Are Preferences Complete? An Experimental Measurement of Indecisiveness Under Risk*

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Abstract

We propose an experimental design allowing a behavioral test of the axiom of completeness of individual preferences. The central feature of our design consists in enabling subjects to postpone their choice at a small cost without receiving new objective information. We assume that such postponement reveals indecisiveness. Our main result is that preferences are significantly incomplete which challenges the descriptive power of the axiom of completeness. We use lotteries as choice alternatives and we find that risk aversion is robust to indecisiveness at the aggregate but not at the individual level.

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Experimental data are available at `https://people.econ.mpg.de/~ziegelmeyer/`.

1 Introduction

One of the most common assumptions in decision theory, game theory, and economics is that individuals have *complete* preferences, meaning that they are always able to judge which choice alternatives leave them better off. Consequently, an individual never exhibits *indecisiveness* whatever the choice situation. The quasi-systematic use of the completeness axiom, which is necessary for the existence of a utility function, seems paradoxical since this assumption lacks justification (apart from analytical tractability). First, the completeness axiom is usually considered intuitively demanding and, from the beginning, modern decision theory acknowledged that individuals may not possess firm judgments about their well-being and may therefore remain indecisive in some choice situations (von Neumann and Morgenstern, 1944). Second, several authors questioned the necessity of the completeness requirement for the normative applications of the theory by defending the position that completeness is not a fundamental rationality tenet the way transitivity is (Aumann, 1962; Bewley, 1986; Mandler, 2001, 2005; Danan, 2006). Third, and most importantly, incomplete preference theory has shown the feasability and interest of doing away with the completeness axiom (Bewley, 1986; Ok, 2002; Dubra, Maccheroni, and Ok, 2004; Rigotti and Shannon, 2005). Here some authors have brought out arguments based on the incompleteness of preferences that account for some of the experimentally observed anomalies. For example, Mandler (2004) shows that incomplete preferences may lie behind status quo maintenance whereas Eliaz and Ok (2006) provide choice-theoretic foundations of incomplete preferences that cope with the preference reversal phenomenon. Unlike behavioral theories that are particularly designed to explain the observed anomalies, such approaches yield a unified theory that applies to all choice situations and therefore re-establish the usefulness of rationality as an explanatory tool.

However convincing the last two arguments raised against the completeness axiom may be, the realistic appeal of incomplete preferences has been justified *only* through introspective thought experiments so far, whereas empirical tests of the descriptive validity of the completeness axiom are still missing.[1] What is more, such an empirical test is generally considered incompatible with the methodology of *revealed preference*.

[1] Eliaz and Ok (2002) look at choice correspondences that can be explained by the maximization of an incomplete preference relation, and they provide experimental evidence for a weakening of the *weak axiom of revealed preferences* which characterizes such correspondences. The experimental study was subsequently removed in the published version of the paper (Eliaz and Ok, 2006). See Subsection 2.1 for a discussion of their methodology.

According to the revealed preference approach, one can only observe an individual's choice behavior, not her judgements of preference. Hence, if an individual has to choose between two alternatives a and b and is observed selecting a, say, one does not know whether she chose a because she indeed prefers a to b or because she does not know which alternative she prefers but still had to pick something. Thus, it seems that indecisiveness has to be ruled out in order to be able to elicit preferences on the basis of behavioral data.

This paper provides an experimental design allowing a behavioral test of the completeness axiom. The general idea behind this design is that, although one cannot directly determine whether an individual knows which of two choice alternatives a and b she prefers by merely making her choose between a and b, her preference or lack of preference (i.e., indecisiveness) can nevertheless be indirectly revealed by her behavior in other choice situations involving a and b. More precisely, our subjects have to choose between committing immediately to either a or b and maintaining *flexibility*, i.e., keeping both options open until a later time. Maintaining flexibility allows more time for introspection but no additional objective information. On the other hand, immediate commitment yields a small monetary bonus. Our central assumption is that a subject who gives up the bonus in order to maintain flexibility reveals that she does not know which alternative she prefers, for if she did she would better commit immediately to her most preferred alternative and get the additional bonus.

Our preference elicitation method thus assumes a link between incomplete preferences and the concept of *preference for flexibility*, reflecting the common interpretation of this concept in terms of *uncertainty about tastes* (Koopmans, 1964; Kreps, 1979; Dekel, Lipman, and Rustichini, 2001). We evaluate potential limitations of this assumption, in particular the possibility that an individual could *intrinsically* value her *freedom of choice* (Sen, 1988) and, therefore, choose to maintain flexibility without having incomplete preferences. Although we cannot, by definition, conduct a behavioral test of our hypothesis that maintaining flexibility always reveals indecisiveness, we find behavioral evidence supporting it against the alternative hypothesis that it always reflects intrinsic value of freedom of choice: the observed propensity to maintain flexibility is highly sensitive to its instrumental (as opposed to intrinsic) value.

Concretely, we implement choice situations in which subjects have to choose between committing immediately to either a simple monetary *lottery* or a sure payoff and keeping both options open. Keeping options open implies that subjects will have to choose between the same lottery and sure payoff one week later (subjects take part in two experimental sessions) without receiving any new objective information about these options, whereas committing immediately yields a small additional sure payoff. This risky choice setup enables us to define an individual measure of indecisiveness and, thereby, to provide a *quantitative* test of the completeness axiom, as opposed to only exhibiting an isolated choice situation in which subjects might violate the axiom.

On a sample of 137 subjects, we find that the empirical distribution of the measure of indecisiveness is heavily skewed to the right with a mode at zero (i.e., complete preferences), meaning that a majority of our subjects (59%) exhibit a strictly positive measure (i.e., incomplete preferences). Moreover, many of these latter subjects exhibit a *significantly* positive measure (for example, 28% of them are indecisive in at least one fourth of all situations of choice between a lottery consisting in two equiprobable payoffs and some sure payoff ranging between the lottery's two payoffs). This result clearly challenges the descriptive power of the completeness axiom. Our setup also enables us to analyze subjects' attitudes toward risk. According to our new elicitation method, allowing for indecisiveness, more than 75% of subjects exhibit a positive risk premium (risk aversion) with a modal risk premium almost null (risk neutrality). We also elicit risk premia by means of the usual preference elicitation method (mere choices between immediate commitment to a lottery and to a sure payoff) and find that risk aversion is robust to indecisiveness at the aggregate but not at the individual level.

The paper is organized as follows. In the next section we outline the theoretical framework underlying our experiment. Section 3 describes the experimental design and Section 4 discusses the experimental results. Section 5 concludes. Additional figures and tables as well as samples of software screens, experimental instructions, and the control questionnaire appear in the Appendix.

2 Theoretical framework

In this section, we first discuss the impossibility for a situation of mere choice between two alternatives to reveal a preference judgment when preferences are not assumed to be complete. We then argue that such revelation is possible by resorting to choice situations in which flexibility can be maintained, because indecisiveness can be behaviorally characterized in such situations. This point is made in a general setting in which the choice alternatives are left unspecified. Finally, we introduce a risky choice setup in which subjects have to choose between committing to either a monetary *lottery* or a sure payoff and maintaining flexibility. Besides providing a cardinal measure of indecisiveness, this specific setup enables us to analyze the risk attitudes exhibited by the potentially incomplete preferences we elicit.

2.1 Incomplete preferences and choice behavior

Consider an individual endowed with a *weak preference* relation $\succcurlyeq$ on a set of choice alternatives. Given two alternatives a and b, $a \succcurlyeq b$ means that the individual judges she would be at least as well off with a as with b. If both $a \succcurlyeq b$ and $b \succcurlyeq a$ hold, then the individual is indifferent between a and b which is written $a \sim b$ whereas if $a \succcurlyeq b$ but not $b \succcurlyeq a$, then the individual strictly prefers a to b which is written $a \succ b$. Preferences are said to be *complete* if, for all alternatives a and b, either $a \succcurlyeq b$ or $b \succcurlyeq a$ (possibly both). In this case, one and only one of the three following statements must hold: either $a \succ b$, or $b \succ a$, or $a \sim b$.

Now, if preferences are not assumed to be complete then there is a fourth possibility, namely that neither $a \succcurlyeq b$ nor $b \succcurlyeq a$. In this case, the individual is *indecisive* between a and b which is written $a \bowtie b$. Indecisiveness captures an individual's inability to determine which of two alternatives would leave her better off.

Following the classical methodology of *revealed preference* (Samuelson, 1938), we seek to elicit the individual's preferences on the basis of her choice behavior. Let us assume that the individual can always be forced to choose between two alternatives and denote by $\gamma(a, b)$ the individual's choice between the two alternatives a and b (with the convention that $\gamma(a, b) = \gamma(b, a)$). For the sake of exposition, let us also temporarily assume that, besides observing the individual's choice of an alternative, one can observe her willingness to choose either a or b, which we denote by $\gamma(a, b) = a\&b$.[2] This is a common assumption in the revealed preference approach, which is usually operationalized by proposing the individual to resort to some randomization or delegation device rather than directly selecting an alternative. How does the individual's choice $\gamma(a, b)$ inform us about her preference between a and b? It is reasonable to assume that the individual chooses the alternative she prefers. Hence, if $a \succ b$ (resp., $b \succ a$) then it must be that $\gamma(a, b) = a$ (resp., $\gamma(a, b) = b$). Moreover, it is usual to assume that if $a \sim b$, then $\gamma(a, b) = a\&b$. Under the completeness axiom, the individual's preferences are then straightforwardly revealed by her choice behavior: $a \succcurlyeq b$ if and only if $\gamma(a, b) \neq b$.

[2]We will relax this assumption in Subsection 2.4.

Such a revelation is no longer possible when completeness is not assumed, because any choice behavior is *a priori* conceivable under indecisiveness. For example, observing $\gamma(a, b) = a$ no longer reveals $a \succ b$ because this choice can also result from $a \bowtie b$. Even if it is assumed that $a \bowtie b$ implies $\gamma(a, b) = a\&b$, a common practice in incomplete preference theory, the problem persists because indifference and indecisiveness are behaviorally indistinguishable: $\gamma(a, b) = a\&b$ can result from either $a \sim b$ or $a \bowtie b$.

To sum up, the lack of a behavioral characterization of indecisiveness between two alternatives a and b precludes the mere choice between the two alternatives from fully revealing preference between them. It is therefore necessary to look for such a characterization in other choice situations. Clearly, this can only be done by means of some assumption linking the individual's indecisiveness between a and b and her behavior in other choice situations. Two approaches have recently been proposed in the literature: one relying on *transitivity* of preferences (Eliaz and Ok, 2002, 2006) and one on *preference for flexibility* (Arlegi and Nieto, 2001; Danan, 2003; Manzini and Mariotti, 2003). From a methodological viewpoint, the former approach seeks to identify choice behaviors that are incompatible with complete and normatively sound preferences but compatible with incomplete and normatively sound preferences; indecisiveness between a and b is revealed by normative inconsistencies between the individual's choice between a and b and her choice in situations involving other alternatives bearing no particular relation to a or b. The latter approach, on the other hand, seeks to intuitively capture how indecisiveness can affect an individual's behavioral dispositions concerning the alternatives at stake; indecisiveness between a and b is revealed by the individual's behavior in different choice situations involving only a and b. We find it more appropriate, for an experimental test, to rely on an intuitive rather than normative assumption and shall, therefore, follow the latter approach.

2.2 Indecisiveness and preference for flexibility

The intuitive link between indecisiveness and preference for flexibility can be illustrated by the following example, taken from Kreps (1979). Consider an individual who has to make a reservation at a restaurant for some given later date, say next Monday. There are only two possible meals, a = steak and b = chicken, and three restaurants that only differ by the menu (i.e., set of meals) they offer: a first restaurant proposes both steak and chicken (menu $\{a, b\}$), a second one has only steak (menu $\{a\}$), and a third restaurant has only chicken (menu $\{b\}$). Reserving at restaurant $\{a, b\}$ is the most *flexible* alternative because it enables the individual to wait until next Monday before choosing between steak and chicken, whereas reserving at restaurant $\{a\}$ (resp., $\{b\}$) entails an immediate commitment to eat steak (resp., chicken) on next Monday. Is this flexibility valuable to the individual? If she knows now that she would better have steak (resp., chicken) on next Monday, then reserving at restaurant $\{a, b\}$ is just as good as reserving at restaurant $\{a\}$ (resp., $\{b\}$). Silimarly, if she is indifferent between steak and chicken, then she must be indifferent between all three restaurants. On the other hand, if she does not know now whether she would better have steak or chicken on next Monday, then she must strictly prefer restaurant $\{a, b\}$ to both restaurant $\{a\}$ and restaurant $\{b\}$ (i.e., have a *preference for flexibility*) because she can hope to better feel what she would like to eat by the time of ordering a meal. Thus, maintaining flexibility is valuable if and only if the individual is indecisive.

Assuming such a link between indecisiveness and the value of flexibility, the individual's preference between two alternatives a and b can be elicited on the basis of her choice behavior between the *menus* $\{a\}$, $\{b\}$, and $\{a, b\}$, rather than her mere choice between a and b (or, equivalently, $\{a\}$ and $\{b\}$). If $a \succ b$, then she must be indifferent between $\{a\}$ and $\{a, b\}$ and strictly prefer $\{a, b\}$ to $\{b\}$, so one must observe $\gamma(\{a\}, \{a, b\}) = \{a\}\&\{a, b\}$ and $\gamma(\{b\}, \{a, b\}) = \{a, b\}$. Similarly, if $b \succ a$ then one must observe $\gamma(\{b\}, \{a, b\}) = \{b\}\&\{a, b\}$ and $\gamma(\{a\}, \{a, b\}) = \{a, b\}$. If $a \sim b$, then she must be indifferent between $\{a\}$, $\{b\}$, and $\{a, b\}$, so one must observe $\gamma(\{a\}, \{a, b\}) = \{a\}\&\{a, b\}$ and $\gamma(\{b\}, \{a, b\}) = \{b\}\&\{a, b\}$. Finally, $a \bowtie b$ is characterized by $\gamma(\{a\}, \{a, b\}) = \gamma(\{b\}, \{a, b\}) = \{a, b\}$. To summarize, $a \succcurlyeq b$ if and only if $\gamma(\{a\}, \{a, b\}) \neq \{a, b\}$.

This link between indecisiveness and preference for flexibility is the central assumption underlying our experimental design. It reflects the usual interpretation of preference for flexibility in terms of *uncertainty about tastes* (Koopmans, 1964; Kreps, 1979; Dekel, Lipman, and Rustichini, 2001), and is also formally present in this literature (Arlegi and Nieto, 2001; Danan, 2003; Manzini and Mariotti, 2003). Besides, it is consistent with empirical research in psychology and marketing on *choice deferral* caused by *preference uncertainty*, *tradeoff difficulty* or *conflict* (Tversky and Shafir, 1992; Dhar, 1997; Dhar and Simonson, 2003; Tykocinski and Ruffle, 2003). On the other hand, the assumption is inconsistent with the notion of *intrinsic* (as opposed to *instrumental*) value of *freedom of choice* (Sen, 1988): if freedom of choice (i.e., flexibility) is valued *for itself*, then the individual might exhibit a preference for flexibility without being indecisive.

Similarly, psychological research on *motivation for choice* distinguishes between *intrinsic* and *external* motivations (Deci, 1995), and our assumption is only consistent with the latter. According to this research, however, the presence of monetary incentives in our experimental design pushes subjects toward external motivations. Moreover, intrinsic value of preference for flexibility is, by nature, independent of the particular alternatives at stake and, thereby, observationally distinguishable from its instrumental value for an individual facing several choices between menus of varying instrumental value. We shall make use of this fact to give empirical support to our central assumption (see Subsection 4.2).[3]

2.3 Risky choice and measure of preference incompleteness

The method described so far allows the elicitation of an individual's preference between two arbitrary alternatives a and b, by observing the choices $\gamma(\{a\}, \{a, b\})$ and $\gamma(\{b\}, \{a, b\})$. Concretely, we choose alternatives to be *monetary lotteries*. Risky choice is a very common decision-making context and, furthermore, one in which the theories of incomplete preferences and of preference for flexibility are well-developed (Dekel, Lipman, and Rustichini, 2001; Dubra, Maccheroni, and Ok, 2004). Moreover, this setup enables us to define a cardinal measure of preference incompleteness and to analyze risk attitudes.

We restrict attention to very simple monetary lotteries, modeling the toss of a fair coin (i.e., two equiprobable payoffs). Let us call such a lottery an *elementary lottery* and denote it by $l = (\underline{z}, \overline{z})$, where $\underline{z} \leq \overline{z}$ are the lottery's two possible payoffs. Besides their simplicity, elementary lotteries have the advantage of being completely ordered in terms of risk, a natural index of a lottery's degree of risk being its *spread* $\sigma = \overline{z} - \underline{z}$ (i.e., σ represents second-order stochastic dominance; note that σ is also proportional to l's standard deviation). Furthermore, we do not elicit preferences between two arbitrary elementary lotteries, but only between an elementary lottery l and a sure payoff c (we

[3] It can also be objected that an individual who is indecisive between two alternatives a and b will not exhibit a preference for flexibility if she has no hope of resolving her indecisiveness by the time of choosing within the menu $\{a, b\}$. This objection is confirmed by empirical evidence showing that increasing the number of alternatives in a menu induces a *complexity* effect that can lead individuals to reject additional flexibility (Sonsino and Mandelbaum, 2001; Iyengar, Jiang, and Huberman, 2004). The complexity effect is, however, minimized in our experimental setting, as no menu contains more than two alternatives and only simple alternatives are considered (see Section 3). In any case, the complexity effect implies that there is more indecisiveness than preference for flexibility, without challenging the interpretation of the observed preference for flexibility as reflecting indecisiveness.

identify c with the elementary lottery (c, c)). Focusing on preference between a very simple lottery and a sure payoff prevents, as much as possible, any issue pertaining to complexity of the alternatives. Note that if $c > \overline{z}$ then c dominates l (in the sense of first-order stochastic dominance) so, by any account, it must be that $c \succ l$. Similarly, if $c < \underline{z}$ then l dominates c so one must have $l \succ c$. Hence, for a given lottery l, it is sufficient to observe the choices $\gamma(\{l\}, \{l, c\})$ and $\gamma(\{c\}, \{l, c\})$ for sure payoffs c between $\underline{z}$ and $\overline{z}$.

How do an individual's preferences between a given lottery l and sure payoffs c between $\underline{z}$ and $\overline{z}$ typically look like? A natural assumption is that preferences are *monotonic* with respect to money, i.e., if $c \succcurlyeq l$ then $c' \succ l$ for any $c' > c$ and, similarly, if $l \succcurlyeq c$ then $l \succ c'$ for any $c' < c$. If preferences are complete, there then exists a sure payoff c^* between $\underline{z}$ and $\overline{z}$ (the *certainty equivalent* of l) such that $c \succ l$ for any $c > c^*$ and $l \succ c$ for any $c < c^*$. More generally, without assuming completeness, there exist two sure payoffs $\underline{c}^* \leq \overline{c}^*$ between $\underline{z}$ and $\overline{z}$ (resp., the *lower* and *upper* certainty equivalents of l) such that $c \succ l$ for any $c > \overline{c}^*$, $l \succ c$ for any $c < \underline{c}^*$, and $l \bowtie c$ for any c between $\underline{c}^*$ and $\overline{c}^*$. Completeness is then characterized by $\underline{c}^* = \overline{c}^*$ (to simplify the exposition, we assume that $\overline{c}^* \succ l \succ \underline{c}^*$ if $\overline{c}^* > \underline{c}^*$ and $l \sim c^*$ if $\overline{c}^* = \underline{c}^* = c^*$, but the present study does not rely on this continuity property). Furthermore, one can associate a natural measure of preference incompleteness ν to the lottery l:

$$\nu = \frac{\overline{c}^* - \underline{c}^*}{\sigma} \in [0, 1].$$

Thus, ν is an index ranging between zero (completeness) and one (full incompleteness), measuring the degree to which an individual in indecisive between the lottery l and sure payoffs. Normalizing ν with respect to the spread σ enables us to compare the degree of preference incompleteness across different lotteries.

2.4 Indifferent selection and monetary incentives

Let us now come back to the assumption about indifference we made in Subsection 2.1: if $a \sim b$, then one must observe $\gamma(a, b) = a\&b$, i.e., concretely, the individual should choose to randomize or delegate her choice rather than directly selecting a or b, if she is offered this possibility. Although convenient, this assumption is difficult to justify: why could an individual who is indifferent between a and b not decide to select a rather than randomizing between a and b? Indifference precisely means that she judges such an *indifferent selection* inconsequential for her well-being.

This problem of indifferent selection is of particular importance in the present study, because weak preference for an alternative a over an alternative b is revealed by indifference between the menus $\{a\}$ and $\{a, b\}$, as opposed to strict preference for $\{a, b\}$ over $\{a\}$. For example, the upper certainty equivalent $\overline{c}^*$ of an elementary lottery l is characterized by the fact that the individual is indifferent between $\{c\}$ and $\{l, c\}$ for any $c > \overline{c}^*$ and strictly prefers $\{l, c\}$ to $\{c\}$ for any $c < \overline{c}^*$. But if she makes the indifferent selection $\gamma(\{c\}, \{l, c\}) = \{l, c\}$ for some sure payoffs $c > \overline{c}^*$, then the afore-mentioned assumption would lead to mistakenly conclude that she strictly prefers $\{l, c\}$ to $\{c\}$ and, hence, to potentially over-estimate $\overline{c}^*$. Similarly, when eliciting $\underline{c}^*$ by observing choices $\gamma(\{l\}, \{l, c\})$, indifferent selection might lead to under-estimate it. Thus, there is a risk of over-estimating the incompleteness measure ν.

In his pioneering work on decision-making under uncertainty, Savage (1954) incidentally proposed a more careful way of behaviorally distinguishing between indifference and strict preference. He argued that if $a \sim b$ then, for any monetary bonus ε added to b, one must have $b + \varepsilon \succ a$ and, hence, $\gamma(a, b + \varepsilon) = b + \varepsilon$ (we denote by $b + \varepsilon$ the alternative b with an additional sure payoff ε). On the other hand, if $a \succ b$ then there must exist a small enough monetary bonus ε added to b such that one still has $a \succ b + \varepsilon$ and, hence, $\gamma(a, b + \epsilon) = a$. Note that it then becomes unnecessary to give the individual the possibility of randomizing or delegating her choice.

Following this approach, the behavioral characterization of preference between a and b is amended as follows to control for indifferent selection (Danan, 2003): $a \not\succcurlyeq b$ if and only if, for any $\varepsilon > 0$, $\gamma(\{a + \varepsilon\}, \{a, b\}) = \{a + \varepsilon\}$. Figure 1 summarizes our elicitation method for a given elementary lottery $l = (\underline{z}, \overline{z})$ and some small monetary bonus ε.

2.5 Attitudes toward risk

Besides the measurement of preference incompleteness, our setup allows the assessment of *risk attitudes*. For complete (and monotonic) preferences, this is usually achieved by computing the individual's *risk premium* for a lottery $l = (\underline{z}, \overline{z})$, i.e., the difference between l's expected payoff $e = \frac{1}{2}(\underline{z} + \overline{z})$ and her certainty equivalent c^* for l. The individual is then said to be *risk averse* (resp., *attracted*, *neutral*) if the risk premium is positive (resp., negative, null).

Noting that $e - c^* = \frac{1}{2}[(\overline{z} - c^*) - (c^* - \underline{z})]$, it appears that the risk premium is

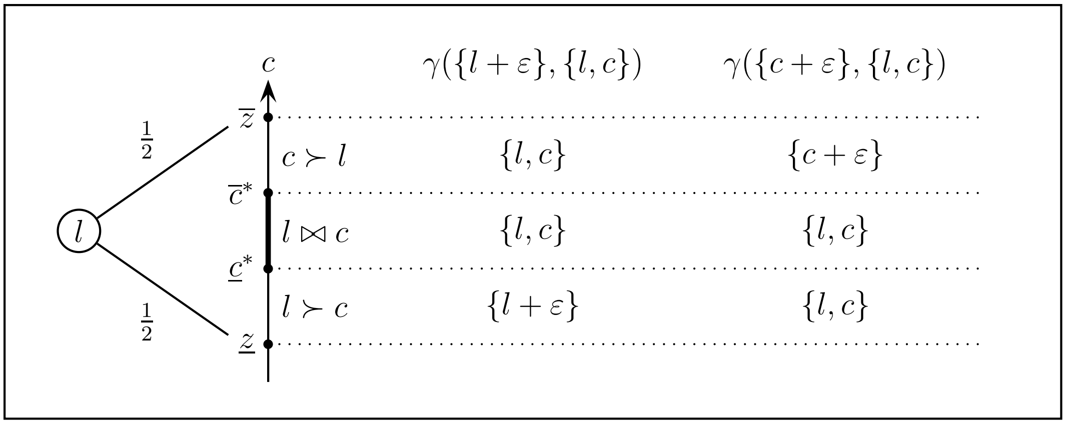

Figure 1. Elicitation of preferences.

proportional to the difference in length between the interval $[c^*, \overline{z}]$ (i.e., the set of sure payoffs c such that $c \succcurlyeq l$) and the interval $[\underline{z}, c^*]$ (i.e., the set of sure payoffs c such that $l \succcurlyeq c$). This suggests to generalize the definition of the risk premium to incomplete preferences by replacing the former interval by $[\overline{c}^*, \overline{z}]$ and the latter by $[\underline{z}, \underline{c}^*]$. We thus define the individual's (normalized) risk premium π for the lottery l by:

$$\pi = \frac{(\overline{z} - \overline{c}^*) - (\underline{c}^* - \underline{z})}{\sigma} = \frac{2e - \overline{c}^* - \underline{c}^*}{\sigma} \in [-1, 1].$$

Note that $\pi = 0$ only implies $e \sim l$ if $\nu = 0$, whereas if $\nu > 0$ it implies $e \bowtie l$. More generally, $e \succcurlyeq l$ (resp., $l \succcurlyeq e$) is equivalent to $\pi \geq \nu$ (resp., $\pi \leq -\nu$). According to our generalized definition of the risk premium, the interpretation of risk aversion (i.e., of $\pi > 0$) is that, considering all sure payoffs $c \in [\underline{z}, \overline{z}]$, $c \succcurlyeq l$ occurs more often than $l \succcurlyeq c$ (and similarly for risk attraction and risk neutrality). Although preference incompleteness sets an upper bound to the absolute value of the risk premium (formally, $|\pi| \leq 1 - \nu$), the value of ν yields no presumption about the sign of π unless $\nu = 1$.

Now, a distinctive feature of incomplete preferences is that they don't fully determine the individual's choice behavior (see Subsection 2.1). Namely, in the present risky choice setup, $l \bowtie c$ yields no presumption about $\gamma(l, c)$. This indeterminacy gives rise to a potential discrepancy between the individual's attitude toward risk in terms of preference and her attitude toward risk in terms of behavior (e.g., if $\gamma(l, c) = c$ whenever $l \bowtie c$, then she is more risk averse in terms of behavior than preference).

To capture this distinction, we refer to π as the individual's *preferential* risk premium for l (and, accordingly, we say that she is preferentially risk averse, attracted, or neutral) and now proceed to define its behavioral analogue. To this end, assume that choice behavior is *monotonic* with respect to money, i.e., if $\gamma(l,c) = c$ then $\gamma(l,c') = c'$ for any $c' > c$ and, similarly, if $\gamma(l,c) = l$ then $\gamma(l,c') = l$ for any $c' < c$. There then exists a sure payoff $\hat{c}$ between $\underline{c}^*$ and $\overline{c}^*$ (the *behavioral* certainty equivalent of l) such that $\gamma(l,c) = c$ for any $c > \hat{c}$ and $\gamma(l,c) = l$ for any $c < \hat{c}$. The individual's *behavioral* risk premium $\hat{\pi}$ for l is defined by:

$$\hat{\pi} = \frac{(\overline{z} - \hat{c}) - (\hat{c} - \underline{z})}{\sigma} = \frac{2(e - \hat{c})}{\sigma} \in [-1, 1].$$

The individual is said to be *behaviorally risk averse* (resp., *attracted*, *neutral*) if $\hat{\pi}$ is positive (resp., negative, null). Reflecting the fact that $\hat{c}$ must lie between $\underline{c}^*$ and $\overline{c}^*$, preference incompleteness sets an upper bound to the absolute difference between the behavioral and preferential risk premiums (formally, $|\hat{\pi} - \pi| \leq \nu$), but the value of ν yields no presumption about the sign of this difference unless $\nu = 0$.

3 Experimental design

In this section, we first present the general features of our design, namely the choice situations as well as the choice alternatives that were implemented in the experiment. Second, we describe our practical procedures and the incentives schemes that were used in order to motivate subjects.

3.1 General features

Subjects are required to agree to participate in two experimental sessions, taking place on the same weekday and at the same hour of two consecutive weeks. In the first session, subjects choose between menus while in the second session they select alternatives within their chosen menus. For each decision, subjects have to select one and only one menu or alternative.

In the first session, subjects make series of choices between two menus. Each menu contains either a single element which can be a sure payoff (*sure commitment menu*) or an elementary lottery (*risky commitment menu*), or it contains both elements (*flexible menu*), i.e., it consists of a sure payoff and an elementary lottery. In order to avoid intertemporal tradeoffs, subjects' choices are only paid after the second session even if they choose only commitment menus in the first session. Subjects leave the first session without any document about the experimental procedures or their choices as they may otherwise express a preference for flexibility simply in order to leave the first session early and make their choices at their most preferred time between the two sessions.

The data collected in the first session enable us to elicit subjects' present preferences over alternatives which will materialize in one week. The data collected in the second session are not relevant for eliciting these preferences and, therefore, are not analyzed. Each subject is assigned to one elementary lottery $l = (\underline{z}, \overline{z})$, and the subject's preferences between l and sure payoffs are elicited by means of *choice bracketing procedures*.

Choice bracketing procedures

Each subject goes through three successive choice bracketing procedures (henceforth bracketings) over a sure payoff c ranging from $\underline{z}$ to $\overline{z}$, always in the following order:

1. Choices between the risky commitment menu $\{l\}$ and the sure commitment menus $\{c\}$, yielding $\gamma(\{l\}, \{c\})$.
2. Choices between the risky commitment menu $\{l + \varepsilon\}$, in which the lottery l is augmented by a bonus $\varepsilon = 0.10$ euros, and the flexible menus $\{l, c\}$, yielding $\gamma(\{l + \varepsilon\}, \{l, c\})$.
3. Choices between the sure commitment menus $\{c + \varepsilon\}$, in which the sure payoff c is augmented by a bonus $\varepsilon = 0.10$ euros, and the flexible menus $\{l, c\}$, yielding $\gamma(\{c + \varepsilon\}, \{l, c\})$.

The second (resp., third) bracketing yields the lower (resp., upper) certainty equivalent of the lottery. Hence, the last two bracketings are sufficient to elicit subjects' preferences. By going through the first bracketing, subjects have the possibility to introspect their preferences between the same lottery and sure payoffs they are going to face in the two subsequent bracketings. We believe that such a procedure eliminates potential indecisiveness arising from mere unfamiliarity with the objects of choice. Moreover, the first bracketing yields the behavioral certainty equivalent of the lottery and, thereby, enables us to compare subjects' behavioral and preferential attitudes towards risk.

Choices in the first bracketing are the simplest as they involve two commitment menus and therefore boil down to ordinary choices between two alternatives: a lottery and a sure payoff. In the second bracketing, flexible menus as well as the monetary bonus attached to the risky commitment menu are introduced. Still, the commitment

Lottery (l)	Low payoff ($\underline{z}$)	High payoff ($\overline{z}$)	Spread (σ)	Bracketing step (τ)	Bracketing length
l_1	0	40	40	2	21 choices
l_2	4	36	32	2	17 choices
l_3	10	30	20	1	21 choices
l_4	12	28	16	1	17 choices
l_5	17	23	6	0.50	13 choices
l_6	18	22	4	0.50	9 choices

Table 1. Lotteries and bracketings (euros).

menu remains fixed throughout the second bracketing. Finally, in the third bracketing, the risky commitment menu is replaced by the sure commitment menu and, therefore, varying the sure payoff c affects both menus simultaneously.

We chose $\varepsilon = 0.10$ euros to act as a small monetary bonus. There is arbitrariness in this choice because, in theory, one should use an infinitely small ε, which is obviously impossible in practice. Note, however, that the introduction of a monetary bonus, whatever its value, induces an underestimation of the actual measure of indecisiveness.[4]

Lotteries

Our experimental design relies on six different elementary lotteries (see Table 1). All lotteries' payoffs (as well as all sure payoffs) are gains between 0 and 40 euros. All lotteries have the same expected value of 20 euros and, hence, they only vary in risk (spread). In fact, three groups of lotteries can be distinguished: the *high spread* group (lotteries l_1 and l_2), the *medium spread* group (lotteries l_3 and l_4), and the *low spread* group (lotteries l_5 and l_6). By considering three different spread groups, we can evaluate the impact of the degree of risk on the measure of indecisiveness.

All subjects in a given experimental session are assigned to the same lottery $l = (\underline{z}, \overline{z})$. Half of them start all three bracketings with the sure payoff $\underline{z}$ whereas the other half start all three bracketings with $\overline{z}$. In this way we intend to eliminate the potential influence of a bracketing's starting value. The *step* τ of a bracketing depends on the considered lottery but, whatever the spread group, it is always significantly larger than

[4] We could have chosen the smallest practically implementable bonus $\varepsilon = 0.01$ euros but we were concerned that this would lead subjects to merely ignore the bonus. As already mentioned, the bonus plays a crucial role in our setup because it enables us to disentangle between indifference and strict preference in the second and third bracketings. A bonus is neither necessary nor useful in the first bracketing because there is presumably no more than one value of c for which $\{l\} \sim \{c\}$.

the monetary bonus. Consequently, bracketings in the low spread group are shorter than in the medium and high spread groups.

Let us illustrate our elicitation method with the example of a subject who has been assigned to the lottery l_1 and the starting value $\overline{z}$. In the first bracketing, the subject first has to choose between the risky commitment menu $\{(0, 40)\}$ and the sure commitment menu $\{40\}$, then between $\{(0, 40)\}$ and $\{0\}$, then between $\{(0, 40)\}$ and $\{38\}, \dots,$ and finally between $\{(0, 40)\}$ and $\{20\}$. In the second bracketing, she first has to choose between the risky commitment menu $\{(0, 40) + 0.10\}$ and the flexible menu $\{(0, 40), 40\}, \dots,$ and finally between $\{(0, 40) + 0.10\}$ and $\{(0, 40), 20\}$. In the third bracketing, she first has to choose between the sure commitment menu $\{40 + 0.10\}$ and the flexible menu $\{(0, 40), 40\}, \dots,$ and finally between $\{20 + 0.10\}$ and $\{(0, 40), 20\}$. In all three bracketings, the subject is required to make 21 choices.

3.2 Practical procedures

All subjects were undergraduate students from various disciplines at Friedrich Schiller University in Jena. The experimental sessions were conducted in small groups of nine to sixteen subjects using the computerized network of the Max Planck Research Laboratory. Twelve pairs of sessions were organized between February and June 2004. As such a procedure is very unusual, the invitation email emphasized that participation in two sessions, separated by one week, was compulsory. 171 subjects were recruited to participate in the experiment.[5] Among them, 15 subjects either did not show up or signaled at the beginning of the first session that they would not be able to attend the second session taking place one week later and, consequently, could not take part in the experiment. Each subject participated in only one pair of sessions.

First session

Subjects were randomly assigned to a computer terminal, which was physically isolated from other terminals. Communication between subjects was not allowed. Subjects first had to read a set of instructions privately (see Appendix C). They could ask questions by raising their hand at any time during the reading of instructions, and the questions were answered privately. After having read the instructions, each subject had to answer a short on-screen control questionnaire comprising two multiple-choice questions (see

[5]Subjects were recruited and invited using ORSEE (Greiner, 2003). They belonged to a subject pool comprising more than one thousand students.

Appendix D), in order to check her understanding of the experimental procedures. Any mistake in the questionnaire implied the exclusion from the experiment. Subjects' understanding of the procedures was good with only about 10% of the subjects making one mistake in the questionnaire and a single subject making two mistakes. In total, 137 subjects answered the control questionnaire correctly and all of them were present at the second session.

For half of these 137 participants, each bracketing started with $c = \overline{z}$ whereas, for the other half, each bracketing started with $c = \underline{z}$. The subjects' allocation to these starting values was performed by the laboratory server after subjects had completed the control questionnaire. After the questionnaire phase, each subject went through three training bracketings, corresponding to one training lottery. Subjects' choices were not payoff-relevant in this training phase. Subjects were told to take their time and were encouraged to proceed at their own pace. The training lotteries for the high, medium, and low spread groups were $(0, 32)$, $(8, 24)$, and $(14, 18)$, respectively. The step of each training lottery was chosen so that each bracketing had a length of 9 choices. After the training phase, each subject went through the three payoff-relevant bracketings.[6]

During the second and third bracketings, the monetary bonus and the alternative to which it was attached were displayed as separate items on subjects' computer screens. For example, the risky commitment menu $\{l + \varepsilon\}$ was displayed as the sum of the two items $l = (\underline{z}, \overline{z})$ and ε rather than as the lottery $(\underline{z} + \varepsilon, \overline{z} + \varepsilon)$ (see Appendix B). This was done in order to highlight the monetary benefit of commitment with respect to flexibility.

Before leaving the room, each subject was asked to provide a password so that her choices could be recovered from the laboratory server at the beginning of the second session. Once all passwords had been provided, each subject was paid 2.50 euros for participation. Subjects were not allowed to leave the first session with any document, in particular concerning the choices they were to be presented in the second session. Each first session took between 30 and 45 minutes.

[6] The lengths of the training and payoff-relevant phases were set based on the experiences gained in a pilot experiment with 12 subjects in January 2004. In the first session of this pilot experiment, subjects had to go through nine payoff-relevant bracketings, corresponding to three different lotteries, and the training phase was only made up of three single choices. The data collected from both the first three and the last three bracketings showed much more violations of monotonicity than those from the three middle bracketings. We therefore decided to reduce the number of payoff-relevant bracketings to three in the final study, corresponding to one single lottery, but included a longer training phase.

Second session

One week later, subjects went through the menus they had chosen in the first session and selected one alternative from each menu. After the subject made all her choices, her final earnings were determined according to one of the following three *incentive schemes*:

- Random Selection of One Choice for Payment (*Pay One*): Only one of the subject's choices was selected at random and the subject received the corresponding payoff.
- Random Selection of Three Choices for Payment (*Pay Three*): Three of the subject's choices were selected at random (one choice per bracketing) and the subject received one third of the sum of the three corresponding payoffs.
- Payment of All Choices (*Pay All*): All the subject's choices were paid and the subject received the sum of the corresponding payoffs divided by the total number of choices.

If a lottery had been selected for payment, a subsequent random draw was made to determine its outcome. All random draws were equiprobable and done manually by each subject herself.

Pay One is a widely used incentive scheme usually referred to as the *random lottery incentive system*. Under the assumption that subjects treat each choice in isolation, just as if it were the only choice, the random lottery incentive system neutralises both portfolio effects and wealth effects which might otherwise interfere with the interpretation of subjects' choices. This desirable property of the incentive scheme has been questionned (Holt, 1986) but several experimental studies have established its validity in simple pairwise choices (Starmer and Sugden, 1991; Beattie and Loomes, 1997; Cubitt, Starmer, and Sugden, 1998). In the same vein, Laury (2005) reports a lottery choice experiment where payoff scale effects have been demonstrated to matter (Holt and Laury, 2002) and addresses the question of whether subjects whose payments are determined by a single decision make choices as they would when they are paid for all decisions. More risk averse choices are observed under *Pay One* than under *Pay All* which indicates that subjects do not view random payment for one choice as a decrease in stakes for each choice that is presented. By using three different incentive schemes to motivate subjects, we investigate: i) whether the nature of incentives has an impact upon the measure of indecisiveness; and ii) whether subjects whose payments are determined by a single choice exhibit similar risk attitudes to subjects who are paid for either three or all choices *when the assessment of risk attitudes takes indecisiveness into account*.

After all subjects' earnings had been determined, subjects were asked to leave the room and they had to wait in front of the laboratory for about ten minutes. Subjects were then asked to participate in an additional unrelated experiment. We included an unrelated experiment at the end of each second session in order to disable the otherwise justified belief that the time to be spent at the laboratory for the second session could be influenced by the choices made in the first session.

Table 3 in Appendix A provides details about the schedule of the experimental sessions and the associated number of participants. Sessions A_i, A'_i, A''_i are the first sessions for the lottery l_i (see Table 1) and sessions B_i, B'_i, B''_i are the corresponding second sessions. In each first session, participants are those invited subjects who showed up and confirmed that they could attend the second session. Thus, the difference between the number of participants in the first session and the number of invitations in the second session is the number of subjects who made at least one mistake in the control questionnaire (e.g., 1×2 indicates that one subject made two mistakes whereas 2×1 indicates that two subjects made one mistake).

In the next section, we analyze all first-session, payoff-relevant choices of the 137 subjects who successfully completed the control questionnaire.

4 Results

Throughout our theoretical framework, we assumed that preferences are monotonic with respect to money. A small fraction of choices in our data set however violate the monotonicity assumption. Such inconsistent choices remind us that stochastic variation is an essential feature of decision-making behavior and cannot be completely eliminated even in a tightly-controlled experiment (see the special issue of *Experimental Economics*, vol. 8, number 4, edited by Chris Starmer and Nicholas Bardsley in December 2005 and the references therein). Though modelling the stochastic element in decision making is beyond the scope of this paper, we first introduce in this section generalized definitions of the indecisiveness measure and the risk premia which do not rely on monotonicity. These generalized measures reflect our attempt to take into account the stochastic component of experimental data and, consequently, they allow us to base our statistical analyses on the entire set of observed choices. Second, we present the results of a statistical analysis which assesses the validity of the assumption that flexibility is valued instrumentally rather than intrinsically. Third, we estimate the degree of indecisiveness

c	10	...	15	16	17	18	19	20	21	22	23	24	25	...	30
$\phi_1(c)$	0	...	0	0	0	0	0	1	1	1	1	1	1	...	1
$\phi_2(c)$	0	...	0	0	1	1	1	1	1	1	1	1	1	...	1
$\phi_3(c)$	1	...	1	1	1	1	1	1	1	0	0	0	0	...	0

Table 2. Data example.

revealed by the subjects' choices. Finally, we evaluate the relationship between the behavioral and the preferential risk premia both at the aggregate and the individual level.

4.1 Generalized measures of indecisiveness and risk attitudes

Consider a subject assigned to the elementary lottery $l = (\underline{z}, \overline{z})$ with spread σ and bracketing step τ. In each of the three bracketings, the subject makes one choice for each sure payoff c in the set $X = \{\underline{z}, \underline{z}+\tau, \ldots, \overline{z}-\tau, \overline{z}\}$. We encode her choice behavior by means of three indicator functions defined on X:

1. $\phi_1(c) = \begin{cases} 1 \text{ if } \gamma(\{l\}, \{c\}) = \{c\}; \\ 0 \text{ otherwise.} \end{cases}$
2. $\phi_2(c) = \begin{cases} 1 \text{ if } \gamma(\{l+\varepsilon\}, \{l, c\}) = \{l, c\}; \\ 0 \text{ otherwise.} \end{cases}$
3. $\phi_3(c) = \begin{cases} 1 \text{ if } \gamma(\{c+\varepsilon\}, \{l, c\}) = \{l, c\}; \\ 0 \text{ otherwise.} \end{cases}$

For each $c \in X$, $\phi_1(c) = 1$ indicates that the subject chooses the sure commitment menu in the first bracketing, while $\phi_2(c) = 1$ and $\phi_3(c) = 1$ indicate that she chooses the flexible menu in the second and third bracketings, respectively. As an illustration, Table 2 summarizes the choice behavior of one of our subjects who had been assigned to the lottery $(10, 30)$. Note that monotonicity is satisfied in all bracketings and that $\phi_2(10) = \phi_3(30) = 0$ whereas $\phi_2(30) = \phi_3(10) = 1$. Accordingly, the flexible menu is chosen over a commitment menu if and only if the added alternative is valuable enough which suggests that flexibility is valued instrumentally rather than intrinsically.

Generalized measure of indecisiveness

Based on the last two indicator functions, we now introduce a generalized measure of indecisiveness which is defined independently of whether monotonicity is satisfied or not. This enables us to include in our statistical analyses the choices of ten subjects who violate monotonicity in the second and/or third bracketing and therefore prevent us from computing either $\underline{c}^*$, or $\overline{c}^*$, or both. The (generalized) measure of indecisiveness relies on the number of occurences of $\phi_2(c) = 1$ and $\phi_3(c) = 1$ and is given by

$$\nu = \frac{\sum_{c \in X} \rho(c)[\phi_2(c) + \phi_3(c) - 1]}{\sigma} \in [-1, 1], \text{ where } \rho(c) = \begin{cases} \tau & \text{if } c \neq \underline{z} \text{ and } c \neq \overline{z}, \\ \dfrac{\tau}{2} & \text{if } c = \underline{z} \text{ or } c = \overline{z}. \end{cases}$$

Note that we allow for negative measures of indecisiveness. Indeed, the observed behavior leading us to elicit $\underline{c}^* > \overline{c}^*$ is compatible with our theoretical framework provided that choices are perturbed by errors and our measure of indecisiveness could be biased upwards if we exclude subjects with a negative measure.[7]

Obviously, if a subject's choices satisfy monotonicity then her measure of indecisiveness can be computed in a more straightforward but equivalent way. According to the last two rows of Table 2, the subject's choices are compatible with any monotonic preferences such that $\underline{c}^* \in [16, 17]$ and $\overline{c}^* \in [21, 22]$. The two certainty equivalents are obtained by taking the midpoints of these intervals, $\underline{c}^* = 16.5$ and $\overline{c}^* = 21.5$, which leads to $\nu = (21.5 - 16.5)/20 = 0.25$.

Generalized risk premia

We now provide generalized definitions of the two risk premia in order to be able to also include the three subjects who violated monotonicity in the first bracketing into our statistical analyses:[8]

$$\begin{cases} \pi = \alpha_3 - \alpha_2 \in [-1, 1], \\ \hat{\pi} = 1 - 2\alpha_1 \in [-1, 1], \end{cases} \text{ where } \alpha_i = \frac{\sum_{c \in X} \rho(c)[1 - \phi_i(c)]}{\sigma} \in [0, 1] \; (i = 1, 2, 3).$$

[7] If a subject has complete and monotonic preferences such that $\underline{c}^* = \overline{c}^* = c^* \in X$ and chooses without error, then we observe $\phi_2(c^*) = \phi_3(c^*) = 0$ and, hence, we mistakenly elicit a slightly negative measure of indecisiveness ($\nu = -\tau/\sigma$). We cannot, however, correct this potential downwards bias because such choices could also be attributed to a subject with a lower $\underline{c}^*$ or a higher $\overline{c}^*$ who makes errors.

[8] All three subjects also violated monotonicity either in the second or in the third bracketing.

If a subject's choices satisfy monotonicity then her two risk premia can be computed according to the two definitions provided in Subsection 2.5. Continuing the example in Table 2, we can compute the preferential risk premium $\pi = (2 \times 20 - 21.5 - 16.5)/20 = 0.1$, from which we conclude that the subject is slightly preferentially risk averse for $(10, 30)$. Note that this is the case even though $(10, 30) \bowtie 20$ (indeed, $\pi < \nu$). The subject is risk averse in the sense that $c \succcurlyeq (10, 30)$ happens more often than $(10, 30) \succcurlyeq c$ where $c \in \{10, 11, \ldots, 29, 30\}$ (equivalently, her indecisiveness interval $[16.5, 21.5]$ is centered below the expected value of the lottery). Similarly, we use the midpoint method in the first bracketing to elicit the behavioral certainty equivalent $\hat{c} = 19.5$ and compute the behavioral risk premium $\hat{\pi} = (2(20 - 19.5))/20 = 0.05$, from which we conclude that the subject is very slightly behaviorally risk averse for $(10, 30)$ (we could never obtain $\hat{\pi} = 0$ because our design and elicitation method imply $e \in X$ and $\hat{c} \notin X$). Note that π and $\hat{\pi}$ are almost equal, indicating that $\gamma(\{(10, 30)\}, \{c\}) = \{(10, 30)\}$ and $\gamma(\{(10, 30)\}, \{c\}) = \{c\}$, $c \in \{10, 11, \ldots, 29, 30\}$, happen about equally often when $(10, 30) \bowtie c$ (this is not guaranteed *a priori*, e.g., if $\hat{c} = \underline{c}^* = 16.5$ then $\hat{\pi} = 0.35$ and, hence, $\hat{\pi} - \pi = 0.25 = \nu$, i.e., more behavioral than preferential risk aversion).

4.2 Preference for flexibility

Our preference elicitation method relies on the assumption that flexibility is valued instrumentally rather than intrinsically. We now provide evidence in support of this assumption.

An intrinsic value of flexibility is, by nature, independent of the particular alternatives at stake. Accordingly, a subject who values flexibility intrinsically should choose, for a given lottery $l = (\underline{z}, \overline{z})$, the flexible menu $\{l, \underline{z}\}$ over the risky commitment menu $\{l + \varepsilon\}$ in the second bracketing. On the other hand, a subject who does not value flexibility intrinsically would presumably choose $\{l + \varepsilon\}$ because the lottery l dominates its low payoff $\underline{z}$ (in the sense of first-order stochastic dominance). The choice behavior $\gamma(\{\overline{z} + \varepsilon\}, \{l, \overline{z}\}) = \{l, \overline{z}\}$ can similarly be used to detect subjects who value flexibility intrinsically in the third bracketing. More generally, we assess the relative importance of intrinsic and instrumental value of flexibility in the second and third bracketings by estimating the relationship between the propensity to choose the flexible menu $\{l, c\}$ and the value of the sure payoff $c \in [\underline{z}, \overline{z}]$.

Result 1 (Flexibility is chosen for its instrumental value). In the second and third bracketings, the propensity to choose the flexible menu $\{l, c\}$ is highly sensitive to the value of the sure payoff c. Very few subjects choose the flexibility gained by adding a dominated alternative whereas almost all of them choose the flexibility gained by adding a dominating alternative.

Support. We first note that only 10 subjects (7%) choose the flexible menu for $c = \underline{z}$ in the second bracketing, and only 7 subjects (5%) choose the flexible menu for $c = \overline{z}$ in the third bracketing. On the other hand, all 137 subjects choose the flexible menu for $c = \overline{z}$ in the second bracketing and for $c = \underline{z}$ in the third bracketing. Moreover, 127 subjects (93%) satisfy monotonicity in the second and third bracketings, a property that logically follows from instrumental value of flexibility but bears no particular relationship with its intrinsic value.

We then carry out an econometric analysis in order to estimate subjects' propensity to choose the flexible menu. Our sample consists of all 4778 choices made by the 137 subjects in the second and third bracketings. We estimate a logit mixed effects model in which the dependent variable takes value 1 if the flexible menu is chosen and 0 otherwise. The fixed effects are the normalized sure payoff $c_{norm} = (c - \underline{z})/\sigma \in [0, 1]$, the two experimental factors *Spread*, which takes the value *High*, *Medium*, or *Low*, and *Incentive scheme*, which takes the value *Pay One*, *Pay Three*, or *Pay All*, and a dummy variable for the bracketing.

We start by estimating the full model, i.e., including all possible interaction effects, and then sequentially drop variables that are insignificant at a 1% level according to likelihood ratio tests (we rely on penalized quasi-likelihood to approximate the log-likelihood of subsequent models, as the log-likelihood of a generalized linear mixed effects model does not have a closed form expression). Random effects both in the intercept and in the linear term for each subject are included in the final model and they are assumed to be distributed independently and normally with a zero mean. Random effects represent between-subject variations and they allow for correlations between the choices of the same subject.

Table 4 in Appendix A displays the final regression results. As the final statistical model still contains numerous interaction terms, we provide several graphical representations of the estimated propensity to choose the flexible menu in order to facilitate the interpretation of our regression results. Each graphical representation is generated by relying *only* on the variables which are significant at a 1% level. We first plot the average estimated propensities as a function of c_{norm} (see Figure 2; we average across combinations of the two experimental factors *Spread* and *Incentive scheme* based on

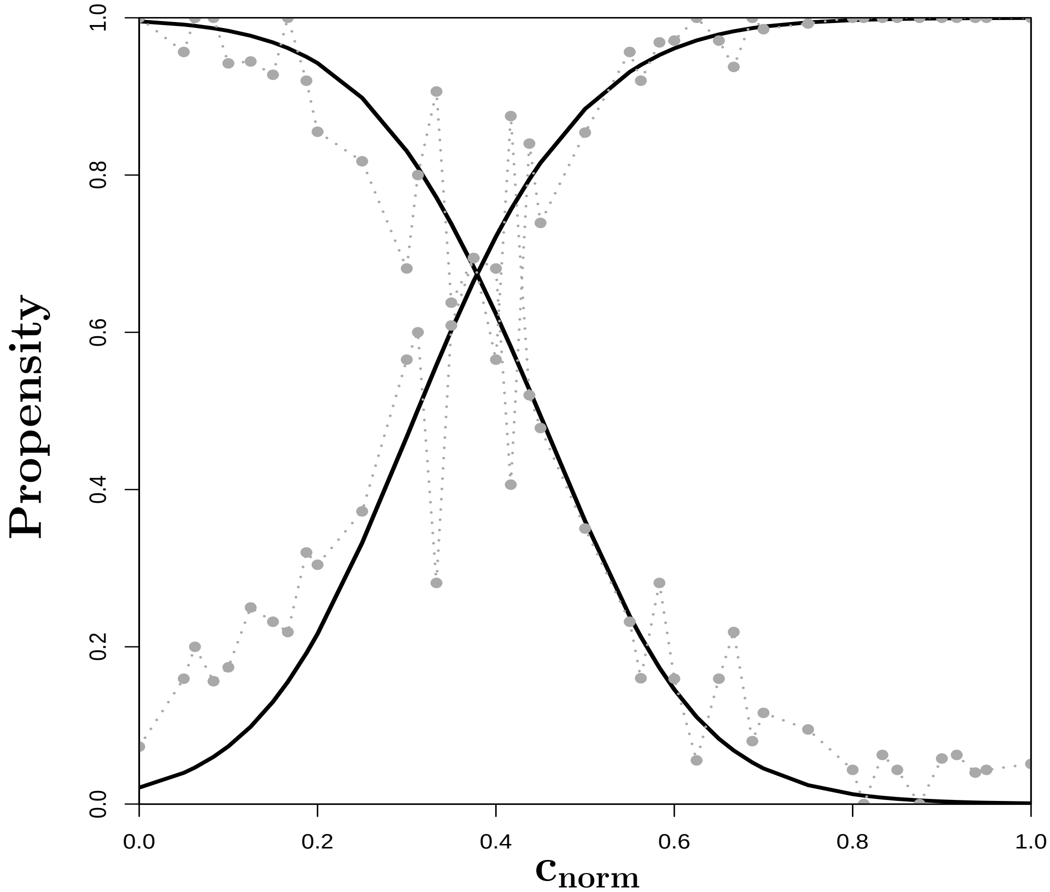

Figure 2. Average estimated propensities to choose the flexible menu.

Note: Solid (resp., dotted) curves correspond to the average estimated (resp., empirical) propensities. Increasing (resp., decreasing) curves correspond to the second (resp., third) bracketing.

the corresponding numbers of subjects). Clearly, the overall propensity to choose the flexible menu in the second and third bracketings is highly sensitive to the value of the sure payoff. This propensity is increasing in the second bracketing (c_{norm} is significantly positive at a 1% level) and decreasing in the third bracketing (the interaction term c_{norm}:*Third Bracketing* is significantly negative at a 1% level and twice as large as c_{norm}). Moreover, the relatively small standard deviations of the random effects indicate that a large majority of our subjects exhibit such a relationship between the propensity to choose the flexible menu and the value of the sure payoff.[9]

[9]The non-negligible standard deviations of the random effects also point out the substantial variation in the strength of this relationship. Actually, 8 subjects always chose the flexible menu in the second bracketing and, among them, two always chose the flexible menu in the third bracketing. All subjects chose at least once the flexible menu in both bracketings.

In order to analyze the effect of the two experimental factors, we plot the average estimated propensities as a function of c_{norm} separately for each spread group and each incentive scheme (see Figure 5 in Appendix A). We first note that these curves exhibit a common pattern irrespective of the spread group or the incentive scheme: increasing from 0 (or almost 0) to 1 in the second bracketing and decreasing from 1 to 0 in the third bracketing. Second, in *Pay One* and *Pay Three*, there is a common order between the three spread groups: in the second bracketing, the propensity to choose the flexible menu is highest in the high spread group and is lowest in the low spread group. The reversed order is observed in the third bracketing. Apparently, increasing the spread makes risk less attractive in the sense of increasing the value of flexibility gained by adding a sure payoff to a lottery and decreasing the value of flexibility gained by adding a lottery to a sure payoff, although this effect is clearer for the high spread group. Finally, in *Pay All*, the propensity to choose the flexible menu is generally lower than in *Pay One* and *Pay Three* for the second bracketing and higher for the third bracketing. Thus, it seems that paying all choices makes risk more attractive in the same sense as above, although this effect is only salient for the high spread group. □

We view this evidence as supporting the assumption that preference for flexibility reveals indecisiveness. Still, this evidence is only preliminary as it itself relies on the assumption that flexibility cannot be intrinsically valued for some values of the sure payoff and not others. Testing for more sophisticated patterns of the intrinsic value of flexibility goes beyond the scope of the present study.

4.3 Indecisiveness

Our second and main result challenges the descriptive power of the completeness axiom in preference theory as a majority of our subjects violate this axiom.

Result 2 (Preferences are significantly incomplete). The elicited measure of indecisiveness is strictly positive for more than half of our subjects (59%) and it is greater or equal to 0.25 for more than one fourth of our subjects (28%). Neither the spread of the lottery nor the incentive scheme have a systematic impact on the measure of indecisiveness.

Support. The histogram in Figure 3 represents the empirical distribution of the measure of indecisiveness. It is clearly skewed to the right, with a mode at 0 corresponding to the 37 subjects (27%) whose observed choice behavior is consistent with complete

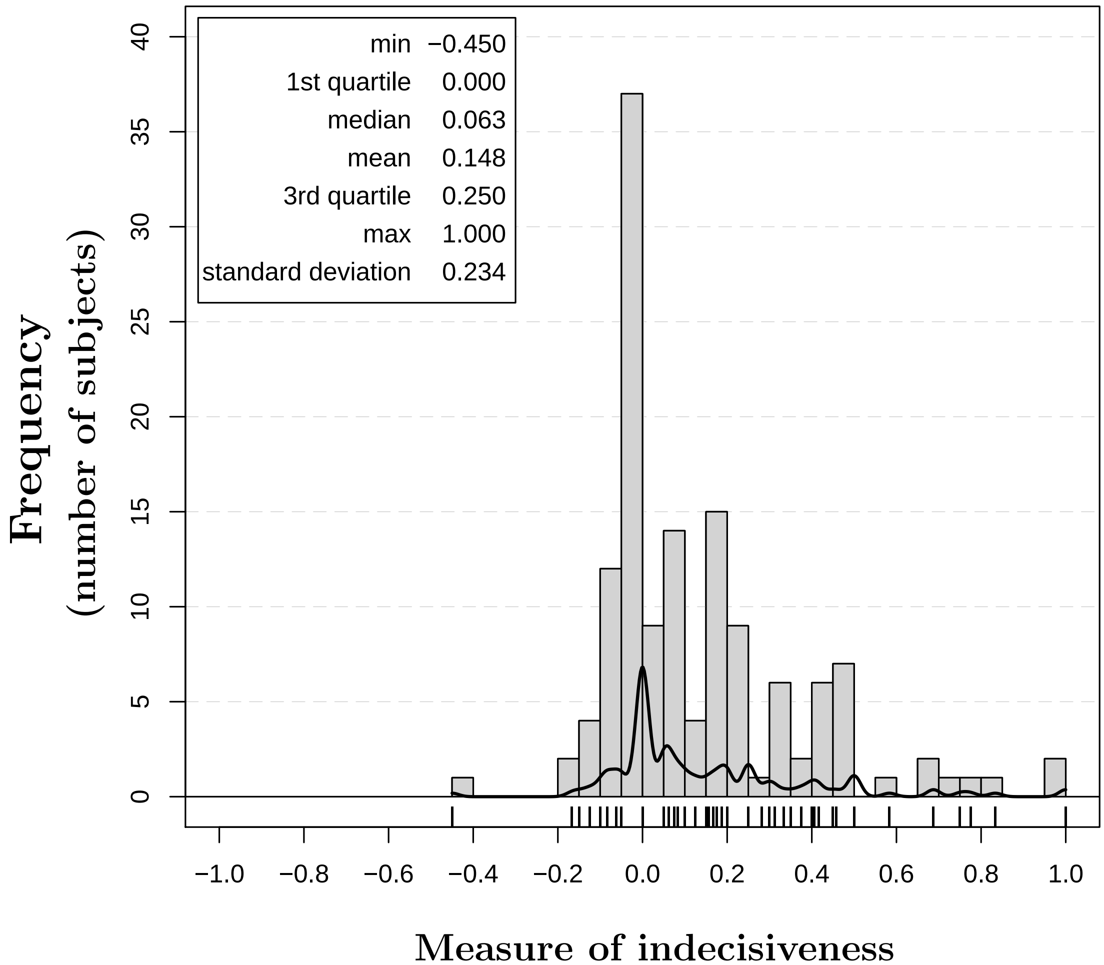

Figure 3. Empirical distribution of the measure of indecisiveness.

Note: The black curve corresponds to the nonparametric kernel-density estimation whereas the lower rug plot corresponds to the exact measure values.

preferences. The elicited measure is strictly negative for 19 subjects (14%), in line with errors affecting choice but also, for four of them, with an underestimated null measure. The 81 remaining subjects (59%) exhibit a strictly positive measure, and 39 subjects (28%) exhibit a measure greater or equal to 0.25. According to one-tailed permutation tests at a 5% level, the median is significantly higher than 0.03 ($p < 0.01$) and the mean is significantly higher than 0.11 ($p = 0.031$).

We now assess the impact of the two experimental factors, the spread group and the incentive scheme, on the measure of indecisiveness. Figure 6 in Appendix A shows the nonparametric kernel-density estimation of the measure of indecisiveness separately for each spread group and each incentive scheme. All these distributions are skewed to the right with mean higher than median, except for an almost symmetric distribution in the combination *Low Spread Group-Pay All*. Moreover, all distributions are relatively close to each other, with the exception of *Low Spread Group-Pay One*, which is notably more concentrated.

Overall, neither the spread group nor the incentive scheme seem to have a systematic impact on the measure of indecisiveness. This is confirmed by a Kruskal-Wallis test (one-way analysis of variance by ranks): at a 5% level, we cannot reject the null hypothesis that the nine subsamples (one per combination spread group-incentive scheme) come from identical populations with the same median ($\chi^2 = 3.476, df = 8, p = 0.901$). This holds similarly for the three subsamples corresponding to the three spread groups ($\chi^2 = 0.606, df = 2, p = 0.739$), and for the three subsamples corresponding to the three incentive schemes ($\chi^2 = 1.100, df = 2, p = 0.577$). □

4.4 Risk aversion

In this final results section, we assess subjects' risk attitudes which have been elicited through two experimental methods. First bracketing choices enable us to compute subjects' behavioral risk premium $\hat{\pi}$, corresponding to the usual preference elicitation method neglecting indecisiveness. Second and third bracketing choices yield subjects' preferential risk premium π, according to our elicitation method allowing for the incompleteness of preferences. As it turns out, risk aversion prevails over risk attraction both in a preferential and behavioral sense, and the two elicitation methods lead to a similar pattern of risk attitudes at the aggregate level.

Result 3 (Risk aversion is globally robust to indecisiveness). The behavioral and preferential risk premia have similar distributions with more than 75% of the subjects exhibiting risk aversion. Both risk premia increase with the spread of the lottery but decrease when all choices are paid.

Support. Figure 4 presents the nonparametric kernel-density estimations of the behavioral and preferential risk premia. Both risk premia are positive for a vast majority of subjects, with a first quartile at 0.05. Both distributions are bimodal with a first mode around the first quartile, i.e., near risk neutrality, and a second mode around the third quartile (0.45, i.e., risk aversion). The two distributions are remarkably close to each other; according to two-tailed permutation tests for paired replicates, the behavioral and preferential risk premia have equal mean ($p = 0.154$) and median ($p = 0.999$).

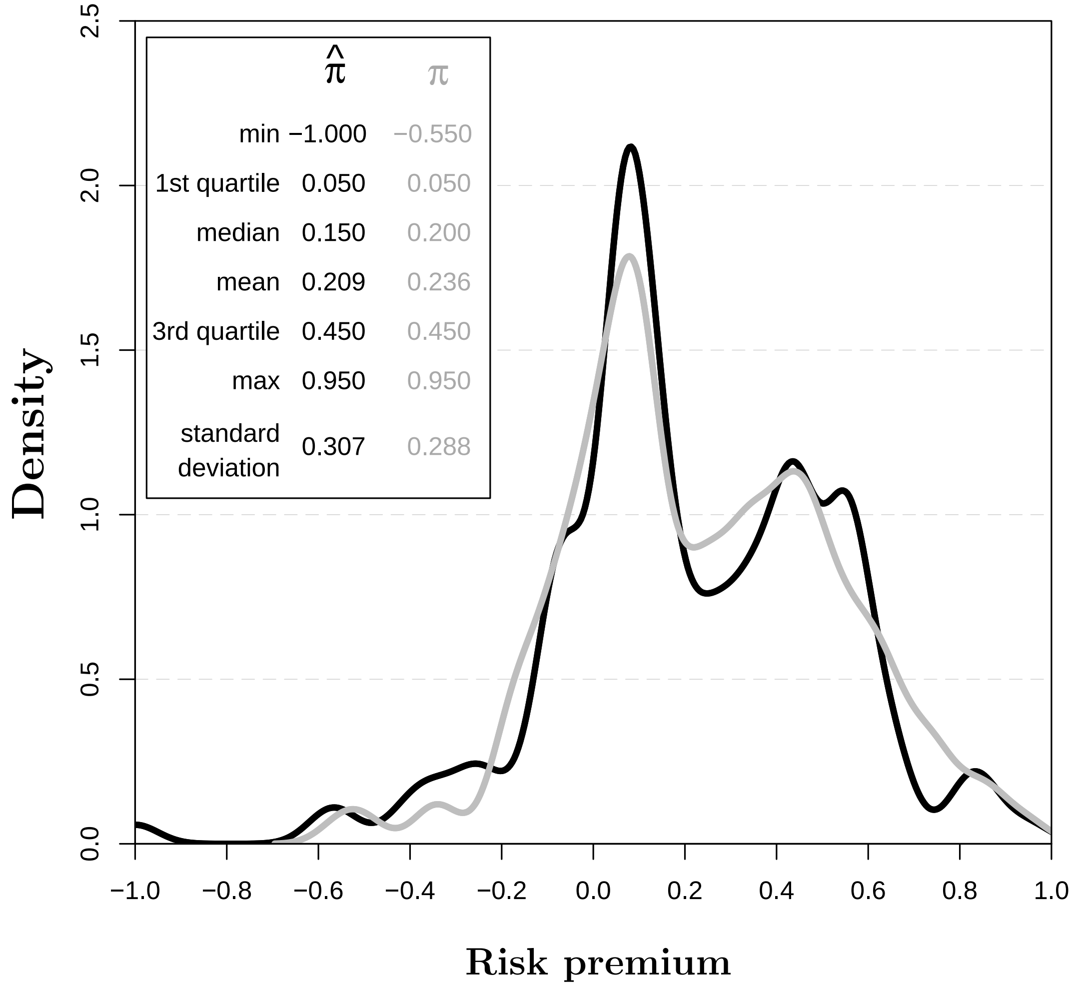

Figure 4. Nonparametric kernel-density estimations of the two risk premia.

Note: The black (resp., grey) curve corresponds to the behavioral (resp., preferential) risk premium.

In order to investigate the impact of the two experimental factors on the behavioral risk premium, we plot the nonparametric kernel-density estimation of the behavioral risk premium separately for each spread group and each incentive scheme (see Figure 7 in Appendix A). The behavioral risk premium seems to systematically increase with the spread of the lottery. This result is predicted by increasing relative risk aversion and/or decreasing absolute risk aversion (Holt and Laury, 2002). Indeed, increasing a lottery's spread while keeping its expected value constant amounts to multiplying all payoffs by a positive constant and then subtracting a positive constant from all payoffs. As far as the incentive scheme is concerned, distributions in *Pay All* are generally shifted to the left but no systematic difference between *Pay One* and *Pay Three* is observed. Paying all choices apparently led subjects to take more risk which confirms Laury's (2005) findings and suggests that they extend to the case of a random selection procedure where more than one choice is paid. All these patterns are confirmed by one-tailed permutation tests at a 5% significance level, both on the mean and the median.

Similarly, we plot the nonparametric kernel-density estimation of the preferential risk premium separately for each spread group and each incentive scheme (see Figure 8 in Appendix A). We observe the same patterns as for the behavioral risk premium: the preferential risk premium increases with the spread of the lottery but is lower in *Pay All*.[10] These results are generally confirmed by one-tailed permutation tests at a 5% significance level with two exceptions: first, there is no significant difference between the low and the medium spread groups, neither for the mean ($p = 0.061$) nor for the median ($p = 0.180$); second, the incentive scheme *Pay All* does not have a significant impact on the median of the preferential risk premium. □

Our third result seems to suggest that the behavioral risk premium elicited without taking indecisiveness into account is a good approximation of the preferential risk premium. Thus, one might assess risk aversion by means of the usual, simple choice procedure (first bracketing) without fully eliciting preferences. We should note, however, that this is only true at the global and not at the individual level, as many subjects turn out to have significantly different behavioral and preferential risk premia, reflecting a variety of behavioral attitudes towards risk under indecisiveness. In fact, only 72 subjects (53%) (resp., 44 (32%) and 101 (74%) subjects) exhibit an absolute difference between the two risk premia of less than 0.1 (resp., 0.05 and 0.2). In addition, numerous subjects exhibit risk premia which have opposite signs: 12 subjects have a strictly positive preferential risk premium but a strictly negative behavioral risk premium, the absolute difference between the two risk premia averaged over the 12 subjects being equal to 0.37; another 10 subjects have a strictly negative preferential risk premium but a strictly positive behavioral risk premium, the absolute difference between the two risk premia averaged over the 10 subjects being equal to 0.25. Though the distribution of risk attitudes in the population might not be influenced by the elicitation method, the researcher who is interested in obtaining the risk preferences of a given individual should take indecisiveness into account.

[10] This result is consistent with our former observation concerning the impact of *Pay All* on the propensity to choose the flexible menu.

5 Conclusion

We propose an experimental design allowing a behavioral test of the axiom of completeness of preferences. Our design enables subjects to postpone commitment at a small cost and therefore assumes a link between incomplete preferences and preference for flexibility. We find evidence supporting this assumption which suggests that incomplete preferences are not *per se* incompatible with a revealed preference approach and that the debate over the completeness axiom can be moved to the laboratory.

Rather than only exhibiting an isolated situation in which subjects are indecisive, our preference elicitation method provides an individual measure of preference incompleteness. We observe that a majority of our subjects exhibit a strictly positive measure of indecisiveness which clearly challenges the descriptive power of the completeness axiom in preference theory.

The choice alternatives we use are lotteries, which enables us to measure subjects' risk attitudes and we find that risk aversion is globally robust to indecisiveness. In order to reach a general assessment of the completeness axiom, it is necessary to conduct additional experiments in other choice settings. In particular, our design can easily be adapted to choice under ambiguity, by giving subjects less precise information about the lotteries' probabilities. This would provide an experimental test of the theoretical relationship between indecisiveness and ambiguity (Bewley, 1986; Rigotti and Shannon, 2005).

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Appendix A. Additional figures and tables

Incentive scheme	Spread group	Session	Date, time	Invitations	Participants	Mistakes
Pay Three	High	A_1	05/02, 12:00	17	16	2×1
		B_1	12/02, 12:00	14	14	—
		A_2	20/02, 10:00	15	14	1×1
		B_2	27/02, 10:00	13	13	—
	Medium	A_3	05/02, 10:00	16	14	1×1
		B_3	12/02, 10:00	13	13	—
		A_4	20/02, 12:00	15	13	1×1
		B_4	27/02, 12:00	12	12	—
	Low	A_5	05/02, 14:00	15	14	1×2, 1×1
		B_5	12/02, 14:00	12	12	—
		A_6	20/02, 14:00	15	14	3×1
		B_6	27/02, 14:00	11	11	—
Pay One	High	A'_1	10/06, 11:00	14	13	1×1
		B'_1	17/06, 11:00	12	12	—
	Medium	A'_3	10/06, 12:30	12	12	3×1
		B'_3	17/06, 12:30	9	9	—
	Low	A'_5	10/06, 14:00	13	10	1×1
		B'_5	17/06, 14:00	9	9	—
Pay All	High	A''_1	15/06, 11:00	13	12	1×1
		B''_1	22/06, 11:00	11	11	—
	Medium	A''_3	15/06, 12:30	14	12	2×1
		B''_3	22/06, 12:30	10	10	—
	Low	A''_5	15/06, 14:00	12	12	1×1
		B''_5	22/06, 14:00	11	11	—
Total A_i+A'_i+A''_i				171	156	1×2, 18×1
Total B_i+B'_i+B''_i				137	137	—

Table 3. Experimental sessions.

	Estimate	Std. error	z-statistic	p-value
Intercept	-3.108	0.232	-13.384	< 0.01
Pay One	0.831	0.351	2.363	0.018
Pay All	-2.054	0.345	-5.957	< 0.01
c_{norm}	13.420	0.473	28.399	< 0.01
Low Spread	-1.432	0.324	-4.416	< 0.01
Medium Spread	-1.122	0.278	-4.041	< 0.01
Third Bracketing	7.617	0.294	25.943	< 0.01
Pay One:*Low Spread*	-2.081	0.583	-3.571	< 0.01
Pay All:*Low Spread*	1.320	0.543	2.431	0.015
Pay One:*Medium Spread*	-0.749	0.513	-1.461	0.144
Pay All:*Medium Spread*	2.130	0.502	4.246	< 0.01
Pay One:*Third Bracketing*	-0.696	0.397	-1.751	0.080
Pay All:*Third Bracketing*	4.634	0.417	11.112	< 0.01
c_{norm}:*Third Bracketing*	-26.718	0.618	-43.249	< 0.01
Low Spread:*Third Bracketing*	3.619	0.406	8.923	< 0.01
Medium Spread:*Third Bracketing*	3.091	0.336	9.199	< 0.01
Pay One:*Low Spread*:*Third Bracketing*	2.154	0.701	3.075	< 0.01
Pay All:*Low Spread*:*Third Bracketing*	-3.416	0.677	-5.043	< 0.01
Pay One:*Medium Spread*:*Third Bracketing*	-0.331	0.592	-0.559	0.576
Pay All:*Medium Spread*:*Third Bracketing*	-4.697	0.597	-7.862	< 0.01
Standard deviation of random effects	*Intercept* = 2.3258; c_{norm} = 4.4089			
Number of observations	4778			
Number of subjects	137			
Log-likelihood at zero	-3248.145			
Log-likelihood at convergence	-1315.214			

Note: We denote an interaction between two fixed effects by ':'.

Table 4. Logit estimation of the propensity to choose the flexible menu.

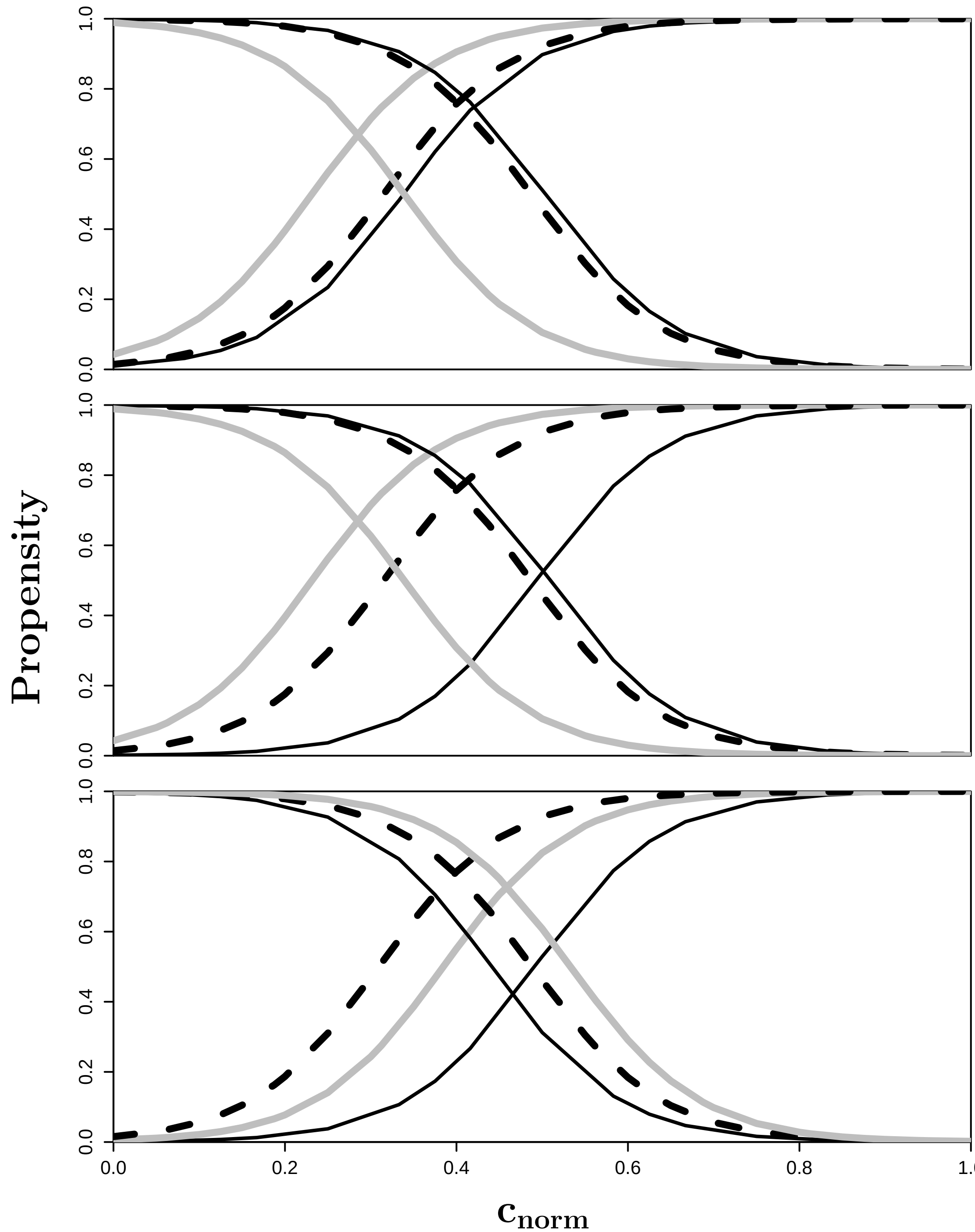


Figure 5. Detailed estimated propensities to choose the flexible menu.

Note: The top (resp., middle, bottom) graph corresponds to the treatment *Pay Three* (resp., *Pay One*, *Pay All*). The increasing (resp., decreasing) curves correspond to the second (resp., third) bracketing. The grey (resp., dashed, black) curves correspond to the high (resp., medium, low) spread group.

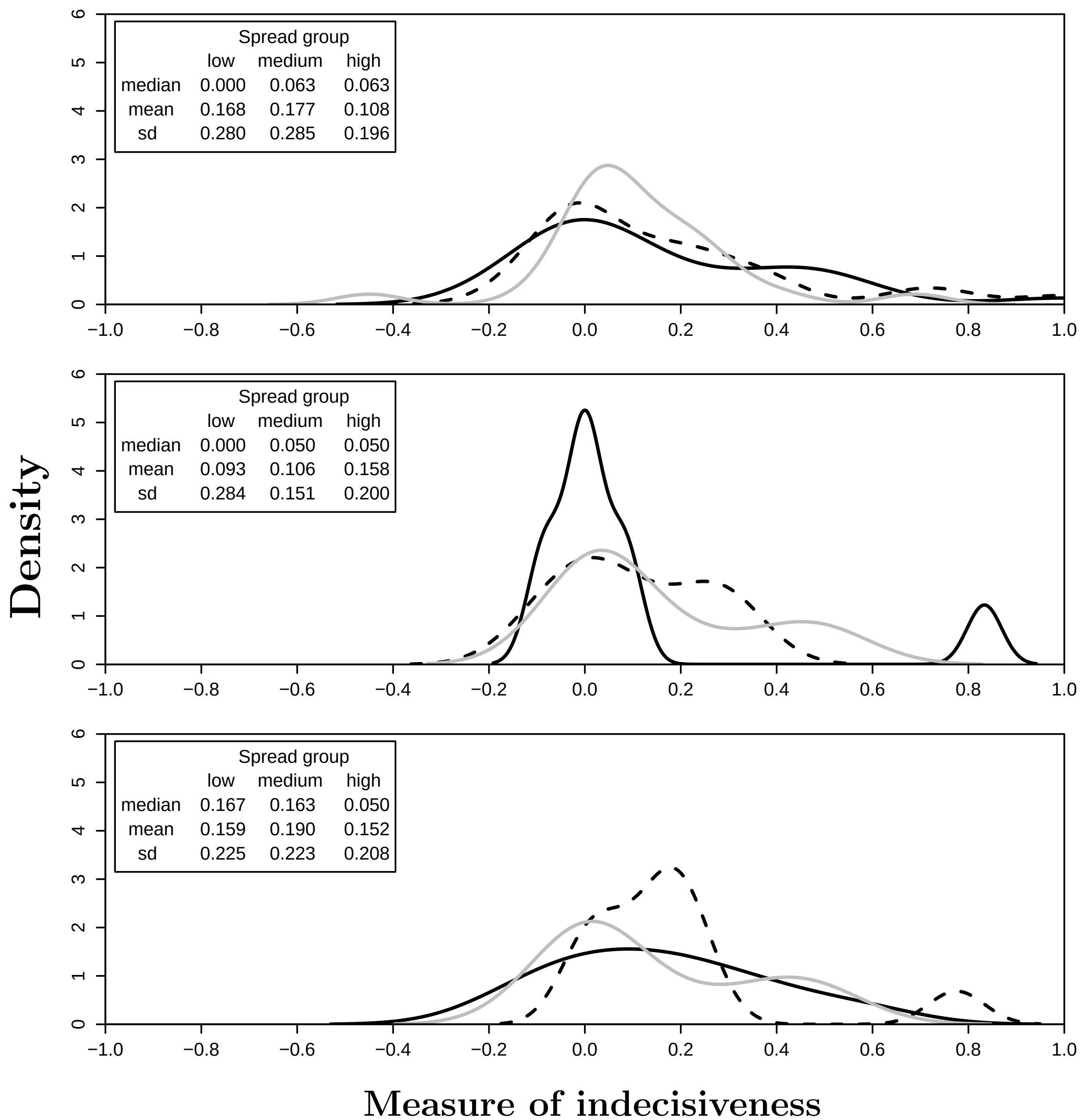


Figure 6. Nonparametric kernel-density estimations of the measure of indecisiveness.

Note: The top (resp., middle, bottom) graph corresponds to the treatment *Pay Three* (resp., *Pay One*, *Pay All*). The grey (resp., dashed, black) curves correspond to the high (resp., medium, low) spread group.

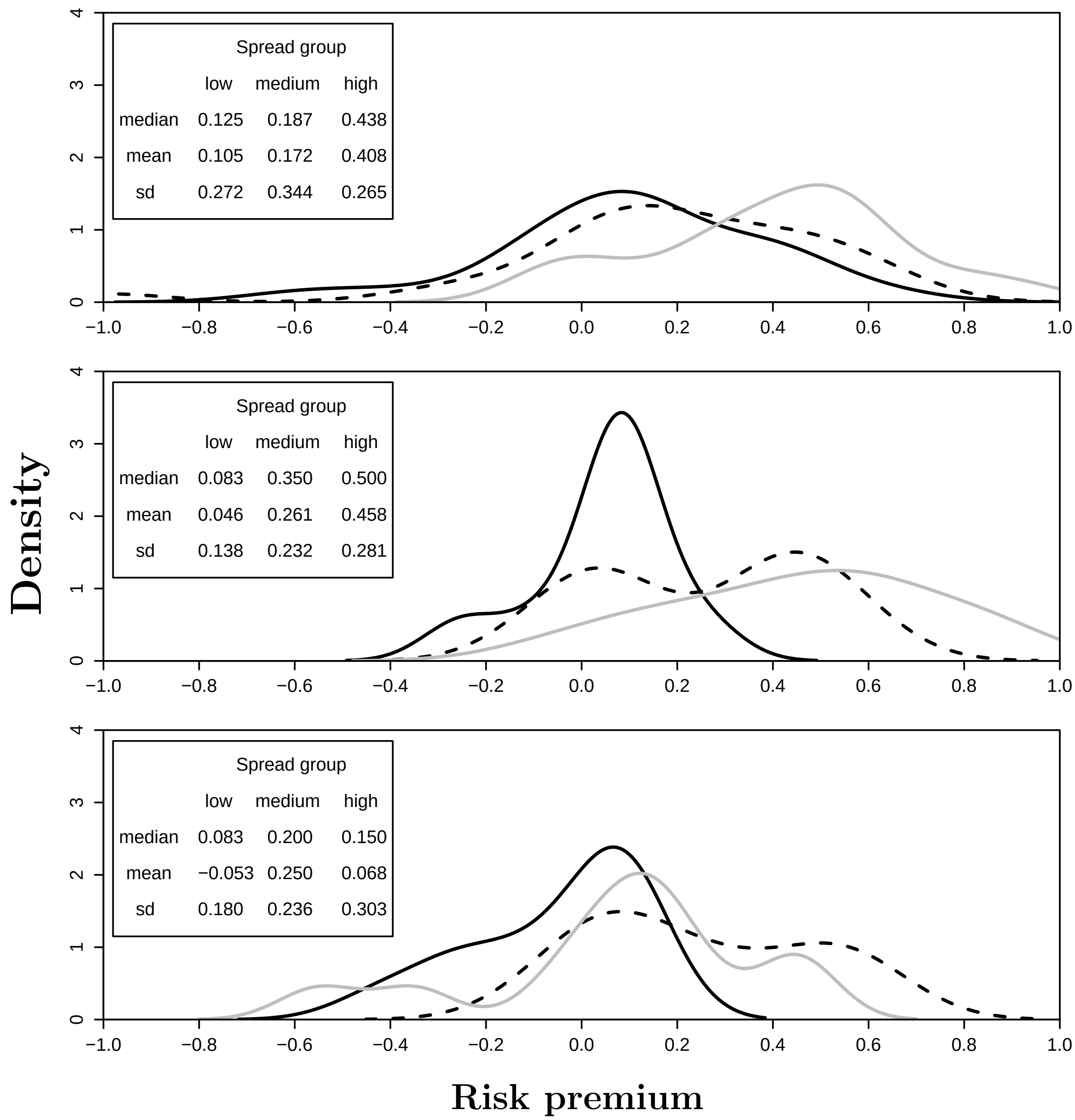


Figure 7. Nonparametric kernel-density estimations of the behavioral risk premium.

Note: The top (resp., middle, bottom) graph corresponds to the treatment *Pay Three* (resp., *Pay One*, *Pay All*). The grey (resp., dashed, black) curves correspond to the high (resp., medium, low) spread group.

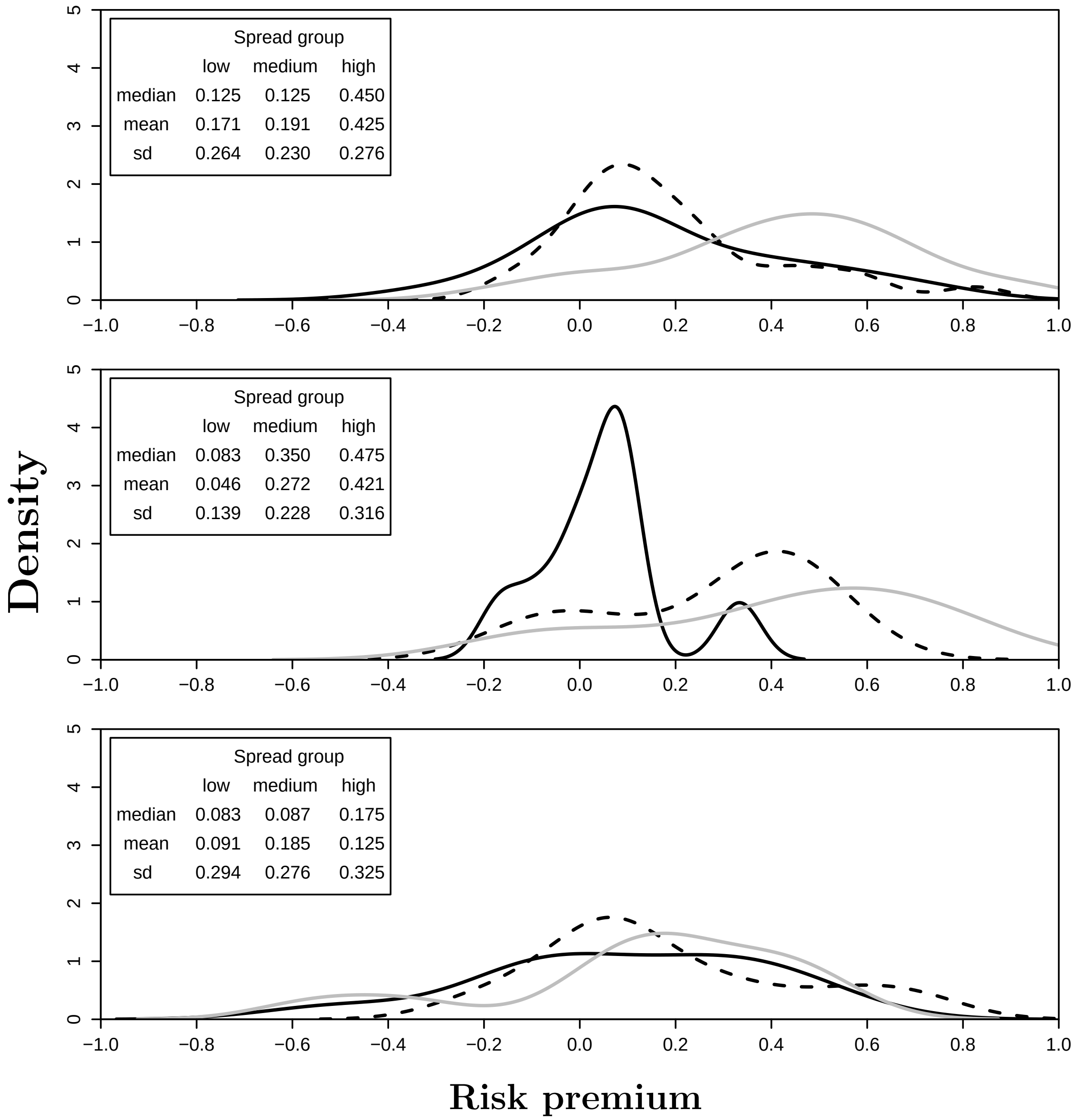


Figure 8. Nonparametric kernel-density estimations of the preferential risk premium.

Note: The top (resp., middle, bottom) graph corresponds to the treatment *Pay Three* (resp., *Pay One*, *Pay All*). The grey (resp., dashed, black) curves correspond to the high (resp., medium, low) spread group.

Appendix B. Translated software screens

The original language was German. Here we include only the translation of three screens that subjects who were assigned to lottery l_2 saw. These translated screens are not meant for publication but could be made available on a webpage.

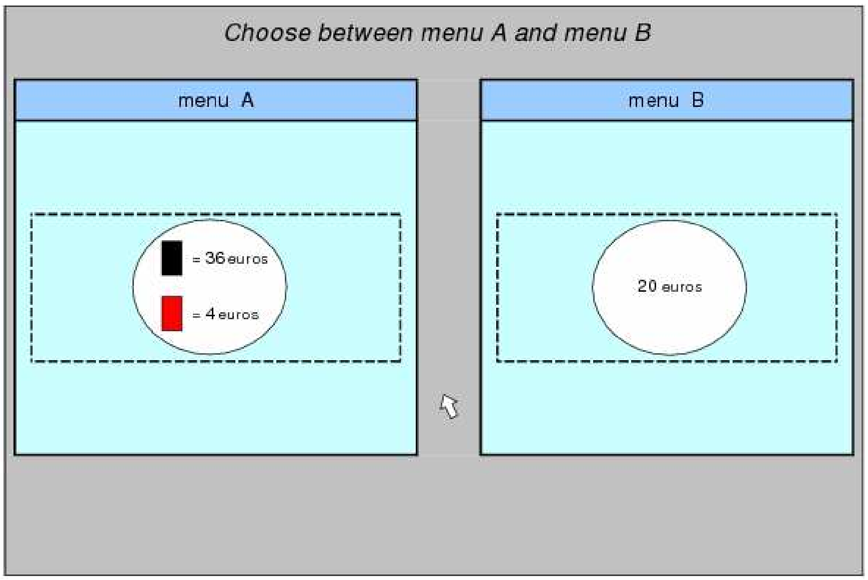


Figure 9. First bracketing, last choice.

Note: Each option within a menu is delimited by a dashed rectangle. The subject must click on a menu to select it.

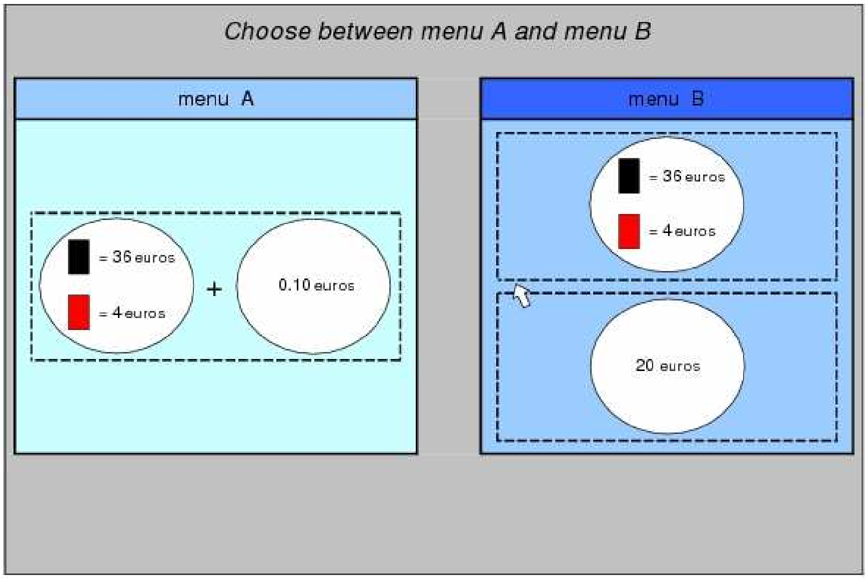


Figure 10. Second bracketing, last choice.

Note: The bonus is displayed separately from the lottery in order to emphasize it. When the mouse cursor passes over a menu, the whole menu is highlighted.

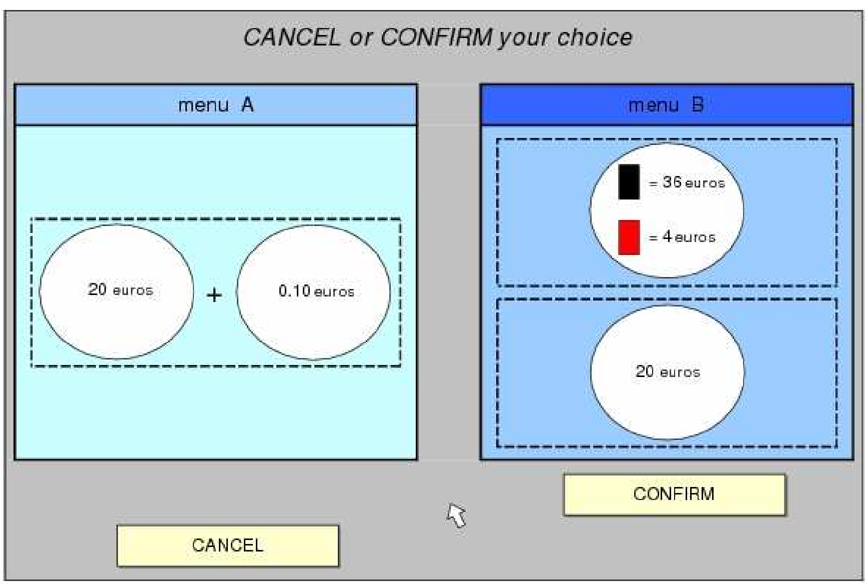


Figure 11. Third bracketing, last choice.

Note: After a menu has been clicked, it remains highlighted. The subject can either confirm her choice or cancel it.

Appendix C. Translated instructions

The original instructions were written in German. Here we include only the translation of the instructions used in Session A_2 (first session of treatment *Pay Three* with lottery l_2). The session took place on Friday, February 20, 2004. The instructions for the other first sessions involve only minor changes from those reprinted here. These translated instructions are not necessarily meant for publication but could be made available on a webpage.

Welcome to this experiment.

This experiment consists of two experimental sessions. The first session takes place today while the second session will take place on Friday, February 27, 2004. It is essential that you participate in both sessions, meaning that you have to attend the session on Friday, February 27, 2004.

As a compensation for your participation in both sessions you will receive a fixed payoff of 2.50 euros, which will be paid to you today at the end of the session. By making decisions in both sessions you can earn additional money as explained in the following instructions. Your earnings will be paid to you in cash at the end of the experiment without any other participant obtaining information about the amount you earned.

From now on and until the end of this session you are not allowed to leave your place, talk loudly, or try to communicate with any of your neighbors. If you would like to ask a question, raise your hand and one of the assistants will come to you and answer it individually. At the end of this session, please do not take any written documents with you out of the laboratory (neither these instructions nor the scratch paper).

Once you have read these instructions we will ask you to answer two questions intended to evaluate your comprehension of the instructions. **In order to take part in the experiment you have to answer both control questions correctly.** If one of your answers is wrong we will pay you 2.50 euros and ask you to leave the room. If this is the case you cannot further take part in the experiment, including also the second session.

This experiment is conducted in order to study individual decision-making. There will be no interaction between the participants of this experiment, meaning that your decisions have no influence on the decisions and payoffs of other participants and vice versa.

In the following we provide a detailed description of the procedures of the two sessions.

First session (today)

You will go through 3 decision series consisting of 17 decisions each. In each of the decision series you will have to choose 17 times between a **menu A** and a **menu B**. A menu either consists of one or two elements. The menus you choose today will be again presented to you in the second session on February 27 where you will then be asked to pick an element out of the menu.

If, for a given decision, you choose today a menu that consists of only one element, then you will have to pick this element in the second session. If however the menu you choose today consists of two elements, then you will have to choose one of the two elements in the second session.

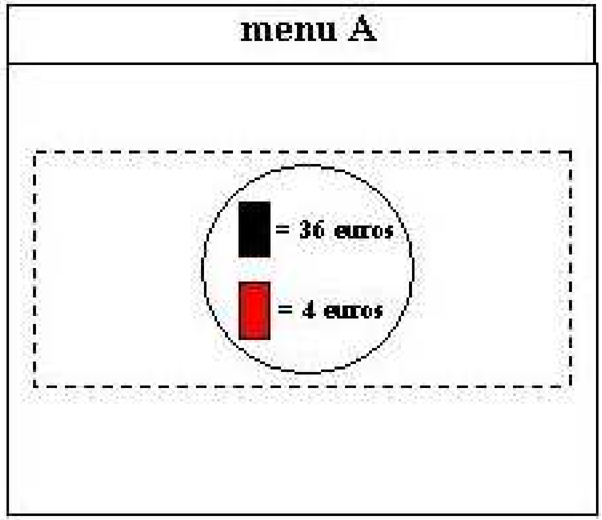
The elements that you choose in the second session determine your payment. Today, you choose the menus out of which you will pick the elements in the second session.

We will now describe - for each of the three decision series - the menus that are up for choice as well as their elements.

1. <u>First decision series</u>

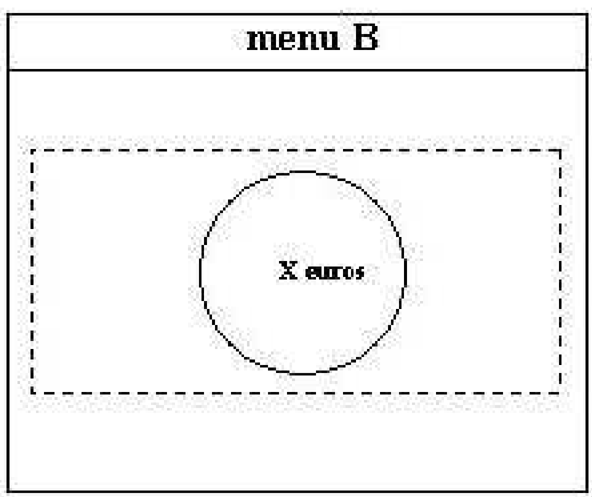
In each of the 17 decisions of the first decision series, **menu A** consists of a single element, namely a **lottery ticket**. **Menu B** consists of a single element, namely a **sure gain**.

The element of which menu A consists remains the same for all 17 decisions. Concretely, it is a lottery ticket, which either results in a gain of 4 euros or 36 euros. If you choose menu A you yourself will in the second session draw one out of two cards, one of which is red and the other black. You will not be able to distinguish the colors when drawing the card. The lottery ticket results in a gain of 4 euros if you draw the red card and it results in a gain of 36 euros if you draw the black card. **Consequently, the lottery ticket gives you a 50-percentage chance of winning 36 euros and a 50-percentage chance of winning 4 euros.** In each of the 17 decisions, menu A is graphically represented on your screen in the following way:



The dotted frame indicates that menu A consists of just one element. Looking within the circle you see that this one element is a lottery ticket with a gain of either 4 euros or 36 euros.

The element of which menu B consists varies in the course of the 17 decisions. The element is given by a sure gain of X euros where X is always an amount between 4 and 36 euros. If you choose menu B you receive a sure gain of X euros in the second session. In each of the 17 decisions, menu B is graphically represented on your screen in the following way:

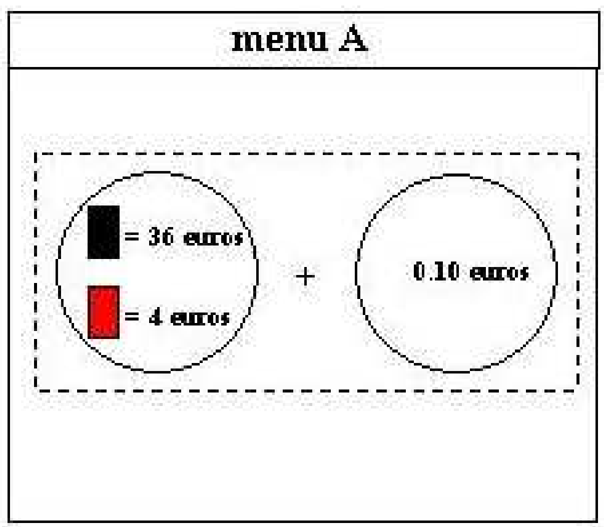


The dotted frame indicates that menu B consists of just one element. Looking within the circle you see that this one element is a sure gain of X euros. X varies in the course of the 17 decisions ranging from 4 euros to 36 euros.

2. Second decision series

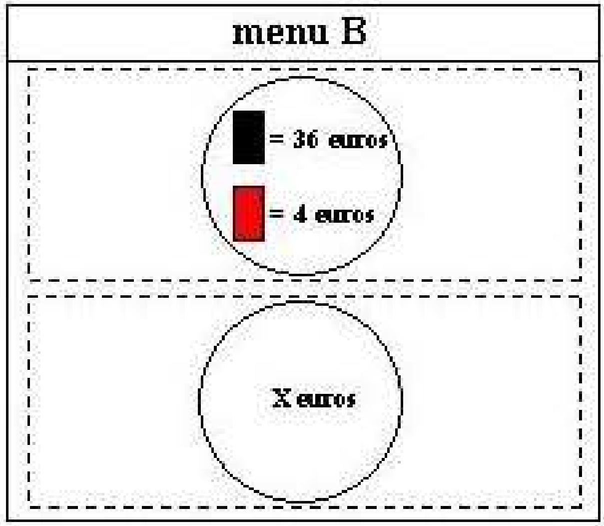
In each of the 17 decisions of the second decision series, **menu A** consists of a single element, namely a **lottery ticket with bonus**. **Menu B** consists of two elements, namely a **lottery ticket** and a **sure gain**.

The element of which menu A consists remains the same for all 17 decisions. Concretely, it is a lottery ticket that either results in a gain of 4 euros or 36 euros, and on top of each result you receive a bonus of 10 eurocents. The lottery ticket results in a gain of 4 euros if you draw the red card and it results in a gain of 36 euros if you draw the black card. Independently of which card you draw you receive a bonus of 10 eurocents. In each of the 17 decisions, menu A is graphically represented on your screen in the following way:



The dotted frame indicates that menu A consists of just one element. Looking within the circles you see that this element consists of a lottery ticket (which either results in a gain of 4 euros or 36 euros) and a bonus of 10 eurocents.

The top element of menu B remains the same for all 17 decisions. It is a lottery ticket that results in a gain of either 4 euros or 36 euros. The bottom element of menu B is a sure gain of X euros, where X ranges from 4 to 36 euros. If you choose menu B you will have to choose between **the lottery ticket and the sure gain** in the second session. In each of the 17 decisions, menu B is graphically represented on your screen in the following way:

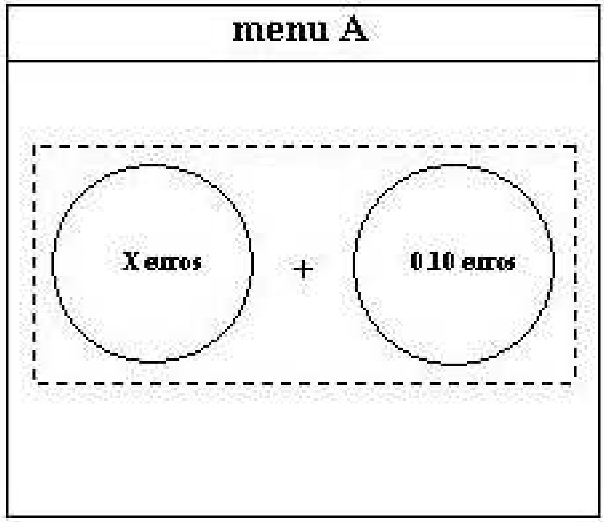


The two dotted frames indicate that menu B consists of two elements. Looking within the circle of each frame you see that one of them is a lottery ticket and the other is a sure gain of X euros. X varies in the course of the 17 decisions ranging from 4 euros to 36 euros.

3. <u>Third decision series</u>

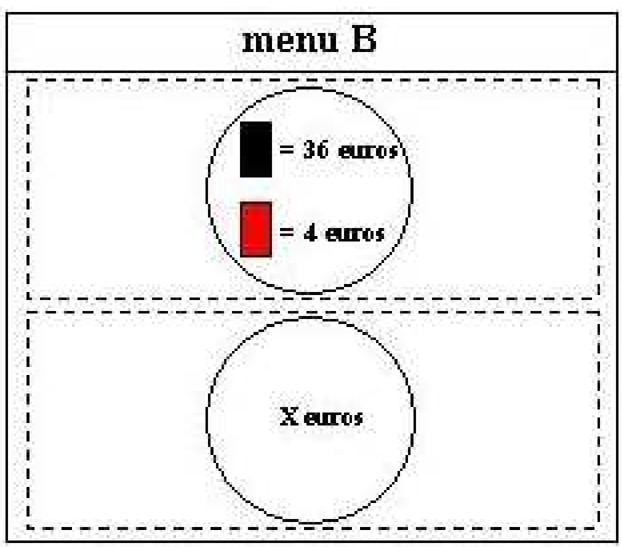
In each of the 17 decisions of the third decision series, **menu A** consists of a single element, namely a **sure gain with bonus**. **Menu B** consists of two elements, namely a **lottery ticket** and a **sure gain**.

The element of which menu A consists is given by a sure gain of X euros, where X ranges from 4 euros to 36 euros, in addition to which you receive a bonus of 10 eurocents. In each of the 17 decisions, menu A is graphically represented on your screen in the following way:



The dotted frame indicates that menu A consists of just one element. Looking within the circles you see that this element consists of a sure gain of X euros and a bonus of 10 eurocents. X varies in the course of the 17 decisions ranging from 4 euros to 36 euros.

The top element of menu B remains the same for all 17 decisions. It is a lottery ticket that results in a gain of either 4 euros or 36 euros. The bottom element of menu B is a sure gain of X euros, where X ranges from 4 to 36 euros. If you choose menu B you will have to choose between **the lottery ticket and the sure gain** in the second session. In each of the 17 decisions, menu B is graphically represented on your screen in the following way:



The two dotted frames indicate that menu B consists of two elements. Looking within the circle of each frame you see that one of them is a lottery ticket and the other is a sure gain of X euros. X varies in the course of the 17 decisions ranging from 4 euros to 36 euros.

For each of the 17 decisions in each of the three decision series, a menu A and a menu B will be displayed on your screen. You will be asked to choose one of the two displayed menus by clicking on it and to confirm your choice. Each participant proceeds at his own speed. Once you have completed the three decision series, please remain seated and silent, and abstain from communicating with your neighbors until one of the assistants signals that all participants have made all their decisions.

Second Session (Friday, February 27, 2004)

In the second session you will once more go through 3 decision series with 17 decisions each. But this time you will not choose between a menu A and a menu B. Instead, only one menu will be displayed on your screen and you will be asked to pick one of its elements. The menus that will be displayed on your screen are those that you choose today.

As both menus in today's first decision series only consist of one element you will have to pick this element in the first decision series of the second session. If a menu displayed on your screen in the second or third decision series of the second session consists of only one element you will have to pick this element. If instead the menu displayed on your screen consists of two elements you will have to pick one of the two elements.

Once you have completed the three decision series with 17 decisions each, all your choices of the first decision series will be displayed on your screen. You will be asked to randomly draw one of these 17 choices and the randomly drawn choice will be **paid 1/3 of its value** to you. Then your choices of the second decision series will be displayed on your screen. You will be asked to randomly draw one of these 17 choices and the randomly drawn choice will be **paid 1/3 of its value** to you. Finally, your 17 choices of the third decision series will be displayed on your screen and you will be asked again to randomly draw one of them which will be **paid 1/3 of its value** to you.

For each decision series you will make the random draw that determines the payoff-relevant choice yourself. Concretely, you will draw one card out of a pile of cards that are consecutively numbered from 1 to 17. The numbers of the cards are not visible to you when you make the random draw. If the card you draw bears number 1 then the first choice in the respective decision series is paid (if this is the lottery ticket you will be asked to make a random draw between a red and a black card). For each decision series, **each of your 17 choices has the same chance to be paid**. In total, **three of your choices (one in each decision series) will be paid to you**.

After the completion of the second session and after having received your payoff you will be asked to participate in another experiment which is unrelated to this one. For your participation in this experiment you will receive an additional payoff between 2.50 euros and 12.50 euros.

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Once you have read these instructions we will ask you to answer two questions that test your understanding of these instructions. **In order to be allowed to take part in this experiment you have to answer both control questions correctly.** If you correctly answer both questions you will go through three training series that are not payoff-relevant. The three training series are very similar to the payoff-relevant series that are following them. If you have any questions please raise your hand. One of the assistants will then come to you. Finally, two important remarks:

- **A choice of either menu A or menu B is never good or bad, right or wrong, but just a personal decision.**
- **The time needed to make a choice is neither limited nor do we keep track of it. The only thing that matters is your choice. So, take your time.**

Appendix D. Translated control questionnaire

The original language was German. Here we include only the translation of the control questionnaire used in Session A_2 (first session of treatment *Pay Three* with lottery l_2). The control questionnaires for the other first sessions involve only minor changes from those reprinted here. This translated control questionnaire is not meant for publication but could be made available on a webpage.

Subjects see a screen with two menus as in Figure 10, and are asked to answer the two following questions (which appear on two successive screens) by selecting the correct statement:

Question 1. Suppose that, among the two menus below, you have chosen menu A. If this choice is payoff-relevant in the second session, then:

- You will be asked to draw one out of two cards, one of which is red and the other is black. You will not be able to distinguish the colors when you draw the card. If you draw the red card your gain from the lottery ticket will be 4 euros whereas if you draw the black card your gain from the lottery ticket will be 36 euros. On top of the gain you receive from the lottery ticket you will get a bonus of 0.10 euros. One third of your overall gain will be paid to you.
- You will be asked to draw one out of two cards, one of which is red and the other is black. You will not be able to distinguish the colors when you draw the card. If you draw the red card your gain from the lottery ticket will be 4 euros whereas if you draw the black card your gain from the lottery ticket will be 36 euros. After having drawn the card, you will be asked to choose between the gain from the lottery ticket and the bonus of 0.10 euros. One third of the amount you will have chosen will be paid to you.
- You will be asked to choose between the lottery ticket and the bonus of 0.10 euros. If you choose the bonus of 0.10 euros, one third of 0.10 euros will be paid to you. If you choose the lottery ticket, you will be asked to draw one out of two cards, one of which is red and the other is black. You will not be able to distinguish the colors when you draw the card. If you draw the red card your gain from the lottery ticket will be 4 euros whereas if you draw the black card your gain from the lottery ticket will be 36 euros. One third of the gain

of the lottery ticket will be paid to you.

Question 2. Suppose that, among the two menus below, you have chosen menu B. If this choice is payoff-relevant in the second session, then:

– If in the second session, you have chosen the top element of menu B, then you will be asked to draw one out of two cards, one of which is red and the other is black. You will not be able to distinguish the colors when you draw the card. If you draw the red card your gain from the lottery ticket will be 4 euros whereas if you draw the black card your gain from the lottery ticket will be 36 euros. One third of the gain from the lottery ticket will be paid to you. If in the second session, you have chosen the bottom element of menu B, then one third of 20 euros will be paid to you.

– Whatever element of menu B you have chosen in the second session, you will be asked to draw one out of two cards, one of which is red and the other is black. You will not be able to distinguish the colors when you draw the card. If you draw the red card your gain from the lottery ticket will be 4 euros whereas if you draw the black card your gain from the lottery ticket will be 36 euros. You will then be asked to choose between the gain from the lottery ticket and the 20 euros. One third of the amount you will have chosen will be paid to you.

– Whatever element of menu B you have chosen in the second session, you will be asked to draw one out of two cards, one of which is red and the other is black. You will not be able to distinguish the colors when you draw the card. If you draw the red card your gain from the lottery ticket will be 4 euros whereas if you draw the black card your gain from the lottery ticket will be 36 euros. One third of the gain from the lottery ticket on top of which the 20 euros have been added will be paid to you.

For both questions, the correct statement is the first one.