,0,s)$$

That is, if for every $p' > p$, a *responder* who knows the proposer's type prefers to reject p', then the *proposer* prefers p to be accepted. In other words: let $\hat{s}$ be the solution to $u_r(p,0,s) = u_r(p,1,s)$. This is the proposer's type such that if the responder believed the proposer had that type for sure, she would be just indifferent between accepting and rejecting the demand p. Roughly the Assumption above states that provided a type s isn't too much lower than $\hat{s}$, the proposer of type s would strictly prefer to have the demand p accepted.

Under these assumptions, all perfect Bayesian Nash equilibria exhibit the property that higher demands are accepted with lower probability.

Theorem 5. *Let $p' > p$ be two demands made on the equilibrium path. The probability with which the demand p is accepted is at least as large as the probability with which p' is accepted.*

We now identify all the equilibrium outcomes for the game with negative interdependence. We first prove that a sequence of demands can be supported in a Perfect Bayesian Nash Equilibrium only if the highest demand is the whole pie, and the demands partition the proposer's types in a way that if the responder knows that a certain offer is made by an interval of proposer's types - she is just indifferent between accepting and rejecting the offer (except possibly the lowest demand).

Theorem 6. *Suppose negative interdependence, that Assumptions 1, 2, 3, 4 hold and that that* $u_p(1, 0, \underline{s}) > u_p(1, 1, \underline{s})$*. Then an ascending sequence of demands* $(\pi_1, \ldots, \pi_K)$ *can be supported as a Perfect Bayesian Nash Equilibrium demands if*

(1) $\pi_K = 1$*; and*
(2) *there exists a strictly descending sequence of* $K+1$ *types* $(s_1, \ldots, s_K, s_{K+1})$ *with* $s_1 = \overline{s}$ *and* $s_{K+1} = \underline{s}$ *satisfying*

$$\int_{s_{k+1}}^{s_k} \{u_r(\pi_k, 0, s) - u_r(\pi_k, 1, s)\} \, dF(s) \leq 0$$

with equality holding for all k *except possibly for* $k = 1$*.*

We verify below that the theorem isn't vacuous in the sense that interesting equilibria of this kind always exist. We next show that all equilibria must look like this.

Theorem 7. *Under the Assumptions of Theorem 6, the ascending sequence of demands* $\{\pi_1, \ldots, \pi_K\}$ *can be supported as equilibrium offers in some Perfect Bayesian Nash Equilibrium in which every demand is accepted with positive probability only if Conditions 1 and 2 of Theorem 6 hold.*

The proofs of Theorems 6 and 7 are contained in Appendix B.[8] The equilibrium with negative interdependence has a very simple characterization: From (1), some proposer types must demand 1 and this must be weakly acceptable given responders beliefs when they see this demand. So there must be an interval of types $[\underline{s}, s_m]$ who demand 1. Let $\overline{p}$ be the lowest demand that a responder, who believes that the proposer type is s_m, prefers to reject. No demand between $\overline{p}$ and 1 will be made with positive probability. At the other extreme, from Assumption 3, there is a demand $\underline{p}$ such that $u_r\left(\underline{p}, 1, \overline{s}\right) > u_r\left(\underline{p}, 0, \overline{s}\right)$. This demand is acceptable to the responder independently of her beliefs. No demand below this can be sustained in any Perfect Bayesian Nash Equilibrium. In every PBNE the demands are a weakly decreasing functions of the

[8]Subsection 3.1 contains demonstration of the equilibrium for $K = 3$.

proposer's type. That is, the less eager the proposer is that his demand will be accepted, the higher will be his demand.

Appendix C describes the most informative equilibrium - the *Maximally Dispersed Equilibrium*, in which beyond the partial pooling at the highest demand (made by the lowest type proposers), the equilibrium virtually separates all proposers in $(s_m, \bar{s}]$.

One property of particular interest is the expected payoff to proposers associated with different offers. In a collection of experimental results, for example, one might check empirically how often an offer p_k is accepted, then compute the product of p_k and the observed acceptance probability in order to compute an expected payoff. Many experimental studies have shown that the expected revenue to the proposer is hump shaped (e.g. Roth et al [43], Slonim and Roth[47]).[9] The following Theorem states sufficient conditions for the expected revenue to the proposer to be hump-shaped in the case that the proposer's payoff if his demand is accepted is linear in demand (proof in Appendix B.)

Theorem 8. *Suppose that $u_p(p, 1, s) = p\phi(s)$ for some strictly positive function ϕ and that there is some proposer type $s < \overline{s}$ such that $u_p(0, 0, s) < 0$. Then the function $q_k p_k$ is decreasing when $u_p(p, 0, s)$ is positive and increasing otherwise.*

3. A Comparative Static Experiment: Capping the Demand

We now turn to an experimental investigation of the proposed equilibrium with negative interdependence. As demonstrated in the previous section, a Perfect Bayesian Nash Equilibrium of the ultimatum game with negative interdependence can account for the known experimental regularities of the game. We were able to characterize the equilibrium based on basic assumptions of the underlying preferences, without assuming specific utility function. In this section we provide a testable implication that can differentiate it from other models of other-regarding preferences, and in particular models of intention-based reciprocity.

3.1. Theoretical Predictions.

Consider the following slight variation of the ultimatum game: instead of allowing the proposer to demand anything between 0 and $\bar{p}$, only demands between 0 and $k\bar{p}$ are allowed ($k < 1$). That is, an upper bound on the demand is a proportion k of the surplus. It is well known from the existing experimental

[9]Note that the fact that the probability of acceptance is decreasing in demand is not sufficient for the revenue to have a unique maximum.

literature that for high enough k (e.g. 90%), only very few demands are made in the excluded interval. [10]

The effect of truncating the range of offers within the models of social preference (outcome based) is straightforward: proposers who would otherwise demand more than $k\bar{p}$ would demand $k\bar{p}$, and the acceptance probability should not change.

Any model of intention-based reciprocity would predict that the conditional acceptance probability would (weakly) fall, and equilibrium demands would (weakly) fall. The intuition is simple: any demand (especially close to $k\bar{p}$) reflects lower kindness of the proposer, since the set of alternative low demands is smaller. Therefore the responder will reciprocate to a given demand with a lower probability of acceptance.

The effect of setting an upper bound on the proposer's demand (a lower bound on his offer) in any Perfect Bayesian Nash Equilibrium with negative interdependent preferences is more subtle. We demonstrate the arguments in Figure 3.1 using $K = 3$. The top part corresponds to the standard PBNE: start with $\pi_3 = 1$ and choose s_3 such that a responder who receives a demand of 1 will believe that it came from a proposer whose type is in the interval $[\underline{s}, s_3)$ and will be indifferent between accepting and rejecting the offer. The responder will choose q_3 (the probability of accepting a demand of 1) such that a proposer of type s_3 will be indifferent between demanding 1 and $\pi_2 < 1$. This latter demand is made by proposers whose type is in $[s_3, s_2)$, so the responder is indifferent between accepting and rejecting π_2. Now q_2, the probability of accepting π_2, is determined by making a proposer of type s_2 indifferent between demanding π_2 and $\pi_1 < \pi_2$. Finally, π_1 is made by proposer whose type is in $[s_2, \overline{s}]$, and a responder who observes this demand would weakly prefer to accept.

When the proposer's demand is capped at π_2, a proposer of type lower than s_3 can demand at most π_2. Remembering that the responder's marginal utility of rejecting is increasing in the proposer's type, if a responder who receives such a demand had believed that it came only

[10] This situation is quite different from Falk, Fehr and Zehnder [19] who study the effects of setting a upper bound on demand (using a minimum wage) that is lower than most demands made in its absence. Furthermore, their experiment is much more involved than the simple comparative static exercise performed here (simultaneous uniform wage offers to up to three potential employees). In another work, Falk and Kosfeld [20] study the effect of allowing the receiver in a Dictator game to set a lower limit on the dictator's transfer. This is a considerably different problem than the game studied in this paper, although interdependent preferences could be applied there as well: in her decision whether to constrain the dictator, the receiver is able to signal her type, that affects the dictator's payoff.

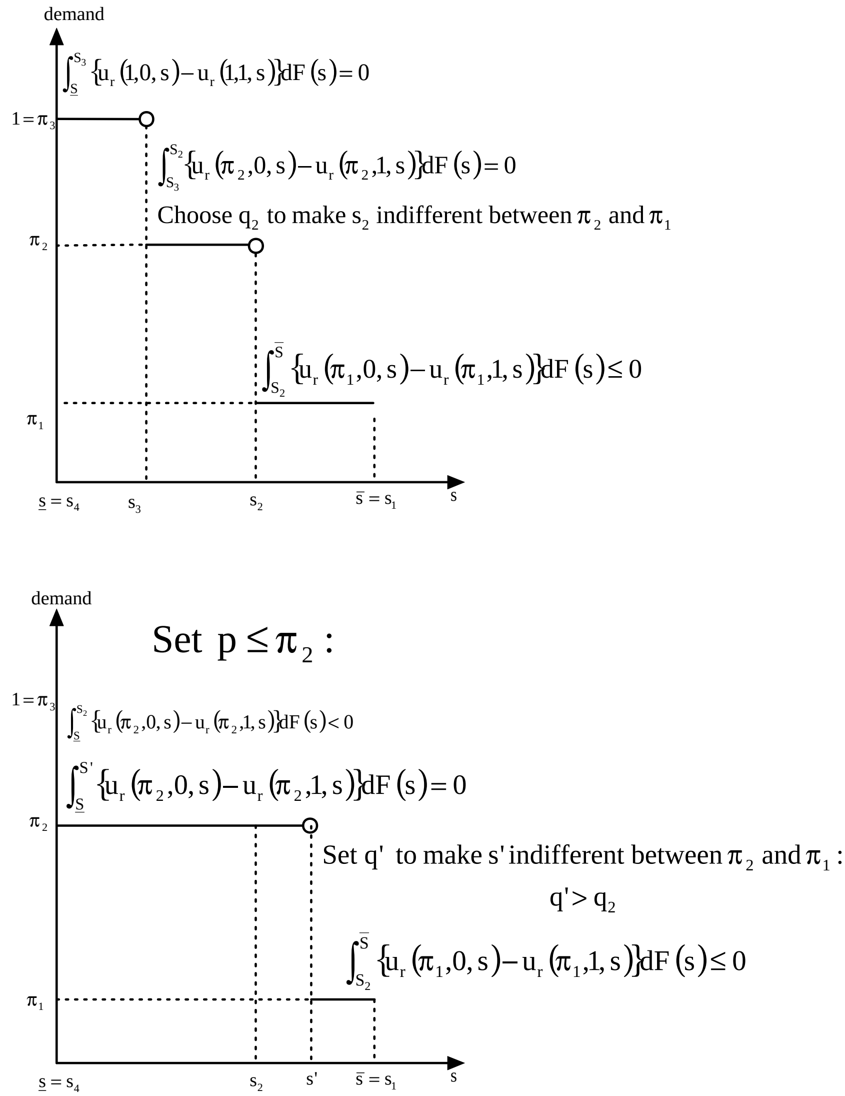

FIGURE 3.1. Perfect Bayesian Nash Equilibrium and Capped Demand

from proposers in $[\underline{s}, s_2)$, she would strictly prefer to accept π_2. Therefore, to make the responder indifferent between accepting and rejecting π_2, the set of proposers who demand π_2 must be $[\underline{s}, s')$ where $s' > s_2$. That is, the subset of proposers $[s_2, s')$, who demanded π_1 before setting the cap, would demand now $\pi_2 > \pi_1$. Moreover, the probability of accepting π_2 is now determined by the new pivotal proposer type s'. From the construction of the original PBNE, s' strictly preferred to demand π_1 to demand π_2, when the probability of acceptance of π_2 is

q_2. In order to make q' indifferent between the two demands, the probability of accepting π_2 must increase to $q' > q_2$. The same argument can be made when the grid of demands is finer, and the effect continues beyond the upper bound itself. Similarly, if the cap is set between π_2 and 1, if only proposers in the interval $[\underline{s}, s_3]$ had demanded the upper demand, then a responder would strictly prefer to accept it (since the responder's marginal utility of rejection is increasing in p). Hence the set of proposers who demand the lower bound must increase, and the argument continues as above.

To summarize, the predictions for any PBNE with negative interdependent preferences, is that when a maximal demand (minimal offer) is set then: higher demands (lower offers) will be made, and the probability of acceptance of these demands will increase relative to the base.[11] These predictions are in opposite directions to the predictions derived from models of social preferences and intention-based reciprocity, and serve as a simple experimental method to differentiate between these theories.

3.2. **Experimental Design and Implementation.** Subjects were undergraduate students at the University of British Columbia who were recruited by an e-mail message sent from the Student Service Centre to a random group of students. After signing a consent form, the subjects received a detailed explanation about the experiment. After the subjects read the instructions, they were asked to answer some questions to verify that they understood how the payment will be implemented. Those subjects who didn't fully understand the implementation (see below), received a detailed explanation from a research assistant. Only after confirming that all subjects understood the procedures, the experiment started.

In order to allocate the subjects to a "proposer" and "responder" role, they all participated in an "I Spy" contest. The contest treatment was implemented in earlier studies in order to legitimize the position of a proposer (e.g. Hoffman *et al* [30], Bolton and Zwick [12], List and Cherry [38]). Subjects who scored higher in the contest were designated a "proposer" and received $5. The rest were asked to move to a

[11] Notice that the comparative static is performed on a single equilibrium. We don't have an equilibrium selection rationale that will suggest which equilibrium is being played. However, the interdependence (both positive and negative) framework is the only model that is consistent with increase in demand and conditional acceptance rate as a response to capping the demand. Furthermore, since all PBE share identical pooling on the highest possible demand, if the cap on demand is high enough the effect on all equilibria will be similar.

nearby room and were designated a "responder." The motivation behind paying the proposers was to mitigate the property rights effect created by the contest: we didn't want the contest treatment to interfere in creating a baseline comparable to previous ultimatum game experiments, but we felt that a random assignment (which is used in many studies) may be problematic as well, as it creates substantial ex-post asymmetries between ex-ante identical subjects.

The bargaining was over \$55, that were to be paid on top of the \$5 (a total of \$60). Although convergence to equilibrium strategies in ultimatum game is not the main focus of the current study, we acknowledge it is a non-trivial process. Previous studies (e.g. Roth et al [43], Slonim and Roth [47], List and Cherry [38]) used a sequence of random matching (without replacement) between proposers and responders. As there is learning on both sides, it creates a complex learning problem (Roth and Erev [42]). We decided to implement a new learning technology: each group (proposers and responders) was divided into two. In the first round, each proposer made offers[12] to half of the responders (those offers could have been different). Each responder received offers from half of the proposers and chose whether to accept or reject each offer. Then each proposer learned whether the offers he made were accepted or not (he didn't know the offers made by other responders, and the responses they received). In the second round, each proposer made offers to the second half of the responders, and each responder received offers from the proposers he had not interacted with before. This method allows a proposer to experiment in the first round offers, an instantaneous learning among responders (who received various offers in the first round), and full learning by proposers in the second round. If the conditional acceptance rate of responders does not change between the first and the second round, it would confirm the hypothesis that they fully learned in the first round. Therefore, we should not expect additional experience to alter the responders or proposers strategies. This conjecture is crucial for consistency with the common prior assumption incorporated in the Bayesian equilibrium.[13] This design also

[12]Note that throughout the experimental part of the work we use "offer", in order to maintain consistency with the way the problem was presented to subjects.

[13]Harrison and McCabe [29] used one-to-one matching but allowed the proposers to observe the distribution of the minimal acceptable offer of responders in the previous round. This strategic information is finer (and less costly) than the information proposers receive in the current design. Bellemare, Kröger and van Soest [6] showed recently that utilizing subjective-stated probabilities of rejection allows an econometrician to better fit of the data than by using observed frequencies of rejection from the game played. The current design is able to overcome this challenge

allowed to see whether proposers mixed among offers, and to see how much of the mixing is strategic and how much is due to experimentation. The payment was determined by choosing at random one match (out of the two rounds), and implementing the outcomes for each pair in the match. In the baseline treatment the offers were allowed to vary between \$0 and \$55, and in the limit treatment the offers were between \$5 and \$55 (that is, demands were capped at \$50).[14]

The design maintained anonymity between proposers and responders (responders didn't know who made each offer, and proposers couldn't know the identity of the responder who received a specific offer). Furthermore, the recruiting strategy guaranteed that the probability that a subject will know other subjects was extremely low. The design kept the strategy and payoff of the subjects hidden from the experimenters: experimenters in the rooms could not see the offers and acceptance/rejection decisions of subjects, and the payment was distributed by a third group of experimenters (not present in the rooms where the experiment took place) who placed the money in numbered sealed envelops.

3.3. **Results.** Table 1 reports summary statistics of the baseline treatment and the limit treatment. A total of 52 subjects took part in the two sessions: 24 in the baseline (B) treatment and 28 in the limit (L) treatment. Each proposer in the baseline treatment made 12 offers: 6 in each round, when the offers in round 2 (R2) were made after observing the acceptance/rejection of his offers in round 1 (R1). Similarly, each proposer in the limit treatment made 14 demands - half in the second round.

	B-R1	B-R2	L-R1	L-R2
Average offer	19.07	21.21	15.31	15.00
Average acceptance rate	0.63	0.88	0.87	0.90
Within SD of demand	2.26	1.47	3.18	2.09
Total SD of demands	8.15	6.64	6.45	5.78

Table 1. Summary Statistics

Table 1 indicates the main finding of the investigation: setting a lower bound on the offer (capping the demand) caused the offer to

by allowing proposers to estimate the (stable) probabilities of rejection in the first round.

[14]No show-up fee was paid since we felt it could distort the ultimatum structure of the game: with a positive show-up fee a responder who rejects still leaves the experiment with a positive payment.

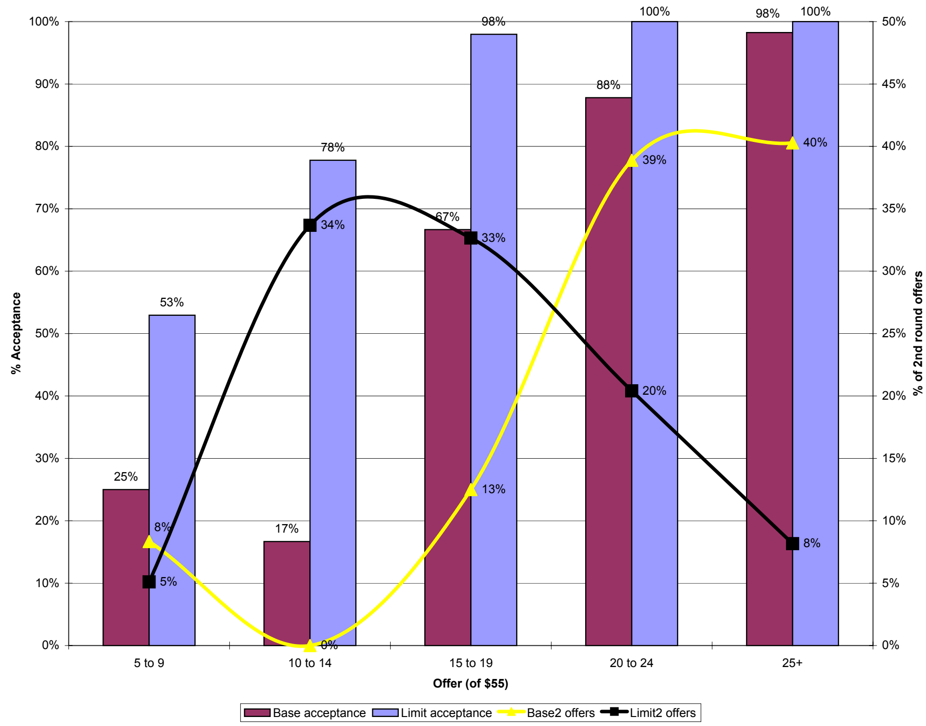

FIGURE 3.2. The Effect of Setting a Lower Limit on Offers and Acceptance Rate

fall by almost 30% from \$21.21 to \$15 (mean demand increased from \$33.79 to \$40). In spite of the lower offers, the average acceptance rate was marginally higher (90% in the limit treatment and 88% in the base treatment), implying that the conditional acceptance rate increased substantially. The learning and experimentation from the first to the second round could be seen by the decrease of about 35% of the within proposer standard deviation: many proposers experimented in the first round by submitting different offers, but used a single offer in the second round.

Figure 3.2 demonstrates graphically the effect of setting a lower limit: the columns height represents the conditional acceptance rate for every interval, and curve approximates the distribution of offers under the two treatments.

Table 2 reports the distribution of offers and acceptance rate. Although Table 2 reports the results for intervals, it is important to note that about 90% of offers were made in multiples of \$5. The table reveals the effect of setting a lower limit to the offers: the conditional acceptance rate increases and the frequency of low offers increases.

offer	%	Base-R1	Base-R2	Limit-R1	Limit-R2
\$0 to \$4	offers	0	0	0	0
	acceptance				
\$5 to \$9	offers	8	8	12	5
	acceptance	33	17	50	60
\$10 to \$14	offers	25	0	31	34
	acceptance	17		80	76
\$15 to \$19	offers	8	13	17	33
	acceptance	50	78	94	100
\$20 to \$24	offers	18	39	28	20
	acceptance	77	93	100	100
\$25+	offers	39	40	12	8
	acceptance	96	100	100	100

TABLE 2. Distribution of Offers and Acceptance Rate by Treatment and Round

It is very important to note that although we introduced some new and unconventional design methods in the experiment, the results in the baseline treatment are comparable to existing experimental findings in the literature: offers below 25% of the pie (up to \$14) are accepted only 20% of the time, and 79% of offers are higher than \$20 (which is accepted most of the time). Furthermore, statistical tests that investigated the effect of the offer's rank on its acceptance probability, showed that receiving several offers at once (and being able to compare between them) had no significant effect on the conditional acceptance probability.

3.3.1. *Acceptance Rate.* As noted above, 90% of offers are made at multiples of \$5. This implies that using parametric assumptions, would extends those observations to intervals were offers have rarely been made. Instead, we compare (non-parametrically, using Fisher exact test) the acceptance rate at offers of \$5, \$10, \$15, \$20 between the base treatment and the limit treatment. We use both rounds since there is no significant difference between the conditional acceptance rates at different rounds, within the same treatment (for both the base and the limit treatments). As noted above, this result indicates that the first round offers had sufficient variation to allow responders to learn the type distribution of proposers instantaneously. Since we simultaneously test four hypotheses, care should be taken not to reject the joint null hypothesis of "no limit treatment effect" when it is true. That is, the p-values need to be adjusted such that the probability that at least one of the tests in the family would exceed the critical value under the joint null hypothesis of no effect is less than 5%. We use the most conservative approach - the Bonferroni adjustment (Savin [45, 46]), in which each p-value is multiplied by the number of tests (four in our case). It should be noted that we take a very conservative approach of using the Fisher exact test and the Bonferroni adjustment, that treats the acceptance rate at different offers as independent.

offer	B accept	B reject	L accept	L reject	p-value
5	2	6	6	5	0.208263
10	3	15	49	14	0.000003
15	6	2	46	1	0.052297
20	35	5	39	0	0.029196

Table 3. Fisher Exact p-value (one-sided) for the effect of Limit Treatment on conditional acceptance probability

As Table 3 clearly reveals, the null hypothesis that limiting the offer (capping the demand) did not have an effect on the acceptance probability is rejected at 1%. The strongest and most dramatic effect occurred at \$10: in the first round, 25% and 31% of the offers in the baseline and the limit treatments, respectively, were made at that level. However, the acceptance rate in the base treatment was only 17% while in the limit treatment the acceptance rate of those offers was 80%. The experimental design allowed the proposers to learn this behavior, and in the second round there were no offers of \$10 in the base treatment, while 34% of the offers in the limit treatment were made at \$10.

It is of interest to note that the proposer's expected revenue in the base treatment is maximized at an offer of \$20 (\$30.625) - which is the mode of the offer distribution, while in the limit treatment the expected revenue are maximized at an offer of \$15 (\$39.15), although the mode of the offer distribution is at \$10.

3.3.2. *Offers.* In order to test whether capping the demands has a significant effect on offers we conduct a feasible GLS regression. We used second-round offers since after the first round, proposers learned the conditional acceptance probability (as established above, the responders used the same acceptance probability in the two rounds). Therefore, the second round is consistent with the common prior assumption underlying the Bayesian signaling game. The negative effect of the limit treatment on second-round offers is significant at 1%.

As noted above, the standard deviation of offers decreased significantly between the first and the second round in both treatments

# of observation=	170		Obs per group			
# of Groups=	26		min=	6		
Estimated covariances=	26		max=	7		
Panels: heteroskedastic;			Wald χ^2 (1) =	228.19		
no auto-correlation			$Prob > \chi^2 =$	0.0000		
offer	*coef*	*SE*	*z*	$P > \|z\|$	*[95%*	*CI]*
Limit treatment	-5.404759	0.35778	-15.11	0.000	-6.10601	-4.703506
Constant	20.42277	0.25102	81.36	0.000	19.9308	20.91476

TABLE 4. Second-Round Offers: Feasible GLS

(p<0.0001 in a random effect GLS controlling for treatment and round without interaction). This result is consistent with the hypothesis that proposers experimented in the first round, and after estimating the acceptance probability made less dispersed offers in the second round.[15]

3.4. **Equilibrium or Anchoring?** A skeptical reader may wonder whether the results of the experiment had anything to do with interdependent preferences, and may conjecture they are due to the "anchoring and adjustment" bias identified in the behavioral decision theory literature (e.g. Slovic and Lichtenstein [48], Kahneman and Tversky [33], Tversky and Kahneman [50]). According to this explanation, imposing a minimum offer simply provides an anchor to the players, making low offers seem more "fair", thereby increasing their incidence and the respective acceptance probability. This conjecture is *inconsistent* with the experimental instructions and procedures: if providing a minimum of $5 in the limit treatment created an anchor, then the $0 in the baseline treatment should have created an even lower anchor (the wording of the instructions are almost identical in the two treatments). However, the argument may go that the $0 does *not* provide an anchor. Moreover, the results are inconsistent with this conjecture as well: as clearly shown in Table 2 and Table 3 most of the response to setting a minimum offer of $5 occurred at higher offers ($10 and $15). Furthermore, Table 2 reveals that the dramatic effect of setting a low bound to offers was on responders' acceptance rate (especially at $10) in the first round. The proportion of proposers who offered this amount in the first round of the two treatments differed only slightly (25% in the baseline and 31% in the limit treatment), but the acceptance rate differed significantly (17% in the baseline and 80% in the limit treatment). As a result, proposers in the *baseline* treatment, didn't make any offers in the interval

[15] In the base treatment 67% of the proposers made 6 identical offers in the second round, and in the limit treatment 35% of proposers made 7 identical offers in the second round. We didn't find a treatment effect on the standard deviation of offers.

	B-R1	B-R2	I-R1	I-R2
Average offer	19.07	21.21	16.82	17.81
Average acceptance rate	0.63	0.88	0.75	0.82
Within SD of demand	2.26	1.47	1.19	1.03
Total SD of demands	8.15	6.64	7.96	6.45

Table 5. Summary Statistics: the Incentive vs. Base Treatments

of \$10-\$14 during the second round (the proportion of offers made in this interval in the limit treatment increased only marginally to 34% in the second round). The model of negative interdependence can account for this change in acceptance probability: in the limit treatment, lower types (relative to the baseline treatment) made low offers, which decreased the responders' marginal utility of rejecting them. Therefore, the decrease in offers between the two treatment is due to lower acceptance rate of low offers by responders (results consistent with many other studies) and learning by proposers, both occurring in the baseline treatment. One of the general lessons from the anchoring and adjustment literature is that an initial high demand in a bargaining interaction will increase the proposer's final payoff. The conclusions from the experiment are the exact opposite: limiting the bargaining power of the proposer increases his expected payoff substantially.

However, in order to convince even the most skeptic reader (and ourselves) of the importance of interdependent preferences and equilibrium reasoning, we conducted a third treatment, that was strategically equivalent to the limit treatment, but did not provide an anchor. As argued above the anchoring rationale can be applied only if a minimum offer of \$0 does not set an anchor. We therefore allowed the proposer to make an offer between \$0 and \$50, and paid the responder an additional \$5 if she accepted an offer (an "incentive"). 36 subjects participated in this treatment, that otherwise was identical to the base treatment. As is evident from Table 5 average offer in the incentive treatments was lower by \$3.40 than in the base treatment, and the average acceptance rate was about the same.

Table 6 compares the effect of the incentive design (that did not provide an anchor) on the conditional acceptance probability. As in the limit treatment, the conditional acceptance probability is higher in the incentive treatment, and the effect is especially strong at offers of \$10 (less than 20% of the pie).

The effect on offers is significant as well. A feasible GLS finds that an incentive lowers offers by \$2.5 relative to the base treatment (significant

offer	B accept	B reject	I accept	I reject	p-value
5	2	6	4	10	0.63
10	3	15	41	24	0.000947
15	6	2	36	10	0.5754
20	35	5	71	3	0.099

TABLE 6. The Effect of the Incentive Treatment on Conditional Acceptance Probability: Fisher Exact one sided p-values

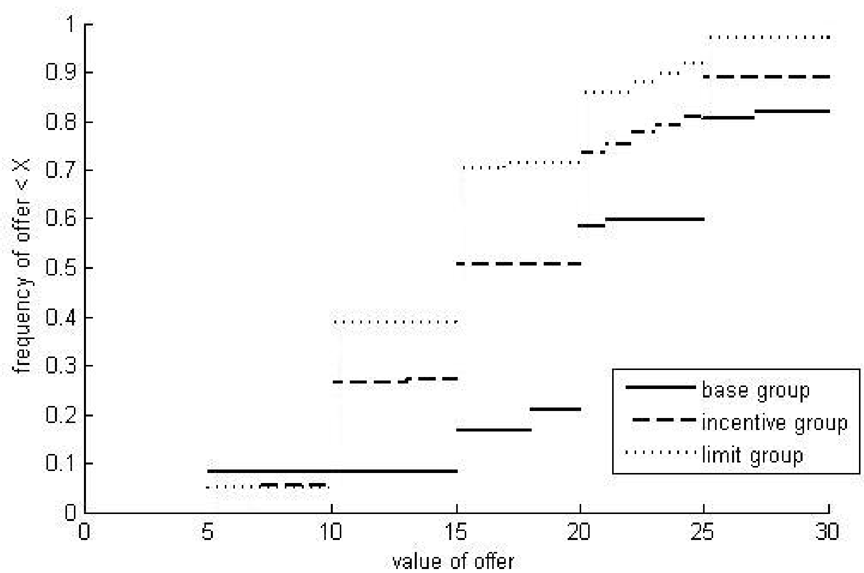

FIGURE 3.3. Effects of the Limit and Incentive treatments on CDF of offers

at 0.01%). Figure 3.3 shows that there is almost a first order stochastic dominance between the offer distributions in the three treatments. That is, for almost any offer, the probability of receiving an equal or lower offer is highest in limit treatment, followed by the incentive treatment and is lowest in the base treatment. Similar ranking is evident in the conditional probability of acceptance.

Our conclusion from the three treatments is that the limit treatment incorporates two effects: the equilibrium reasoning of interdependent preferences which is the focus of the current paper (the incentive treatment compared to the baseline treatment), and the anchoring effect - which explains the lower offers and higher probability of acceptance in the limit treatment compared to the incentive treatment.

3.5. **Conclusion from the experiment.** We conclude that the outcome of the experiment is consistent with a Perfect Bayesian Nash Equilibrium of the model with negative interdependence, while being inconsistent with models of outcome and intention-based preference.

Although we are not aware that this type of argument has been used before in the bargaining literature in Economics, it seems that economic agents are well aware of this phenomenon. For example, an incentive contract structure is quite common in labor agreements and other contracts, and allows the proposer (employer, retailer, marketing agent) to achieve higher expected revenue. In particular, posting of a very low minimum wage (unlike [19] where the minimum wage is set higher than 92% of the offers) may lead to a *decrease* in wages. Similarly, government intervention in the form of maximum price where price dispersion exists, may lead to an *increase* in average price of a good.

An even more doubtful reader may question the robustness of our results. We acknowledge that replication of every experimental result is important in order to draw general conclusions. We tried our best to design the experiment thoughtfully and carefully. The stakes were significant: subjects could have earned $60 in less than an hour, and our results are highly significant even with a modest sample size. But even more important than the specific results in the specific experiment we performed, is the modeling exercise we executed: we suggested a revealed choice-based model of the ultimatum game, whose equilibria can account for the known experimental findings. We then suggested an out-of-sample comparative static experiment on these equilibria, that can differentiate our model from existing models of other-regarding preferences. Therefore, the study contributes new insights to the ongoing research and debate of how to model other-regarding preferences, and to the question whether game theory can provide the appropriate tools to study those preferences. More generally, it provides an example how economic theory can be silent of the psychological motives of the economic actors, and yet provide testable predictions.

4. Concluding comments

The arguments above illustrate that it is possible to interpret the results of the ultimatum game experiments using standard game-theoretic reasoning. We believe that it points to further complication that experimenters are well aware off, but theorist have not paid sufficient attention to: an experiment is actually a Bayesian game between three players - the proposer, the responder, and the experimenter. The experimenter is the one for whom the stakes in the game are actually highest. The same sort of type dependencies ought to exist between the experimenter and subjects. Of course, a single experiment contains no variation in experimenter behavior that would make it possible to uncover this information, so the subjects' interpretation of the experimental design and its influence on them presents a much more complicated problem.

4.1. **The Dictator Game.** With this in mind, one may ask how the proposers modeled in the current study would play the Dictator game in which the proposer selects a demand then gets it for sure, and the 'responder' simply receives whatever the proposer offers. Since our proposers are better off with higher demands conditional on them being accepted, they should presumably demand all the surplus from the experiment for themselves.[16] As noted above, the reason that this doesn't happen is that the same type dependence exists between the proposer and the experimenter - both the fact that the experimenter suggests a Dictator game, and the other characteristics of the experiment alter the proposer's perception of the payoffs in the experiment. For example, Hoffman, McCabe and Smith [31] and Cherry, Frykblom and Shogren [14] showed that implementing a subject-experimenter anonymity and generating the surplus through effort, led almost all dictators to make minimal transfers. These results stand in a sharp contrast to standard dictator experiments (without contest/earned income and experimented-dictator anonymity) where at least some of the dictators give substantial amounts. Those "standard" dictator games, stand also in contrast to the social-economic reality, were anonymous charitable giving is quite rare (after all, how frequently do people share the content of their bank accounts with complete strangers and without anyone else knowing about that?) It is not a coincidence that already in the twelve century, when Maimonides [41] enunciated eight distinctive levels of charitable giving, anonymous giving occupied the second-highest level of giving to the poor.[17] We believe that the apparent inconsistency between experimental outcomes (with random-assignment and without subject-experimenter anonymity) and actual charitable giving calls into doubt the main criticism of the monotonicity

[16] One may want to relax this assumption, but it is essential for the construction of the PBE we study in the current paper

[17] The highest level of giving is someone who establishes a personal relationship with the needy person, helping him with a loan or a partnership in a way that doesn't make the latter a subordinate.

assumptions in the interdependent preference model (both in Levine's positive interdependent specification [18] and our model of negative interdependence). This inconsistency led us to adopt the contest-anonymity treatments in our experiment.[19] Furthermore, Bardsley [4] and List [37] showed that changing the dictator's strategy set to include negative giving (taking) caused almost all dictators to behave selfishly. Dana, Weber and Kuang [16] showed that many dictators were willing to leave the experimenter part of the surplus, instead of facing the choice of how much to allocate to a passive responder - possibly showing preference to share with the experimenter rather than with the other subject (see also Lazear, Malmendier and Weber [35]). It may be impossible to control all aspects, but using the theoretical methods described in this study, it would presumably be possible to interpret the impact that the experimental design has on outcomes. Recently, Andreoni and Bernheim [2] proposed a model of the dictator game that employs exactly this type of reasoning to explain transfers in the dictator game. In their framework, the dictator's payoff depends on an audience (which may include the receiver, the experimenter and possibly other parties) belief about his type. They analyze the signaling equilibrium in the standard game as well as in a game where the transfer may be determined by an external mechanism, and show that in the standard game there is pooling of dictators on the "fair" transfer, while when the probability of forced external transfer increases, more proposer types pool on that offer. Their model is an excellent example of the richness available in the Bayesian model of interdependent preferences to study important aspects of giving in experimental and real world setting.[20]

4.2. **Beyond experiments.** The interpretation of the ultimatum game as a Bayesian game between agents with interdependent preferences has applications beyond the experiments themselves. For example, it would seem possible to incorporate negative interdependence into a standard principal-agent incentive problem. Another possible application can be

[18] Rotemberg [44] adds the responder beliefs into the dictator's payoff function to rationalize positive dictator offers.

[19] It is important to note that our baseline results, as previous experiments that implemented contest and anonymity (e.g. Hoffman et al [30], Bolton and Zwick [12]), fall within the standard range of outcomes in ultimatum experiments. That is, the strategic bargaining environment in the ultimatum game is robust to these manipulations, while the charitable giving environment studied in the dictator game is very sensitive to these treatments (see also Fershtman et al [22]).

[20] The audience effect may be responsible to lower giving reported recently by Hamman et al [28] when dictators can delegate transfer decisions to agents who represent their interests.

in an auction design. In this case it is reasonable to expect that the seller has some private information that is of interest to the buyers. Conditional on this private information which is of common interest, the buyers may have independent private valuations. The seller sets a reservation price, that acts similarly to the demand in the ultimatum game. If a buyer accepts this reservation price, she can bid in the auction. The structure of negative interdependence lends itself naturally to this problem. The insights suggested by the analysis of the ultimatum game, and in particular the equilibrium played, can be applied to this problem.

Even more importantly, the direct economic implications of modeling interdependent preference in a bargaining environment and the comparative statics performed in the current study have immediate implications for understanding price (including wage) negotiations and consequences of policy. As argued above, setting minimum wage in an environment where wage dispersion exists, may shift the wage distribution to the left. Similarly, setting a maximum price for a commodity whose price is not unique may shift the price distribution to the right. These examples suggest that policymakers should incorporate the fact that agents are not selfish and have interdependent preferences when considering alternative policy tools.

Appendix A. Equilibrium with Positive Interdependence

In this appendix, we analyze a model with positive interdependence. Positive interdependence means that as the proposer's type increases, both the proposer and the responder become less interested in having any given demand accepted. One example might be when the proposer's type is inversely related to his altruism. A less altruistic (higher type) proposer gets less utility from the payoff received by the responder, and therefore cares less about whether a demand is accepted. Responders are less inclined to accept demands by less altruistic proposers, especially when they are themselves less altruistic.

It is not difficult to show that if we simply replace negative interdependence with positive interdependence in our model, no more than two distinct demands can be supported in equilibrium. So we also use this Appendix to illustrate how our approach is extended to one in which responders have private types.

The simplest example of positive interdependence is perhaps the model of Levine [36], who interprets the proposer's type as a measure of his altruism. More altruistic proposers in Levine's model obtain higher utility from the payoff received by the responder. So for any given offer, the higher the proposer's type, the higher is the cardinal utility of acceptance. Responder's payoff in Levine's model increases the more altruistic the responder thinks that the proposer is.[21] The payoff to rejection is normalize to zero, so proposers' and responders' desire to have an offer accepted move in the same direction as the proposer's type changes, which corresponds to positive interdependence. For this reason, this Appendix also clarifies the relationship between our paper and Levine's.

For the rest of this appendix, we assume that the responder has a privately known type $t \in \left[\underline{t}, \overline{t}\right]$. We will assume that the proposer's payoff, as in the main body of the paper, depends on his own type $s \in [\underline{s}, \overline{s}]$. To be consistent with the argument in the main body of the paper, the proposer of type $\underline{s}$ is the most altruistic proposer, while the proposer of type $\overline{s}$ is the least altruistic. The proposer's payoff when the proposal π is accepted is $u_p(\pi, 1, s)$. In this appendix we normalize the payoff of a rejection to zero, as in [36].

The responder's payoff depends on both his own type, and the proposer's type, and is given by $u_r(\pi, 1, s, t)$. The responder of type $\underline{t}$ is the most altruistic responder, the type $\overline{t}$ is the least altruistic responder. As with the proposer, the payoff to rejection is normalized to zero.

Levine's payoff function for the responder is given by

$$u_r(\pi, 1, s, t) = (1 - \pi) + \frac{\tilde{t} + \lambda \tilde{s}}{1 + \lambda} \pi$$

where $0 < \lambda < 1$ and $\tilde{t}$ and $\tilde{s}$ measures the responder and the proposer altruism respectively. This is equivalent to our payoff function when types are transformed as

$$\tilde{s} = -\frac{2s - \overline{s} - \underline{s}}{\overline{s} - \underline{s}}$$

and

$$\tilde{t} = -\frac{2t - \overline{t} - \underline{t}}{\overline{t} - \underline{t}}.$$

In [36], the payoff to the proposer is given by the same formula with the share and types interchanged, i.e., $\pi + \frac{\tilde{s} + \lambda \tilde{t}}{1 + \lambda}(1 - \pi)$.

As mentioned above, we will impose the additional assumption that the proposer's payoff is independent of $\tilde{t}$. We maintain the single crossing Assumption 2 and add the following:

[21] It is interesting to compare to the rationale used by Cox et al [15]: in their model higher (more generous) offers make the responder more altruistic. Hence interdependence provides a structure through this assumption can be justified.

Assumption 9. *The function $-u_r(p,1,s,t)$ is monotonically increasing and supermodular in s and p uniformly in t. For every s, there is a $p>0$ and a t such that $u_r(p,1,s,t)>0$; $u_r(p,1,\overline{s},t)<0$ for some p; and $u_r(p,1,\underline{s},\underline{t})>0$ for all $p\in P$.*

An increase in the proposer's demand has a bigger impact on the responder's payoff the higher the responder thinks the proposer's type is. The other parts of Assumption 9 simply require the type space to be large enough to accommodate different behavior. For instance, no matter what the responder thinks of the proposer, there is some demand she will want to accept. Alternatively if a responder thinks the proposer has the highest type, there is some demand she will want to reject. Finally, the most altruistic responder dealing with the most altruistic proposer will want to accept any demand. Levine's payoff function satisfies these.

As with negative interdependence, there are multiple equilibria. However, unlike negative interdependence, these equilibria can't be unambiguously interpreted with respect to the information conveyed by equilibrium demands. So we focus on the kind of equilibrium Levine 'calibrated'. In such an equilibrium, higher demands are made by less altruistic proposers (or higher type proposers in our formalism). Even under this assumption, there are many equilibrium outcomes. To hone in a little more, we take Levine's approach, and assume that we already know the distribution of demands made in equilibrium, and the probability with which each demand is accepted (possibly because we have access to experimental data).

Let π^* be an interval such that for each $\pi\in\pi^*$, $u_r\left(\pi,1,s,\overline{t}\right)<0<u_r\left(\pi,1,s,\underline{t}\right)$ for each type s of the proposer. Demands that don't satisfy this property will never appear in equilibrium. By Assumption 9, all demands are accepted by some types of responders. If demands are always accepted, they won't appear in equilibrium, since proposer's payoff is assumed to increase in demand.

We can now characterize a class of equilibria that resemble those in [36]. A sequence of demands is *supported as an altruistic equilibrium* if there is a perfect Bayesian equilibrium in which each demand in the sequence is made and accepted with strictly positive probability on the equilibrium path, and no other demand is made with positive probability on the equilibrium path; and in which the equilibrium demand is a weakly increasing function of the proposer's type. An altruistic equilibrium is one in which higher demands are made by less altruistic proposers.

Let $\pi_1, \ldots, \pi_K$ be any increasing finite sequence of demands from π^*. Suppose that the proportion Q_k of all demands are equal to π_k. Then we'll construct an equilibrium in which proposers whose types lie below s_k make a demand that is no larger than π_k where s_k is chosen to satisfy $F(s_k) = \sum_{i=1}^{k} Q_i$. If the demand π_k is accepted with probability q_k, then q_k must be the proportion of types who find the demand acceptable.

Theorem 10. *Let $\pi = \{\pi_1, \ldots, \pi_K\}$ be such that each $\pi_k \in \pi^*$. There exist distributions F and G of proposer and responder types respectively such that the sequence is supported as an altruistic equilibrium if and only if the system*

$$q_k u_p(\pi_k, 1, s_k) = q_{k+1} u_p(\pi_{k+1}, 1, s_k) \tag{A.1}$$

has an increasing solution for each $k = 1, \ldots, K$.

Proof. We deal with two directions.

If part of the theorem: Let $\{s_1, \ldots, s_K\}$ be a solution to (A.1). Since the proportion of all demands equal to π_k is given by Q_k, we have some distribution F of proposer types such that $F(s_k) = \sum_{n=0}^{k} Q_n$. Since K is finite, we can assume F is continuous. From Lemma 11 below, each array of types $\{s_1, \ldots, s_K\}$ can then be associated with a set of types $\{t_1, \ldots, t_k\}$ that satisfy (A.2). This means that given the distribution F, responder type t_k is just indifferent between accepting and rejecting the demand π_k. Since the payoff to acceptance is decreasing in responder type, it is a best reply for responder types $t' > t_k$ to reject π_k and for types $t' < t_k$ to accept it. If the system (A.1) has a solution, then $q_{k+1} < q_k$, and so there is some continuous distribution G such that $G(t_k) = q_k$ for each k.

It remains to show that proposers whose types are in the interval $[s_{k-1}, s_k]$ should demand π_k. It follows immediately from the single crossing assumption 2, that types in this interval prefer π_k to any other demand that occurs on the equilibrium path. So let $\pi_k < \pi < \pi_{k+1}$. Since $\pi \in \pi^*$, there is some type s such that $u_r(\pi, 1, s, t_{k+1}) = 0$. Suppose that responders believe that a proposer who deviates to π has exactly this type. Then the probability with which the proposal will be accepted is the same as the probability with which the proposal π_{k+1} is accepted. Then all proposer types prefer the demand π_{k+1} to π_k, and according to the previous argument, they must prefer their equilibrium demands.

Only if part of the theorem: Let s_k be the highest type who makes the demand π_k in equilibrium. Since proposer's demands are weakly increasing in type, and each demand occurs with strictly positive probability, the types s_k are strictly ordered, and $s_K = \overline{s}$. If equality fails at any s_k then by continuity, some types will want to change their demands. □

Lemma 11. *For any continuous distribution F of proposer types, any increasing sequence $\{\pi_k\}_{k=1,\dots K}$ of demands from π^*, and any increasing sequence $\{s_1, \dots, s_K\}$ of proposer types with $s_k = \overline{s}$, there is a decreasing sequence $\{t_1, \dots, t_K\}$ such that*

$$\mathbb{E}_{s\in[s_{k-1},s_k]} u_r(\pi_k, 1, s, t_k) = 0 \tag{A.2}$$

for each k, where $s_0 = \underline{s}$.

Proof. Begin with π_1. Since $\pi_1 \in \pi^*$

$$\mathbb{E}_{s\in[\underline{s},s_1]} u_r(\pi_1, 1, s, \overline{s}) < 0 < \mathbb{E}_{s\in[\underline{s},s_1]} u_r(\pi_1, 1, s, \underline{s})$$

as the assumption holds uniformly in s. By the mean value theorem, there is a t_1 such that

$$\mathbb{E}_{s\in[\underline{s},s_1]} u_r(\pi_1, 1, s, t_1) = 0.$$

Now replace π_1 with π_2, and the interval $[\underline{s}, s_1]$ with $[s_1, s_2]$. Since both these changes reduce the acceptance payoff to the responder of type t_1, we have

$$\mathbb{E}_{s\in[s_1,s_2]} u_r(\pi_2, 1, s, t_1) < 0 < \mathbb{E}_{s\in[s_1,s_2]} u_r(\pi_2, 1, s, t_1),$$

since $\pi_2 \in \pi^*$. The mean value theorem then gives t_2 such that

$$\mathbb{E}_{s\in[s_1,s_2]} u_r(\pi_2, 1, s, t_2) = 0.$$

Repeat this procedure for the other demands. □

Whether the system (A.1) has a solution or not depends jointly on the demands π_k, the acceptance probabilities Q_k, and the payoff function u_p. For example, with Levine's formulation of the payoff function

$$q_k u_p(\pi_k, 1, s) = q_k \left(\pi_k - \frac{2s - \overline{s} - \underline{s}}{\overline{s} - \underline{s}} (1 - \pi_k) \right)$$

which is linear in proposer type. This function is flatter the lower is π_k (at least as long as q_k is lower the higher is π_k). Apparently (A.1) can have a solution in this case only if the sequence $q_k \pi_k$ is decreasing.

Appendix B. Proofs of Theorems in Section 2.1

Proof of Theorem 5.

Theorem. *Let $p' > p$ be two demands made on the equilibrium path. The probability with which the demand p is accepted is at least as large as the probability with which p' is accepted.*

Proof. Let q and q' be the acceptance probabilities associated with p and p' respectively, and suppose to the contrary that $q' > q$. In particular, this means that $q < 1$. Let $S(p)$ be the set of proposer types who make the demand p with positive probability on the equilibrium path. Since $q < 1$ there must be some type $s \in S(p)$ such that $u_r(p, 0, s) > u_r(p, 1, s)$. Since the responder's marginal utility of rejection is increasing in p, this same inequality must be true for every $p'' > p$. Then by Assumption 4, $u_p(p, 1, s) > u_p(p, 0, s)$. This is a contradiction since a proposer of type s could then strictly increase his payoff by demanding p' which is accepted with higher probability. □

Proof of Theorem 6.

Theorem. *Suppose negative interdependence, that Assumptions 1, 2, 3, 4 hold and that that $u_p(1, 0, \underline{s}) > u_p(1, 1, \underline{s})$. Then an ascending sequence of demands $(\pi_1, \ldots, \pi_K)$ can be supported as a Perfect Bayesian Nash Equilibrium demands if*

(1) $\pi_K = 1$*; and*
(2) *there exists a strictly descending sequence of $K+1$ types $(s_1, \ldots, s_K, s_{K+1})$ with $s_1 = \overline{s}$ and $s_{K+1} = \underline{s}$ satisfying*

$$\int_{s_{k+1}}^{s_k} \{u_r(\pi_k, 0, s) - u_r(\pi_k, 1, s)\}\, dF(s) \leq 0$$

with equality holding for all k except possibly for $k = 1$.

Proof. The proof involves constructing a Perfect Bayesian Nash Equilibrium. Begin with the lowest demand π_1. Since

$$\int_{s_2}^{s_1} \{u_r(\pi_1, 0, s) - u_r(\pi_1, 1, s)\}\, dF(s) \leq 0$$

this demand is acceptable to a responder who believes that the proposer who makes it has a type in the interval $[s_2, s_1]$. Set $q_1 = 1$ so that the lowest demand is surely accepted. Proposers whose types are in the interval $[s_2, s_1]$ will make demand π_1 and responders will accept this offer with probability 1.

Now for each $k > 1$, select q_k such that

(B.1)
$$q_k u_p(\pi_k, 1, s_k) + (1-q_k) u_p(\pi_k, 0, s_k) = q_{k-1} u_p(\pi_{k-1}, 1, s_k) + (1-q_{k-1}) u_p(\pi_{k-1}, 0, s_k)$$

That is, q_k is chosen such that a proposer of type s_k is indifferent between demanding π_k and π_{k-1}.

We need to show that (B.1) has a positive solution. Observe that the inequalities

$$\int_{s_k}^{s_{k-1}} \{u_r(\pi_{k-1}, 0, s) - u_r(\pi_{k-1}, 1, s)\} \, dF(s) \leq 0$$

and

$$\int_{s_{k+1}}^{s_k} \{u_r(\pi_k, 0, s) - u_r(\pi_k, 1, s)\} \, dF(s) \leq 0$$

imply that a responder who believes that the offer comes from a proposer of type s_k must want to accept π_{k-1} and reject π_k and every higher demand. Then by Assumption 4,

$$u_p(\pi_k, 1, s_k) > u_p(\pi_k, 0, s_k) = u_p(\pi_{k-1}, 0, s_k)$$

So from Assumption 1, (B.1) has a positive solution. Let proposers whose type is in the interval $[s_{k+1}, s_k]$ make the demand π_k, and suppose this is accepted with probability q_k.

From this construction, a proposer whose type is s_k is just indifferent between demanding π_k and π_{k-1}. By the single crossing Assumption 2, proposers whose types are below s_k strictly prefer the demand π_k to the demand π_{k-1}. On the other hand, if a proposer whose type exceeds s_k strictly prefers to make the demand π_k instead of π_{k-1}, then a proposer whose type is s_k must also by Assumption 2. Applying this argument at each value of k, it follows that the best equilibrium path offer for a proposer whose type is in the interval $(s_{k+1}, s_k]$ is the demand π_k.

To deal with off equilibrium offers, observe that the lowest offer π_1 that is made on the equilibrium path leads responders to believe that the proposer has a type in some interval $[s_2, \overline{s}]$ such that

$$\int_{s_2}^{\overline{s}} \{u_r(\pi_1, 0, s) - u_r(\pi_1, 1, s)\} \, dF(s) \leq 0$$

If this inequality is strict, then the offer is accepted with probability 1. In that case, suppose that lower offers are treated the same way - i.e., they lead to the same inference about the proposer's type, and are accepted with probability 1. Since proposer's payoff is strictly increasing as the size of an accepted demand increases, it will not pay any proposer to make a demand below π_1.

On the other hand, let p' be an off equilibrium demand that exceeds π_1. Suppose that π_k is the highest equilibrium path offer that is less than p'. By assumption, a responder who thinks that the proposer's type is s_{k+1} is willing to accept the offer π_k but wants to reject every higher equilibrium path offer. Let $[s', s'']$ be any interval such that

$$\int_{s'}^{s''} \{u_r(p', 0, s) - u_r(s', 1, s)\} \, dF(s) = 0$$

Now choose q' as above such that

$$q_k u_p(\pi_k, 1, s_{k+1}) + (1 - q_k) u_p(\pi_k, 0, s_{k+1}) = q' u_p(p', 1, s_{k+1}) + (1 - q') u_p(p', 0, s_{k+1})$$

Then as along the equilibrium path, if responders believe the proposer's type is in the interval $[s', s'']$ when p' is offered, and accept the demand with probability q', then proposers will all find higher payoffs with equilibrium path offers. $\square$

Proof of Theorem 7.

Theorem. *Under the Assumptions of Theorem 6, the ascending sequence of demands $\{\pi_1, \ldots, \pi_K\}$ can be supported as equilibrium offers in some Perfect Bayesian Nash Equilibrium in which every demand is accepted with positive probability only if Conditions 1 and 2 of Theorem 6 hold.*

Proof. Condition 1: Let π_K be the highest demand and suppose it is accepted with probability q_K. If $\pi_K < 1$, then the off equilibrium demand 1 must be accepted with probability at least q_K to prevent the proposer with type $\underline{s}$ (who prefers every demand to be rejected) from deviating. This requires that for every proposer type s in the set of proposer types $S(\pi_K)$ who make the offer π_K in equilibrium, $u_p(1, 0, s) > u_p(1, 1, s)$, else one of these proposer types would deviate.

Now from Condition 4, $u_r(\pi_K, 1, s) > u_r(\pi_K, 0, s)$ for every $s \in S(\pi_K)$ (if equality holds for some s then a responder who believed the proposer's type were s would reject any higher demand requiring a proposer of that type to want the demand 1 to be accepted). As a consequence, the proposal π_K, and also $p_n = 1$, must be accepted for sure. Since the payoff to acceptance is increasing as the demand rises, every type in $S(\pi_K)$ will want to deviate which is inconsistent with equilibrium.

Condition 2: Any array of K distinct offers made on the equilibrium path partitions the interval $[\underline{s}, \overline{s}]$ into K subsets through the inference that the responder makes from price. No two distinct demands which are accepted with positive probability can be accepted with the same probability in equilibrium, because proposers prefer higher demands. The single crossing condition can then be used as in the proof of Theorem 6 to show that all the subsets in the partition are intervals. The requirement that all demands are accepted with positive probability then gives Assumption 2. ☐

Proof of Theorem 8.

Theorem. *Suppose that $u_p(p,1,s) = p\phi(s)$ for some strictly positive function ϕ and that there is some proposer type $s < \overline{s}$ such that $u(0,0,s) < 0$. Then the function $q_k p_k$ is decreasing when $u_p(p,0,s)$ is positive and increasing otherwise.*

Proof. From (B.1) in the proof of Theorem 6

$$q_{k+1}p_{k+1}\phi(s_{k+1}) + (1-q_{k+1})u_p(p_{k+1},0,s_{k+1}) =$$
$$= q_k p_k \phi(s_{k+1}) + (1-q_k)u_p(p_k,0,s_{k+1})$$

Re-arranging and using Assumption 1 gives

$$\{q_{k+1}p_{k+1} - q_k p_k\}\,\phi(s_{k+1}) = (q_{k+1}-q_k)u_p(p_k,0,s_{k+1})$$

By Theorem 6, $q_{k+1} \leq q_k$. The sign of $q_{k+1}p_{k+1} - q_k p_k$ is then determined by the sign of $u(p_k,0,s_{k+1})$. ☐

Appendix C. The Maximally Dispersed Equilibrium

In spite of the partial pooling present in every equilibrium, the discussion in this Appendix focuses on one particular equilibrium which is the most informative. The *Maximally Dispersed Equilibrium* is constructed by generating a particular sequence of demands, and the intervals associated with them. Begin by setting $\pi_m = p_n = 1$. Select an interval $[\underline{s}, s_m)$ with $s_m < \overline{s}$ such that

$$\int_{\underline{s}}^{s_m} \{u_r(\pi_m,0,s) - u_r(\pi_m,1,s)\}\,dF(s) = 0$$

if such an s_m exists. If the expression above is non-positive for all s_m, then the equilibrium is complete and all proposer types demand $p_n = 1$ (the whole pie) in the Maximally Dispersed Equilibrium.

Otherwise, assume a sequence $\{(\pi_m,s_m),(\pi_{m-1},s_{m-1}),\ldots,(\pi_{k+1},s_{k+1})\}$ has been constructed for $m, m-1, \ldots, k+1$, with $\pi_{k+1} > 0$ and $s_{k+1} < \overline{s}$. Let π_k be defined to be

(C.1) $$\pi_k := \max\{P \ni p < \pi_{k+1} : u_r(p,0,s_{k+1}) - u_r(p,1,s_{k+1}) < 0\}$$

This price exists because by Assumption 3, there is some offer that is acceptable to the responder no matter what her beliefs. Now select s_k such that

$$\int_{s_{k+1}}^{s_k} \{u_r(\pi_{k+1},0,s) - u_r(\pi_{k+1},1,s)\}\,dF(s) = 0$$

if such an s_k exists. Otherwise set $s_k = \bar{s}$ and stop the construction.

Repeat this procedure until $s_k = \bar{s}$. Then re-index the demands and cutoffs such that m is the number of demands in the sequence.

The demands and cutoffs satisfy the Conditions of Theorem 6 by construction. The construction itself illustrates that such a sequence always exists. If responders want to reject the highest demand given their prior beliefs, then this sequence has at least two demands. At each step in the construction, the next highest demand is always chosen to be the highest demand that is consistent with conditions (1) and (2).

Figure C.1 illustrates how these demands are constructed.

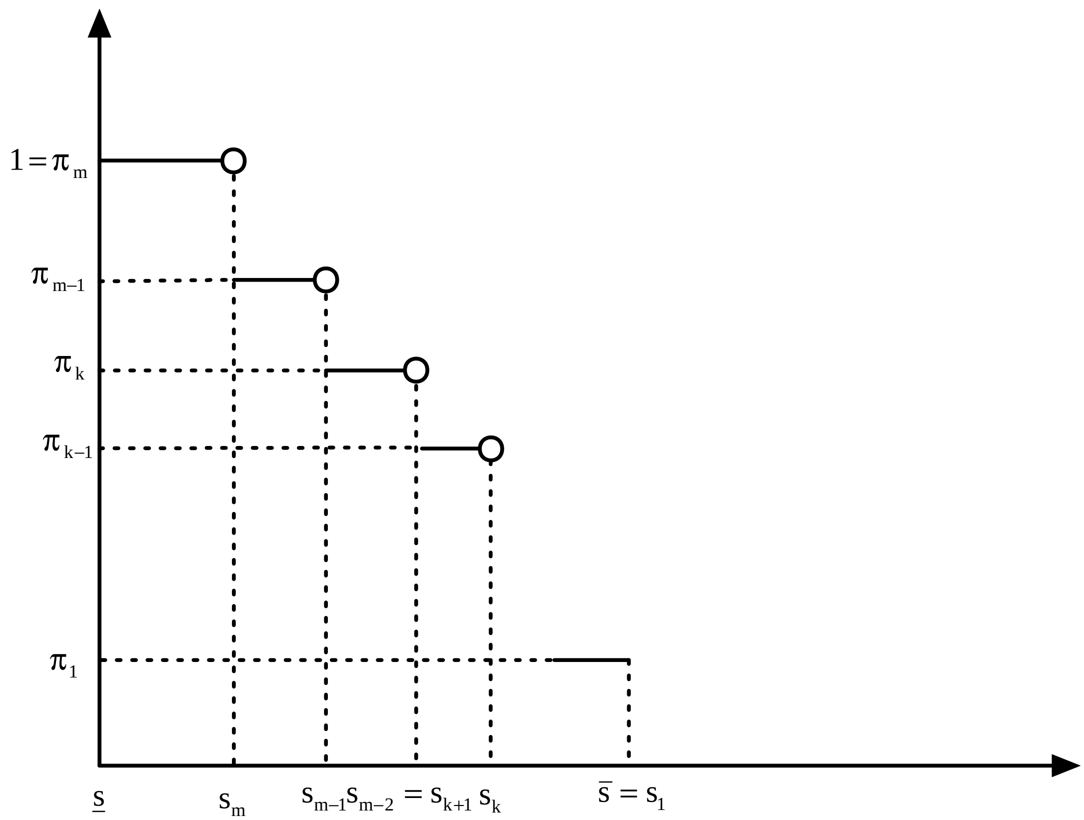

Figure C.1. Construction of Demands in Equilibrium

To make any more progress characterizing the equilibrium, we need to put a little more structure on the feasible offers. Specifically

Assumption 12. *For any feasible offer p_k, let $\theta(p_k)$ be the type for the proposer such that*

$$u_r(p_k, 1, \theta(p_k)) = u_r(p_k, 0, \theta(p_k))$$

Then

$$\int_{\theta(p_{k+2})}^{\theta(p_k)} \{u_r(p_{k+1}, 1, s) - u_r(p_{k+1}, 0, s)\} \, dF(s) \le 0$$

If the function $\theta(p)$ is monotonically decreasing, then it will always be possible to construct a grid that satisfies this assumption. Let $[\underline{s}, s_m]$ be the interval described in the construction of the Maximally Dispersed equilibrium such that

$$\int_{\underline{s}}^{s_m} \{u_r(1, 0, s) - u_r(1, 1, s)\} \, dF(s) = 0$$

Now choose any price p_{m-1} such that

$$u_r(p_{m-1}, 0, s_m) - u_r(p_{m-1}, 1, s_m) < 0$$

This price is the first important element in the grid, since offers between p_{m-1} and 1 will be strictly dominated in equilibrium.

Now

$$\int_{s_m}^{\theta(p_{m-1})} \{u_r(p_{m-1}, 0, s) - u_r(p_{m-1}, 1, s)\} \, dF(s) > 0$$

So pick $s' > \theta(p_{m-1})$ such that

$$\int_{s_m}^{s'} \{u_r(p_{m-1}, 0, s) - u_r(p_{m-1}, 1, s)\} \, dF(s) = 0$$

and select any price $p_{m-1} < p : \theta(p) = s'$ as the next point in the grid of feasible demands. Repeating this procedure for lower demand generates a set of feasible demands satisfying Assumption 12. So this Assumption imposes a restriction on the set of feasible demands, not on the preferences or beliefs of the players.

Theorem 13. *If the grid of feasible demands satisfies Assumption 12, and the Assumptions of Theorem 6 hold, then the Maximally Dispersed Equilibrium supports the demand 1 and every feasible demand in the interval $(\underline{p}, \overline{p})$ being made with positive probability on the equilibrium path.*

Proof. The proof simply involves showing that the sequential construction of demands in the definition of the Maximally Dispersed Equilibrium must cover every price in the interval. First note that if the demand 1 is acceptable to the proposer given his prior beliefs, then $\overline{p}$ and $\underline{p}$ coincide. Then the theorem follows trivially since there aren't any feasible demands in the interval $(\underline{p}, \overline{p})$.

Now consider the second highest demand π_{m-1}. This is the highest feasible demand that is strictly acceptable to a responder who believes the proposer's type is s_m. Since $\overline{p}$ is defined such that a responder who believes the proposer's type is s_m is just indifferent between accepting and rejecting, a responder with the same belief will strictly accept the highest demand in the grid that is less than $\overline{p}$.

So let π_k be a feasible demand, and suppose that for each of the feasible demands above π_k there is an interval of types satisfying (2). In particular, there is some type s_{k+1} such that proposer types above s_{k+1} are assigned to demands above π_k, and if π_{k+1} is the next highest feasible demand, then

$$u_r(\pi_{k+1}, 1, s_{k+1}) < u_r(\pi_{k+1}, 0, s_{k+1})$$

Then by Assumption 12

$$\int_{s_{k+1}}^{\theta(\pi_{k-1})} \{u_r(\pi_k, 1, s) - u_r(\pi_k, 0, s_k)\} \, dF(s) < 0$$

Hence $s_k > \theta(\pi_{k-1})$, so that

$$u_r(\pi_{k-1}, 1, s_k) > u_r(\pi_{k-1}, 0, s_k)$$

This means that π_{k-1} is the next demand used in construction of the Maximally Dispersed equilibrium.

Since this construction continues until s_k hits the boundary $\underline{s}$, every feasible demand above $\underline{p}$ will appear in this construction. □

References

[1] Andreoni, James, Marco Castillo and Ragan Petrie (2003): "What Do Bargainers' Preferences Look Like? Experiments with Convex Ultimatum Game," *American Economic Review*, 93 (3), 672-685.

[2] Andreoni, James and Douglas B. Bernheim (2009): "Social Image and the 50-50 Norm: A Theoretical and Experimental Analysis of Audience Effects," *Econometrica*, forthcoming.

[3] Aumann, Robert J. (1986): "Rationality and Bounded Rationality," *The 1986 Nancy L. Schwartz Memorial Lecture*.

[4] Bardsley, Nicholas (2008): "Dictator Game Giving: Altruism or Artifact?" *Experimental Economics,* 11, 122-133..

[5] Battigalli, Pierpaolo and Martin Dufwenberg (2008): "Dynamic Psychological Games," *Journal of Economic Theory* (forthcoming).

[6] Bellemare, Charles, Sabine Kröger and Arthur van Soest (2008): "Measuring Inequity Aversion in a Heterogeneous Population Using Experimental Decisions and Subjective Probabilities," *Econometrica*, 76 (4), 815-839.

[7] Binmore, Ken, John McCarthy, Giovanni Ponti, Larry Samuelson (2002): "A Backward Induction Experiment," *Journal of Economic Theory*, 104, 48-88.

[8] Binmore, Ken and Larry Samuelson (1999): "Evolutionary Drift and Equilibrium Selection," *Review of Economic Studies*, 66, 363-393.

[9] Binmore, Ken and Larry Samuelson (2006): "The Evolution of Focal Points," *Games and Economic Behavior*, 55, 21-42.

[10] Blount, Sally (1995): "When Social Outcomes Aren't Fair: The Effect of Causal Attributions on Preferences," *Organizational Behavior and Human Decision Making*, 63 (2), 131-144.

[11] Bolton, Gary E. and Axel Ockenfels (2000): "ERC: A Theory of Equity Reciprocity and Competition," *American Economic Review*, 90, 166-193.

[12] Bolton, Gary E. and Rami Zwick (1995): "Anonymity versus Punishment in Ultimatum Bargaining," *Games and Economic Behavior*, 10, 95-121.

[13] Camerer, Colin F. (2003): *Behavioral Game Theory: Experiments in Strategic Interaction.* Russel Sage Foundation NY (NY) and Princeton University Press Princeton (NJ).

[14] Cherry. Todd L., Peter Frykblom and Jason Shogren (2002): "Hardnose the Dictator" *American Economic Review*, 92 (4), 1218-1221.

[15] Cox, James C. Daniel Friedman and Vjollca Sadiraj (2008): "Revealed Altruism," *Econometrica*, 76 (1), 31-69.

[16] Dana, Jason, Roberto E. Weber and Jason Xi Kuang (2007): "Exploiting Moral Wiggle Room: Experiments Demonstrating an Illusory Preference for Fairness," *Economic Theory*, 33, 67-80.

[17] Falk, Armin, Ernst Fehr and Urs Fischbacher (2008): "Testing Theories of Fairness - Intentions Matter," *Games and Economic Behavior*, 62, 287-303.

[18] Falk, Armin, Ernst Fehr and Urs Fischbacher (2003): "On the Nature of Fair Division," *Economic Inquiry*, 41 (1), 20-26.

[19] Falk, Armin, Ernst Fehr and Christian Zehnder (2006): "Fairness Perceptions and Reservation Wages - The Behavioral Effects of Minimum Wage Laws," *Quarterly Journal of Economics*, 121 (4), 1347-1381.

[20] Falk, Armin and Michael Kosfeld (2006): "The Hidden Costs of Control," *American Economic Review*, 96 (5), 1611-1630.

[21] Fehr, Ernst and Klaus M. Schmidt (1999): "A Theory of Fairness, Competition and Cooperation,"*Quarterly Journal of Economics*, 114, 817-868.

[22] Fershtman, Haim, Uri Gneezy and John List (2008): "Equity Aversion," CEPR Discussion Paper #6853.

[23] Frank, Robert H. (1988): *Passion Within Reason,* New York, NY: W. W Norton.

[24] Gale, John, Kenneth G. Binmore and Larry Samuelson (1995): "Learning to Be Imperfect: The Ultimatum Game," *Games and Economic Behavior*, 8, 56-90.

[25] Geanakoplos, John, David Pearce and Ennio Stacchetti (1989): "Psychological Games and Sequential Rationality," *Games and Economic Behavior*, 1, 60-79.

[26] Gul, Faruk and Wolfgang Pesendorfer (2007): "The Canonical Space for Behavioral Types," mimeo.

[27] Güth, Werner, R. Schmittberger and B. Schwarz (1982): "An Experimental Analysis of Ultimatum Bargaining," *Journal of Economic Behavior and Organization*, 3, 367-388.

[28] Hamman, John, George Loewenstein and Roberto Weber (2008): "Self-Interest through Agency: An Alternative Rationale for the Principal-Agent Relationship," mimeo.

[29] Harrison, Glenn W. and Kevin McCabe (1996): "Expectations and Fairness in a Simple Bargaining Experiment," *International Journal of Game Theory*, 25, 303-327.

[30] Hoffman, Elizabeth, Kevin McCabe, Keith Shachat and Vernon Smith (1994): "Preferences, Property Rights, and Anonymity in Bargaining Games," *Games and Economic Behavior*, 7, 346-380.

[31] Hoffman, Elizabeth, Kevin McCabe and Vernon Smith (1996): "Social Distance and Other-Regarding Behavior in Dictator Games," *American Economic Review*, 86 (3), 653-660.

[32] Isaac, Mark R. and Charles R. Plott (1981): "Price Controls and the Behavior of Auction Markets: An Experimental Examination," *American Economic Review*, 71 (3) 448-459.

[33] Kahneman, Daniel and Amos Tversky (1973): "On the Psychology of Prediction," *Psychological Review*, 40 (4), 237-251.

[34] Knittel, Christopher R. and Victor Stango (2003): "Price Ceilings as Focal Points for Tacit Collusion: Evidence from Credit Cards," *American Economic Review*, 93 (5), 1703-1729.

[35] Lazear, Edward P., Ulrike Malmendier and Roberto A. Weber (2006): "Sorting in Experiments with Application to Social Preferences," mimeo.

[36] Levine, David K. (1998): "Modeling Altruism and Spitefulness in Experiments," *Review of Economic Dynamics*, 1, 593-622.

[37] List, John A. (2007): "On the Interpretation of Giving in Dictator Games," *Journal of Political Economy*, 115 (3), 482-493.

[38] List, John A. and Todd L. Cherry (2000): "Learning to Accept in Ultimatum Games: Evidence from an Experimental Design that Generates Low Offers," *Experimental Economics*, 3, 11-29.

[39] McCabe, Kevin A., Mary L. Rigdon and Vernon Smith (2003): "Positive Reciprocity and Intentions in Trust Games," *Journal of Economic Behavior & Organization*, 52, 267-275.

[40] Rabin, Matthew (1993): "Incorporating Fairness into game theory and economics," *American Economic Review*, 83 (5), 1281-1302.

[41] Rabbi Moshe ben Maimon, Maimonides (1170): *Mishneh Torah*, Zera'im (Seeds), Matanot Aniyim (gifts to the poor), 10, 8-15.

[42] Roth, Alvin E. and Ido Erev (1995): "Learning in Extensive-Form Games: Experimental Data and Simple Dynamic Models in the Intermediate Term," *Games and Economic Behavior*, 8, 164-212.

[43] Roth, Alvin E., Vesna Prasnikar, Masahiro Okuno-Fujiwara and Shmuel Zamir (1991): "Bargaining and Market Behavior in Jerusalem, Ljubljana, Pittsburgh and Tokyo: An Experimental Study," *American Economic Review*, 81 (5), 1068-1095.

[44] Rotemberg, Julio J. (2008): "Minimally acceptable altruism and the ultimatum game," *Journal of Economic Behavior and Organization*, 66, 457-476.

[45] Savin, N. E. (1980): "The Bonferroni and the Scheffé Multiple Comparison Procedures," *The Review of Economic Studies*, 47 (1), 255-273.

[46] Savin, N. E. (1984): "Multiple Hypothesis Testing," in: Handbook of Econometrics, Ed: Zvi Griliches and Michael D. Intriligator, Volume II, 827-879. Amsterdam: Elsevier Science Publishers

[47] Slonim, Robert and Alvin E. Roth (1998): "Learning in High Stakes Ultimatum Games: An Experiment in the Slovak Republic," *Econometrica*, 66 (3), 569-596.

[48] Slovic, Paul and Sarah Lichtenstein (1971): "Comparison of Bayesian and Regression Approaches to the Study of Information Processing in Judgment," *Organizational Behavior and Human Performance*, 6, 649-744.

[49] Smith, Vernon L. and Arlington W. Williams (1981): "On Nonbinding Price Controls in a Competitive Market," *American Economic Review*, 71 (3), 467-474.

[50] Tversky, Amos and Daniel Kahneman (1974): "Judgment under Uncertainty: Heuristics and Biases," *Science*, 185, 1124-1131.

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