Indifference or indecisiveness: a strict discrimination

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1 May 2017

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September 18, 2017

Abstract

We develop a new approach to directly and strictly distinguish indecisiveness from indifference. In our approach experimental subjects face a list of pairs of options. Besides the standard choice of choosing one option out of the pair (the binary choice), we also allow experimental subjects to randomize over the two options by choosing probabilities according to which either option determines the payoffs (the randomized choice). Furthermore, we elicit subjects' willingness to pay (WTP) of using the randomized choice via a modified multiple price list method. We show that subjects might strictly prefer the randomized choice over the binary choice when they are indecisive. Our results suggest that (1) the vast majority of subjects randomized actively; (2) subjects took longer time to make strictly randomized decisions; (3) subjects were willing to pay a strictly positive amount of money to randomize, and they were willing to pay more for randomized choices with randomizing probabilities close to 0.5 than those with randomizing probabilities close to 0 or 1. These results provide strong evidence for the existence of indecisiveness in choices. More importantly, it suggests that there might exist significant welfare losses when indecisive individuals are forced to make all-or-nothing decisions against their potentially incomplete preferences.

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Key words: indecisiveness, indifference, experiment, randomized choices
JEL classification: C91, D81

1 Introduction

Indecisiveness is a widely observed phenomenon in real life with yet little economic studies of its existence and implications. In a standard economic setting, an individual is often assumed to have complete preferences and hence no avenue is provided for the individual to express his indecisiveness. As a result, indecisiveness is often masked and/or treated as indifference. Such identification problem exists in all elicitation technique which relies on indifference, such as in studies to measure time discount rates in inter-temporal choices (see, e.g., the references in Frederick et al., 2002), to obtain the valuation of a good (see e.g., Andersen et al., 2006), to estimate risk attitudes (Holt and Laury, 2002), and to assess probability estimates (Trautmann and Kuilen, 2015). Since indecisiveness is not an anomaly or error, its denial has extensive implications. Confusing indecisiveness with indifference could lead to measurement biases in the estimation of time preferences, valuations, risk attitudes, and probability estimates. More generally, there might exist significant welfare losses when indecisive individuals are forced to make all-or-nothing decisions against their true, potentially incomplete preferences.

The primary objective of this paper is to provide a mechanism for individuals to express indecisiveness and to allow us to strictly discriminate indecisiveness from indifference through individuals' choices. Our focus is on the type of indecisiveness that arises from distinct conflicting underlying motives facing an individual (Levi, 1986; Dubra et al., 2004; Eliaz and Ok, 2006), and its resultant indecisive behavior as deliberate randomization (Agranov and Ortoleva, 2017). We study indecisiveness in an ultimatum game with a novel design. We choose the ultimatum game as a working horse for its receiver is known for facing distinct conflicting motives: to maximize own gains versus to be treated fairly. These motives correspond nicely to the different utility functions that individuals may have when they have incomplete preferences (Dubra et al., 2004; Eliaz and Ok, 2006). We exploit the presence of these conflicting motives to study the prevalence and welfare implications of indecisiveness.

In an ultimatum game, a proposer offers a payoff distribution, and a receiver can decide to accept or reject the offer (binary choice). Both receives the proposed payoff distribution when the receiver accepts, and both receive zero when the receive rejects. We depart from the standard ultimatum game by allowing receivers to combine the two choices and build a randomized choice in addition to making the standard binary choice (accept or reject). In addition, we also asked receivers for their willingness to pay (WTP) to use the randomized choice instead of the – free – binary choice to determine their final payoff. This helps us to rule out "cheap talk" in utilizing randomized choices and to establish the presence of welfare gains from allowing indecisiveness, if any. We show that all important models of complete preferences predict no strictly randomized choices, let alone paying to use them. However, when subjects have incomplete preferences and would like to complete them using rules as those in Cerreia-Vioglio et al. (2015) or in Qiu (2015), they may strictly prefer the randomized choices over the binary choice. In Section 3 we offer a concrete example to illustrate this point.

We have three main findings. First, the vast majority of subjects (over 90%) made randomized choices. Among those who randomized, they randomized for half of the possible allocations (53% of the allocations on average). The extensive use of randomized choice suggests that complete preferences are rare in scenarios involving conflicting motives, such as the ultimatum game, and indecisiveness is a common human behavior that should not be neglected.

Second, subjects took significantly longer time to make strictly randomized decisions than to make decisions in which the randomized probability is 0 or 1. This result is consistent with indecisive behavior rather than indifference. When subjects are indifferent towards options, they would spend less time on the decision because the choices are equally attractive and time is costly. In contrast, when subjects are indecisive towards an allocation, they would spend more time to contemplate on the allocation as they face conflicting motives, which is supported by our results.

Finally, we find that subjects were willing to pay a strictly positive amount of money to randomize, and they were willing to pay more for randomized choices which have randomizing probabilities close to 0.5 than those with randomizing probabilities close to 0 or 1. This finding is important because it not only shows that the randomized choices are deliberate and meaningful rather than cheap talk, it also shows that there are benefits to the subjects from being allowed to make randomized choices. Together, the result reinforces the earlier point that indecisiveness is a common human behavior, and providing a channel that allows people to express indecisiveness is welfare enhancing.

Our paper relates to studies on incomplete preferences and indecisiveness. Danan and Ziegelmeyer (2006) found that subjects postponed choices even when postponing was costly, and they interpreted a preference for flexibility - postponing choices – as an evidence for indecisiveness. In Agranov and Ortoleva (2017), subjects facing the same choice set deliberately randomize (choosing one option in some choices and choosing another option in other choices) even though they were told that the same choices were repeated three times. Dwenger et al. (2014) found that decision makers sometimes preferred delegating the decision to an external random device, e.g., a coin flip. In a similar vein, Cettolin and Riedl (2015) allowed subjects to select an indifference option in addition to choosing one option out of the two options. When the indifference option was chosen, the choice was delegated to a fair random device, e.g., a coin flip. Choosing indifference option multiple times was interpreted as an evidence for indecisiveness. They found that about half of the subjects can be attributed to have incomplete preferences.

Our paper is an improvement over previous attempts to distinguish indifference and indecisiveness in three ways. First, our subjects choose their own probabilities of randomization between the two options, instead of using an exogenously given random device, e.g., flipping a coin. We believe it reduces some confounding effects, e.g., the possibility of regret aversion that could be present in Dwenger et al. (2014) and Cettolin and Riedl (2015).[1] Second, in the ultimatum game, the receiver's payoff following acceptance or rejection is certain, hence the randomized choice is a simple lottery. This allows for a more direct

[1] In Dwenger et al. (2014) and Cettolin and Riedl (2015) subjects are assumed to regret only over active choices should those choices deliver bad consequences. Delegating choices to an external random device is seen as a passive decision and thus involves no regret. Here the randomized choices are also active.

identification of indecisiveness. In contrast, the randomized choice becomes a compound lottery when options are risky or ambiguous lotteries (as in e.g., Cettolin and Riedl, 2015). To evaluate the randomized choice, we need some additional rules to reduce the compound lottery. Violations from standard decision models could be due to either indecisiveness or violations of rules to reduce compound lotteries. Third, we additionally elicit the WTP for the use of randomized choices over the binary choices. Subjects need to pay a strictly positive amount in order to implement the randomized choices to determine their final payoffs. Willingness to do so strictly discriminates indecisiveness from indifference. More importantly, it demonstrates the welfare loss resulting from having to make all-or-nothing decisions in the absence of a mechanism which allows them to express their indecisiveness.

Our paper proceeds as follows. Section 2 reports the experimental design. Section 3 derives the benchmark solutions under all major decision theories. Experimental results are reported in Section 4. Finally, Section 5 discusses some important implications and concludes.

2 Experimental design

Our experiment is built on a (modified) ultimatum game with a proposer and a receiver over the distribution of €20. The experiment consists of three stages. Binary choices are elicited in Stage 1. Subjects face two options and they pick one option out of the two. Stage 2 elicits randomized choices. Subjects are allowed to combine the two options from Stage 1 to build a randomized choice. Stage 3 elicits subjects' WTP. Having made the binary choices and the randomized choices, subjects decide which choices they wish to implement to determine their final experimental payoffs. The use of binary choices is always free of charge but subjects need to pay a fee if they wish to use the randomized choices.

We have chosen a symmetric design in which we elicit three choices – the binary choice, the randomized choice, the willingness to pay for using the randomized choice – from both the proposer and the receiver. Our focus is on the receiver. The receiver faces no risk or uncertainty when deciding to accept or reject. This eliminates the possibility of indecisiveness due to multiple priors (Ok et al., 2012). The proposer, on the other hand, faces strategic uncertainty of not knowing whether the receiver would accept or reject an allocation, and the indecisiveness might also come from beliefs.

Below we explain the detailed procedure. Decision screens are provided in Appendix: decision screens.

2.1 Binary choices

In Stage 1 we elicit subjects' binary choice via the strategy method (see, e.g., Selten, 1967; Brandts and Charness, 2011). The proposer faces a randomized sequence of pairs of allocations. Each pair of allocation comprises of an equal allocation (€10, €10) and an unequal allocation (€$20 - a$, €a), where $a \in \{0, 1, 2, ..., 9\}$ is the payoff of the receiver. The proposer has to decide which of the two allocations to propose to the receiver. The receiver is informed that the proposer will decide whether to propose an unequal allocation or an equal allocation, and the receiver's decision is to decide whether to accept the offer. If the receiver accepts the allocation, the proposer and the receiver receive the proposed allocation, and both receive €0 if the receiver rejects the proposal. However, the receiver has to decide whether to accept or reject all possible allocations that could be made by the proposer before the proposer's actual allocation is revealed. In other words, between two allocations, one equal and one unequal, the receiver has to decide whether to accept or reject if the proposer proposes the unequal allocation. For completeness, the receiver is also asked to decide, for any pair of allocations (€10, €10) and (€$20 - a$, €a), $a \in \{0, 1, 2, ..., 9\}$, whether to accept or reject if the proposer proposes the *equal* allocation.

2.2 Randomized choices

In Stage 2, both the proposer and the receiver are told that they can make a different decision for each pair of allocations. The receiver is told that, instead of choosing acceptance or rejection, they can assign a probability, p, to acceptance and $1 - p$ to rejection, where $0 \leq p \leq 1$. The value of p is understood as the probability according to which payoffs are determined by acceptance or rejection. For example, if the receiver indicates a decision of $(0.4, Acceptance; 0.6 Rejection)$ for the unequal offer, a random draw determines that the proposed unequal allocation is accepted with a chance of 40% and is rejected with a chance of 60%. The probabilities are in an increment of 10%, thus one can choose $p\% = \{0, 10\%, 20\%, 30\%, ..., 100\%\}$. When the slider is moved, the p under acceptance, $100-p\%$ under rejection, and the $p\%$ above the slider change to reflect the decision. Figure 1 provides an illustration of the receiver's decision screen.

Similarly, the proposer, instead of choosing one allocation, can combine the two allocations. The combination is done by assigning a probability that the proposer would like either allocation to be proposed to the receiver. In the experiment subjects the slider to choose the probability p of unequal allocation. The probabilities are in an increment of 10%. Thus, one can choose $p\% = \{0\%, 10\%, 20\%, 30\%, ..., 100\%\}$. When the slider is moved, the $p\%$ under Allocation 1, $100 - p\%$ under Allocation 2, and the $p\%$ above the slider change to reflect the decision. Figure 12 in Appendix: decision screens provides an illustration of the proposer's decision screen.

Our intent of having subjects make randomized choices after binary choices is to allow subjects to see simple, binary choices before encountering the more complex situations. But this gives subjects an opportunity to contemplate on their decisions, and, as a consequence, it could improve the completeness of subjects' preferences. This reduces the possibility of observing indecisive choices, and the evidence of indecisiveness would be stronger if we observe it nonetheless. Thus, our design represents a conservative test of indecisiveness.

2.3 WTP

In Stage 3, one pair of allocations is randomly chosen by the computer for each subject. We elicit subjects' WTPs for the random chosen pair by asking them how much they are willing to pay to implement the randomized choice they have made earlier for that allocation pair. Stating a willingness to pay of €0 dollars will imply that they are unwilling to pay for the randomized choices and prefer to implement the binary choices. On the contrary, stating a positive WTP implies that subjects strictly prefer the randomized choices to the binary

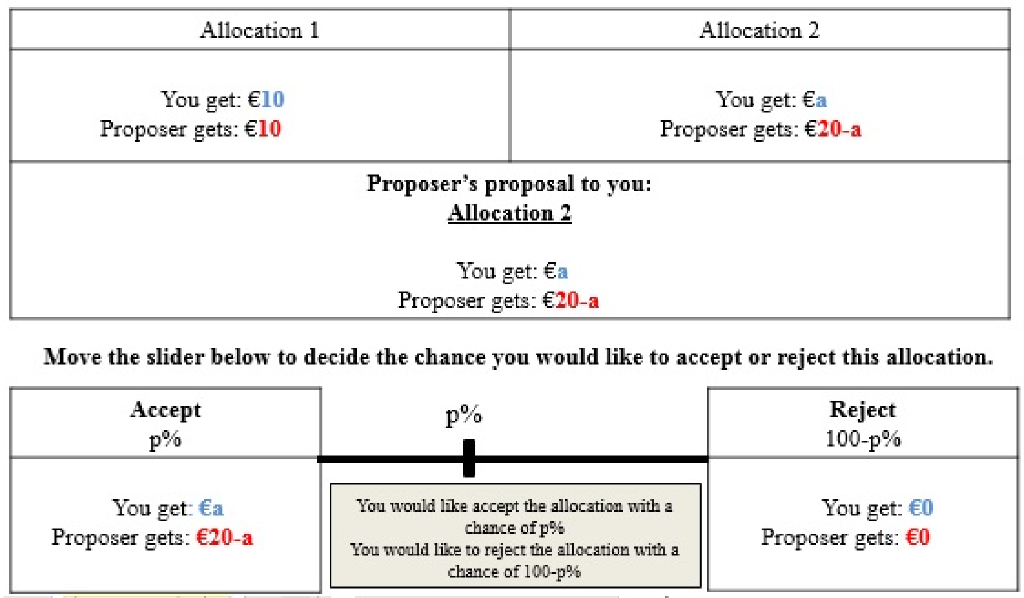

Figure 1: The elicitation of the receiver's randomized choices. The probabilities are in an increment of 10%, $p\% = \{0\%, 10\%, 20\%, 30\%, ..., 100\%\}$. When the slider is moved, the $p\%$ under Accept, $100 - p\%$ under Reject, and the $p\%$ above the slider change to reflect the decision.

Allocation 1	Allocation 2	Suppose the proposer proposes	Your single choice	Your combined choice
You get: €a The proposer get: €20-a	You get: €10 The proposer get: €10	Allocation 1 You get: €a The proposer get: €20-a	Accept Or Reject	Accept the proposed allocation p% of times Reject the proposed allocation 100-p% of times

For each fee stated in the table below, indicate whether you are willing to pay that fee to use the combined choice to determine your decision.

Fee	I want	I do not want
0	☐ to use the combined choice	☐ to use the combined choice
0.2	☐ to pay the fee of 0.2 to use the combined choice	☐ to pay the fee of 0.2 or higher to use the combined choice
0.4	☐ to pay the fee of 0.4 to use the combined choice	☐ to pay the fee of 0.4 or higher to use the combined choice
⋮	⋮	⋮
1.8	☐ to pay the fee of 1.8 to use the combined choice	☐ to pay the fee of 1.8 or higher to use the combined choice
2	☐ to pay the fee of 2.0 to use the combined choice	☐ to pay the fee of 2 or higher to use the combined choice

Figure 2: The decision screen of the elicitation of the receiver's WTP for the use of the randomized choice. After subjects confirm decisions for all rows, one row is randomly chosen by the computer, and the preferred option at this row determines whether subjects' randomized choice is implemented. The proposer's decision screen is similar, except that the decision is about which allocation to propose.

choices and are hence willing to pay to implement them.

We elicit subjects' WTPs via a modified multiple price list method rather than the Becker, De Groot and Marschak mechanism to avoid potential issues with the BDM mechanism (Plott and Zeiler, 2005). Subjects face a table with 11 rows. In each row, subjects have to decide whether to pay the stated fee to implement the randomized choice to determine the final payoff, or not to pay the fee and to use the binary choice instead to determine the final payoff. The fee ranges from €0 to €2, with an increment of €0.2. Subjects are told that one of the rows will be randomly chosen by the computer, and the chosen option in that row determines whether subjects' randomized choices are implemented as well as the corresponding fees for doing so.

Figure 2 illustrates the decision screen for the elicitation of the WTP for using the randomized choice. In the experiment a revision screen appears after subjects click OK. In the revision screen subjects can confirm their choices or make adjustments.

There are two WTPs for the receiver for the randomly chosen pair. The receiver is asked for the WTP if the unequal allocation out of the pair is proposed, and, for completeness, also the WTP if the equal allocation is proposed. We focus on the WTP conditional on an unequal allocation.

Since subjects' WTPs depend on the randomized choices that were specified earlier, a plausible concern is whether their randomized choice decisions are incentive compatible (see e.g., the trade-off method in Qiu and Steiger, 2011). This concern does not exist in our experimental design. To see this, one can apply a backward induction argument as in extensive form games with complete information: given any randomized choices, our modified multiple price list method elicits the player's true WTP, and given the incentive compatible WTP after any randomized choices, it is the best interest of the receiver to specify the optimal – in the sense of maximizing the receiver's decision utility based on his or her decision model – randomized choice for any pair of allocations. Thus it is the unique subgame perfect equilibrium for the receiver to construct the optimal randomized choices for any pair of allocations in Stage 2 and reports the true WTP for the use of the randomized choice for the randomly chosen pair of allocations in Stage 3.

The experiment was run in the DISCON lab in Radboud University. Recruitment was done via ORSEE (Greiner, 2015). We had 4 sessions with 100 subjects in total. The experiment lasted about an hour, and the average payment was €11.62.

3 Benchmark solutions

Consider a proposer who suggests an unequal payoff distribution $(20 - a, a)$, where $20 - a$ stands for the payoff of the proposer and a stands for the payoff of the receiver. The receiver decides whether to accept (denote by A) or reject (denote by R) the proposed payoff distribution. Below we derive benchmark solutions under the expected utility (EU) theory , under some popular non-EU theories, and under models of incomplete preferences.

3.1 Benchmark solutions under EUT and some popular non-EU theories

Prediction under EUT: $p \in (0,1)$ occurs only when subjects are indifferent between A and R, and WTP$=0$ for all p.

Proof: This result follows directly from the independence axiom. Suppose $A \succ R$, then by the independence axiom $pA + (1-\lambda)A \succ pR + (1-p)A \, \nabla p \in (0,1)$. A randomized choice of A and R offers no utility gain than the binary choice, and thus WTP$=0$. The other case $A \prec R$ can be shown similarly.

Prediction under some popular non-EU theories, such as (cumulative) prospect theory, rank dependent utility theory (Quiggin, 1982), and Guls (1991) disappointment aversion theory: Similar to EUT, $p \in (0,1)$ occurs only when subjects are indifferent between A and R, and WTP$=0$ for all p.

Proof: The lottery $(p, A; 1-p, R)$ which accepts the unequal payoff distribution $(20-a, a)$ with probability p and rejects it with probability $1-p$ is a binary prospect, and in the evaluation of binary prospects, (cumulative) prospect theory, rank dependent utility theory **(Quiggin, 1982)**, and Guls (1991) disappointment aversion theory gives qualitatively the same evaluation (Observation 7.11.1 in Wakker, 2010, p. 231). Below we illustrate the proof under (cumulative) prospect theory. With a slight abuse of notations, let $v(\cdot)$ denote the value function, $V(\cdot)$ denote the prospect value of a lottery, $w(\cdot)$ denote the probability weighting function. Suppose $A \succ_{CPT} R$, where $\succ_{CPT}$ denotes a strict preference relation implied by CPT. Under CPT we have$V(A) = v[(20-a, a)] > V(R) = v[(0,0)]$. Consider now $pA + (1-p)R$. By CPT we have $V[pA + (1-p)R] = w(p)v[(20-a, a)] + [1 - w(p)]v[(0,0)] = v[(0,0)] + w(p)[v[(20-a, a)] - v[(0,0)]]$. Since $w(p)$ increases with p, we have $p = 1$ when $A \succ_{CPT} R$. Thus randomization offers no gain and WTP$=0$. The other case $R \succ_{CPT} A$ can be shown similarly.

3.2 Benchmark solution under incomplete preferences

Indecisiveness could result from beliefs, i.e., multiple priors, or from tastes, i.e., multiple utility functions (Ok et al., 2012). Indecisiveness from beliefs plays no role in our study, and we focus on indecisiveness from tastes.

Specifically, let C be a compact metric space, and $c \in C$ be an outcome. A risky lottery $l \in L$ is then a Borel probability measure over C. Let $\succeq$, an individual's preference over L. Dubra et al. (2004) suggest that when individuals' preferences are incomplete, there exists a set $\{u_\tau\}_{\tau \in \mathit{\Gamma}}$ of real functions on L such that, for all lotteries l_1 and l_2,

$$l_1 \succeq l_2 \Longleftrightarrow \int_C u_\tau\,(c)\,dl_1 \geq \int_C u_\tau\,(c)\,dl_2\;\nabla\tau \in \mathit{\Gamma}.$$

The construction of an individual having a set of utility functions instead of a unique utility function is related to the idea of multiple selfs within an individual that has conflicting motives. The intra-personal conflict leads to difficulties in making a decision and hence the incompleteness in preferences (Levi, 1986; Eliaz and Ok, 2006). When forced to make a decision nonetheless, individuals apply rules to complete their incomplete preferences. We consider the two models for such a completion: Cerreia-Vioglio et al. (2015) and Qiu (2015).

Cerreia-Vioglio et al. (2015) suggest a model in which any alternatives l is evaluated according to the function $V(\cdot)$,

$$V(l) = inf_{\tau \in \mathit{\Gamma}} CE(l, u_\tau).$$

Thus individuals evaluate alternatives according to the utility function giving the lowest certainty equivalent. They show that their representation can be "derived from a cautious completion of incomplete preferences" (Cerreia-Vioglio et al., 2015, page 693).

Qiu (2015) constructed a model with an axiomatic foundation that explicitly attempts to complete incomplete preferences. His representation theorem states that, an alternative l is evaluated as

$$V(l) = \int_{\mathit{\Gamma}} \phi\,[EU_\tau(l)]\,d\pi,$$

where $EU_\tau(l)$ is the expected utility of the alternative l conditional on the utility function u_τ, and$\phi(\cdot)$ concavely transforms $EU_\tau(l)$.

To establish a more precise correspondence between the value of p and the incomplete preferences of the receiver, we make further assumptions about the set of the receiver's utility functions in our decision framework. We assume the receiver has two selfs: a material payoff driven self and an inequality averse self. Specifically, given a payoff distribution $(20-a, a)$, the material payoff driven self has the utility function:

$$u_S(20-a, a) = a.$$

The inequality aversion self cares only the inequality of the payoff distribution, which is captured by $|20-2a|$. Note that in our design $20-a \geq a$, and thus we write the utility function of the inequality averse self as

$$u_F(x, y) = k - \gamma(20-2a),$$

where $k > 0$, γ captures the individual's sensitivity to inequality. Such an utility construction for the inequality averse self is consistent with, for example, Fehr and Schmidt (1999). We derive our benchmark solution according to Cerreia-Vioglio et al. (2015). In this model the receiver is extremely cautious and considers only the utility function with the lowest certainty equivalent. To illustrate the intuition more directly, we have chosen to work directly with the decision utility instead of with the certainty equivalent.

We first consider a simple numerical example for illustration before proceeding to derive the full solution. Suppose the values of $(20-a, a)$, k, and γ are constructed such that $u_S(20-a, a) = 1$ and $u_S(0,0) = 0$, and $u_F(20-a, a) = 0.2$ and $u_F(0,0) = 0.8$. Let A denote the acceptance and R denote the rejection of the receiver. The decision utility of acceptance is

$$V(A) = min\left\{u_S(20-a, a), u_F(20-a, a)\right\} = 0.2,$$

and the decision utility of rejection is

$$V(R) = min\left\{u_S(0,0), u_F(0,0)\right\} = 0.$$

When the receiver randomizes and chooses the lottery$(p, A; 1-p, R)$, where $0 \leq p \leq 1$, the decision utility is:

$$\begin{aligned} V(p, A;(1-p), R) &= min\left\{pu_S(20-a, a)+(1-p)u_S(0,0), pu_F(0,0)+(1-p)u_F(20-a, a)\right\} \\ &= min\left\{p, 0.8p+0.2(1-p)\right\}. \end{aligned}$$

Thus, there exists a unique $p^* = 0.5$ that maximizes the decision utility, which is $V(0.5, R; 0.5, A) = 0.5$. We can see that $V(0.5, R; 0.5, A) = 0.5 > V(A) = 0.2 > V(R) = 0$. This implies that the receiver is strictly better off by randomizing between A and R.

More generally, with our assumption on utility functions, we have:

$$V(A) \quad = \quad min\left\{u_S(20-a, a), u_F(20-a, a)\right\} = min\left\{a, k-\gamma(20-2a)\right\},$$

and

$$V(R) = min\left\{u_S(0,0), u_F(0,0)\right\} = min\left\{0, k\right\} = 0.$$

We would like to focus on payoff distributions $(20-a, a)$ over which there is a different utility ranking over A and R. Otherwise decision situation becomes trivial; the receiver has a complete preferences. Specifically, we are interested in situations where $u_S(20-a, a) > u_F(20-a, a)$ and $u_S(0,0) < u_F(0,0)$. The two conditions imply $a > k-\gamma(20-2a)$ and thus

$$V(A) \quad = \quad min\left\{u_S(x, y), u_F(x, y)\right\} = k-\gamma(20-2a).$$

Proposition 1. *When the receiver is indecisive, i.e.,* $u_S(20-a, a) > u_F(20-a, a)$ *and* $u_S(0,0) < u_F(0,0)$*, the receiver has a strict preference for randomization.*

Proof: When individual randomizes and builds a lottery$(p, A; 1-p, R)$, the decision utility of such a lottery is:

$$\begin{aligned} V(p, A;(1-p), R) &= min\left\{pu_S(20-a, a)+(1-p)u_S(0,0), pu_F(20-a, a)+(1-p)u_F(0,0)\right\} \\ &= min\left\{(pa, k-p\gamma(20-2a)\right\}. \end{aligned}$$

The optimal p^*maximizes $V(p, A;(1-p), R)$ can be calculated as

$$p^* = \frac{k}{20\gamma-(2\gamma-1)a}. \tag{3.1}$$

The receiver is indecisive when $a > k - \gamma(20 - 2a)$, and in that case we have $0 < p^* < 1$. With the optimal p^* the decision utility of $(p^*, A; 1 - p^*, R)$ becomes

$$V(p^*, A; (1 - p^*), R) = \frac{ka}{20\gamma - (2\gamma - 1)a}.$$

It is clear that $V(p^*, A; (1 - p^*), R) > 0$. It can also be shown that $\frac{ka}{20\gamma-(2\gamma-1)a} > k - \gamma(20 - 2a)$.[2] Thus, when the receiver is indecisive, i.e., $u_S(20 - a, a) > u_F(20 - a, a)$ and $u_S(0, 0) < u_F(0, 0)$, the receiver has a strict preference for randomization. Q.E.D.

In Equation 3.1 the optimal p^*– the probability of acceptance – increases with a when $\gamma > 1/2$. Experimental evidences suggest that virtually all receivers reject the offer when $a = 0$ and accept it when $a = 10$. This implies $\gamma > 1/2$, i.e., the receiver is relatively sensitive to inequality. In the analysis below we impose $\gamma > 1/2$.

Proposition 2. *When the receiver is indecisive, i.e., $u_S(20 - a, a) > u_F(20 - a, a)$ and $u_S(0, 0) < u_F(0, 0)$, the WTP for the use of the randomized choice first increases with p^* when p^* is below a threshold, and it decreases with p^* when p^* exceeds that threshold. .*

An intuition of the above proposition is as follows. When a is sufficiently small (or sufficiently large), the receiver would simply reject (or accept, respectively) the offer, and there is no utility gain from randomization, which implies a WTP of zero. Proposition 1 suggests that there is a range where the receiver strictly prefers randomization. Together we know that the relationship between the WTP and p^* is non-monotonic. For a rigorous proof, please see Appendix: proof for proposition 2. The utility gain from randomization peaks at a threshold. It can be shown that the threshold is $p^* = \frac{2\gamma k}{20\gamma+2k\gamma-k}$, which depends on k and γ, or more generally on the functional assumptions of different selfs. We can however make some reasonable speculation about this value. Note that the difference between the decision utilities of the material payoff-driven self and the inequality averse self when the receiver accepts a payoff distribution of $(20 - a, a)$ is $a + \gamma(20 - 2a) - k$. The difference between the decision utilities of the inequality averse self and the material payoff-driven

[2]To see this, note that $k - \gamma(20 - 2a) = \frac{1}{20\gamma-(2\gamma-1)a} [k - \gamma(20 - 2a)] \times [20\gamma - (2\gamma - 1)a] = \frac{1}{20\gamma-(2\gamma-1)a} \{ka + \gamma(2a - 20) [20\gamma - (2\gamma - 1)a - k]\} < \frac{ka}{20\gamma-(2\gamma-1)a}$. The last inequality follows from $20\gamma - (2\gamma - 1)a - k > 0$ and $\gamma(2a - 20) < 0$.

self rejecting a proposal, resulting in a payoff distribution of $(0, 0)$, is k. The conflict is the strongest and the receiver is most indecisive when $a + \gamma(20 - 2a) - k = k$, as the two utility functions exerts equal "push" on the individual in the opposite direction. We have $p^* = 0.5$ when $a + \gamma(20 - 2a) - k = k$. In this sense, the receiver chooses a randomization probability close to $p^* = 0.5$ for the allocation where s/he is the most indecisive.

The intuition of a preference for randomization when preferences are incomplete can be most easily seen by drawing a comparison with a group decision making where members have different preferences. Suppose a loving couple is thinking of going on a date. The wife wants to go to see a movie, while the husband prefers to watch a football match. Together they are indecisive: they want to be together, but there is no easy solution. In this case, as one can easily imagine, a solution that both would happily accept is to flip a coin, i.e., a randomized choice. Sure enough, the above example is about two persons making one decision, not two selfs in one individual to make a decision. But we believe the same intuition applies. We think the randomized choice offers the acknowledgment of conflicting motives, and it is a fair solution to resolve the intra-personal conflict.

4 Experimental results

Overall we find that 92% of the subjects (46 out of 50 receivers and 46 out of 50 proposers) chose p>0 and p<100 in the randomized choice. In other words, more than 90% of the subjects displayed some degree of indecisiveness, while less than 10% had complete preferences. Of those with incomplete preferences, they made randomized choice for more than half of the possible allocations (average numbers of allocations where randomized choice is made are 53.0% for receivers and 53.5% for proposers). We report the results below. Our primary focus is on the receivers, thus below we discuss only the results of the receivers, and move results of the proposers to Appendix: results for proposers.

4.1 Results on binary choices and randomized choices

Figure 3 reports the relationship between the receiver's acceptance probability and the proposed share out of €20. Consistent with previous research, receivers tend to reject low offers. The median acceptance probability is 0 for allocations giving €2 or less to the receivers . When the allocated share to the receiver improves, receivers became increasingly likely to accept the allocation. The median acceptance probabilities are 0.1 when the receiver's share is €3, 0.2 for €4, 0.5 for €5 and €6, 0.7 for €7, 0.9 for €8, and 1.0 for €9 or €10, respectively. This result is consistent with equation 3.1 in subsection 3.2, as the acceptance probabilities increase with the receiver's share a.

For each allocation receivers made two choices: the binary choice of either acceptance or rejection, and the randomized choice of acceptance and rejection. In Figure 3 we also report the population acceptance ratios – the square with cross in the figure – in binary choices for each proposed allocation. In general, the population acceptance ratios are quite close to the median acceptance probabilities. One way to interpret the results is by treating the receivers collectively as a representative agent and group members as different selfs with different utility functions. The population acceptance ratios can then be seen as the acceptance probability of the representative agent. In this sense, the decision of the representative agent with members of different preferences mimics the median randomized choice of the receivers. This idea fits nicely with the fundamental construction of models of incomplete preferences (Dubra et al., 2004; Cerreia-Vioglio et al., 2015; Qiu, 2015), where individuals are assumed to have a set of utility functions.

Comparing the population acceptance ratios with the individual acceptance probabilities reveals that the population acceptance ratios are in general higher than the individual acceptance probabilities.[3] This seems to suggest that the receivers are more likely to

[3]Except for a proposed share of €5. Two-sided Wilcoxon rank sum tests of individual acceptance probabilities against population acceptance ratios as the means suggest that the difference is highly significant for a proposed share of €0, €1, and €2 ($p - value < 0.01$), significant for a proposed share of €7 ($p - value < 0.05$), and weakly significant for a proposed share of €8 ($p - value < 0.10$), and not significant for a proposed share of €3, €4, €5, €6, and €9 ($p - value > 0.10$).

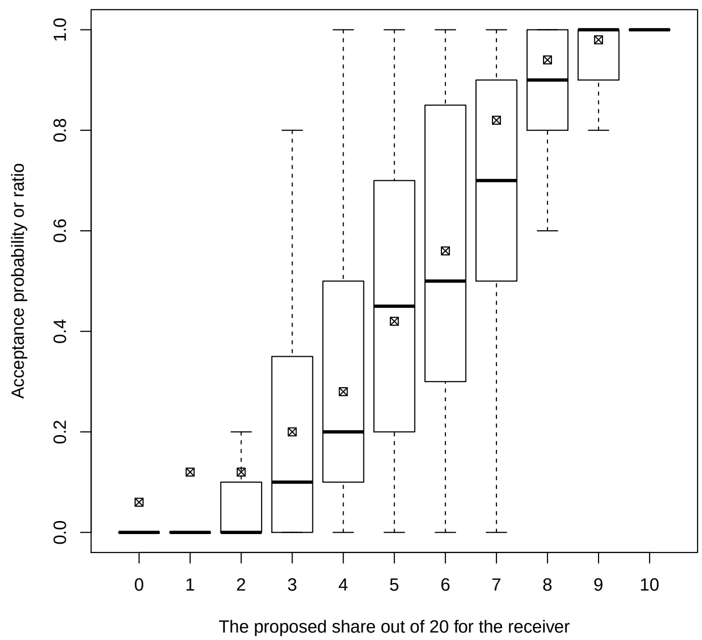

Figure 3: A boxplot of the receivers' acceptance probability and the proposed share out of €20. The squares with cross denote the population acceptance ratios in binary choices.

accept an allocation if they face only binary choices. In the example of Section 3 we propose to capture the receiver's preference with two selfs: the material payoff driven self and the inequality averse self. The utilities associated with different selfs are $u_F(20-a, a) = k + 2\gamma(a-10)$ and $u_S(20-a, a) = a$, and the difference of utilities from acceptance between the two selfs is $a(2\gamma - 1) + k - 20\gamma$, while $u_F(0,0) = k$ and $u_S(0,0) = 0$ and the difference of utilities from rejection between the two selfs is fixed at k. It can easily be verified that $a(2\gamma - 1) + k - 20\gamma < k$ holds for any $0 \leq a \leq 9$ and $\gamma > 0$. The above result thus suggests that the two selfs disagree less on the utilities from acceptance than on the utilities from rejection. This result is consistent with the models on the completion of incomplete preferences, where individuals, when forced to make a choice, favor the option over which they are less indecisive, i.e., the difference of utilities from different selfs is smaller.

Our findings also support our derivation in subsection 3.2 which argues that the receiver chooses a randomization probability close to 0.5 when the tension is the largest. To see this clearly, we examine the data both at the individual receivers level, and at the aggregate level. At the individual level, for each receiver, we define the lower threshold $\underline{a}$ as the value for which the receiver still rejects but accepts $\underline{a}+1$ for the first time, and the upper threshold $\overline{a}$ as the value for which the receiver accepts but rejects $\overline{a}-1$ for the last time. Thus, at $\underline{a}$ we have $V(A) \leq V(R)$, and at $\overline{a}$ we have $V(A) \geq V(R)$. [4] We then identify the receiver's acceptance probabilities at $\underline{a}$ and $\overline{a}$. Those probabilities provide insights into the connection between the receiver's binary choices and her/his indecisiveness. We find that the median $\underline{a}$ and $\overline{a}$ are 5 and 6, respectively (the mean $\underline{a}$ and $\overline{a}$ are 4.47 and 5.80, respectively), and the corresponding median acceptance probabilities at $\underline{a}$ and $\overline{a}$ are 0.3 and 0.7, respectively (the mean acceptance probabilities at $\underline{a}$ and $\overline{a}$ are 0.32 and 0.67, respectively). On the aggregate level, we observe that at $a = 5$ or 6 the receivers chose a median acceptance probability close to 0.5 (0.55 when $a = 5$, and 0.5 when $a = 6$.).[5] Furthermore, the standard deviations of acceptance probabilities are among the highest with those two allocations.[6] Those results suggest that receivers are relatively confident with their choices when $a < 5$ or $a > 6$, as their acceptance probabilities are far away from 0.5, and they are highly indecisive for $a = 5$ or 6, as they choose an acceptance probability close to 0.5. A more detailed result is reported in Figure 4.

4.2 Decision time and acceptance probability

There is evidence that people make slower decisions as they approach the switching pairs (see e.g., Chabris et al., 2009). Our data exhibits a similar pattern. Figure 5 depicts the

[4] For receivers who switch once from rejection to acceptance with the increase of a, $\overline{a} - \underline{a} = 1$. For receivers who switch multiple times from rejection to acceptance with the increase of a, $\overline{a} - \underline{a} > 1$. Consider, for example, subject Nr. 18 whose binary choices are (Reject at $a \leq 4$; Accept at $a = 5$; Reject at $6 \leq a \leq 9$; Accept at $a = 9$ or 10), we have $\underline{a} = 4$ and $\overline{a} = 9$.)

[5] The acceptance probabilities in our experiment take only the values of $\{0.1, 0.2, ..., 1.0\}$. The median value of 0.55 is due to statistical reporting. Apparently there are exactly the same number of observations with $p \leq 50$ and $p \geq 60$. As a result, the median value is reported as 0.55.

[6] The standard deviations of the acceptance probabilities at $a = 5$ or 6 are second to that of $a = 4$.

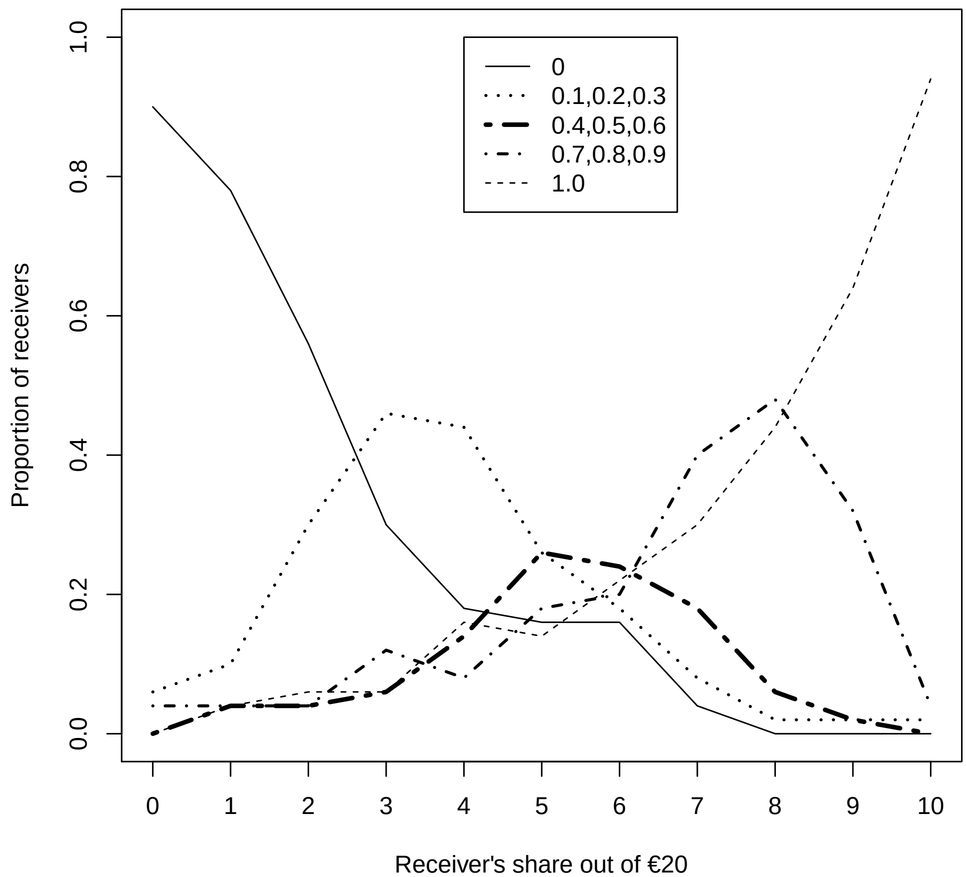

Figure 4: Y-axis is the proportion of receivers with the associated acceptance probabilities, x-axis is the receiver's shares (out of €20) in the allocation. Different line types capture acceptance probabilities in different ranges.

result.[7] As we can see, the median decision time has an inverse U-shaped pattern in relation to acceptance probabilities. The decision time is shorter when acceptance probabilities are near 0 or 1, with median decision time stands around 15 seconds (16.37 seconds for acceptance probabilities of 0 and 14.73 seconds for acceptance probabilities of 1), increases to 19.00 seconds for acceptance probabilities of $p = 0.1, 0.2, 0.3$ and 19.31 seconds for $p = 0.7, 0.8, 0.9$, and tops at 20.73 seconds for acceptance probabilities of $p = 0.4, 0.5, 0.6$. The decision time for acceptance probabilities of 0 and 1 is significantly different from those for acceptance probabilities of $0 < p < 1$ (two-sided Wilcoxon test, $p < 0.01$). We also find that median decision time is the highest for allocations between (15,5) and (13,7), in both binary and randomized choices. This result is inconsistent with individuals having complete preferences. If individuals randomize because they are indifferent, then they should spend less time with randomized choices. After all, time is costly and there is little gain from randomization when the options that subjects face have little difference in utilities.

4.3 Results on WTPs

Finally, we report the receiver's WTP for the use the randomized choice when facing an unequal offer. Recall that each receiver only had to make WTP decision for one randomly chosen allocation. The receivers were asked how much they would be willing to pay for the use of the randomized choice when facing an unequal offer. The advantage of this design is that receivers would be more likely to perceive the choice as a "hot play" and thus felt the tension more strongly between the two selfs. The disadvantage, however, is that we obtain WTP for just one allocation per receiver. This limits the number of observations. To make statistical tests meaningful and robust, we categorize the receivers with an acceptance probability of 0.0 as a group, those with an acceptance probability of 1.0 as another group. Among the receiver with an acceptance probability between 0.1 and 0.9, we build three further subgroups: those with an acceptance probability of 0.1, 0.2, and 0.3, those with an acceptance probability of 0.4, 0.5, and 0.6, and those with an acceptance

[7] We have excluded the first period in randomized choices from this part of analysis, as the decision time in the first period included the time for reading the instruction.

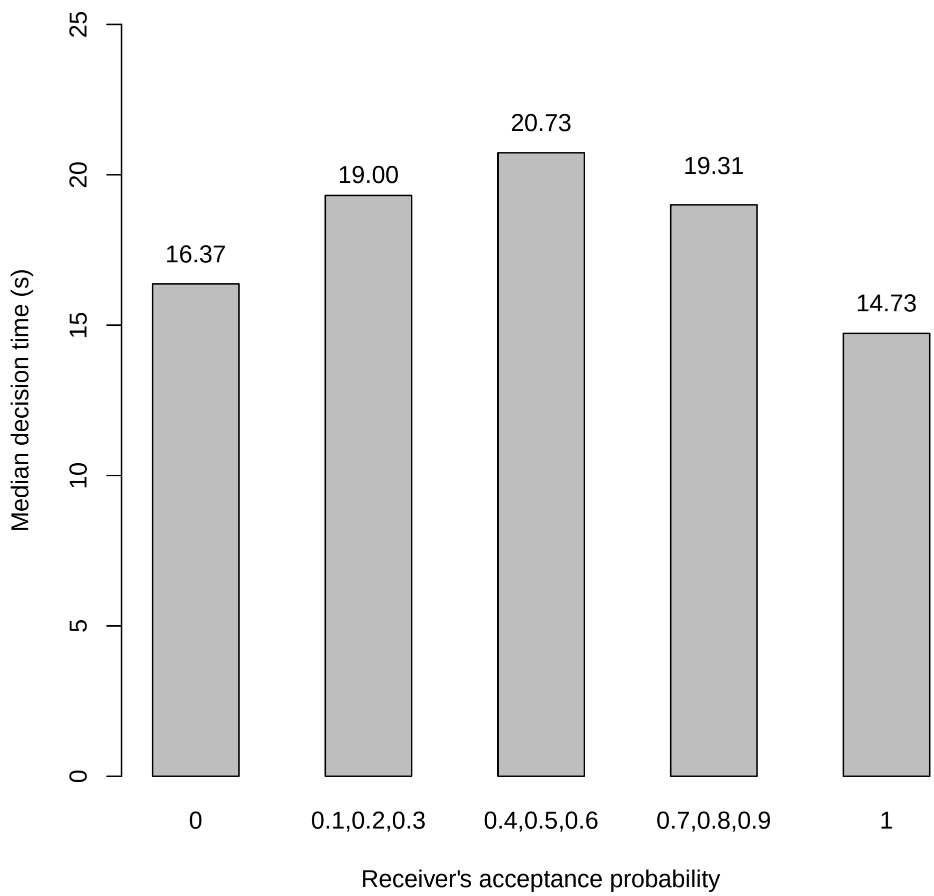

Figure 5: The Y-axis is decision time and x-axis is acceptance probability.

probability of 0.7, 0.8, and 0.9. Such a classification is also in line with our results above and the observation in subsection 3.2 that an acceptance probability in the neighborhood of 0.5 implies a high degree of indecisiveness, and thus the randomized choice could be particularly useful in those situations.

Our results are consistent with Proposition 1 which predicts a strictly positive WTP for the acceptance probability $0 < p < 1.0$. Figure 6 reports the boxplot of WTP with respect to the five groups of acceptance probabilities. Recall that receivers could choose not to use the randomized choice or choose to use the randomized choice with a WTP ranging from €0 to €2 with an increment of €0.2.[8] Among the 31 receivers with acceptance probabilities $0 < p < 1$, 20 receivers stated a strictly positive WTP and 7 receivers stated a WTP of 0. The median WTP for the acceptance probability $0 < p < 1.0$ is strictly positive, at €0.40. In comparison, among the 19 receivers with acceptance probabilities $p = 0$ *or* 1, only 1 receivers stated a positive WTP, and the median response for the acceptance probability of $p = 0$ or 1.0 is not to use the randomized choice. One-sided Wilcoxon rank sum test suggests that receivers deciding for an acceptance probability $0 < p < 1.0$ have WTPs significantly higher than those of the receivers deciding for an acceptance probability of $p = 0$ or $p = 1.0$ ($p < 0.01$).

Proposition 2 also suggests that the WTP peaks at certain acceptance probability, and it decreases as the acceptance probability moves away from this threshold. Our experimental result confirms this prediction. All 7 receivers with acceptance probabilities $p = 0.4, 0.5, 0.6$ stated a positive WTP, with a median WTP of €1.00. In contrast, among 12 receivers with acceptance probabilities $p = 0.1, 0.2, 0.3$, 8 receivers stated a positive WTP, with a median (mean) WTP of €0.30, and among 12 receivers with acceptance probabilities $p = 0.7, 0.8, 0.9$, 5 receivers stated a positive WTP, with a median WTP of €0.0. One-sided Wilcoxon rank sum test suggests that receivers deciding for an acceptance probability of $p = 0.4, 0.5, 0.6$ have WTPs significantly higher than those of the receivers deciding for an acceptance probability of $p = 0.1, 0.2, 0.3$ or $p = 0.7, 0.8, 0.9$ ($p < 0.01$).

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[8] We code the choice of not to use the randomized choice as having a negative WTP. As we report median responses and use non-parametric tests, the exact value of the negative WTP is irrelevant.

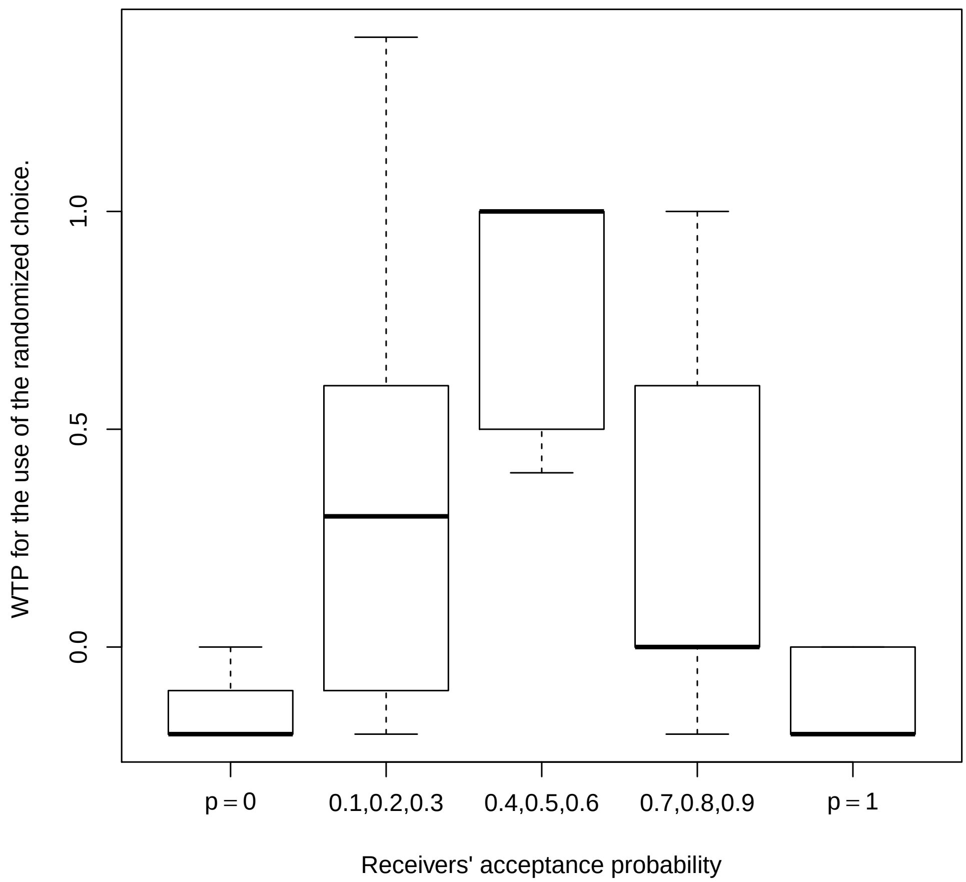

Figure 6: A boxplot of the WTP of using the randomized choice and the receiver's acceptance probability. WTP ranges from €0 to €2 with an increment of €0.2. The WTPs below 0 imply receivers are not willing to use the randomized choice.

To address more directly the welfare implication of the randomized choices, we computed receivers' willingness to pay out of their potential gains in order to resolve the conflicts: the ratio of WTP over the receiver's expected payoff (the acceptance probability times the receiver's share). We find that, among the receivers who at least weakly prefers the use of randomized choices (WTP≥ 0), the median (mean) ratio for an acceptance probability of $p = 0.4, 0.5, 0.6$ is 0.42 (0.36, respectively), the median (mean) ratio for an acceptance probability of $p = 0.1, 0.2, 0.3$ is 0.42 (0.49, respectively), and the median (mean) ratio for an acceptance probability of $p = 0.7, 0.8, 0.9$ is 0.01 (0.10, respectively). Thus, receivers were willing to pay a significant portion of their potential gains for the use of the randomized choices when the acceptance probability is below 0.7. This result highlights the significant welfare losses when indecisive individuals are forced to make all-or-nothing decisions against their incomplete preferences.

We have also analyzed the behavior of the proposers. In general, the findings from the proposers' decisions are quite similar to those of the receivers. However, the motives behind the proposers are more complicated. In additional to the conflicting motives, they also faces strategic uncertainty. Their indecisiveness could thus come from both beliefs and tastes. We have put the results of the proposers to Appendix: results for the proposers.

5 Discussion and conclusion

The assumption of the completeness in preferences plays a critical role in many important theories, such as EUT, CPT. However, the completeness of the preferences is neither realistic nor normative (Von Neumann and Morgenstern, 1944; Aumann, 1962) There have been abundant indications that individuals do not always have complete preferences. For example, many exhibit inconsistent choices (Camerer, 1989; Starmer and Sugden, 1989), and these choices occur more often around the indifference points (Qiu and Steiger, 2011). Our study contributes to the literature by providing evidence of incomplete preferences-led indecisiveness in an ultimatum game where individuals face conflicting motives in their decisions. Our experiment allows receives to make randomized choices regarding acceptance and rejection through which they could express their indecisiveness. We find that (1) the vast majority of subjects randomized actively; (2) subjects took longer time to make strictly randomized decisions; (3) subjects were willing to pay a strictly positive amount of money to randomize, and they were willing to pay more for randomized choices with randomizing probabilities close to 0.5 than those with randomizing probabilities close to 0 or 1. These results provide strong evidence for the indecisiveness in choices. The last finding, in particular, suggests that there exists significant welfare losses when indecisive individuals are forced to make all-or-nothing decisions against their potentially incomplete preferences.

While we have chosen to illustrate indecisiveness via the ultimatum game, the approach to reveal indecisiveness and the implications from our findings can be applied to other settings where individuals have to make all-or-nothing decisions while facing multiple conflicting objectives. An area which could benefit from incorporating indecisiveness are studies which relies on indifference to obtain measurements, such as the estimation of time preferences, valuations, risk attitudes, and probability estimates. Confusing indecisiveness with indifference could lead to biases in these estimates. To see the potential biases concretely, consider a risk attitude elicitation task that is often used in the literature (see, e.g., Abdellaoui, 2000; Holt and Laury, 2002). In the task, subjects face a list of decisions. In each decision they are required to choose one option out a pair of options. In one format the first option is a lottery, and it is fixed in the entire list. The second option is a monetary payment with certainty, and the amount is increasing down the list. The lottery is more attractive than the certainty payment in the first few decisions, but the certainty payment becomes more attractive than the lottery as one progresses down the list.[9] An example is offered in Table 1 in Appendix: an example. In the example anyone who prefers more to less should pick Option A in the first row and pick Option B in the last row. An individual with a complete and transitive preference switches from Option A to Option B somewhere in the list, for example, between a certainty payment of €3.5 and €4, and between €3.5 and €4 an indifference relationship between the lottery and the certainty payment exists.

[9]The attractiveness is often obvious as it is based on the first degree stochastic dominance criterion.

That certainty payment is the certainty equivalent of the lottery. An individual with an incomplete preference but with the same risk attitude would exhibit a similar choice pattern with just one switch. But, due to an aversion to indecisiveness, the individual would stay a bit longer with the option over which the valuation is relatively easy to assess, which is often the less risky or the certainty option (Cerreia-Vioglio et al., 2015; Qiu, 2015). For example, the individual would switch from Option A to Option B between a certainty payment of €3 and €3.5. If, however, this individual with an incomplete preference is taken as one having a complete preference, s/he would be estimated to be more risk averse than s/he actually is. Based only on the behavioral observations, one cannot distinguish one individual with a complete preference and higher risk aversion from another who has an incomplete preference but is less risk averse. Such identification problem exists in any method that relies on indifference (see e.g., Andersen et al., 2006).

The second area where allowing indecisiveness would be useful is in raising voting rates. Voting often requires individuals to make difficult tradeoffs between candidates or policies. Indecisiveness occurs when these options embody conflicting values or beliefs. When individuals are indecisive, a natural thing to do is tochoose the "safer" option of not to do anything (Masatlioglu and Ok, 2005), i.e., not to vote. If voters were provided with a randomization mechanism and were allowed to vote probabilistically, their decision utility increases, and they are consequently more likely to vote.

The third area where indecisiveness is possible and randomization is beneficial is in the selection of job candidates. It is common for a job profile to have multiple criteria, and rarely would we see a candidate dominates in all criteria. As a result, indecisiveness arises. Without a randomization possibility, it can be shown that a small favoritism could go a long way as to select 100% of times the candidate who enjoys the bias. When given a randomization possibility, however, candidates who are biased against might also have a chance to be selected. [10]

[10] To see this concretely, suppose there are two candidates - A and B - who need to be assessed according to two criteria. Suppose the employer always favors slightly the male candidate - candidate A here - in the following way: $u_1(A) = 1$ and $u_1(B) = 0$, and $u_2(A) = 0.2$ (instead of $u_2(A) = 0$ should the employer is not biased) and $u_2(B) = 1$, where $u_i(\cdot)$ denotes criterion i. When the employer has to pick one candidate and applies the cautious rule as in Cerreia-Vioglio et al. (2015) to make the final choice, candidate A will

References

Abdellaoui, M. (2000). Parameter-Free Elicitation of Utility and Probability Weighting Functions. *Management Science*, 46(11):1497–1512.

Agranov, M. and Ortoleva, P. (2017). Stochastic choice and preferences for randomization. *Journal of Political Economy*, 125(1):40–68.

Andersen, S., Harrison, G. W., Lau, M. I., and Rutström, E. E. (2006). Elicitation using multiple price list formats. *Experimental Economics*, 9(4):383–405.

Aumann, R. J. (1962). Utility theory without the completeness axiom. *Econometrica*, 30(3):pp. 445–462.

Brandts, J. and Charness, G. (2011). The strategy versus the direct-response method: a first survey of experimental comparisons. *Experimental Economics*, 14(3):375–398.

Camerer, C. F. (1989). An experimental test of several generalized utility theories. *Journal of Risk and Uncertainty*, 2(1):61–104.

Cerreia-Vioglio, S., Dillenberger, D., and ortoleva, P. (2015). Cautious Expected Utility and the Certainty Effect. *Econometrica*, 83:693–728.

Cettolin, E. and Riedl, A. (2015). Revealed incomplete preferences under uncertainty. CESifo Working Paper Series 5359, CESifo Group Munich.

Chabris, C. F., Laibson, D., Morris, C. L., Schuldt, J. P., and Taubinsky, D. (2009). The Allocation of Time in Decision-Making. *Journal of the European Economic Association*, 7(2-3):628–637.

Danan, E. and Ziegelmeyer, A. (2006). Are preferences complete? An experimental measurement of indecisiveness under risk. Papers on Strategic Interaction 2006-01, Max Planck Institute of Economics, Strategic Interaction Group.

Dubra, J., Maccheroni, F., and Ok, E. A. (2004). Expected utility theory without the completeness axiom. *Journal of Economic Theory*, 115(1):118–133.

be chosen 100% of times. When given a randomization possibility, however, candidates will be chosen roughly equally likely.

Dwenger, N., Kübler, D., and Weizsäcker, G. (2014). Flipping a Coin: Theory and Evidence. CESifo Working Paper Series 4740, CESifo Group Munich.

Eliaz, K. and Ok, E. A. (2006). Indifference or indecisiveness? Choice-theoretic foundations of incomplete preferences. *Games and Economic Behavior*, 56(1):61–86.

Fehr, E. and Schmidt, K. M. (1999). A Theory of Fairness, Competition, and Cooperation. *The Quarterly Journal of Economics*, 114(3):817–868.

Frederick, S., Loewenstein, G., and O'Donoghue, T. (2002). Time discounting and time preference: A critical review. *Journal of Economic Literature*, 40(2):351–401.

Greiner, B. (2015). Subject pool recruitment procedures: organizing experiments with orsee. *Journal of the Economic Science Association*, 1(1):114–125.

Gul, F. (1991). A theory of disappointment aversion. *Econometrica*, 59(3):667–686.

Holt, C. A. and Laury, S. K. (2002). Risk Aversion and Incentive Effects. *American Economic Review*, 92(5):1644–1655.

Levi, I. (1986). *Hard Choices: Decision Making under Unresolved Conflict.* Cambridge University Press.

Masatlioglu, Y. and Ok, E. A. (2005). Rational choice with status quo bias. *Journal of Economic Theory*, 121(1):1–29.

Ok, E. A., Ortoleva, P., and Riella, G. (2012). Incomplete Preferences Under Uncertainty: Indecisiveness in Beliefs versus Tastes. *Econometrica*, 80(4):1791–1808.

Plott, C. R. and Zeiler, K. (2005). The willingness to pay-willingness to accept gap, the "endowment effect," subject misconceptions, and experimental procedures for eliciting valuations. *The American Economic Review*, 95(3):530–545.

Qiu, J. (2015). Completing incomplete preferences. working paper, MPRA.

Qiu, J. and Steiger, E.-M. (2011). Understanding the Two Components of Risk Attitudes: An Experimental Analysis. *Management Science*, 57(1):193–199.

Quiggin, J. (1982). A theory of anticipated utility. *Journal of Economic Behavior & Organization*, 3(4):323–343.

Selten, R. (1967). *Die Strategiemethode zur Erforschung des eingeschrankt rationalen Verhaltens im Rahmen eines Oligopolexperiments.* in Sauermann, H. (Ed.), Beitrage zur experimentellen Wirtschaftsforschung. J.C.B. Mohr, Tubingen, pp. 136-168.

Starmer, C. and Sugden, R. (1989). Violations of the independence axiom in common ratio problems: An experimental test of some competing hypotheses. *Ann. Oper. Res.*, 19(1-4):79–102.

Trautmann, S. T. and Kuilen, G. (2015). Belief Elicitation: A Horse Race among Truth Serums. *Economic Journal*, 125(589):2116–2135.

Von Neumann, J. and Morgenstern, O. (1944). *Theory of Games and Economic Behavior.* Princeton University Press.

Wakker, P. (2010). *Prospect Theory: for Risk and Ambiguity.* Cambridge University Press, Cambridge, UK.

Appendix: results for proposers

In general results for proposers are similar to those of receivers. Figure 7 gives a boxplot of the proposer's probability proposing the equal allocation, depending on the proposer's share out of €20 in the unequal allocation. Proposers actively randomize, in particular when the proposers' share is between €12 to €18 in the unequal allocation. . It seems proposers are most indecisive when the proposers' share is €14 in the unequal allocation. Similarly, the group averages in binary choices are quite close the median probabilities in the randomized choices. A more detailed result is reported in Figure 8.

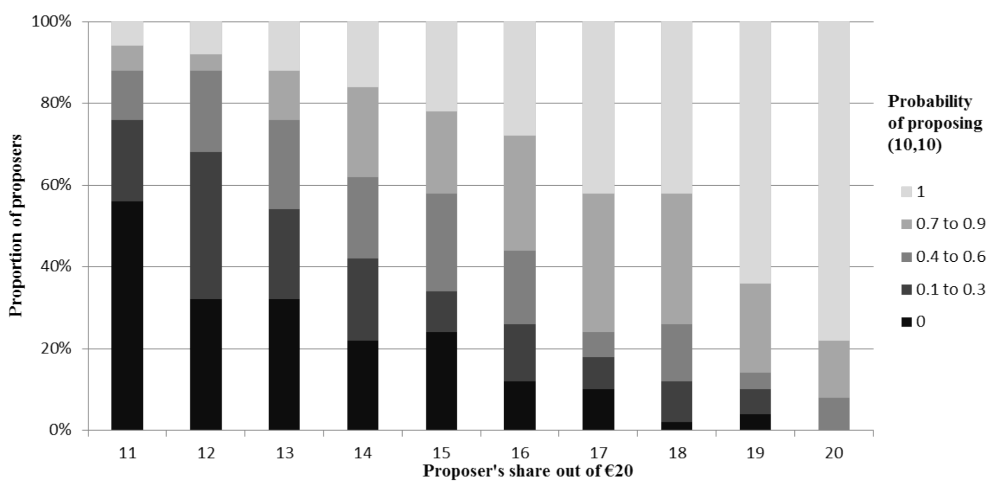

Figure 8: The y-axis is the proportions of proposers, x-axis the proposer's share out of €20 in the share of unequal allocation. Different colors represent the proposer's probabilities to propose the equal allocation $(10, 10)$.

Similar to the results of receivers, proposers who chose a proposing probability of $p = 0$ or $p = 100$ for the equal allocation have WTPs significantly lower than those of proposers choosing a proposing probability of $0 < p < 100$ ($p < 0.01$). There is one significant difference between the behavior of the receivers and that of the proposers. The proposers with proposing probabilities of $p = 0.1, 0.2,$ *or* 0.3 have WTPs higher than those with proposing probabilities of $p = 0.4, 0.5,$ *or* 0.6, though the difference is not significant (two-sided Wilcoxon rank sum test, $p > 0.10$).

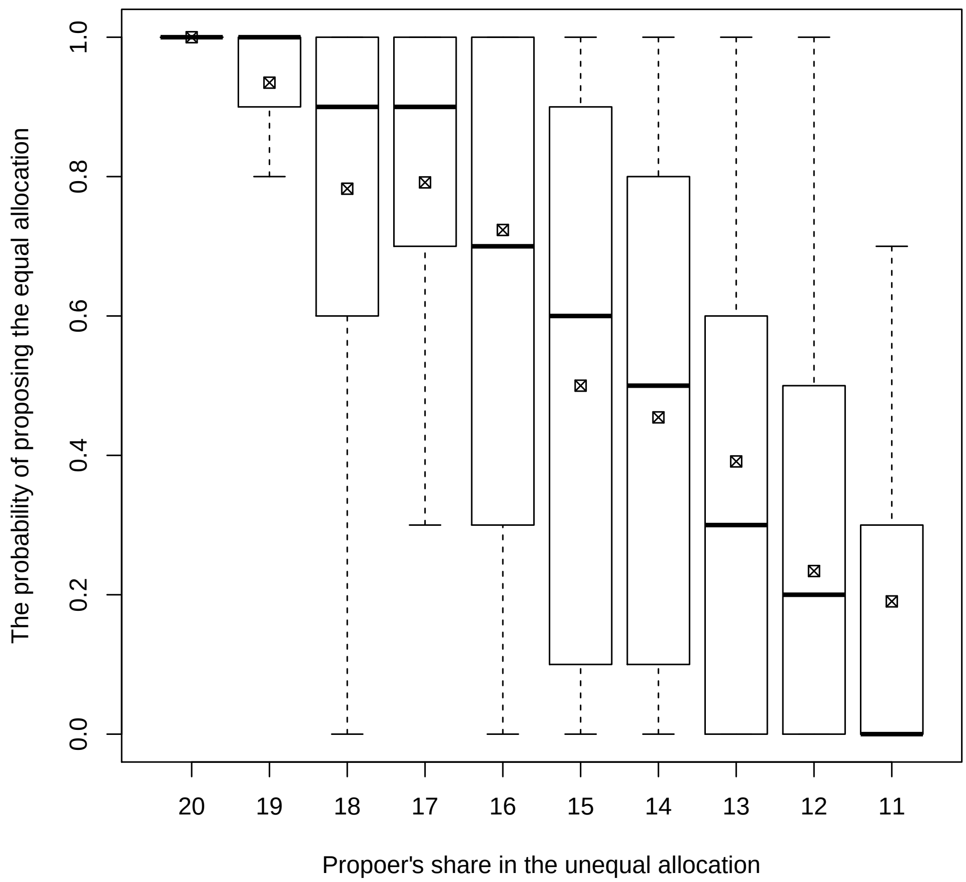

Figure 7: A boxplot of the proposer's probability proposing the equal allocation, depending on the proposer's share out of €20 in the unequal allocation. The squares with cross denote the population ratios of proposing the equal allocation in binary choices.

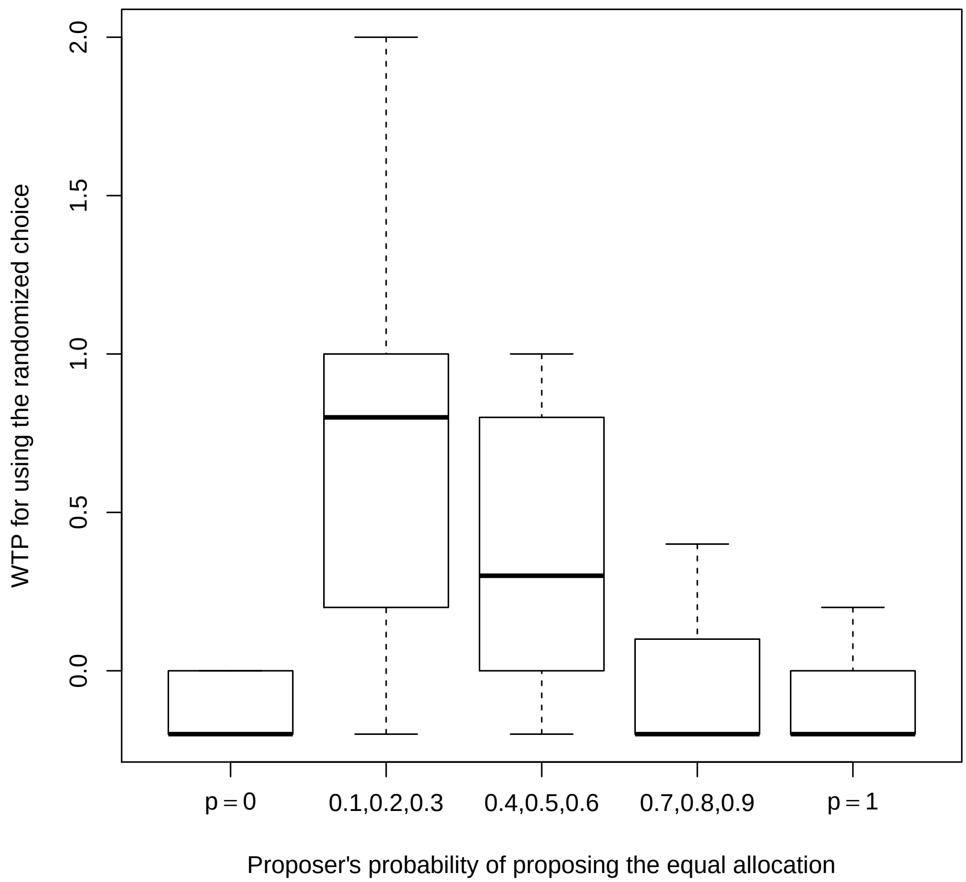

Figure 9: The WTP of using the randomized choice and its associated probability of proposing the equal allocation $(10, 10)$. WTP ranges from €0 to €2 with an increment of €0.2. The WTP below 0 implies receivers are not willing to use the randomized choice.

Appendix: proof for proposition 2:

Proof: It is clear that with a sufficiently small a the utility of acceptance is smaller than the utility of rejection, i.e., $V(A) = k - \gamma(20 - 2a) \leq V(R) = 0$. This gives $a \leq \frac{20\gamma - k}{2\gamma}$. Note $p^* = \frac{k}{20\gamma - a(2\gamma - 1)}$, using p^* to define the value of a, and we have $a = \frac{20\gamma - k/p^*}{2\gamma - 1}$. Notice also that $a \leq \frac{20\gamma - k}{2\gamma}$, and thus $\frac{20\gamma - k/p^*}{2\gamma - 1} \leq \frac{20\gamma - k}{2\gamma}$. This defines the upper threshold of p^* as $p^* \leq \frac{2\gamma k}{20\gamma + 2k\gamma - k}$. When p^* is below this threshold we have:

$$\Delta V = V(p^*, A; (1 - p^*), R) - max\left\{V(A), V(R)\right\} = p^* a = \frac{20p^*\gamma - k}{2\gamma - 1}.$$

Since ΔV increases with p^*, the utility gain from randomization increases with p^* when $p^* \leq \frac{2\gamma k}{20\gamma + 2k\gamma - k}$. The WTP increases with the utility gain, and thus the WTP increases with p^* when $p^* \leq \frac{2\gamma k}{20\gamma + 2k\gamma - k}$.

With a sufficiently large a the utility of acceptance should be larger than the utility of rejection, i.e., $V(A) = k - \gamma(20 - 2a) > V(R) = 0$. Similarly, we have $a = \frac{20\gamma - k/p^*}{2\gamma - 1} \geq \frac{20\gamma - k}{2\gamma}$, and this defines the lower threshold of p^* as $p^* \geq \frac{2\gamma k}{20\gamma + 2k\gamma - k}$. When p^* is above this threshold we have:

$$\Delta V = V(p^*, A; (1 - p^*), R) - max\left\{V(A), V(R)\right\} = \frac{20p^*\gamma - k}{2\gamma - 1} - \left[k - 20\gamma + \frac{2\gamma(20\gamma - k/p^*)}{2\gamma - 1}\right]$$

Taking the first-order derivative of ΔV with respect to p^* gives, for $p^* < 1$, that:[11]

$$\frac{\gamma}{p^{*2}(2\gamma - 1)}\left(20p^{*2} - 2k\right) \leq \frac{\gamma}{p^{*2}(2\gamma - 1)}\left(20p^{*2} - 20\right) < 0.$$

The negative value of the first-order derivative implies a decreasing utility gain from randomization with p^* when p^* is above $\frac{2\gamma k}{20\gamma + 2k\gamma - k}$. Similarly, it follows that the WTP decreases with the decreasing utility gain from randomization when $p^* \geq \frac{2\gamma k}{20\gamma + 2k\gamma - k}$. Q.E.D.

[11] The latter inequality is obtained by recognizing that $p^* = k/10$ when $a = 10$. To make sure $p^* = 1$ when a is sufficiently close to 10, we must have $k \geq 10$.

Appendix: an example

Option A	Option B	Choices with a complete preference	Choices with incomplete preference
0.5, €10; 0.5, €0	€0	☑A B☐	☑A B☐
0.5, €10; 0.5, €0	€2	☑A B☐	☑A B☐
0.5, €10; 0.5, €0	€3	☑A B☐	☑A B☐
0.5, €10; 0.5, €0	€3.5	☑A B☐	☐A B☑
0.5, €10; 0.5, €0	€4	☐A B☑	☐A B☑
0.5, €10; 0.5, €0	€4.5	☐A B☑	☐A B☑
0.5, €10; 0.5, €0	€5	☐A B☑	☐A B☑
0.5, €10; 0.5, €0	€6	☐A B☑	☐A B☑
0.5, €10; 0.5, €0	€8	☐A B☑	☐A B☑
0.5, €10; 0.5, €0	€10	☐A B☑	☐A B☑

Table 1: The risk attitudes elicitation task. Option A is a lottery and is fixed in the table. Option B pays out a monetary amount with certainty, and the amount increases down the list. Anyone prefers more to less should pick Option A in the first row and pick Option B in the last row. An individual with a complete preference might switch from Option A to Option B between a certainty payment of €3.5 and €4. An individual with an incomplete preference with the same risk attitude might, due to an aversion to incomplete preferences, switch from Option A to Option B between a certainty payment of €3 and €3.5.

Appendix: decision screens.

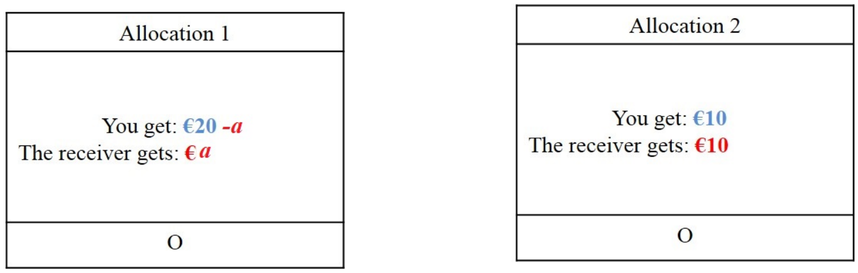

Figure 10: The elicitation of the proposer's binary choices. The value of $a \in \{0, 1, ..., 9\}$, and the sequence is random.

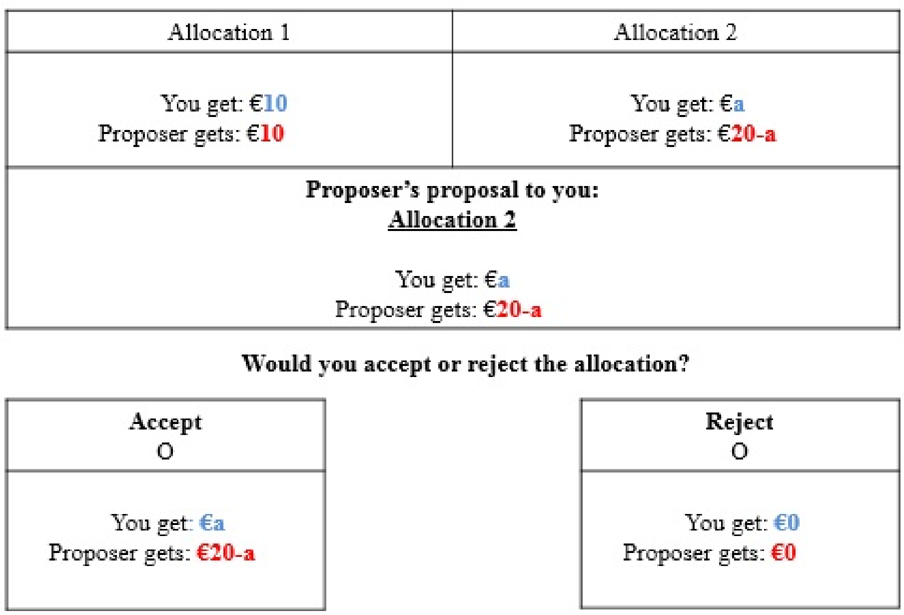

Figure 11: The elicitation of the receiver's binary choices. The value of $a \in \{0, 1, ..., 9\}$, and the sequence is random.

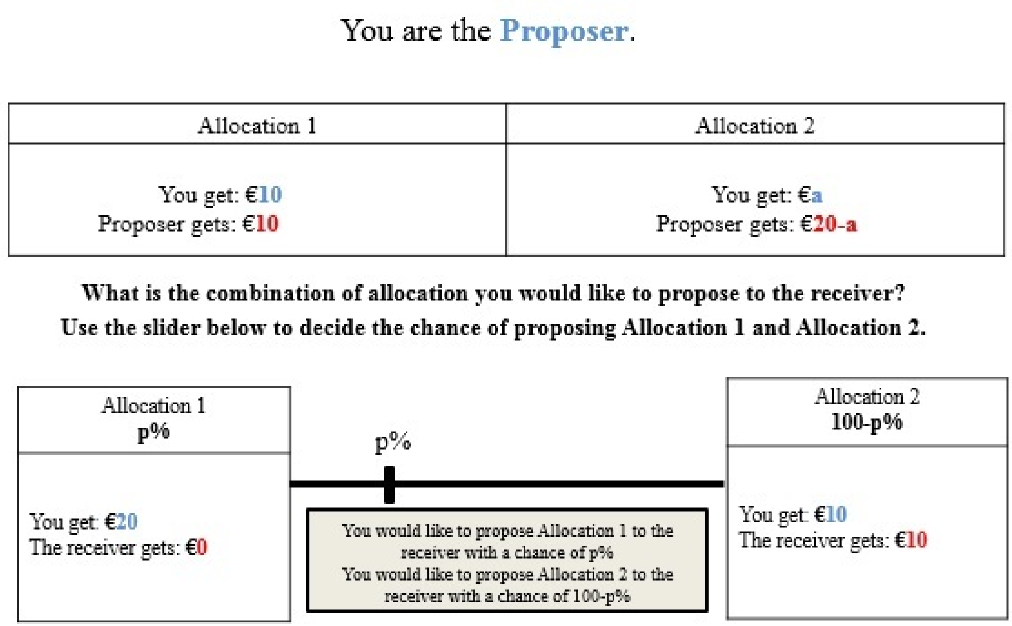

Figure 12: The elicitation of the proposer's randomized choices. The probabilities are in an increment of 10%, $p = \{0\%, 10\%, 20\%, 30\%, ..., 100\%\}$. When the slider is moved, the p under Allocation 1, $100 - p\%$ under Allocation 2, and the $p\%$ above the slider all change to reflect the decision.