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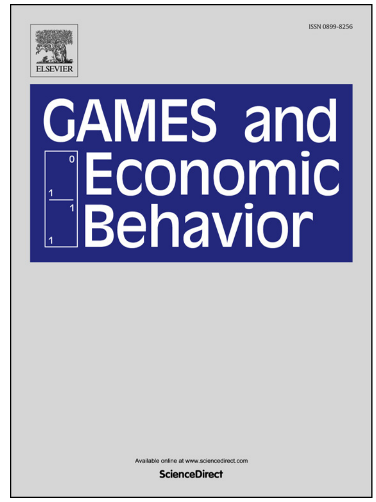

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Fairness and Risk in Ultimatum Bargaining

By KYLE HYNDMAN AND MATTHEW J. WALKER*

Abstract: We conduct an ultimatum bargaining experiment but, rather than bargaining over money, subjects bargain over lottery tickets for a mutually exclusive prize. We find that proposers offer a significantly lower percentage of lottery tickets to responders than the equivalent offer when bargaining over money. In contrast, responders have a significantly higher acceptance threshold, which is consistent with responders being risk averse and possessing ex-post fairness concerns. This difference can be rationalized if proposers have incomplete information or incorrect beliefs about responders' preferences. We provide evidence supportive of proposers holding incorrect beliefs. Specifically, we observe an incongruence between how sensitive proposers expect responders to be to regret, and how sensitive responders are. By varying the timing of responders' decision, we show that intentions matter and present evidence of an anomaly in responders' preferences. Specifically, when responders decide after the resolution of uncertainty, they are more willing to accept extreme inequality.

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1. Introduction

We are concerned with how risk affects behavior in an ultimatum bargaining environment. Prior theoretical work on fairness preferences (Krawczyk, 2011; Andreozzi et al., 2013; Saito, 2015; Chassang and Zehnder, 2016) considers two approaches to the evaluation of outcomes when there is uncertainty about the final distribution of payoffs: *ex-ante fairness* and *ex-post fairness*. That is, given a known lottery over outcomes, agents either evaluate the fairness of *ex-ante* expected payoffs, or they evaluate the fairness of *ex-post* outcomes by expected utility maximization. Distributional models of social preferences (e.g., Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000; Andreoni and Miller, 2002; Charness and Rabin, 2002) implicitly assume expected utility maximization when extended to lotteries over outcomes. If these models are to preserve *ex-ante* fairness concerns, then they violate the independence axiom (Fudenberg and Levine, 2012).

Empirical evidence suggests that both types of fairness concerns affect behavior. Several papers demonstrate the importance of *ex-ante* (or procedural) fairness in decision-making (e.g., Kircher et al., 2009; Cappelen et al., 2013; Bartling et al., 2014; López-Vargas, 2015). Trautmann and van de Kuilen (2016) provide evidence from a risky choice task that *ex-post* (or distributive) fairness cannot be dismissed. Krawczyk and Le Lec (2010) and Brock et al. (2013) observe that a mix of procedural and distributive concerns best explain data from probabilistic dictator games.[1] These studies focus on the effects of uncertainty on generosity. What constitutes a fair and equitable allocation of risk, however, is also pertinent to many strategic settings. Bolton et al. (2005) compare rejection rates between the implementation of fair procedures versus fair allocations in an ultimatum game. They observe that deviation from a fair procedure is considered to be just as unacceptable during bargaining as deviation from a fair outcome, and that an unbiased randomization that allocates each negotiating party the same risk is more acceptable than a biased randomization that shares risk unequally. The random procedures implemented by Bolton et al. are pre-determined and their bias or lack thereof is not attributable to actions.

In this study, we experimentally investigate how fairness ideas impact bargaining when there is risk – and the allocation of risk is endogenous – as well as how the timing of the resolution of

[1] A related strand of literature considers the relationship between relative social position and risk preferences (e.g., Vendrik and Woltjer, 2007; Hill and Buss, 2010; Rohde and Rohde, 2011; Lahno and Serra-Garcia, 2015; Linde and Sonnemans, 2012; Friedl et al., 2014). Freundt and Lange (2014) provide experimental evidence from a dictator game that giving declines when recipients are believed to be non-risk-averse. Celse et al. (2021) find that competitive preferences over outcomes and actions best explain investment decisions in a risk elicitation task.

uncertainty influences behavior.[2] The advantage of the lab for implementing random procedures is that the risks can be precisely manipulated and clearly communicated to subjects. We used a within-subjects design, which enables us to observe how fairness preferences differ between a standard ultimatum game and a risky ultimatum game in which bargaining is over the distribution of lottery tickets for a mutually exclusive prize. We also varied between-subjects whether the uncertainty was resolved before or after the responder made his/her acceptance decision.

The ultimatum game has served as a natural environment for studying fairness considerations in the experimental literature. The risky variant can be thought of as a stylized representation of the uncertainties inherent in real-world bargaining settings. Many negotiations involve uncertainties that have yet to be resolved at the contracting stage, and the allocation of risk is often at the heart of these negotiations. Examples include risk-sharing in contingent contracts (Bazerman and Gillespie, 1999), cost overruns in procurement (Bajari et al., 2014), demand uncertainty in labor negotiations (Riedl and van Winden, 2012), wholesale price contracts in supplier-retailer relationships in which inventory risk is allocated exclusively to one party, or more complicated supply-chain contracts in which the risk is shared between the parties (Cachon, 2004).

We find clear evidence of a mismatch between proposers' beliefs (as inferred from their offers) and responders' fairness preferences. Compared to the standard ultimatum game, responders have a significantly higher acceptance threshold, which is consistent only with a preference for *ex-post* fairness. We construct numerical examples to demonstrate that this comparative static does not depend on the responders' level of risk aversion under reasonable assumptions. Proposers, however, offer a significantly lower percentage of lottery tickets, which leads to a greater likelihood of disagreement. Since lower thresholds can be rationalized by both *ex-post* and *ex-ante* fairness preferences, but only under the assumption of risk-loving preferences or anticipated regret, this suggests that proposers form incorrect beliefs about responders' propensity to take a chance to come out ahead in the risky ultimatum game.[3]

[2] An early experimental bargaining study involving uncertainty is Shogren (1992). He found no substantive difference in bargaining behavior over *ex-ante* lotteries for a fixed reward versus *ex-post* rewards given a fixed probabilistic schedule, and strong evidence to support normative appeal of the equal split. There are several design aspects of Shogren's study that make his findings difficult to compare with ours. First, bargaining is face-to-face rather than anonymous. Second, one party has an advantageous (if inefficient) outside option. Third, the size of the pie is endogenously determined by the negotiation process.

[3] As we show, this "mismatch" may also be driven by incomplete information about responders' fairness preferences rather than proposers holding a mistaken belief about a "known" fairness preference. However, both explanations have the same root cause: that proposers do not know for certain the responders' true underlying preferences.

We provide evidence from a follow-up experiment to suggest that the apparent mismatch in proposers' beliefs and responders' preferences may be driven by an incongruence between how sensitive proposers expect responders to be to anticipated regret and how sensitive responders actually are. Specifically, we conducted a variant on the risky ultimatum game in which we revealed the outcome of the lottery to the responder even if the responder had rejected the proposer's offer. This design increased the salience of regret for responders. Whereas proposers do not significantly adjust their offers under this variant, we no longer observe a significant difference in responders' acceptance behaviors between the standard and risky ultimatum games. That is, when responders know that they will find out the financial outcome of the lottery not taken, they demand less than they otherwise would. This finding is consistent with prior theoretical and experimental work on the role of anticipated regret in decision-making under uncertainty (e.g., Bell, 1982; Loomes and Sugden, 1982; Filiz-Ozbay and Ozbay, 2007). The differential effect of lottery feedback by role suggests that proposers may over-estimate the sensitivity of responders to regret considerations; whereas proposers offer proportionally less in the risky ultimatum game regardless of the feedback protocol, responders are sensitive to the salience of regret and state a lower minimum acceptance threshold when regret is salient than when it is not salient. Even when regret is salient, the average minimum acceptance threshold remains at least as high as the average threshold when bargaining over money.

Individuals are heterogeneous in the importance attached to different fairness motives. For between 40 and 60% of responders, behavior is best explained by *ex-post* fairness. This lends support to the plurality of fairness views found in related experiments involving uncertainty among stakeholders (Cappelen et al., 2007; Brock et al., 2013) and impartial spectators (Cettolin and Riedl, 2017). Unlike these studies, uncertainty is not exogenous in our design.[4] Instead, in the risky ultimatum game, proposers determine their own chance of winning conditional on their beliefs about fairness.

Several previous experimental studies of the standard ultimatum game observe that responders are more willing to accept inequality if the proposer's actions are perceived to be kind (Blount, 1995; Charness and Rabin, 2002; Offerman, 2002; Falk et al., 2003; Charness, 2004; Falk et al., 2008). We find some evidence that intentions matter for responder behavior after the resolution of

[4] See Cappelen et al. (2013) and Cettolin and Tausch (2015) for examples of studies in which risk exposure is a choice and its implications for *ex-post* income redistribution.

uncertainty, i.e., holding the outcome constant, the choice of a less biased randomization is viewed by responders as more acceptable. The strength of this evidence depends on whether the direct response or strategy method was used to implement responder acceptance decisions. These findings complement the observation of Bolton et al. (2005) that holding attribution constant, an unbiased randomization is viewed as more acceptable than a biased one.

Our study also contributes to recent literature assessing the dynamic inconsistency of fairness preferences (Trautmann and Wakker, 2010; Andreoni et al., 2016; Trautmann and van de Kuilen, 2016). We uncover evidence of a choice anomaly in responders' acceptance decisions. Specifically, responders are more likely to accept a zero-payoff allocation after the resolution of uncertainty in the risky ultimatum game than they are to accept a zero-payoff allocation in the standard ultimatum game or a lottery ticket allocation that guarantees a zero payoff in the risky ultimatum game. This anomaly is observed both between- and within-subjects and implies that uncertainty creates a "veneer of absolved responsibility" such that people are more willing to accept inequality than they might otherwise let on. Andreoni and Bernheim (2009) observe that individuals like to be perceived as fair, demonstrated by a lowering of dictator game offers when their source is obscured by nature. Bartling and Fischbacher (2012) find that subjects can at least partially absolve themselves of responsibility by delegating allocation decisions to a random device. Our results suggest that, in an ultimatum bargaining environment with uncertainty, responders perceive less need to demonstrate their aversion to inequality *ex-post* or view *ex-post* rejection as a weaker signal of their fairness preferences.

2. Theory: *Ex-post* versus *Ex-ante* Fairness

We consider a simple setting in which two agents, denoted the Proposer (P) and the Responder (R), engage in ultimatum bargaining. To fix ideas, consider a bilateral trading relationship where P seeks to buy an item from R and where the surplus generated from a trade is $S > 0$. We assume that there are two possible trade outcomes and that the agents differ in which outcome they prefer. Let $s_k \in [0, S]$, $k \in \{P, R\}$, be the trade surplus realized by Agent P in outcome k, and so Agent R realizes surplus equal to $(S - s_k)$. Without loss of generality, we assume that $s_P > s_R$. That is, Agent P prefers outcome P, while Agent R prefers outcome R. For concreteness, we assume that they bargain over the probability that each agent is chosen to implement his/her preferred outcome.

The timing of the game is as follows:

1. Agent P allocates the chances to implement the preferred outcome by choosing $z \in [0,1]$; the probability with which Agent P can implement her own preferred outcome is $(1-z)$ and the probability with which Agent R can implement his own preferred outcome is z.
2. Agent R observes his chance of implementing the preferred outcome and can accept or reject.
3. The uncertainty is resolved and payoffs (x, y) – x for Agent P, y for Agent R – are realized. If Agent R accepted and Agent P can implement her own preferred outcome, then the payoffs are $(s_P, S - s_P)$. If Agent R accepted and can implement his own preferred outcome, then the payoffs are $(s_R, S - s_R)$. If Agent R rejected, no trade occurs, and the payoffs are $(0,0)$.

Standard game-theoretic arguments predict that Agent R accepts any chances to implement his own preferred outcome in Stage 2; thus, in Stage 1, Agent P retains the full chance to implement her own preferred outcome.

Consider instead a model of Fehr and Schmidt (1999) aversion to inequitable payoffs from the perspective of Agent P (the perspective of R is symmetric).[5] The utility function is as follows,

$$\tilde{u}(x, y) = x - \alpha \cdot \max[0, y - x] - \beta \cdot \max[0, x - y], \qquad (1)$$

where α measures aversion to disadvantageous inequality (envy) and β measures aversion to advantageous inequality (guilt).[6] We make the usual assumptions that $\alpha \geq \beta \geq 0$ and $\beta \leq 1$. For now, we assume that the fairness parameters of the utility function are common knowledge, i.e., complete information about types. We return to consider the possibility of incomplete information about the responder's type after presenting the main comparative static predictions.

Müller and Rau (2019) provide theoretical and experimental evidence that, in a social context, inequality averse subjects prefer to take more (less) risky decisions when they find themselves behind (ahead of) a peer. This effect stems from the interaction between subjects' sensitivity to social comparison and the marginal utility of an additional dollar. Their prediction does not directly carry over to our setting in which the interaction is strategic and the reference allocation is equal. Nevertheless, we can adopt their framework to incorporate non-linear utilities. To do so, we add

[5] Since there is a bilateral reference group for payoff comparisons, the predictions are unchanged by using the alternative outcome-based model of Bolton and Ockenfels (2000).

[6] We acknowledge that in our setting, inequity aversion might be interpreted as a notion of social loss aversion. Disentangling the nuances behind these alternative interpretations is beyond the scope of this paper.

the constant relative risk aversion (CRRA) utility function $v(x)$ to the Fehr and Schmidt (1999) model of inequality aversion in (1) to obtain:

$$u(x, y) = v(x) + x - \alpha \cdot \max[0, y - x] - \beta \cdot \max[0, x - y], \text{ where} \quad (2)$$

$$v(x) = x^r.$$

The own risk tolerance parameter is given by r. We restrict attention to $r > 0$; $r = 1$ describes a risk-neutral individual; $r < 1$ represents risk aversion; and $r > 1$ represents risk-loving preferences. Note also that while we insert a CRRA utility component in (2), the overall risk preferences do not display constant relative risk aversion, unless $\beta = 1$ and we are in the advantageous inequality domain. Otherwise, risk aversion displays both decreasing absolute and relative risk aversion (holding constant the domain of inequality).[7] Setting $u(x, x) = v(x) + x$, rather than $u(x, x) = v(x)$, ensures positive marginal returns to own payoff for all $\beta \in [0, 1]$.[8] This formulation is more satisfactory because it avoids the unlikely scenario in which a risk-averse agent can implement the preferred outcome but incurs negative utility due to the fairness penalty. The utility function in (2) satisfies the assumption that an equality-preserving increase in joint payoffs only influences utility through the own payoff component (see Müller and Rau, p. 78).

When outcomes are uncertain, we are concerned not only with the final payoffs x and y, but also preferences over joint payoff distributions implied by the lottery $F(x, y)$. Two approaches are suggested in the literature (e.g., Brock et al., 2013). Either agents evaluate fairness of *ex-post* outcomes by expected utility maximization:

$$w^{EP}(F) = \int u(x, y) dF(x, y), \quad (3)$$

or they evaluate the fairness of expected outcomes *ex-ante*:

$$w^{EA}(F) = u(E[x], E[y]). \quad (4)$$

The approaches are not mutually exclusive: a convex combination of the two might best represent preferences (Fudenberg and Levine, 2012).

[7] As inequality shifts from disadvantageous to advantageous, there is a discontinuous increase in absolute and relative risk aversion.

[8] That is, $\frac{\partial u(x,y)}{\partial x} = rx^{r-1} + 1 - \beta > 0$ for $x > y \geq 0$ in the domain of advantageous inequality.

For simplicity of exposition, we fix the payoffs at $s_P = S$ and $s_R = 0$. This case makes the trade-offs most salient: if Agent P can implement her own preferred outcome, then she obtains all the surplus from trade; if Agent R can implement his own preferred outcome, then he obtains all the surplus from trade. Thus, it is as if there is a single, indivisible prize that each agent wins if he or she can implement the preferred outcome. We will test this case in our experiment.

2.1. *Ex-post* fairness

We begin by considering the evaluation of outcomes under *ex-post* fairness. From (3), R's utility from accepting is

$$(1 - z) \cdot u_R(S, 0) + z \cdot u_R(0, S).$$

Thus, R will accept if and only if

$$z \geq \frac{\alpha_R}{(1 + \alpha_R - \beta_R + S^{r-1})}.$$

This threshold is strictly increasing in R's degree of risk aversion.

Now suppose that P proposes an allocation z^*, which will be accepted. Her expected utility will be non-negative so long as

$$z \geq 1 - \frac{\alpha_P}{(1 + \alpha_P - \beta_P + S^{r-1})}.$$

A less risk averse P will tolerate a higher threshold probability of the unfavorable outcome.

Thus, there will be a subgame perfect equilibrium in which P proposes $z^*$and R accepts if and only if

$$z_{ep}^* = \frac{\alpha_R}{(1 + \alpha_R - \beta_R + S^{r-1})} \leq 1 - \frac{\alpha_P}{(1 + \alpha_P - \beta_P + S^{r-1})}. \tag{5}$$

The more R cares about inequality aversion, the less must P care about it for there to be an equilibrium which ends in agreement. Note that this applies to both unfavorable and favorable inequality aversion because there are positive marginal returns to own payoff for all levels of β. That is, if R suffers guilt, she will require a greater probability of winning to compensate.

2.2. *Ex-ante* fairness

When considering the evaluation of outcomes under *ex-ante* fairness, agents care only about expected payoff inequality. The question is whether it is possible to care about expected inequality, while still evaluating one's own monetary payoffs based on expected utility, or whether we take (4) literally, in which case agents evaluate the own-payoff component of the utility function based on expected values.[9] Both possibilities are plausible and so we consider the implications of both for acceptance behaviors. Since a proposed allocation of $z = 1/2$ would ensure payoff equality in expectation, a rational P would never propose more than this to R in equilibrium and so we can restrict attention to $z < 1/2$. In this situation, expected inequality is disadvantageous from the perspective of R.

Case (i). Agents evaluate own payoff by expected values. In this case, we can think of expected payoffs as directly substituting for certain payoffs in the utility function. This is a common axiomatization in the literature (e.g., the expected inequality-averse model of Saito, 2013), but does not satisfactorily account for risk; the resulting acceptance thresholds coincide exactly with those for the standard ultimatum game with certain payoffs and non-linear utility.[10] There is no closed-form solution for a general utility parameter r. In the next sub-section, we will compute this threshold numerically for several representative values of r. For now, we note that if $r = 1$, then there will be a subgame perfect equilibrium in which P proposes z^* as follows,

$$z^*_{ea.ev} = \frac{\alpha_R}{2(1+\alpha_R)}. \quad (6)$$

Case (ii). Agents evaluate own payoff by expected utility. In this case, R will accept the proposal if and only if:

$$u_R = z \cdot S^r + z \cdot S - \alpha_R \cdot S(1-2z) \geq 0. \quad (7)$$

R's minimum acceptance threshold is

[9] Consider the following thought experiment: With probability ½, Agent P wins \$1 and Agent R loses \$1, and with probability ½, the reverse happens. In this case, expected inequality is 0 and so Agent P (or R) could reasonably view the gamble as not creating inequality, while at the same time each agent may strictly prefer not to take the gamble on purely risk grounds. However, a literal interpretation of (4) would say that each agent must be indifferent between accepting and rejecting the gamble.

[10] To see this, assume that there is a fixed amount, S, to divide and P offers x to R and $S - x$ for him/herself. If we let $x = zS$ and compute the utility from accepting, then we arrive at $u_R = (z \cdot S)^r + z \cdot S - \alpha_R \cdot S(1-2z)$.

$$z \geq \frac{\alpha_R}{(1 + 2\alpha_R + S^{r-1})}.$$

P's utility in this case is

$$u_P = (1 - z) \cdot S^r + (1 - z) \cdot S - \beta_P \cdot S(1 - 2z) \geq 0. \quad (8)$$

Which is positive even if $z = 0$ and $\beta_P = 1$. Rewriting (8), we obtain

$$S^r - z \cdot S^r + S(1 - \beta_P - z + 2\beta_P z).$$

The term in parentheses will be non-negative for any $z \geq 1/2$. Thus, there will be a subgame perfect equilibrium in which P proposes z^* as follows,

$$z^*_{ea.eu} = \frac{\alpha_R}{(1 + 2\alpha_R + S^{r-1})}. \quad (9)$$

The equilibrium proposal in (9) is equivalent to the equilibrium proposal from *case (i)* under the assumption of risk-neutrality (cf., (6)), but this is not generally the case (more details below).

2.3. Comparison

First consider the situation in which both decision-makers are risk neutral.

Under *ex-ante* fairness, R's minimum acceptance threshold is $z^*_{ea} = \alpha_R/2(1 + \alpha_R)$, which coincides exactly with the acceptance threshold in the standard ultimatum game.

Under *ex-post* fairness, R's minimum acceptance threshold is $z^*_{ep} = \alpha_R/(2 + \alpha_R - \beta_R) \geq z^*_{ea}$ (with strict inequality for $\alpha_R > 0$, and the difference increasing in both α_R and β_R).

That is, so long as there is no systematic difference in inequality aversion between responders who evaluate fairness *ex-post* versus *ex-ante*, a responder with *ex-post* fairness preferences requires a greater probability of winning to accept. Furthermore, in this situation the two models have different predictions regarding the possibility of disagreement. Let $F(\alpha, \beta)$ be the joint cumulative distribution function (c.d.f.) of player types having support $\alpha \in [0, \infty)$ and $\beta \in [0, 1]$. For now, we continue to assume that, in both cases, proposers hold correct beliefs about the parameters of the responder's utility function. Then:

(i) Under *ex-ante* fairness, for all $\alpha_R \in (0, \infty)$, $\beta_R \in [0, 1]$, there exists a proposal $z \in (0, 0.5]$ such that $E[y] - \alpha_R(E[x] - E[y]) > 0$, which will be accepted by the responder and which the proposer is willing to offer. Thus, *ex-ante* fairness always yields agreement.

(ii) Under *ex-post* fairness, for all $\alpha_R \in (0, \infty)$, $\beta_R \in [0, 1]$, there exists a proposer pair $\left(\alpha_P^*(\alpha_R, \beta_R), \beta_P^*(\alpha_R, \beta_R)\right)$ as a mapping from responder pair (α_R, β_R) such that the proposer is just indifferent between making an acceptable or an unacceptable offer. All proposer types more averse to inequality than this threshold type strictly prefer disagreement. It follows that the probability of disagreement is strictly greater than 0 under *ex-post* fairness.

Thus, if risk-neutral players evaluate the fairness of outcomes *ex-ante*, then they are more likely to reach an agreement and (on average) there should be no difference in the minimum acceptance thresholds between the standard and risky ultimatum games. If risk-neutral players are governed by *ex-post* fairness, then R's minimum acceptance threshold is higher in the risky ultimatum game than in the standard ultimatum game, and it may be so high that P is unwilling to make an offer that R would accept.

Let us now relax the risk-neutrality assumption. Under *ex-post* fairness, a risk- or inequality averse R's acceptance threshold is strictly higher in the risky ultimatum game than in the standard ultimatum game. By contrast, a risk-loving R may demand less in the risky ultimatum game than in the standard ultimatum game if she is not too inequality averse and the prize to be won is high enough. A sufficient condition for this to hold is:

$$r > 1 + \frac{\ln(1 + \alpha_R + \beta_R)}{\ln(S)}. \tag{10}$$

It follows that if proposers expect sufficiently risk-loving behavior, they will offer less in the risky ultimatum game than in the standard game.

By contrast, under *ex-ante* fairness and regardless of the evaluation of own payoffs, we are unlikely to observe higher minimum acceptance thresholds in the risky ultimatum game than in the standard deterministic setting even for a very risk-averse R. This is because an *ex-ante* fairness evaluation of expected payoff inequality is identical to the evaluation of actual payoff inequality in a deterministic setting. To demonstrate, in Figure 1 we compute R's thresholds under the two *ex-ante* fairness cases described above, for representative values of $r > 0$ and across types on α_R having support $[0, 4]$. The top (bottom) four panels in the figure simulate varying degrees of risk-averse (risk-loving) responder preferences. We compare these thresholds to those in the standard ultimatum game (assuming non-linear utility) and those under *ex-post* fairness. All thresholds are computed for a surplus of size $S = 6$ to reflect our experimental implementation and allow for responder guilt, $\beta_R = 0.6$. Assuming no guilt would slightly reduce acceptance thresholds under *ex-post* fairness but have no effect under *ex-ante* fairness. In the Supplementary Materials, we also show robustness of our inferences to the specification of the utility function own payoff component and of initial wealth conditions.

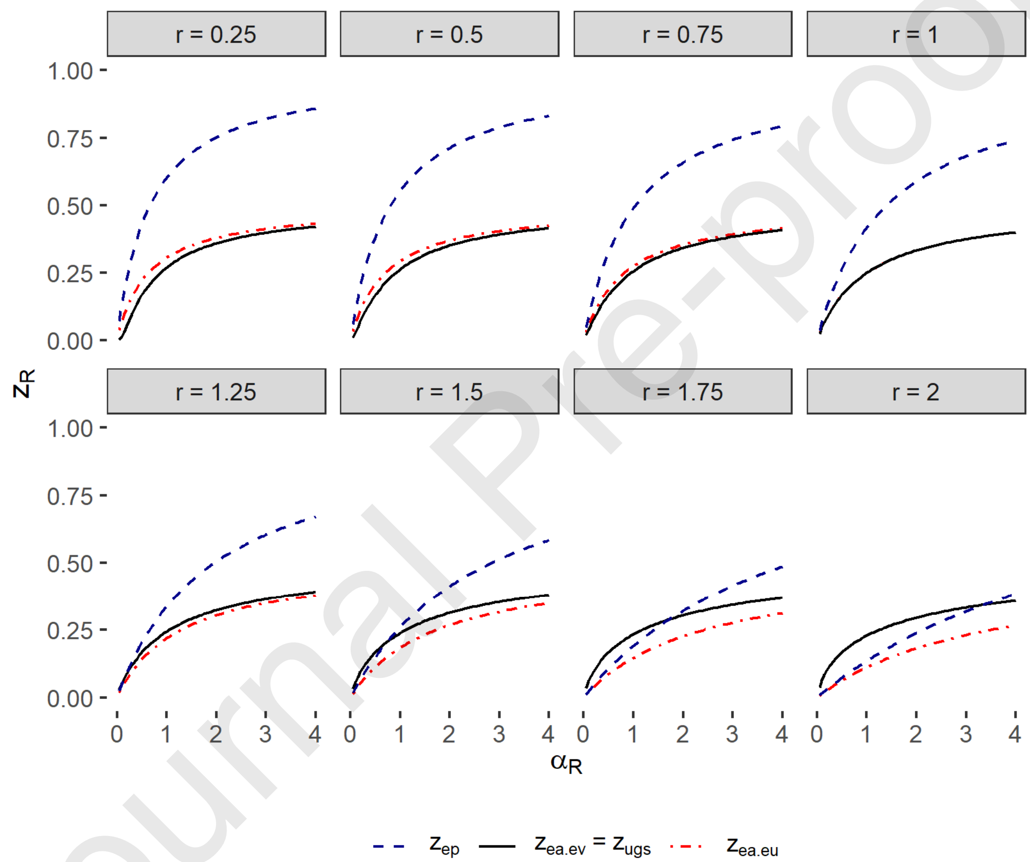

FIGURE 1. RESPONDER ACCEPTANCE THRESHOLDS FOR EQUATION (2):
EX-POST FAIRNESS VERSUS EX-ANTE FAIRNESS.

Notes: Responder acceptance thresholds z_R for representative risk tolerance parameters $r > 0$ and types on α_R having support $[0, 4]$. All thresholds assume a surplus of size $S = 6$ and guilt, $\beta_R = 0.6$. Notation: z_{ugs} = standard ultimatum game benchmark; z_{ep} = *ex-post* fairness computed from (5); $z_{ea.ev}$ = *ex-ante* fairness *case (i)*, computed by finding the root of $u_R = (z \cdot S)^r + z \cdot S - \alpha_R \cdot S(1 - 2z)$ using the bisection method; $z_{ea.eu}$ = *ex-ante* fairness *case (ii)*, computed from (9).

Minimum acceptance thresholds coincide exactly among the standard ultimatum game (z_{ugs}), the risky ultimatum game under *ex-ante* fairness with evaluation of own payoffs by expected values ($z_{ea.ev}$), and – for risk-neutrality only – under *ex-ante* fairness with evaluation of own payoffs by expected utility ($z_{ea.eu}$). For a risk-averse agent, thresholds are substantially higher under *ex-post* fairness (z_{ep}) than in the standard ultimatum game or under *ex-ante* fairness. Under reasonable assumptions on inequality and risk aversion, responders characterized by *ex-ante* fairness concerns would report similar thresholds in both the standard and risky ultimatum games. Even under assumptions of extreme risk aversion, $z_{ea.eu}$ never exceeds z_{ugs} by more than one or two percentage points at acceptance thresholds above 30% of the surplus, which we will find in our experiment.[11] If inequality-averse responders are risk-loving, then we may observe lower thresholds in the risky ultimatum game under either *ex-post* or *ex-ante* fairness, so long as own payoffs are evaluated by expected utility. This final observation complements Müller and Rau (2019), who show that inequality averse subjects prefer to take more risky decisions when they find themselves behind a peer. In our setting, if individuals are risk-seeking, then they are more likely to take a chance on coming out ahead than accept the certainty of coming out behind.

2.4. Incomplete information about the responder's type

We can extend the theoretical analysis to incorporate incomplete information about the responder's type. For simplicity, we assume that the only incomplete information is about the responder's coefficient of disadvantageous inequality aversion (α_R). Details of this extension are contained in the Supplementary Materials. There are two main insights from this analysis.

First, we compare the standard and risky ultimatum games under *ex-ante* fairness. The differences in the proposer's optimal offer between the two variants are small and driven by the riskiness of the own-payoff component, as in the complete information case. In contrast, there can be quite substantial differences under *ex-post* fairness.

Second, under reasonable assumptions on the proposer's expected utility function, if responders evaluate the fairness of *ex-post* outcomes by expected utility maximization, then the optimal offer z^* is decreasing in α_P. That is, as the proposer cares more about disadvantageous inequality, she lowers the offer made to the responder. By contrast, if responders evaluate the fairness of expected outcomes *ex-ante*, then the optimal offer z^* does not depend on α_P, but it is increasing in β_P. As a consequence, a proposer who is sufficiently averse to inequality – *and regardless of risk aversion*

[11] Our experiment has low power to detect such small changes in acceptance thresholds.

– may offer less in the risky ultimatum game than in the standard ultimatum game when there is incomplete information about the responder's type.

2.5. Regret

An alternative hypothesis is that the anticipation of regret may alter the responder's minimum acceptance threshold in the risky ultimatum game. First of all, note that the anticipation of regret is an entirely *ex-post* notion. We would not expect a player with an *ex-ante* notion of fairness to regret either accepting or rejecting an offer. Therefore, we proceed with our analysis based on *ex-post* fairness preference and, for simplicity, we will assume risk neutrality and that all parameters are common knowledge.

There are two types of regret that a responder might experience: (i) accepting an offer to find out that she loses; and (ii) rejecting an offer that she would have won. Thus, we can modify the utility from accepting and rejecting an offer:

$$\text{Accept:} \quad z(S-\beta_R S)+(1-z)\big((-\alpha_R S)+\lambda^A(-\alpha_R S)\big);$$

$$\text{Reject:} \quad -z\lambda^R(S-\beta_R S).$$

In this case, $\lambda^A \geq 0$ is the regret parameter from accepting and losing. This is multiplied by $(1-z)(-\alpha_R S)$ as this event happens with probability $(1-z)$ and the utility is $-\alpha_R S$. On the other hand, $\lambda^R \geq 0$ is the regret parameter from rejecting when the responder would have won. This is weighted by the probability of the event occurring, z, and by $-(S-\beta_R S)$, which is the forgone utility from winning.

Solving for the minimum acceptance threshold, we can see that the responder will accept if and only if

$$z \geq \frac{(1+\lambda^A)\alpha_R S}{(1+\lambda^A)\alpha_R S+(1+\lambda^R)(S-\beta_R S)}. \quad (11)$$

The threshold in (11) is increasing in λ^A and decreasing in λ^R. Our conjecture is that $\lambda^R > \lambda^A$, so that a responder experiences greater regret from rejecting when she would have won than from accepting only to lose. The reason is that accepting and losing has no direct financial consequences – the responder earns 0 in any case and she only feels the pain of disadvantageous inequality, which we already capture via the term $\alpha_R S$. On the other hand, rejecting leads to a payoff of 0, which is strictly less than the S she would have received had she accepted and won. There is then a real potential financial consequence from rejecting, which, we believe, makes the effect more salient. If subjects anticipate the possibility that they could have won and want to avoid this possibility, then they may report lower thresholds than in the standard ultimatum game.

Larrick and Boles (1995) argue that the overall effect of regret could be influenced by feedback. When no feedback is given about the lottery upon rejection, rejecting is relatively more attractive as it means the responder will not experience the regret from losing. In contrast, if feedback is given regardless of the decision, then accepting becomes relatively more attractive because doing so ensures that the responder will never regret rejecting only to learn that she would have won. We will make use of this observation to exogenously vary the salience of regret in our experiment.

3. Experimental Design

Our experiment sought to understand how subjects' behavior differs between a risky and standard ultimatum game to gain insights into how risk affects fairness preferences. To this end, we conducted several experimental treatments. In all treatments, subjects participated in both the standard and risky ultimatum game variants and maintained the same role across variants (within-subjects design). We randomized the order of presentation of the two ultimatum games and limited feedback of accept/reject decisions as well as the resolution of any uncertainty until all decisions had been made.[12]

In one set of experiments, we employed a direct response (DR) method for responders, while in another we employed the strategy method (SM) to get more precise information about their thresholds. We call these treatments Risk-DR and Risk-SM, depending on the response method.

In both ultimatum game variants, there was \$6 to be divided between the proposer and responder if they could reach an agreement. In the standard game (henceforth "Standard UG"), proposers could make offers in increments of \$0.10. In the risky game (henceforth "Lottery UG"), the proposer was allocated 100 "lottery tickets" to divide between the proposer and the responder. If

[12] Subjects were not provided any information about the second ultimatum game task until after the first task had been completed. This protocol ensured that the validity of behavior in the first task would be preserved even if we found evidence of order effects.

the offer was accepted, then the computer would randomly select one winning lottery ticket and the player holding that lottery ticket would receive $6 and the other person would receive nothing.

In the benchmark Risk-DR and Risk-SM treatments, we employed a no lottery feedback upon rejection protocol. To increase the salience of regret, we ran a variant on the Risk-SM treatment in which we revealed the outcome of the lottery to the responder (only) even if the responder rejected the proposer's offer.[13] We call this treatment Risk-SM-Reveal. Again, we only provided this feedback after both UG tasks were completed. This is a conservative approach: while it may reduce the salience of regret, it mitigates wealth effects that might otherwise arise when the Lottery UG is completed first.

We conducted a further two treatments in which, in the Lottery UG, the decision to accept or reject comes after the resolution of uncertainty. That is, before the responder decides, he/she knows the outcome of the lottery. In one of these treatments, we followed a direct response procedure, while in the other, we used an outcome-conditional strategy method in which the responder chooses to accept or reject conditional on winning and conditional on losing the lottery. We call these treatments Intent-DR and Intent-SM because they were designed to provide insight on the role of intentions on one's willingness to accept *ex-post* inequality.

Table 1 summarizes the full set of treatments conducted. The sample size for our Risk-DR and Risk-SM treatments gives us 75% power to detect an offer effect size of 3 percentage points and 99% power to detect an offer effect size of 5 percentage points. Further details on our sampling procedure can be found in our pre-registration. The Risk-SM-Reveal and Intent-SM treatments were not part of our original pre-registration and were added later. The former was added to explore the effect of regret on responders' acceptance behaviors in the Lottery UG; the latter to give us greater power to test our intentions hypotheses, and to explore an additional hypothesis suggested by our original results.

TABLE 1—EXPERIMENTAL TREATMENTS

Treatment	Order	*N* (P, R)	Treatment	Order	*N* (P, R)
Risk-DR	Standard, Lottery	58 (29, 29)	Intent-DR	Standard, Lottery	78 (39, 39)
Risk-DR	Lottery, Standard	54 (27, 27)	Intent-DR	Lottery, Standard	78 (39, 39)
Risk-SM	Standard, Lottery	43 (21, 22)	Intent-SM	Standard, Lottery	73 (36, 37)
Risk-SM	Lottery, Standard	46 (23, 23)	Intent-SM	Lottery, Standard	63 (31, 32)
Risk-SM-Reveal	Standard, Lottery	56 (27, 29)			
Risk-SM-Reveal	Lottery, Standard	67 (31, 36)			

[13] We chose not to provide feedback on the lottery outcome after rejection to the proposer to avoid confounding offers with regret motives.

Note: *N* broken down by Proposer (P) and Responder (R).

3.1. Hypotheses

As discussed above, behavior is expected to differ between the Standard and Lottery UG depending on whether participants are motivated by *ex-post* or *ex-ante* fairness concerns. Which behavioral tendency best-describes behavior is an empirical question and so we pre-registered the following competing hypotheses:

Hypothesis 1. In the Risk-DR and Risk-SM treatments:

(a) Because of a concern for *ex-ante* fairness, neither responder nor proposer behavior will differ between the Standard and Lottery UG;

(b) Because of a concern for *ex-post* fairness, the responders' minimum acceptance thresholds will increase in the Lottery UG relative to the Standard UG and, consequently, proposers will offer more;

(c) Players value the chance to come out ahead in a lottery greater than an equivalent certain amount that guarantees disadvantageous inequality. Consequently, responders' minimum acceptance thresholds will decrease in the Lottery UG relative to the Standard UG and proposers will offer less.

Recall from the previous section that Hypothesis 1(c) may be driven by risk-loving behavior or anticipated regret. Disentangling these explanations motivated our Risk-SM-Reveal treatment.

Our Intent-DR treatment was designed to test whether there is a relationship between the proposer's offer and the responder's willingness to accept *ex-post* inequality. Other social preferences models (Rabin 1993; Dufwenberg and Kirchsteiger, 2004; Falk and Fischbacher, 2006) emphasize that players respond to the perceived kindness or intent of other players' decisions relative to the set of possible actions. Moreover, past work on procedural fairness (Bolton et al 2005; Wang 2017) suggests that decision makers are more willing to accept disadvantageous inequality if it arises from a fair process. In our case, the outcome is fairer towards the responder, the larger the share she was offered. We had the following competing hypotheses:

Hypothesis 2. In the Intent-DR treatment, upon learning that the responder lost:

(a) There is no relationship between the amount offered and the acceptance decision in the Lottery UG;
(b) There will be a positive relationship between the offers and acceptance decisions in the Lottery UG.

If Hypothesis 2(b) is true, then a responder is more likely to accept, even after learning that she lost the lottery, the more that the proposer offered to her. Because of the exploratory nature of Intent-SM, we defer further discussion related to it until after presenting our first results.

3.2. Experimental details

The experiment was conducted as Human Intelligence Tasks (HITs) on the Amazon Mechanical Turk (AMT) platform in May/June 2020 and April 2021 (Risk-SM-Reveal treatment). Prior studies on AMT have replicated core findings in the behavioral economics literature and demonstrated their comparability with laboratory subject pools, both for individual and interactive decision-making tasks (Paolacci et al., 2010; Horton et al., 2011; Suri and Watts, 2011; Amir et al., 2012; Goodman et al., 2013; Arechar et al., 2018; Snowberg and Yariv, 2021).[14] The experimental software was programmed using oTree (Chen et al., 2016). We have data from a total of 616 subjects.[15] Groups of participants were randomized to experimental treatments and no subject participated in more than one treatment.[16]

To ensure subjects understood the experimental details, we implemented two sets of control questions, one set after the instructions for each task. Subjects had to answer all questions correctly to proceed to the ultimatum game tasks and any subject that failed to do so after three attempts was removed from the experiment.[17] After completion of the comprehension check for the first task in any session, subjects entered a waiting lobby. As soon as the lobby contained at least two subjects, a pair was formed, and roles were assigned to the matched participants. The roles were maintained for the second task. After completion of the comprehension check for the second task,

[14] Outside of AMT, Chesney et al. (2009) and Hergueux and Jacquemet (2015) find support for the reliability of behaviors elicited in ultimatum games conducted online.

[15] 23 subjects displayed inconsistent behavior in at least one task in the strategy method treatments and data involving these subjects are excluded from the analysis below. We define inconsistent behavior as switching from accept to reject, or reject to accept, more than twice in an ordered list of proposals. The raw choice sequences for inconsistent responders can be found in the Supplementary Materials.

[16] A randomization check is provided in the Supplementary Materials.

[17] If the subject had already completed one task successfully, he or she was paid the participation fee.

subjects also entered a lobby for matching. Subjects were informed that they would be randomly and anonymously matched with another participant, who may differ from their match in the first task. To balance the competing goals of random re-matching across tasks while maintaining subjects' attention, a period of one minute had to expire before any participant could be matched with the same person as in the first task. As a result, 87.5% of subjects were matched with a different subject in the second ultimatum game.

Attrition and inattention are significant challenges for interactive experiments conducted online (see Arechar et al., 2018). We designed the experiment to minimize these concerns. In addition to the comprehension checks and matching "on the fly", we included concise instructions and on-screen timers that triggered removal from the experiment upon expiration. Further details are provided in the Supplementary Materials.

Subjects were paid the outcome of one of the Standard or Lottery UG tasks, which was determined at random by the computer after completion of both tasks and paid in addition to a participation fee of $0.50. The experiment took around 15 minutes to complete and the median (mean) subject earned $3.50 ($2.94), implying an hourly wage of $12-14.[18] At the end of each session, subjects completed a short questionnaire consisting of non-incentivized attitudinal and demographic questions, including about generalized willingness to take risks.

4. Experimental Results

4.1. Behavior in Risk-DR and Risk-SM

In Table 2, we provide summary results for the Risk-DR and Risk-SM treatments of proposer and responder behavior in the Standard and Lottery UG. We detect no significant difference in offers or accept/reject decisions depending on whether responders used the DR or SM elicitation method. We also detect no significant order effects depending on whether the Standard UG was played first or second. The only exception is that proposers offered slightly more in the Standard UG when it was presented first ($p = 0.087$). The analysis pools over these dimensions. To

[18] See Hara et al. (2018) for a discussion of worker earnings on AMT.

facilitate comparison, all offers and acceptance thresholds are normalized as the percentage of the pie available ($6 in Standard UG and 100 lottery tickets in Lottery UG).[19]

TABLE 2—SUMMARY RESULTS IN RISK-DR AND RISK-SM

Game	Proposed Amount	Acceptance Frequency	Minimum Acceptance (SM)
Standard UG	47.38% (11.98)	91.09% (28.63)	31.67% (17.62)
Lottery UG	43.78% (13.92)	81.19 (39.28)	38.13% (19.45)

Note: Mean values with standard deviations in parentheses.

There are clear differences between the Standard UG and Lottery UG, but these differences depend on the role. Specifically, proposers offer *less* (consistent with Hypothesis 1(c)) in the Lottery UG and the difference is significant ($p = 0.033$).[20] On the other hand, consistent with Hypothesis 1(b) (*ex-post* fairness), responders had *higher* thresholds and were *less* likely to accept the proposer's offer. Both differences are significant at $p < 0.02$.

In Table 3, on the left-hand side, we classify subjects depending on whether their proposal or acceptance threshold was higher/equal/lower in the Lottery UG than in the Standard UG. Comparing the panels (a) and (b), we observe a stark difference in the classification by player role and this is confirmed with Fisher's Exact Test ($p < 0.01$). Indeed, 60% of responders behave in a manner consistent with *ex-post* fairness in that they report a strictly higher threshold for the Lottery UG than for the Standard UG.

For responders, we can consider an alternate classification of their fairness preferences. For example, given their response in the Standard UG, we can calculate the implied degree of inequality aversion, α_B^S and then use this to predict the thresholds in the Lottery UG under the assumptions of *ex-post* fairness, $z_{ep}^{*,L}(\alpha_B^S)$, and *ex-ante* fairness, $z_{ea}^{*,L}(\alpha_B^S)$. We then compare these predictions with the stated threshold and, for each prediction, calculate the squared difference.[21] We say that the subject is consistent with the fairness notion – *ex-ante* or *ex-post* – depending on which notion minimizes the squared difference between actual and predicted threshold.

[19] In our Risk-SM treatment, to simplify the strategy method elicitation, we implemented a two-level approach (similar to the iterative multiple price list of Andersen et al., 2006, for the elicitation of risk preferences). Five responders expressed non-monotone strategies, in which case they did not go to the second level. In our analysis, for their minimum acceptable offer, we took the mid-point between their first accepted level 1 option and the option immediately below. Our results are qualitatively unchanged if these subjects are excluded.

[20] Unless otherwise stated, tests are two-sided, parametric *t*-tests. Our results are robust to using alternative non-parametric tests.

[21] For purposes of this calculation, we assume risk-neutrality. We also repeat the procedure starting from the stated threshold in the Lottery UG.

TABLE 3—CLASSIFICATION OF TYPES

(a) Proposers

By Strategy Comparison	Frequency
Propose More (i.e., *Ex-post* Fairness)	20.00%
Propose Same (i.e., *Ex-ante* Fairness)	49.00%
Propose Less (i.e., *Ex-post* Fairness)**	31.00%

(b) Responders

By Strategy Comparison	Frequency	Least Squares Consistency	Frequency
Require More (i.e., *Ex-post* Fairness)	60.00%	*Ex-post* Fairness	40.00%
Require Same (i.e., *Ex-ante* Fairness)	13.33%	*Ex-ante* Fairness	53.33%
Require Less	20.00%	No Fairness Concerns	6.67%
No Fairness Concerns	6.67%		

Note: For proposers, we use data from both the Risk-DR and Risk-SM treatments, while for responders, we only use data from the Risk-SM treatment. We say that a responder has no fairness concerns if their stated strategy indicated that they would either accept 0 or the lowest positive increment for both the Standard and Lottery UGs. ** If proposers have incomplete information about responders' fairness preferences and, themselves, adopt an *ex-post* notion of fairness, it is possible that they will propose less in the Lottery UG.

Using this classification, 40% of responders are best described as having *ex-post* fairness preferences, while 53.33% of responders are best described as having *ex-ante* fairness preferences. We note that in this classification, *all* the responders who reported equal or lower thresholds are classified according to the *ex-ante* model.[22] On the other hand, 1/3 of responders who reported higher thresholds in the Lottery UG are, nevertheless, classified according to the *ex-ante* model. Regardless of the classification method, we see that a sizeable fraction of responders display behavior consistent with *ex-post* fairness concerns. In contrast, relatively few proposers increase offers in the Lottery UG, which indicates that there may be a mismatch between proposers' beliefs about responders' fairness and risk concerns and responders' actual fairness and risk concerns. However, this could also be driven by incomplete information about responders' fairness preferences. As our equilibrium analysis showed, with incomplete information about the responder's type, it is possible for an (*ex-post*) inequality averse proposer to lower his offer in the Lottery UG relative to the Standard UG.

4.2. Behavior in Risk-SM-Reveal

In Table 4, we present summary results for the Risk-SM-Reveal treatment (and Risk-SM for comparison) of proposer and responder behavior in the Standard and Lottery UG. To formally test whether proposers' offers and/or responders' minimum acceptance thresholds are influenced by

[22] In the Supplementary Materials, we go further and estimate the posterior probability that a responder is classified as either an *ex-post* or *ex-ante* fairness type. To do this, we conduct a structural estimation and permit noise in the responders' decisions. The results are consistent with the least squares method. We find that under risk-neutrality neither fairness approach can well explain responders who require less in the Lottery UG, as captured by posterior probabilities for these responders around 1/2.

anticipated regret, we use a difference-in-differences (DiD) approach, as well as a more direct between-subjects comparison of behavior in the Lottery UG in the Risk-SM-Reveal and Risk-SM treatments, which is where we expect behavior to be affected by increasing the salience of regret. Specifically, for the DiD approach, we compare the magnitude of the within-subjects difference in average offers between the Standard and Lottery UG in Risk-SM-Reveal ($o_s' - o_l'$), with the magnitude of the within-subjects difference in average offers between the Standard and Lottery UG in Risk-SM ($o_s - o_l$). We repeat the analysis for the difference in average acceptance thresholds between ultimatum games in Risk-SM-Reveal ($z_s' - z_l'$) relative to Risk-SM ($z_s - z_l$). Our theoretical discussion from Section 2.5 predicts that if responders are sensitive to anticipated regret, then we will observe $z_s' - z_l' > z_s - z_l$, while if proposers anticipate this, then we will observe $o_s' - o_l' > o_s - o_l$.

TABLE 4—SUMMARY RESULTS IN RISK-SM-REVEAL (AND RISK-SM FOR COMPARISON)

	Proposed Amount		Minimum Acceptance (SM)	
Game	Risk-SM-Reveal	Risk-SM	Risk-SM-Reveal	Risk-SM
Standard UG	45.69% (14.41)	48.30% (11.31)	33.51% (18.76)	31.67% (17.62)
Lottery UG	40.26% (18.96)	45.05% (12.70)	34.88 (19.89)	38.13% (19.45)
Difference: Standard – Lottery	5.43 (22.85)	3.25 (19.19)	-1.36 (16.90)	-6.47 (17.27)

Notes: 1. Mean values with standard deviations in parentheses. 2. Proposed amount for Risk-SM differs from Table 2 as that table also includes data from the Risk-DR treatment. Our results on proposers are qualitatively and quantitatively unchanged if we also include proposers from Risk-DR.

As before, in Risk-SM-Reveal we observe lower offers in the Lottery UG than in the Standard UG. The sign of the DiD for offers between Risk-SM-Reveal and Risk-SM is positive as predicted by the regret hypothesis, but not significant (+2.18, $p = 0.305$).[23] This null finding is unchanged if we include offers from Risk-DR in the comparison (+1.83, $p = 0.282$). Between-subjects, there is some evidence that proposers in Risk-SM-Reveal offer less in the Lottery UG than their counterparts in Risk-SM ($p = 0.076$). Thus, while proposers adapt their behavior qualitatively in the direction predicted by the regret hypothesis, the statistical evidence is weak at best.

We find stronger evidence to support the hypothesis that responders are more accommodating in their lottery ticket demands when the anticipation of regret is salient. Unlike in Risk-SM, where

[23] All tests of our regret hypothesis are one-sided statistical tests.

minimum acceptance thresholds are significantly higher in the Lottery UG than in the Standard UG ($p < 0.02$), there is no discernible within-subjects difference in thresholds between the two ultimatum game tasks in Risk-SM-Reveal ($p = 0.518$). Consistent with the regret hypothesis, the DiD for acceptance thresholds between Risk-SM-Reveal and Risk-SM is +5.10 ($p = 0.063$). If we exclude the five subjects who exhibit non-monotone strategies in either the Standard or Lottery UG (and so exhibit an inconsistency in fairness preferences), the DiD increases to +7.05 ($p = 0.016$). Between-subjects, acceptance thresholds in the Lottery UG are also significantly lower for consistent responders in Risk-SM-Reveal than in Risk-SM ($p = 0.046$).[24]

Taken together, the results of the Risk-SM-Reveal treatment suggest that the anticipation of regret may contribute to the mismatch between proposers' beliefs and responders' preferences. Whereas proposers offer proportionally less in the Lottery UG regardless of the feedback protocol, responders only report (comparatively) lower acceptance thresholds when regret is made salient.

4.3. Behavior in Intent-DR and Intent-SM

Table 5 shows summary results of behavior in the Standard UG and Lottery UG of the Intent-DR treatment. For the Lottery UG, we condition on whether the proposer or responder held the winning lottery ticket.

First, observe that unlike in the Risk-DR and Risk-SM treatments, in the Intent-DR treatment the average proposals for the Standard UG and Lottery UG are virtually identical, though the variance of offers is substantially higher in the Lottery version. This may suggest that proposers have heterogeneous beliefs about whether intentions matter in the Lottery version. Despite this heterogeneity, the fact that proposers now offer similar amounts in the Standard UG and Lottery UG (where before they offered significantly less in the Lottery UG, see Table 2), suggests that at least some proposers believe that their intentions will matter.

TABLE 5—SUMMARY RESULTS IN INTENT-DR

Game	Proposed Amount	Acceptance Frequency	
		Proposer Won	Responder Won
Standard UG	45.34% (11.35)	92.31% (26.82)	
Lottery UG	45.44% (17.01)	56.41% (50.24)	97.44 (16.01)

24 Note that our pre-registration did not explicitly mention the possibility of excluding subjects who display this inconsistency. Nevertheless, we think it is instructive to point out that our results are strengthened if such an exclusion is made.

Note: Mean values with standard deviations in parentheses.

Second, we see that when the proposer was revealed to be the winning lottery ticket holder, 56.41% of responders accepted the proposal, even though it meant that they would receive \$0 and the proposer would receive \$6. This suggests that they are either not motivated by inequality aversion or there is some other factor that influences their decision to accept such an unequal split. Our Hypothesis 2(b) was that this would be driven by the intent of the proposer, with the responder more likely to accept the larger the share offered. Indeed, the Spearman rank correlation is positive at 0.155, but we cannot reject that it is zero ($p = 0.345$). Column (1) of Table 6 also reports the results of a logistic regression with dependent variable being a 0/1 indicator for accepting after it was revealed that the responder lost and the lone explanatory variable is the offer made by the proposer. The coefficient estimate is positive but not significant. An alternative possibility is that these subjects are concerned about efficiency and *ex-post* prefer to maximize the earnings of the pair (Charness and Rabin, 2002).[25]

The Intent-DR data also suggest an inconsistency in many subjects' acceptance behavior. Observe that in Risk-SM, over 90% of responders had strictly positive minimum acceptance thresholds in the Standard UG and Lottery UG. That is, for over 90% of responders, the payoff vector (self, match): $(0,0) \succ (\gamma, 6-\gamma)$ for some dollar amount, $\gamma > 0$, in the Standard UG and $(0,0) \succ [(0,6)\ w.p.\ \mu; (6,0)\ w.p.\ 1-\mu]$ for some probability, $\mu > 0$, of winning in the Lottery UG. Yet, our results from Intent-DR suggests that $(0,6) \succ (0,0)$ for over 50% of responders. Combining these (in the Standard UG for simplicity) yields: $(0,6) \succ (0,0) \succ (\gamma, 6-\gamma)$, which violates monotonicity of preferences.

TABLE 6 —LOGIT REGRESSIONS FOR ACCEPTANCE DECISION IN INTENT TREATMENTS

Variable	(1) – Intent-DR Only		(2) – Intent-SM Only		(3) – Pooled	
Amount Offered (%)	0.0048	(0.0053)	0.0059**	(0.0028)	0.0055**	(0.0027)
Indicator for Intent-SM					0.1757*	(0.0935)
Minimum Acceptance Threshold in Standard UG			-0.0091***	(0.0028)		
Number of Observations	39		69		108	

Note: The dependent variable is a 0/1 indicator for whether the responder accepted upon losing the lottery. The table reports estimated marginal effects with standard errors in parentheses. *, **, and *** denote significance at the 10, 5 and 1% level, respectively.

25 Related are the money burning experiments of Zizzo and Oswald (2001) and Zizzo (2003). A significant fraction of subjects in these experiments chose to reduce the earnings of (predominantly richer) others at private cost to themselves, after the resolution of a gambling stage.

Although suggestive of anomalous behavior, the above analysis rests on a between-subjects comparison. To test the robustness of this finding, we designed the Intent-SM treatment. In this treatment, responders participated in the strategy method version of the Standard UG and in an outcome-conditional strategy method version of the Lottery UG. For the latter, after learning the proposed number of tickets sent by the proposer, the responder stated whether she would accept the proposal if she held the winning ticket and also if the proposer held the winning ticket. After making her decisions, the uncertainty was revealed, and her relevant choice was implemented.

Table 7 provides summary statistics for the Intent-SM treatment. Proposer behavior is virtually identical to the Intent-DR treatment and, as before, there is no difference in proposals between the Standard UG and Lottery UG. For responders, the minimum acceptance threshold is, on average, 27.00%, which is not significantly different from the Risk-SM treatment.

TABLE 7—SUMMARY RESULTS IN INTENT-SM

Proposed Amount (Standard UG)	Proposed Amount (Lottery UG)	Minimum Acceptance Threshold in Standard UG	Frequency Accept if Proposer Wins	Frequency Accept if Responder Wins
43.98%	44.85%	27.00%	73.91%	98.55%
(10.93)	(11.17)	(16.51)	(44.23)	(12.04)

Note: Mean values with standard deviations in parentheses.

Turning to the acceptance frequencies, we see that 73.91% of responders state that they will accept even if the proposer wins, i.e., they receive \$0 and the proposer receives \$6. This is higher than in the Intent-DR treatment and a proportions test is marginally significant ($p = 0.062$), which suggests a difference between direct response and the outcome-conditional strategy method in willingness to accept inequality. Columns (2) and (3) of Table 6 also show stronger support for our intent hypothesis (Hypothesis 2(b)). That is, responders who were offered more are significantly more likely to accept when they lose the lottery and are faced with a highly unequal outcome. We find that 46 out of 69 responders in Intent-SM display the anomalous behavior identified above; that is, they report a strictly positive acceptance threshold in the Standard UG but then indicate acceptance conditional on losing the lottery.

5. Discussion

5.1. Risk preferences

We observed some heterogeneity in responders' acceptance thresholds between the Standard and Lottery UGs (see Table 3). One explanation for this heterogeneity posited by the theory is between-subject variation in risk preferences. While we do not have incentivized decision data on risk preferences, we can investigate the relationship between acceptance behaviors and responders' self-reported willingness to take risks in the post-experiment questionnaire. Recall that both *ex-post* fairness and *ex-ante* fairness predict a risk preference ranking according to the change in minimum acceptance thresholds between the Standard and Lottery UGs. Specifically, we expect responders who report lower (higher) acceptance thresholds in the Lottery UG to exhibit greater (lesser) willingness to take risks than those who report equal acceptance thresholds between tasks. As we show in the Supplementary Materials, there is weak evidence to support this ranking. This cannot, however, explain the mismatch between proposers' beliefs and responders' preferences.

5.2. Intent anomaly

What might explain the anomalous behavior observed in our intent treatments? One possibility is that subjects adopt an *ex-ante* fairness perspective even after learning the outcome of the lottery. Trautmann and van de Kuilen (2016) found that 27% of subjects in their experiment subscribed to procedural fairness after the resolution of uncertainty. This argument requires our intent Hypothesis 2(b) to hold, for which we found modest support (when combining data from Intent-DR and Intent-SM). However, 6 out of 14 responders (42.9%) accepted the (0,6) split even though the offer that they received was less than or equal to their minimum acceptance threshold in the Standard UG. Thus, intentions cannot be the full story.

Another possibility is that responders do not attribute responsibility to proposers for outcomes in the Lottery UG in the same way that they do in the Standard UG. Bartling and Fischbacher (2012) find strong empirical support for a measure that assigns most responsibility for an unfair outcome to the player whose action had most influence on the likelihood of that outcome. This explanation neglects the fact that proposers had direct control over the probability of winning or losing and could choose to make the game fair or unfair.[26] Nevertheless, it is plausible that the resolution of uncertainty moderates reciprocal considerations relative to the deterministic and *ex-ante* lottery cases. In this sense, risk produces a "veneer of absolved responsibility".

To see this, suppose the proposer offered 30% to the responder and it was revealed that the responder lost. The responder could reason that the proposer bears most – but not all – responsibility for her receiving zero. At the same time, if she rejects the offer, then she would bear 100% of the responsibility for the proposer receiving zero. The implied imbalance in responsibility may leave her compelled to accept the unequal outcome. Future work should seek to disentangle fairness preferences from issues about responsibility for allocations.

One issue with the between-subjects identification of this anomaly is that it relied on a strategy method elicitation from the Risk-SM treatment and compared it to a direct response decision from the Intent-DR treatment. Prior ultimatum game experiments (e.g., Eckel and Grossman 2001) report lower acceptance frequencies in the strategy method versus direct response formats, a finding which we also replicate. Hence, the mismatch in elicitation methods could overstate the true prevalence of this behavior. Our Intent-SM treatment alleviates this concern on two fronts. First, it is a within-subjects comparison and, second, for both the Standard and Lottery UGs, we employ the strategy method. Therefore, the treatment effect should still be valid so long as the strategy method affects behavior in the same way (relative to direct response) for the two treatments. The fact that we find even stronger evidence for the choice anomaly suggests that it is a real phenomenon.[27]

6. Concluding Remarks

Many situations in which agents must negotiate a division involve uncertainty over outcomes. It is therefore important to assess how individuals judge the fairness of allocations when there is risk. By comparing behavior in the standard ultimatum game and a risky ultimatum game variant, we were able to gain insight into this question. For both proposers and responders, we observed an

[26] For a discussion of why rule-based (or strategy) fairness makes inequalities more acceptable, see Wang (2017).

[27] The ideal test would employ a direct response procedure in both treatment arms. However, such an exercise would prove costly because proposers' offers are often substantially above the minimum acceptable offer of responders and identification of the anomaly comes from subjects who reject a strictly positive amount in the Standard UG or the Lottery UG (before the resolution of uncertainty) but reject in the Lottery UG after the resolution of uncertainty reveals that the proposer won. We take heart from Brandts and Charness (2011), who report that "in no case do we find that a treatment effect found with the strategy method is not observed with the direct-response method" (p. 375).

apparent heterogeneity in whether behavior is best explained by *ex-ante* or *ex-post* fairness concerns. This is consistent with prior empirical work on the evaluation of fairness over lotteries. However, we also found that more responders displayed behavior consistent with *ex-post* fairness – reporting higher minimum acceptance thresholds – than was anticipated by proposers in their offers. As a result, uncertainty drove a greater frequency of disagreements.

One possible explanation for this mismatch may be differences in how proposers expect regret to influence responders and how regret actually influences responders. Specifically, when we made regret salient to responders, offers in the Lottery UG were only modestly lower than when regret was not salient. By contrast, responders reported a significantly lower acceptance threshold when regret was salient relative to when it was not. One interpretation is that proposers believe that responders will be motivated by regret whether or not it is salient, while responders are in fact only motivated by regret when it is salient. Note that, even after making regret salient, it remains the case that proposers offer significantly less in the risky ultimatum game than in the standard ultimatum game, while responders demand insignificantly more. Future work should explore the underlying causes of the remaining mismatch and, in particular, the potential role that incomplete information about responder types plays.

We also uncovered evidence of a choice anomaly amongst responders. Specifically, despite having strictly positive minimum acceptance thresholds in both the standard and risky ultimatum games, many responders were willing to accept the $(0,6)$ outcome – 0 for self – when they were able to accept or reject the proposal after the uncertainty surrounding the allocation was resolved. Proposers might use such knowledge to improve their bargaining position, for example presenting offers as contingent on uncertain events.

The reasons for this choice anomaly remain unclear, not least because we found only weak evidence that proposers' intentions attenuated *ex-post* reciprocity. It may be that some responders are able to adopt an *ex-ante* perspective and reason that they would have accepted the proposal before the realization of uncertainty, so they should accept it after. But a non-trivial fraction of responders accepted even after receiving offers below what was acceptable to them in the standard ultimatum game. Another possibility is that the mediation of outcomes via a random device changes the psychological nature of *ex-post* rejection, absolving the proposer of some responsibility that would have otherwise been attributed to him.

To get a clearer sense of the underlying cause of this choice anomaly, further research is needed to observe a sufficient number of proposals that are low enough to truly test responders' thresholds. Nevertheless, the results give us pause, because they reveal that – when confronted with extreme inequality arising from the allocation of risk – subjects are more willing to accept such an outcome than they might otherwise report.

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