Paradoxes and Mechanisms for Choice under Risk

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Abstract: Experiments on choice under risk typically involve multiple decisions by individual subjects. The choice of mechanism for selecting decision(s) for payoff is an essential design feature unless subjects isolate each one of the multiple decisions. We review theoretical properties of mechanisms including properties of two new mechanisms introduced herein. We report an experiment with several payoff mechanisms that generate data that show systematic differences across mechanisms in subjects' revealed risk preferences. We illustrate the importance of these mechanism effects by identifying their implications for tests of classic properties of theories of decision under risk. We also identify behavioral properties of mechanisms that diverge from theoretical incentive compatibility and may introduce bias in risk preference elicitation.

Keywords: experiments, risky choice, payoff mechanisms, paradoxes
JEL classifications: C91, D81

1. Introduction

Most experiments on choice under risk involve multiple decisions by individual subjects. This necessitates choice of mechanism for determining incentive payments to the subjects. Mechanisms used in papers published by top five general readership journals and a prominent field journal vary quite widely from "paying all decisions sequentially" to "paying all decisions at the end" to "randomly paying one decision for each subject" to "randomly paying a few decisions for each subject" to "randomly paying some of the subjects" to "randomly paying one of the subjects" to "fixed payment" to unidentified mechanisms.[2] This suggests questions about whether different payoff mechanisms can elicit different data in otherwise

[1] Financial support was provided by the National Science Foundation (grant number SES-0849590) and the Fritz Thyssen Stiftung. Glenn W. Harrison provided helpful comments and suggestions.
[2] Table 1 in Azrieli, et al. (2012) reports a survey of some of the payoff mechanisms used in papers published in 2011 in *American Economic Review*, *Econometrica*, *Journal of Political Economy*, *Review of Economic Studies*, *Quarterly Journal of Economics*, and *Experimental Economics*. The present authors' survey of payoff mechanisms used in recent articles in *Review of Economic Studies* identified use of "pay all sequentially" (Goeree, et al., 2007; Oprea, et al., 2009; Potters and Suetens, 2009; Battaglini, et al., 2010; and Sutter, et al., 2010) and "pay one randomly" (Costa-Gomes and Weizsäcker, 2008; Heinemann, et al., 2009; Offerman, et al., 2009; and Deck and Schlesinger, 2010) and "pay all at the end" (Offerman, et al., 2009).

identical experimental treatments and, if so, whether these mechanism effects have significant implications for conclusions drawn from data. We report an experiment with several different payoff mechanisms that directly addresses these questions. Data from our experiment show that subjects' revealed risk preferences differ across mechanisms. We illustrate the importance of these payoff mechanism effects by using data from alternative mechanisms to test for consistency with classic properties of theories of decision under risk.

We provide an explanation of theoretical incentive compatibility or incompatibility of alternative mechanisms for decision theories with functionals that are linear in probabilities or linear in payoffs or linear in neither. Data from our experiment are used to identify mechanism biases in risk preference elicitation such as choice-order effects, previous-outcome effects, and other types of cross-task contamination.

2. Do Payoff Mechanisms Affect Revealed Risk Preferences?

Our experimental treatments include payoff mechanisms commonly used for multiple decision experiments and two new mechanisms, introduced herein, that are theoretically incentive compatible for functionals that are linear in payoffs such as the dual theory of expected utility (Yaari, 1987) and linear cumulative prospect theory (Schmidt and Zank, 2009). We also use another "mechanism" in which each subject makes only one decision. All treatments use the same five pairs of lotteries reported below.

2.1 *Lottery Pairs*

Our experiment includes the five pairs of lotteries reported in Table 1. Payoff in any lottery is determined by drawing a ball in the presence of the subjects from a bingo cage containing 20 balls numbered 1, 2, …, 20. Each lottery pair consists of a relatively safe and a relatively risky lottery.

Table 1.Lottery Pairs

Pair	Safe		Risky		
1	Balls 1-15 $0	Balls 16-20 $3	Balls 1-16 $0	Balls 17-20 $5	
2	Balls 1-20 $6		Balls 1-4 $0	Balls 5-20 $10	
3	Balls 1-15 $0	Balls 16-20 $6	Balls 1-16 $0	Balls 17-20 $10	
4	Balls 1-5 $6	Balls 6-20 $12	Ball 1 $0	Balls 2-5 $10	Balls 6-20 $12
5	Balls 1-20 $18		Balls 1-4 $12	Balls 5-20 $22	

Lotteries were *not* shown to participants in the format of Table 1. They were presented in a format illustrated by the example in Figure 1 which shows one of the two ways in which the lotteries of Pair 4 were presented to subjects in the experiment. Some subjects would see the Pair 4 lotteries as shown in Figure 1 while others would see them (randomly) presented with inverted top and bottom positioning and reversed A and B labeling. (See below for full details on randomized presentation of option pairs.)

<table>
<tr><td>Ball nr</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td><td>16</td><td>17</td><td>18</td><td>19</td><td>20</td></tr>
<tr><td>Option A</td><td colspan="5">$6</td><td colspan="15">$12</td></tr>
<tr><td>Option B</td><td>$0</td><td colspan="4">$10</td><td colspan="15">$12</td></tr>
</table>

Figure 1. An Example of Presentation of Lotteries

2.2 Alternative Payoff Mechanisms

We experiment with the properties of several mechanisms defined below. In one case we experiment with two alternative ways of implementing a mechanism that are both prominent in the literature.

The payoff mechanism that appears to be most commonly used is the one in which each decision is paid sequentially before the following decision is made; we label this mechanism "pay all sequentially" (PAS).[3] Another way in which all decisions are paid is to pay all decisions at the end of the experiment with independent draws of random variables; we label this mechanism "pay all independently" (PAI).[4] Another mechanism is to randomly select one decision for payoff at the end of the experiment. There are two ways in which this payoff mechanism is commonly used, which differ in whether a subject is shown all lotteries before making any choices. In the version of the mechanism used by Holt and Laury (2002) and Starmer and Sugden (1991), a subject is shown all lotteries in advance before any choices are made; we label this version of the mechanism "pay one randomly with prior information" (PORpi). In an alternative version of this mechanism used by Hey and Orme (1994), a subject is shown each lottery pair for the first time just before a choice is made; we call this version of the mechanism "pay one randomly with no prior information" (PORnp). To our best knowledge, a new mechanism is to pay all decisions at the end of the experiment with one realization of a random variable; the theoretical properties of this mechanism are explained in section 3 (for comonotonic lotteries). There are two versions of this mechanism that differ in scale of payoffs. In one version, full payoff for all chosen lotteries is made according to one random draw at the end of the experiment; we label this mechanism "pay all correlated" (PAC). With N decisions, the scale of the payoffs with PAC are the same as with PAS and PAI but they are N times the expected payoff with either version of POR. The alternative version, called PAC/N, pays 1/N of the payoffs for all chosen lotteries; this version of the mechanism has the same scale of payoffs as both versions of POR.

When reviewing the experimental evidence on violations of expected utility, Cubitt, et al. (2001) advocate the use of between-subjects designs, in which each subject makes one choice, rather than within-subjects designs with multiple decisions. We implement this approach and compare the resulting data to the data elicited by several multiple decision protocols using the above payoff mechanisms. We subsequently refer to the single decision per subject protocol as the "one task" (OT) mechanism.

2.3 *Protocol*

The experiment was run in the laboratory of the Experimental Economics Center at Georgia State University. Subject instructions are contained in appendix 2. Subjects in groups OT_i, i = 1, 2, …, 5, just had to perform one binary choice between the lotteries of Pair i which was played out for real. Subjects in an OT_i treatment were first shown a lottery pair at the time

[3] As shown in Table 1 of Azrieli, et al. (2012), this mechanism was used in 27 out of the 42 papers in which the chosen mechanism was reported for 2011 publications.

[4] This mechanism was used in Burks, et al. (2003) and Chaudhuri and Gangadharan (2007).

they made their decision. In treatment PORnp subjects were first shown a lottery pair at the time they made their decision for that pair. In all other multiple decision treatments, including PORpi, subjects were shown all five lottery pairs at the beginning of a session, as follows. Each subject was given an envelope with five (independently) randomly-ordered small sheets of paper. Each of the five small sheets of paper presented one lottery pair in the format illustrated by Figure 1. Each subject could display his or her five sheets of paper in any way desired on his or her private decision table.

Subjects entered their decisions in computers. In all treatments, including OT, the top or bottom positioning of the two lotteries in any pair and their labeling as Option A or Option B were (independently) randomly selected by the decision software for each individual subject. In all treatments other than OT, the five lottery pairs were presented to individual subjects by the decision software in independently-drawn random orders. Each decision screen contained only a single pair of lotteries.

Subjects in treatments PORpi and PORnp had to make choices for all five lottery pairs and at the end one pair was randomly selected (by drawing a ball from a bingo cage) and the chosen lottery in that pair was played out for real (by drawing a ball from another bingo cage). In treatments PAI, PAC, PAC/N, and PAS subjects had to make choices for all five pairs but here the choice from each pair was played out for real by drawing a ball from a bingo cage. In treatment PAI the five choices were played out independently at the end of the experiment whereas in treatments PAC and PAC/N the five choices were played out correlated at the end of the experiment (i.e. one ball was drawn from the bingo cage which determined the payoff of all five choices). In treatment PAS the chosen lotteries were played immediately after each choice was made (by drawing a ball from a bingo cage after each decision). In all treatments subjects were permitted to inspect the bingo cage and the balls before making their decisions. Each ball drawn from a bingo cage was done in the presence of the subjects (and put back in the cage in the presence of the subjects).

2.4 *Revealed Risk Preferences*

The main question we are concerned with is whether the risk preferences revealed by subjects differ systematically across treatments that use different payoff mechanisms. The five columns of Table 2 present, for each lottery choice pair *i* (=1,2,…,5) and each elicitation mechanism, the percentage of subjects who chose the less risky (or "safe") lottery in that pair, denoted by S_i.

There are big differences across mechanisms in the percentages of S_i choices. Looking down the S_i columns of Table 2 we see that in three out of five columns the largest figure is more than three times the smallest one: for pair 2, choices of the safer option vary over mechanisms from 15.52% (OT) to 52.63% (PAC and PAI) or 50.00% (PORpi); for pair 4 these figures vary from 10.26% (PAS) to 34.21% (PAI) or 32.50% (PORnp); and for pair 5, choices of the safer option vary from 17.95% (PAS) to 60% (PORnp). The Kruskal-Wallis rank test rejects at 10% significance level (p-value is 0.089) the null hypothesis that these frequencies come from the same population.

Table 2. Observed Frequencies (in %) of the Less Risky Option Across Pairs

(low and high column figures in bold)

Mechanism	S_1	S_2	S_3	S_4	S_5
OT	**39.47**	**15.52**	27.59	28.95	38.46
PORnp	37.50	45.00	**47.50**	32.50	**60.00**
PORpi	27.50	50.00	42.50	22.50	50.00
PAC/N	37.50	35.00	35.00	22.50	45.00
PAC	36.84	**52.63**	**23.68**	21.05	42.11
PAS	**25.64**	23.08	33.33	**10.26**	**17.95**
PAI	36.84	**52.63**	36.84	**34.21**	52.63

To test for effects of mechanisms on overall revealed level of risk aversion we created a new variable, the total number of times an individual chose the risky option. This ("Total") variable takes integer values from 0 to 5. The distributions of this overall level of risk aversion across different protocols are displayed in Figure 2. The Kruskal-Wallis rank test rejects at 1% significance level (p-value is 0.003) the null hypothesis that observations of the variable Total observed across mechanisms come from the same population.

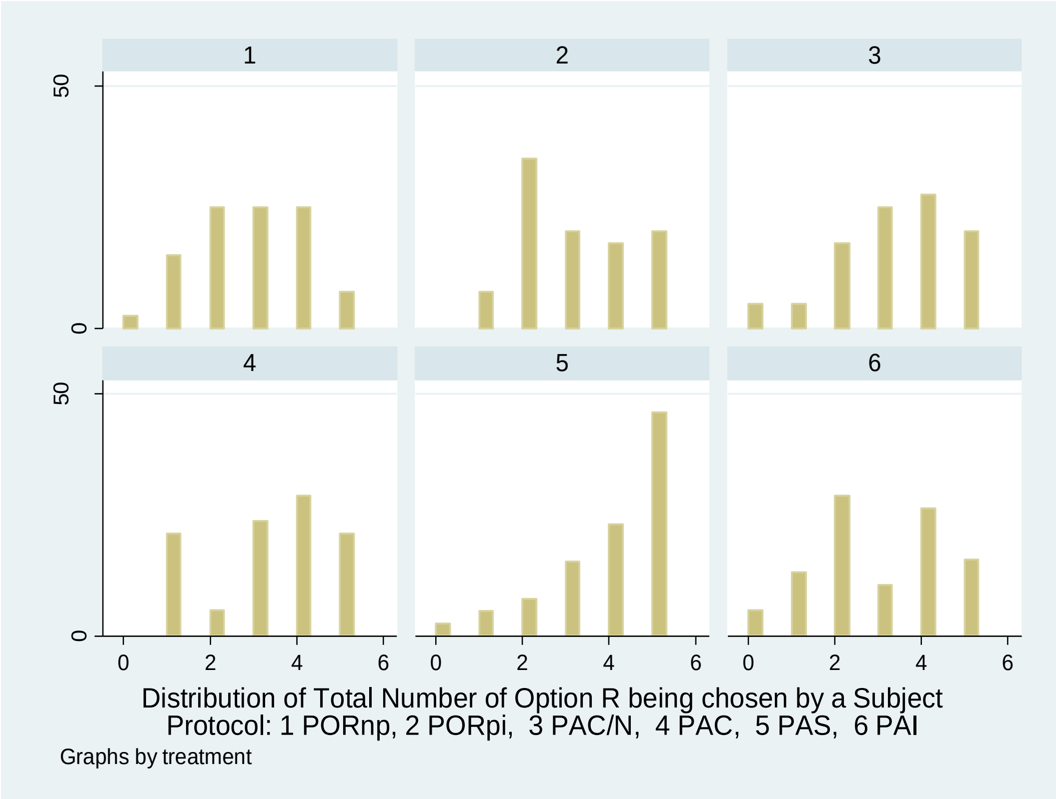

Figure 2. Distributions of Total Choices of Risky Options

The above tests use aggregated data. To retrieve information from data at the individual level we ran probit regressions with subject clusters to correct for correlated errors across choice tasks within an individual and with robust standard errors to accommodate heteroscedasticity.[5] Table 3 reports results from probit estimations of the probability of choosing the risky lottery in a pair. We will discuss results from the Probit 3 column. The alternatives, Probit 1 and Probit 2 differ from Probit 3 by exclusion of some of the right-hand variables. We include these alternative specifications in the table in order to show that our central conclusions about mechanism effects are robust to alternative specifications of the estimation model.

The right hand variables in Probit 3 include difference between expected values (EV Difference) and difference between variances (VAR Difference) of payoffs in a pair of lotteries. The estimated coefficient for EV Difference is not significant.[6] The estimated coefficient for VAR Difference is significantly negative; the sign confirms that subjects'

[5]Probit regressions with random effects and bootstrapped standard errors report the same results with respect to significance of the regressors that are reported in Table 3.

[6]Differences in expected values between options within a pair were \$0.25, \$0.5 and \$2. At these small differences it is expected that this variable will have low explanatory power.

choices respond to differences in variance of returns, revealing aversion to risk: the more risky the riskier option is relative to the safer one the less likely the riskier option is to be chosen.

Table 3. Probit Analysis of Choice Data with Robust Standard Errors

VARIABLES	Probit 1	Probit 2	Probit 3
EV Difference	0.094 (0.360)		0.099 (0.352)
VAR Difference	-0.032*** (0.004)		-0.034*** (0.004)
Field Study		0.080* (0.075)	0.080* (0.080)
Birth Order		0.092** (0.040)	0.093** (0.040)
Female		-0.309*** (0.000)	-0.314*** (0.000)
Black		-0.138 (0.121)	-0.142 (0.117)
Older than 21		0.157* (0.085)	0.162* (0.080)
DPORnp	-0.445*** (0.001)	-0.369*** (0.007)	-0.384*** (0.006)
DPORpi	-0.288** (0.039)	-0.275** (0.050)	-0.289** (0.043)
DPAC	-0.202 (0.187)	-0.263* (0.090)	-0.279* (0.077)
DPAC/N	-0.196 (0.184)	-0.268* (0.053)	-0.285** (0.043)
DPAS	0.193 (0.259)	0.149 (0.380)	0.137 (0.428)
DPAI	-0.397*** (0.009)	-0.468*** (0.002)	-0.489*** (0.001)
Constant	0.771*** (0.000)	0.394** (0.023)	0.606*** (0.001)
Observations (nr. of clusters)	1,406 (466)	1,406 (466)	1,406 (466)
BIC'[7]	6.308	6.637	1.919

P-values in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Some other right-hand variables are demographic controls for factors commonly associated with across-subjects differences in risk attitudes.[8] The subjects' field of study is

[7] By the criterion BIC' (Bayesian information criterion), the Probit 3 model is preferred to the other two probit models.

[8] Birth order has previously been reported as a significant determinant of risk attitudes (Yiannakis, 1976; Nixon, 1981; and Jobe, et al.,2006). Female subjects have previously been reported to be more risk averse than male subjects (Yiannakis, 1976; Nixon, 1981; Jobe, et al., 2006; Croson and Gneezy, 2009; and Castillo, et al., 2011). Black subjects have previously been reported to be less risk averse that whites (Castillo, et al., 2011).

coded 1 to 4 for subjects whose major is in natural science/engineering, economics/business, social science, and undecided, respectively. Students majoring in Social Sciences appear to be less risk averse than others. Arguably the job market favors students who study natural sciences and engineering; so students who choose Social Science majors are taking more risks in the job market**.** The subject's Birth Order is significant; subjects who were an older sibling were less likely to choose the risky lottery than a younger sibling or only child. Female subjects were less likely to choose the risky lottery. Probability of choosing the risky lottery was not significantly affected by a subject's race (Black). Being older than 21 years affects positively the likelihood of the risky option being chosen.

The other variables used in the probit estimations are dummy variables for multiple decision payoff mechanism treatments. All mechanism treatment dummy variables equal 0 for OT data. Otherwise, a value equal to 1 for any one of the multiple decision payoff mechanism dummy variables selects data for that mechanism. The coefficients for all of the dummy variables for multiple decision payoff mechanisms except PAS and PAC are negative at 5% significance; PAC is negative at 8% significance. This provides support for the finding that subjects are less likely to choose the risky option (they appear to be more risk averse) with all multiple decision payoff mechanisms except PAS than they are with the OT (one task) protocol.

The PAS mechanism produces data that clearly differ from data elicited by other multiple decision mechanisms. We tested for differences between the dummy variable coefficient estimates for PAS and those for other mechanisms. Correcting for multiple tests with the same data, we find that the dummy variable coefficient estimate for PAS is different from the estimate for PORpi (0.093), PORnp (0.014), PAI (0.006) and PAC5 (0.098), where the figures in parentheses are Bonferroni-adjusted p-values. The estimate for PAC (0.163) is not different from the one for PAS.

In addition, to get an overall level of risk aversion induced by each protocol, after running probit for each protocol, we simulated predicted probability of choosing the risky option.[9] Simulations after probit estimations report that the probability of the risky option being chosen is 0.72, 0.56, 0.62, 0.67, 0.65, 0.80 and 0.57 respectively, for OT, PORnp, PORpi, PAC/N, PAC, PAS and PAI data. According to these figures PORnp and PAI seem to induce more risk averse behavior whereas OT and PAS induce less risk averse behavior. Note

[9] Explanatory variables were set at their means; the number of simulated parameters was 1000 for each regressor. Clarify software was used to generate predicted probabilities of the risky option being chosen and their 95% Confidence Intervals.

that the 95% significance intervals for OT and PAS are disjoint from the one for PORnp and (nearly from) the one for PAI.

Table 4. 95% Confidence Intervals for Risky Choice Probabilities

Mechanism	Pr(choice=R)	Std. Error	[95% Conf. Interval]
OT	0.721	0.031	[.661, .781]
POR_{np}	0.560	0.036	[.490, .628]
POR_{pi}	0.621	0.038	[.544, .693]
PAC/N	0.666	0.039	[.588, .742]
PAC	0.651	0.046	[.553 , .736]
PAS	0.804	0.039	[.717, .872]
PAI	0.574	0.047	[.483, .663]

The differences between revealed risk preferences elicited by the seven payoff mechanisms are inconsistent with the belief that subjects isolate on each decision in multiple decision experiments. The data provide support for the alternative view that the payoff mechanism chosen by the experimenter can affect risk preferences revealed by the subjects. This calls for researching the properties of alternative mechanisms. We do this in three ways: (1) we examine the theoretical properties of alternative mechanisms; (2) we identify some behavioral properties of mechanisms that differ from their theoretical properties; and (3) we use data from alternative mechanisms to test for properties of revealed risk preferences that are fundamental to testing theories of decision under risk.

3. Theoretical Properties of Incentive Mechanisms

Lotteries will often be represented by (X_1, p_1; …; X_m, p_m), indicating that outcome X_s is obtained with probability p_s, for s = 1,2, …, m. Outcome X_s can be a monetary amount or a lottery. Consider experiments that include n questions in which the subject has to choose between Options A_i and B_i, for i = 1,…,n. The choice of the subject in question i will be denoted by C_i.

3.1 *The Pay All Sequentially (PAS) Mechanism*

We begin with the most widely used mechanism, PAS. Because, with PAS, each decision is paid before a subsequent decision is made, there is no opportunity for subjects to construct risk-diversifying portfolios; hence there is no (theoretical) concern about possible portfolio effects with this mechanism. Nevertheless, it is easy to see that PAS is not theoretically incentive compatible for the expected utility of terminal wealth model. A simple example – referred to as Example 1 in the subsequent analysis – can be used to illustrate possible wealth effects with PAS. Let the utility of payoff in amount x be given by $u(x) = \sqrt{x}$. Consider two choice options: Option A, with a sure payoff of $30, and Option B with a 50/50 payoff of $100 or 0. If the agent would play the lotteries of Example 1 under PAS two times, the optimal strategy for the given utility function would be to choose Option B in the first choice and Option B (resp. Option A) in the second choice if the outcome of the first choice was 100 (resp. 0). This possible wealth effect of PAS is not relevant to the expected utility of income model[10] or the expected utility of terminal wealth model with constant absolute risk aversion (CARA) or the dual theory of expected utility (Yaari, 1987) or reference dependent preferences for which the reference point adjusts immediately after paying out the first choice.

3.2 *The Pay All Independently (PAI) Mechanism*

In the PAI mechanism, at the end of the experiment all tasks are played out independently. Theoretically, PAI has a problem, well known as portfolio effect in the finance literature: the risk of a mixture of two independent random variables is less than the risk of each variable in isolation. Due to this risk reduction effect, PAI is theoretically incentive compatible only in the case of risk neutrality. To illustrate this fact consider again Example 1 in the previous subsection. An expected utility maximizer with utility function $u(x) = \sqrt{x}$ prefers Option A ($30 for sure) to Option B (a coin-flip between $100 and $0). When presenting the choice between A and B twice under PAI, however, Option B would be chosen both times since the resulting lottery ($200, 0.25; $100, 0.5; $0, 0.25) has a higher utility than $60 for sure.

3.3 *The Pay One Randomly (PORnp and PORpi) Mechanisms*

Here each question usually has a 1/n chance of being played out for real. Suppose a subject conforms to the reduction of compound lotteries axiom and that she has made all her

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[10] Three distinct expected utility models (including terminal wealth and income) are compared and contrasted in Cox and Sadiraj (2006).

choices apart from question i. Then, as discussed by Holt (1986), her choice between A_i and B_i determines whether she will receive (1/n)A_i + (1-1/n)C or (1/n)B_i + (1-1/n)C, where C = (C_1, 1/(n-1); …; C_{i-1}, 1/(n-1); C_{i+1}, 1/(n-1); …; C_n, 1/(n-1)) is the lottery for which the subject receives all her previous choices with equal probability 1/(n-1). Consequently, a subject whose preferences satisfy the reduction and independence axioms has an incentive to reveal her preferences truthfully because under those axioms $A_i \succ B_i$ if and only if (1/n)A_i + (1-1/n)C $\succ$ (1/n)B_i + (1-1/n)C. So, both versions of POR are theoretically incentive compatible for all theories that assume the reduction and independence axioms whereas PAS and PAI are not.

The above result does not imply that (either version of) POR is theoretically appropriate for testing other theories that do not include the independence axiom. Consider again the lotteries (presented twice) and utility of payoff function in Example 1 but now assume rank dependent utility theory (RDU) with probability transformation function f(p) = $p^{0.9}$ for the probability of getting the high payoff in a binary lottery. Under (either version of) POR and the reduction of compound lotteries axiom, Option A would be chosen in one task and Option B would be chosen in the other task because the resulting lottery ($100, 0.25; $30, 0.5; $0, 0.25) has a higher utility than $30 for sure. It is true that in PORnp an RDU agent would not know that he will be asked to choose between A and B but the distortion of choices is still present. The first time the subject is asked to choose between A and B he chooses A (which is truthful revelation). Having chosen A the first time, choosing B the second time is preferred to choosing A for the same reason stated above. Therefore (either version of) POR is not theoretically incentive compatible for rank dependent utility theory.

It has been argued in the literature that it is quite unlikely that subjects' behavior conforms to the reduction axiom because it (arguably) requires too much mental effort. Instead, avoidance of cognitive effort may lead subjects into some type of "narrow bracketing." The opposite extreme from reduction is provided by the isolation hypothesis: here, subjects evaluate each option choice independently of the other option choices in the experiment. Given validity of this isolation hypothesis, both versions of POR and all of the other mechanisms would be incentive compatible also for preferences violating the independence axiom.

3.4 *The Pay All Correlated (PAC and PAC/N) Mechanisms*

The independence axiom implies that both versions of POR are incentive compatible. In contrast, the preference revelation properties of PAC and PAC/N depend on the *dual* independence axiom (Yaari, 1987). With these mechanisms, preferences are revealed truthfully if dual independence is satisfied, otherwise an additional assumption like isolation is required.

For the PAC and PAC/N mechanisms, states of the world need to be defined (e.g. tickets numbered from 1 to 100) and all lotteries need to be arranged in the same order such that they are comonotonic. More formally, there are m states indexed by s = 1, 2, …, m and lotteries are identified by $A_i = (a_{i1}, p_1; \ldots; a_{im}, p_m)$ and $B_i = (b_{i1}, p_1; \ldots; b_{im}, p_m)$ where a_{is} (b_{is}) is the outcome of lottery A_i (B_i) in state s and p_s is probability of that state. We arrange lotteries such that $a_{is} \geq a_{is+1}$ and $b_{is} \geq b_{is+1}$ for all s = 1, …, m-1 and all i = 1, …, n. At the end of the experiment one state is randomly drawn and the outcomes of all chosen lotteries are paid out under PAC. Under PAC/N, the payout is 1/N of the sum of all chosen lotteries' payouts in the randomly selected state.

Suppose as above that a subject made all choices apart from choice i. Then her choice between A_i and B_i will determine whether she will receive either $A_i^* = (a_{i1} + \sum_{j\neq i}c_{j1}, p_1; \ldots; a_{im} + \sum_{j\neq i}c_{jm}, p_m)$ or $B_i^* = (b_{i1} + \sum_{j\neq i}c_{j1}, p_1; \ldots; b_{im} + \sum_{j\neq i}c_{jm}, p_m)$ as reward before the state of nature is determined. This shows that PAC is incentive compatible under Yaari´s (1987) dual theory; a subject whose preferences satisfy the dual independence axiom has an incentive to reveal her preferences truthfully because under that axiom $A_i \succ B_i$ if and only if $A_i^* \succ B_i^*$. Moreover, if lotteries are cosigned – i.e. the outcomes in a given state are all gains or all losses – PAC is also incentive compatible under linear cumulative prospect theory (Schmidt and Zank, 2009) since in this case the independence condition of that model has the same implications as the dual independence axiom.

When we wish to compare PAC with (either version of) POR we have to keep in mind that the expected total payoff from the experiment is N times higher under PAC. This may have significant effects on behavior. In particular one can expect lower error rates under PAC as wrong decisions are more costly (see Laury and Holt, 2008). Therefore, we also include PAC/N in our experimental study where the payoff of PAC is divided by the number of tasks. PAC/N has the same theoretical properties as PAC and is incentive compatible under the dual theory and linear cumulative prospect theory.

3.5 *The One Task (OT) Mechanism*

So far we can conclude that some payment mechanisms for binary choice are theoretically incentive compatible only if utility is linear in probabilities or in outcomes. This is not true for the OT mechanism. With this mechanism, each subject has to respond to only one choice task which is played out for real. Besides being rather costly, this mechanism has one obvious disadvantage: OT allows only for tests of hypotheses using between-subjects data. OT is nevertheless very interesting because it is the only mechanism that is always (i.e. for all possible preferences) incentive compatible.

3.6 *Summary of Incentive Compatibility Conditions*

Table 5 gives an overview of the discussion in the present section. Either version of POR or PAC is incentive compatible if the relevant independence condition holds. PAS is incentive compatible for models defined on income. OT is incentive compatible for all theories.

Table 5. Incentive Compatibility of Payoff Mechanisms

Preference condition	**Incentive compatible mechanisms**
All theories	OT
Independence	OT, PORpi, PORnp
Dual independence	OT, PAC, PAC/N
Income models	OT, PAS

4. Tests of Classic Properties of Theories of Decision under Risk

We here ask whether the observed differences in patterns of revealed risk preferences elicited by the several payoff mechanisms have different implications for classic properties of theories of decision under risk. Allais (1953) first raised a fundamental objection to the independence axiom of expected utility theory by constructing thought experiments that seem to imply paradoxical outcomes. Subsequent experiments focused on two behavioral patterns that contradict the independence axiom, the common ratio effect (CRE) and common consequence effect (CCE). The lottery pairs in Table 1 are constructed to make it possible to observe a CRE with Pairs 2 and 3 or a CCE with Pairs 3 and 4.

Yaari (1987) introduced the dual independence axiom and constructed an alternative theory with functional that is nonlinear in probabilities (unless the agent is risk neutral) and linear in payoffs (for all risk attitudes). The dual common ratio effect (DCRE) and dual common consequence effect (DCCE) are the dual analogs of CRE and CCE. The lottery pairs in Table 1 make it possible to observe a DCRE with Pairs 1 and 3 or a DCCE with Pairs 2 and 5.

4.1 Classic Hypotheses for Risk Preferences

A CRE consists of two lottery pairs where the lotteries in the second pair (Pair 3 in our design) are constructed from the lotteries in the first pair (Pair 2 here) by multiplying all probabilities by a common factor (1/4 in our study) and assigning the remaining probability to a common outcome (in our study $0). It is easy to verify (by using the functional) that, according to expected utility theory, either the safe lottery would be chosen in both pairs or the risky lottery would be chosen in both pairs.

A CCE also consists of two lottery pairs. Here, the lotteries in the second pair (Pair 4 in our design) are constructed from the lotteries in the first pair (Pair 3 here) by shifting probability mass (75% in our study) from one common outcome ($0 in our study) to a different common outcome ($12 in our study). It is easy to verify (with the functional) that expected utility theory implies that an agent will either choose the safe lottery in both pairs or the risky lottery in both pairs.

The null hypotheses that follow from the independence axiom of expected utility theory are that the proportion of choices of the risky option in Pair 3 should be the same as the proportions of choices of the risky options in Pairs 2 and 4:

Hypothesis 1: The proportions of choices of the risky option are the same for Pair 2 and Pair 3 (absence of CRE).

Hypothesis 2: The proportions of choices of the risky option are the same for Pair 3 and Pair 4 (absence of CCE).

One-sided alternatives to the above hypotheses are provided by fanning-out (Machina, 1982) and fanning-in (Neilson, 1992). Subjects' revealed risk preferences under each mechanism can be used to test these hypotheses.

DCRE and DCCE play the same role for dual theory of expected utility (Yaari, 1987) as CRE and CCE for expected utility theory. Because utility is linear under dual theory, it exhibits constant absolute and constant relative risk aversion. Consequently, neither multiplying all outcomes in a lottery pair by a constant (DCRE, see Pairs 1 and 3 where the constant equals 2) nor adding a constant to all outcomes in a lottery pair (DCCE, see Pairs 2 and 5 where the constant equals $12) should change preferences. Yaari (1987) stated that the dual paradoxes could be used to refute his theory analogously to the way in which CRE and CCE had been used to refute expected utility theory. As far as we know, however, the dual paradoxes have never been investigated in a systematic empirical test with a theoretically incentive compatible mechanism.

All payoff amounts in Pair 3 are two times corresponding payoff amounts in Pair 1. All payoff amounts in Pair 5 are $12 higher than corresponding payoffs in Pair 2. Responses with each mechanism can be used to analyze behavior with respect to DCRE and DCCE. The null hypothesis that follows from the dual independence axiom (which implies linearity in payoffs) is that the proportion of choices of the risky option should be: (a) the same in Pairs 1 and 3; and (b) the same in Pairs 2 and 5. The null hypothesis of choices in Pairs 1 and 3 coming from the same distribution also follows from a power function for payoffs, with or without linearity in probabilities. On the other hand, the null hypothesis of choices in Pairs 2 and 5 revealing the same distribution is consistent with an exponential function for payoffs. Alternative hypotheses are that choices correspond to DRRA or DARA. Data from each mechanism can be used to conduct tests of the following hypotheses:

Hypothesis 3: The proportions of choices of the risky option are the same for Pair 1 and Pair 3 (CRRA).

Hypothesis 4: The proportions of choices of the risky option are the same for Pair 2 and Pair 5 (CARA).

One-sided alternatives to Hypothesis 3 are given by decreasing relative risk aversion (DRRA) and increasing relative risk aversion (IRRA). One-sided alternatives to Hypothesis 4 are provided by decreasing absolute risk aversion (DARA) and increasing absolute risk aversion (IARA).

4.2 Tests of Hypotheses with Data from Several Mechanisms

Hypothesis 1 is tested with data from each mechanism as follows. Probit analysis is used to estimate the probability of choosing the risky lottery in Pairs 2 and 3. Right-hand variables include a dummy variable for Pair 3 and dummy variables (discussed above) for Field (of) Study, Birth Order, Female, Black, and Older than 21. The question of interest here is whether the dummy variable for Pair 3 is significantly different from 0 and, if so, whether it is positive or negative. Estimates (and two-sided p-values) for all of the variables are reported in tables in the appendix. We here report, in Table 6, only whether the dummy variable for

Pair 3 (referred to as "Task" in the appendix) is significantly positive or negative; complete results from the probit estimation for Hypothesis 1 are reported in appendix Table A.1.

Table 6. Test Results for Hypotheses 1 - 4

Mechanism	Pairs 2 & 3	Pairs 3 & 4	Pairs 1 & 3	Pairs 2 & 5
OT	Parallel	Parallel	CRRA	IARA
PORnp	Parallel	Parallel	CRRA	CARA
PORpi	Parallel	Fan In	IRRA	CARA
PAC/N	Parallel	Fan In	CRRA	CARA
PAC	Fan Out	Parallel	DRRA	CARA
PAS	Parallel	Fan In	CRRA	CARA
PAI	Fan Out	Parallel	CRRA	CARA

We find that PAI data are characterized by the fanning out property; the null hypothesis of parallel indifference curves is rejected at 5% significance level (one sided p-value is 0.035) in favor of fanning out of indifference curves since the coefficient for the Pair 3 dummy variable from the estimation with PAI data is positive. PAC data are also consistent with the fanning out property: the null hypothesis of parallel indifference curves is rejected in favor of the fanning out alternative hypothesis at 1% significance level (one-sided p-value is .003). Estimated coefficients for Pair 3 with data from all other mechanisms are not significantly different from 0 (with two-sided p-values $\geq$ 0.10), so all five of these mechanisms produce data that do not reject the hypothesis of parallel indifference curves in the probability triangle (absence of CRE). These findings are summarized in Table 5, Pairs 2 & 3 column.

Similar probit estimations using data from Pairs 3 and 4 of the probability of choosing the risky lottery within a pair are used in the tests of Hypothesis 2 summarized in the Pairs 3 & 4 column of Table 5 (and complete results are in Table A.2). The estimated coefficients for the Pair 4 dummy variable are significant for PORpi data (two-sided p-value = 0.056), PAC/N data (two-sided p-value = 0.095), and PAS data (two-sided p-value = 0.003); all of these coefficients are positive, which is consistent with indifference curves that fan in. Estimated coefficients with data from other mechanisms are insignificantly different from 0, which is consistent with parallel indifference curves (absence of CCE).

Data from the several mechanisms have different implications for testing expected utility theory. Five of the seven mechanisms produce data that are inconsistent with expected utility theory because the data either reject CRE or reject CCE. Furthermore, these mechanisms produce data that are variously consistent with indifference curves that fan in, fan our, or are parallel.

The test results are less heterogeneous if one looks only at the three mechanisms that are theoretically incentive compatible for expected utility theory: OT, PORpi, and PORnp. Data from OT and PORnp do not reject either absence of CRE or absence of CCE. Data from the PORpi mechanism, however, reject absence of CCE and are thus inconsistent with expected utility theory.

Results from probit tests of Hypothesis 3 that use choice data for Pairs 1 and 3 from each payoff mechanism separately are reported in the Pairs 1 & 3 column of Table 5 (and complete results are reported in Table A.3). The estimated coefficients for the Pair 3 dummy variable are insignificant with data from all mechanisms except PORpi and PAC, which is consistent with revealed risk preferences that exhibit CRRA. Estimation with data from the PAC mechanism yields a coefficient for Pair 3 dummy variable that is significant (two-sided p-value = 0.040) and positive, which is consistent with revealed risk preferences that exhibit DRRA. In contrast, estimation with data from the PORpi mechanism yields a coefficient for Pair 3 dummy variable that is significant (two-sided p-value = 0.039) and negative, which is consistent with revealed risk preferences that exhibit IRRA.

Results from probit tests of Hypothesis 4 are reported in the Pairs 2 & 5 column of Table 5 (and complete results are reported in Table A.4). Coefficients for the Pair 4 dummy variable are insignificant (two-sided p-values $\geq$ 0.10) with data from all mechanisms except OT. Revealed risk preferences with the mechanisms that involve many tasks are consistent with CARA. Estimation with OT data yields a significant coefficient (two-sided p-value = 0.016) that is negative, which is consistent with preferences that exhibit IARA.

Data from the several mechanisms have divergent implications for testing for CARA and CRRA within the range of payoffs used in the experiment. Data from three mechanisms reject either CRRA or CARA whereas data from four mechanisms do not reject either. The three mechanisms that are incentive compatible for dual theory of expected utility are OT, PAC, and PAC/N. Two out of these three incentive compatible mechanisms produce data that are inconsistent with dual theory of expected utility because the data are inconsistent with either CARA or CRRA.

We have used seven mechanisms to generate revealed risk preference data for five lottery pairs that have the potential to test for distinguishing properties of different theories of risk preferences. Out of seven mechanisms, only PORnp seems to be producing data that do not reject any of the four hypotheses.

5. Behavioral Properties of Mechanisms

What can account for these inconsistencies across mechanisms in elicited risk preferences? The probit regressions reported in section 2 show that subjects were responding to the properties of lotteries within a pair. Our subjects made choices that reveal risk aversion since increase in the difference between variances of returns of the risky and safe lottery had a negative effect on the risky option being chosen. Other estimates from the demographics are consistent with findings in other studies. The divergent test results can be explained by failure of isolation, which would be expected to cause different payoff mechanisms to elicit different risk preferences.

The probit regressions reported in Table 7 for data from Round 1 and Round 5 yield further insight into the behavioral properties of the payoff mechanisms. (The Probit 3 results from Table 3 are repeated here for ease of comparison.) It is important to recall that the choice order of the five lottery pairs is randomly and independently selected for each subject. Therefore the Round 1 and Round 5 choices reported in Table 7 will each include a random selection of distinct lottery pairs. Hence the dummy variables for protocols in Round 1 and Round 5 are picking up choice order effects not lottery pair effects.

The performance of PAS shows risk preferences that are not different from OT in any comparison in Table 7, including all rounds (Probit 3) and Round 1 and Round 5. This is a particularly interesting result because, of all the multi-decision payoff mechanisms, PAS would seem to be the one that would most likely exhibit behavior consistent with the isolation hypothesis. The way in which PAS might exhibit cross-task contamination would be if there were a significant wealth effect on risk preferences, in which case risk preferences elicited in a subsequent round would not be independent of choices and outcomes in earlier rounds. Probit analysis of data from our experiment that includes total payoff from lotteries chosen in earlier periods, as an explanatory variable for choice between risky and safe options in the current period, finds no significance of the estimated coefficient for this wealth variable (see the result reported in the Variable X coefficient row and PAS column of Table 8). This finding is consistent with earlier detailed analyses of possible wealth effects in other experiments that use PAS (Cox and Epstein, 1989; Cox and Grether, 1996).

Table 7. Probit Analysis of Rounds 1 & 5 Choice Data with Robust Standard Errors

VARIABLES	Probit 3	Round 1	Round 5
EV Difference	0.099 (0.352)	0.068 (0.703)	0.109 (0.543)
VAR Difference	-0.034*** (0.004)	-0.015 (0.495)	-0.018 (0.395)
Field Study	0.080* (0.080)	0.046 (0.520)	0.030 (0.678)
Birth Order	0.093** (0.040)	0.120** (0.048)	0.131** (0.034)
Female	-0.314*** (0.000)	-0.159 (0.221)	-0.296** (0.024)
Black	-0.142 (0.117)	-0.139 (0.276)	-0.195 (0.128)
Older than 21	0.162* (0.080)	-0.004 (0.975)	0.162 (0.218)
DPORnp	-0.384*** (0.006)	-0.677*** (0.003)	-0.497** (0.028)
DPORpi	-0.289** (0.043)	-0.213 (0.343)	-0.530** (0.017)
DPAC	-0.279* (0.077)	-0.263 (0.250)	-0.452** (0.046)
DPAC/N	-0.285** (0.043)	-0.452** (0.042)	-0.068 (0.772)
DPAS	0.137 (0.428)	0.125 (0.604)	0.198 (0.425)
DPAI	-0.489*** (0.001)	-0.460** (0.043)	-0.538** (0.020)
Constant	0.606*** (0.001)	0.463* (0.074)	0.494* (0.052)
Observations	1,406	466	466
Log-likelihood	-885.0	-874.3	-864.7

P-values in parentheses: *** p<0.01, ** p<0.05, * p<0.1

In Section 3 we provided some examples that illustrate the possible lack of incentive compatibility of mechanisms for different theories. Those examples offer insights on cross-task effects that different mechanisms might induce. We shall be testing for cross-task effects when a subject saw the tasks relevant to the hypothesis one right after the other. The example in section 3 for the PAS mechanism suggests that the payoff received in the preceding round is expected to have a positive effect on the likelihood of choosing the risky option in the current round. Probit regression reported in Table 8 using PAS data, however, reveal that the payoff in the immediately preceding round (see the Preceding Payoff (PAS) row) does not affect the likelihood of the risky option being chosen in the current round; the estimate is positive (0.026) but the (two-sided) p-value is 0.137. This shows that PAS data reject a cross-task effect of this type, an effect of the most recent lottery (or sure) payoff.

Table 8. Probit Tests of Cross-Task Effects

Variables / Mechanism	**PORnp (CRE)**	**PORnp (CCE)**	**PAS**	**PAI**
Variable X	Dummy for Pair 3	Dummy for Pair 4	Accumulated Payoff	Accumulated nr of times option R choice
Variable X coefficient	-0.686	1.411**	-0.004	0.215*
	(0.164)	(0.027)	(0.698)	(0.073)
EV differences			0.788**	-0.279
			(0.013)	(0.297)
VAR differences			-0.095***	-0.003
			(0.003)	(0.914)
Field Study	-0.009	0.382*	0.232	-0.089
	(0.973)	(0.072)	(0.113)	(0.584)
Birth Order	0.204	0.298	0.078	0.191
	(0.468)	(0.285)	(0.645)	(0.168)
Female	-0.228	-1.060	-0.706***	-0.027
	(0.733)	(0.177)	(0.009)	(0.915)
Black	-0.293	-0.478	0.493	-0.281
	(0.564)	(0.473)	(0.134)	(0.259)
Older than 21	0.035	0.681	-0.058	0.915***
	(0.947)	(0.476)	(0.829)	(0.001)
Preceding Payoff (PAS)			0.026	
			(0.137)	
Preceding Choice (PAI)				-0.309
				(0.275)
Constant	0.608	-0.619	0.263	-0.444
	(0.465)	(0.381)	(0.663)	(0.148)
Observations	32	32	195	190
Log-Likelihood	-19.35	-13.96	-90.68	-116.5

p-values in parentheses: *** denotes p<0.01; ** denotes p<0.05; * denotes p<0.1

Results differ for the two implementations of POR. Consider first the highly significant, negative coefficient on the PORnp dummy variable for Round 1 reported in Table 7. In Round 1, subjects in the PORnp experimental treatment have the same lack of previous experience with lottery pair choices and the same information about lottery pairs as subjects in the OT treatment. But the highly significant negative coefficient on the Round 1 dummy variable shows that PORnp elicited much more risk averse preferences in the first round than did the OT mechanism. The only difference between these two treatments in Round 1 is that in PORnp subjects had been informed that there would be subsequent choices and that one choice would be randomly selected for payoff. This information, itself, led to much more aversion to risk in the preferences elicited in Round 1.

The alternative implementation of random selection, the PORpi mechanism, yielded quite different results in Round 1. Here, the estimated coefficient for the Round 1 dummy variable is insignificant. Recall that the difference in subjects' information across the PORnp and PORni mechanisms at the time of a Round 1 choice consists entirely of their knowing in PORpi what the subsequent lottery choice pairs will be and their not having this information in PORnp. Together, these results suggest that the uncertainty about future choice options that subjects faced in PORnp caused them to behave as if they were more risk averse in Round 1.

The Round 5 results look very different. Here, the dummy variable coefficients for PORnp and PORni are almost identical. But in Round 5 subjects in both treatments knew that this would be their last decision. With both versions of the random selection mechanism, the subjects were significantly more risk averse than in OT in the last round.

POR is immune to preceding-payoff cross-task effects because no lottery payoff is realized before any choice is made. In order to test for cross-task effects with POR, we test for choice order effects on revelation of classical paradoxes. In this case, as with PAS, we look at adjacent choices but now we focus on the case in which the pairs involved in a paradox were faced by a subject one right after the other. If there is any cross-task effect of this type one would expect it to be weaker in PORpi because subjects have already seen all five pairs in advance with this implementation of the mechanism. The data support this conjecture. As shown in Table 5, PORnp does not reveal CRE or CCE when all data are used. In contrast, as shown in Table 8 (Variable X Coefficient row), if we focus only on adjacent choices then PORnp reveals a CCE (p-value = 0.027) effect but not a CRE (p-value = 0.164) effect. For PORpi data, however, conclusions with respect to paradoxes are robust to tests with all data or tests only with adjacent round data. This result is inconsistent with the Round 1 and Round 5 effects on choices observed in PORnp. Both approaches to data analysis support the conclusion that PORnp data are characterized by choice order effects.

Comparison of the estimated coefficients for PAC and PAC/N in Table 7 also yields behavioral insight into mechanism effects. Recall that the only difference between these two mechanisms is the scale of payoffs; experimental treatments with these two mechanisms are otherwise identical. Subjects in the PAC and PAC/N treatments have the same information about lotteries in Round 1 and Round 5 as do subjects in the PORpi treatment. Expected payoffs for PAC are N times as large as for PORpi; they are the same for PAC/N and PORpi. Risky choice behavior in PAC follows the same pattern as in PORpi, with no significant difference from OT in Round 1 but significantly more risk averse behavior by Round 5. PAC/N follows the reverse pattern, with significantly more revealed risk aversion than OT in Round 1 but no difference from OT in Round 5.

The section 3 example of possible portfolio effects from the PAI mechanism shows how, with *uncorrelated* lotteries, a portfolio with several risky options may be preferred to other portfolios even when the agent prefers the safe lottery to the risky lottery in isolation. If so, then we should observe that a current choice of the risky option has a positive effect on the likelihood of the risky option being chosen latter. Data are consistent with this conjecture. Probit regression reported in Table 8 (Variable X coefficient row) shows a positive effect (two-sided p-value is 0.073) of the previous total number ("Accumulated nr") of choices of the risky option on the likelihood of choosing the risky option in the current decision task.

6. Summary

Experiments on choice under risk typically involve multiple decisions by individual subjects and use of a payoff mechanism to implement incentive payoffs. If subjects isolate each individual decision from other decisions then choice of payoff mechanism is an unimportant detail of experimental protocols. Our data imply rejection of the hypothesis that subjects' revealed risk preferences are generally isolated from mechanism effects. Our data also reveal that different mechanisms elicit data that have different implications for fundamental properties of decision theories such as the independence axiom vs. fanning in or fanning out as well as risk preference patterns such as CRRA and CARA.

PORni and PORpi are theoretically incentive compatible for testing hypotheses from expected utility theory. However, the changes in elicited risk preferences across rounds in our experiment raise serious questions about the behavioral properties of these two alternative implementations of this random decision selection mechanism. In contrast, PAS elicited risk preferences that did not change between rounds. This reflects the absence of significant wealth effects found in this study and in two previous studies that carefully analyzed PAS data for wealth effects. Our PAS data also do *not* exhibit a preceding-round outcome effect on current option choice. Thus, our PAS data are consistent with subjects' isolation on each one of multiple decisions.

Empirical failure of isolation from mechanism effects can be especially a problem for design of experiments to test theories such as rank dependent utility theory, cumulative prospect theory, and betweenness theories that do not include either the independence axiom or the dual independence axiom. The one task (OT) mechanism avoids any possible cross-task contamination and is the only known theoretically incentive compatible payoff protocol to use in experiments designed to test all theories. But OT has significant limitations in that it is expensive to use in experiments and it requires that all hypothesis tests be conducted between subjects. The PAS mechanism elicits data in our experiment that do not differ significantly from OT data. This suggests that PAS may be a good choice of mechanism for testing hypotheses from theories such as cumulative prospect theory that are defined on income rather than terminal wealth. Possible wealth effects from PAS make it theoretically questionable for testing hypotheses for theories such as rank dependent utility theory that are defined on terminal wealth and which do not include the independence axiom. But data reported here, and results in two previous studies that analyzed PAS data for wealth effects (Cox and Epstein, 1989; Cox and Grether, 1996), found that wealth effects were insignificant. This provides behavioral support for use of PAS to elicit risk preferences in experiments testing hypotheses from rank dependent utility theory and similar theories defined on terminal wealth.

The finding that the data are not generally consistent with the isolation hypothesis makes clear the importance of systematic study of the properties of alternative payoff mechanisms and the relationship of those properties to validity of conclusions about theory that can be drawn from data. Our experiment is a step in the direction of such study.

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Appendix 1: Probit Tests of Hypotheses 1 - 4

Table A.1. Probit Tests of Hypothesis 1

Variables / Mechanism	**OT**	**PORnp**	**PORpi**	**PAC/N**	**PAC**	**PAS**	**PAI**
Task	-0.443	-0.059	0.206	-0.000	0.827***	-0.321	0.498*
	(0.113)	(0.851)	(0.425)	(0.999)	(0.005)	(0.311)	(0.069)
Field Study	0.060	0.121	0.198	0.273*	0.245	0.370**	-0.098
	(0.715)	(0.405)	(0.254)	(0.081)	(0.190)	(0.032)	(0.709)
Birth order	0.194	0.190	-0.024	0.185	-0.202	0.083	0.228
	(0.117)	(0.167)	(0.883)	(0.159)	(0.210)	(0.639)	(0.205)
Female	-0.123	-0.458	-0.026	-0.106	-0.306	-0.835***	-0.466
	(0.683)	(0.119)	(0.941)	(0.689)	(0.379)	(0.008)	(0.225)
Black	-0.275	-0.288	-0.242	-0.248	-0.329	0.374	-0.330
	(0.333)	(0.288)	(0.443)	(0.375)	(0.359)	(0.300)	(0.400)
Older than 21	0.032	-0.303	0.544	0.273	-0.178	0.113	1.820***
	(0.907)	(0.242)	(0.114)	(0.282)	(0.589)	(0.700)	(0.000)
Constant	0.708	0.027	-0.476	-0.611	0.181	0.027	-1.612***
	(0.159)	(0.951)	(0.507)	(0.257)	(0.761)	(0.970)	(0.004)
Nobs	116	80	80	80	76	78	76
Log-likelihood	-57.37	-52.00	-52.34	-48.47	-44.53	-41.11	-42.81

p-values in parentheses: *** denotes p<0.01; ** denotes p<0.05; * denotes p<0.1

Table A.2. Probit Tests of Hypothesis 2

Variables / Mechanism	**OT**	**PORnp**	**PORpi**	**PAC/N**	**PAC**	**PAS**	**PAI**
Task	-0.052	0.419	0.594*	0.422*	0.074	1.079***	0.049
	(0.858)	(0.241)	(0.056)	(0.095)	(0.826)	(0.003)	(0.875)
Field Study	-0.149	0.278***	0.135	0.169	0.042	0.406*	-0.229
	(0.409)	(0.009)	(0.428)	(0.419)	(0.825)	(0.053)	(0.295)
Birth Order	0.317**	0.180	0.162	0.002	-0.028	-0.041	0.373**
	(0.019)	(0.166)	(0.307)	(0.989)	(0.861)	(0.847)	(0.041)
Female	-0.225	-0.630**	-0.005	-0.606*	0.022	-1.597***	-0.625*
	(0.460)	(0.010)	(0.988)	(0.096)	(0.950)	(0.000)	(0.069)
Black	0.035	-0.381	-0.222	-0.345	-0.699**	0.266	-0.043
	(0.907)	(0.144)	(0.466)	(0.352)	(0.034)	(0.511)	(0.896)
Older than 21	0.264	0.054	0.441	0.689*	0.247	0.023	0.448
	(0.356)	(0.857)	(0.154)	(0.081)	(0.439)	(0.952)	(0.221)
Constant	0.252	-0.268	-0.548	0.073	0.824	0.515	-0.008
	(0.636)	(0.532)	(0.369)	(0.919)	(0.132)	(0.557)	(0.986)
Nobs	96	80	80	80	76	78	76
Log-Likelihood	-53.28	-47.81	-46.51	-42.04	-37.86	-29.19	-44.10

p-values in parentheses: *** denotes p<0.01; ** denotes p<0.05; * denotes p<0.1

Table A.3. Probit Tests of Hypothesis 3

Variables / Mechanism	**OT**	**PORnp**	**PORpi**	**PAC/N**	**PAC**	**PAS**	**PAI**
Task	0.348	-0.357	-0.497**	0.081	0.428**	-0.260	0.021
	(0.208)	(0.197)	(0.039)	(0.735)	(0.040)	(0.387)	(0.935)
Field Study	-0.090	-0.017	-0.135	0.408**	0.158	0.256	-0.237
	(0.596)	(0.927)	(0.556)	(0.033)	(0.476)	(0.222)	(0.374)
Birth Order	0.170	0.286	0.055	0.113	-0.194	-0.165	0.440**
	(0.187)	(0.139)	(0.783)	(0.487)	(0.356)	(0.353)	(0.034)
Female	0.006	-1.399***	-0.295	-0.375	0.323	-1.286***	-0.322
	(0.982)	(0.000)	(0.416)	(0.317)	(0.436)	(0.001)	(0.395)
Black	-0.121	0.105	-0.646*	-0.406	-0.643	0.869*	-0.219
	(0.659)	(0.753)	(0.076)	(0.249)	(0.119)	(0.053)	(0.583)
Older than 21	0.098	0.046	0.788**	0.838**	0.239	0.152	1.115**
	(0.726)	(0.913)	(0.037)	(0.030)	(0.564)	(0.672)	(0.031)
Constant	0.092	0.610	0.971	-0.931	0.332	0.865	-0.800
	(0.866)	(0.277)	(0.222)	(0.134)	(0.626)	(0.196)	(0.235)
Nobs	96	80	80	80	76	78	76
Log-likelihood	-58.60	-43.17	-44.24	-43.40	-42.49	-38.54	-42.81

p-values in parentheses: *** denotes p<0.01; ** denotes p<0.05; * denotes p<0.1

Table A.4. Probit Tests of Hypothesis 4

Variables / Mechanism	**OT**	**PORnp**	**PORpi**	**PAC/N**	**PAC**	**PAS**	**PAI**
Task	-0.756**	-0.393	-0.000	-0.288	0.289	0.165	-0.001
	(0.016)	(0.108)	(0.999)	(0.279)	(0.270)	(0.474)	(0.998)
Field Study	0.374**	-0.040	-0.003	0.199	0.220	0.214	0.140
	(0.046)	(0.810)	(0.986)	(0.328)	(0.267)	(0.224)	(0.597)
Birth Order	0.002	-0.139	-0.125	0.262	-0.036	0.246	-0.047
	(0.986)	(0.441)	(0.497)	(0.124)	(0.841)	(0.303)	(0.819)
Female	0.188	-0.187	-0.074	-0.483	-0.539	-0.138	0.374
	(0.598)	(0.593)	(0.843)	(0.143)	(0.117)	(0.716)	(0.339)
Black	-0.619*	-0.245	-0.028	-0.022	0.427	0.304	-0.531
	(0.078)	(0.470)	(0.942)	(0.950)	(0.245)	(0.483)	(0.185)
Older than 21	-0.129	-0.546	0.109	-0.337	0.083	-0.121	+
	(0.689)	(0.117)	(0.765)	(0.352)	(0.798)	(0.749)	
Constant	0.615	0.887	0.303	-0.142	-0.440	-0.245	0.033
	(0.264)	(0.142)	(0.700)	(0.817)	(0.401)	(0.782)	(0.962)
Observations	97	80	80	80	76	78	66
Log-likelihood	-46.72	-52.46	-54.91	-48.87	-49.45	-37.52	-43.70

p-values in parentheses: *** denotes p<0.01; ** denotes p<0.05; * denotes p<0.1; + Younger than 21 predicts "choice S" perfectly, so it is not included here.

For Online Publication

Appendix 2: Subject Instructions

Subject Instructions (OT)

In this experiment, you are asked to choose between two options. The example below shows two options that are similar to ones on the decision page.

In Option A you receive either $3 or $10. Your payoff is determined by drawing one ball from a bingo cage containing 20 balls numbered 1, 2, 3, …, 20. If a ball with number 1 to 4 is drawn then you receive $3. If a ball with number 5 to 20 is drawn then you receive $10.

In Option B you receive either $5 or $7 or $8. Your payoff is determined by drawing one ball from a bingo cage that contains 20 balls numbered 1, 2, 3, …, 20. If a ball with number 1 to 3 is drawn then you receive $5. If a ball with number 4 to 7 is drawn then you receive $7. If a ball with numbers 8 to 20 is drawn then you receive $8.

Ball nr	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Option A	$3				$10															
Option B	$5			$7				$8												

Making Choices Please make your choice by clicking on Option A or Option B

Payoffs After you make a decision, your chosen option will be played. Your payoff in the option you selected will be determined by drawing a ball from a bingo cage that contains balls numbered 1,2,3,…,20.

Subject Instructions (PAC)

In this experiment, you are asked to choose between two options on each of five decision pages. On each decision page you will choose between a different pair of options. The example below shows two options that are similar to ones on decision pages.

In Option A you receive either $3 or $10. Your payoff is determined by drawing one ball from a bingo cage containing 20 balls numbered 1, 2, 3, …, 20. If a ball with number 1 to 4 is drawn then you receive $3. If a ball with number 5 to 20 is drawn then you receive $10.

In Option B you receive either $5 or $7 or $8. Your payoff is determined by drawing one ball from a bingo cage that contains 20 balls numbered 1, 2, 3, …, 20. If a ball with number 1 to 3 is drawn then you receive $5. If a ball with number 4 to 7 is drawn then you receive $7. If a ball with numbers 8 to 20 is drawn then you receive $8.

Ball nr	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Option A	$3				$10															
Option B	$5			$7				$8												

Making Choices Please make your choice on each of the five decision pages by clicking on Option A or Option B

Payoffs After you make a decision on each of the five decision pages, all your chosen options will be played as follows. One numbered ball will be drawn from a bingo cage that contains balls numbered 1,2,3,…,20. The ball drawn determines your payoff from the option you chose on all five decision pages.

Your total payoff is the sum of your payoffs from all five decision pages; all payoffs are determined by the one ball drawn.

Subject Instructions (POR)

In this experiment, you are asked to choose between two options on each of five decision pages. On each decision page you will choose between a different pair of options. The example below shows two options that are similar to ones on decision pages.

In Option A you receive either $3 or $10. Your payoff is determined by drawing one ball from a bingo cage containing 20 balls numbered 1, 2, 3, …, 20. If a ball with number 1 to 4 is drawn then you receive $3. If a ball with number 5 to 20 is drawn then you receive $10.

In Option B you receive either $5 or $7 or $8. Your payoff is determined by drawing one ball from a bingo cage that contains 20 balls numbered 1, 2, 3, …, 20. If a ball with number 1 to 3 is drawn then you receive $5. If a ball with number 4 to 7 is drawn then you receive $7. If a ball with numbers 8 to 20 is drawn then you receive $8.

Ball nr	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Option A	$3				$10															
Option B	$5			$7				$8												

Making Choices Please make your choice on each of the five decision pages by clicking on Option A or Option B

Payoffs After you make a decision on each of the five decision pages, one of the pages will be randomly selected and your chosen option on that page will be played. The selection of the page is carried out by drawing a ball from a bingo cage that contains five balls numbered 1,2,3,4,5. The number on the drawn ball determines the decision page that is selected.

After the one page is randomly selected, your money payoff will be determined by playing the lottery in the option you selected on that page. Your payoff in the option you selected will be determined by drawing a ball from a bingo cage that contains balls numbered 1,2,3,…,20.

Subject Instructions (PAS)

In this experiment, you are asked to choose between two options on each of five decision pages. On each decision page you will choose between a different pair of options. The example below shows two options that are similar to ones on decision pages.

In <u>Option A</u> you receive either $3 or $10. Your payoff is determined by drawing one ball from a bingo cage containing 20 balls numbered 1, 2, 3, …, 20. If a ball with number 1 to 4 is drawn then you receive $3. If a ball with number 5 to 20 is drawn then you receive $10.

In <u>Option B</u> you receive either $5 or $7 or $8. Your payoff is determined by drawing one ball from a bingo cage that contains 20 balls numbered 1, 2, 3, …, 20. If a ball with number 1 to 3 is drawn then you receive $5. If a ball with number 4 to 7 is drawn then you receive $7. If a ball with numbers 8 to 20 is drawn then you receive $8.

<table>
<tr><th>Ball nr</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th><th>16</th><th>17</th><th>18</th><th>19</th><th>20</th></tr>
<tr><td>Option A</td><td colspan="4">$3</td><td colspan="16">$10</td></tr>
<tr><td>Option B</td><td colspan="3">$5</td><td colspan="4">$7</td><td colspan="13">$8</td></tr>
</table>

Making your First Page Choice Please make your choice on the first decision page by clicking on Option A or Option B

First Page Payoff A numbered ball is drawn from a bingo cage that contains balls numbered 1,2,3…,20. The ball drawn determines your payoff from the option you chose on the first page. The drawn ball is returned to the bingo cage. Then you turn to the next decision page.

Making your Choices and Determining Payoffs on Subsequent Pages

Make your choice on page 2. Then a ball is drawn to determine your payoff. The ball is returned to the bingo cage. Next, you make your choice on page 3. Another ball is drawn and then returned to the bingo cage. This process continues until your choices and payoffs have been determined for all five decision pages. Your total payoff is the sum of your payoffs from all five decision pages that are determined by the sequence of choices and independently drawn balls.

Subject Instructions (PAI)

In this experiment, you are asked to choose between two options on each of five decision pages. On each decision page you will choose between a different pair of options. The example below shows two options that are similar to ones on decision pages.

In Option A you receive either $3 or $10. Your payoff is determined by drawing one ball from a bingo cage containing 20 balls numbered 1, 2, 3, …, 20. If a ball with number 1 to 4 is drawn then you receive $3. If a ball with number 5 to 20 is drawn then you receive $10.

In Option B you receive either $5 or $7 or $8. Your payoff is determined by drawing one ball from a bingo cage that contains 20 balls numbered 1, 2, 3, …, 20. If a ball with number 1 to 3 is drawn then you receive $5. If a ball with number 4 to 7 is drawn then you receive $7. If a ball with numbers 8 to 20 is drawn then you receive $8.

Ball nr	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Option A	$3				$10															
Option B	$5			$7				$8												

Making Choices Please make your choices on all five decision pages by clicking on Option A or Option B

Payoffs After you make decisions on all five decision pages, **all** of your chosen options will be played as follows.

A numbered ball will be drawn from a bingo cage that contains balls numbered 1,2,3,…,20. The ball drawn determines your payoff from the option you chose on the first page. The drawn ball is returned to the bingo cage. Next, a second ball is drawn, which determines your payoff from the option you chose on the second page. That ball is returned to the bingo cage. This sequential procedure is continued until your payoffs are determined for all five decision pages.

Your total payoff is the sum of your payoffs from all five decision pages, each of which is determined by an independently drawn ball.

Subject Instructions (PAC/5)

In this experiment, you are asked to choose between two options on each of five decision pages. On each decision page you will choose between a different pair of options. The example below shows two options that are similar to ones on decision pages.

In Option A you receive either $3 or $10. Your payoff is determined by drawing one ball from a bingo cage containing 20 balls numbered 1, 2, 3, …, 20. If a ball with number 1 to 4 is drawn then you receive $3. If a ball with number 5 to 20 is drawn then you receive $10.

In Option B you receive either $5 or $7 or $8. Your payoff is determined by drawing one ball from a bingo cage that contains 20 balls numbered 1, 2, 3, …, 20. If a ball with number 1 to 3 is drawn then you receive $5. If a ball with number 4 to 7 is drawn then you receive $7. If a ball with numbers 8 to 20 is drawn then you receive $8.

<table>
<tr><td>Ball nr</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td><td>16</td><td>17</td><td>18</td><td>19</td><td>20</td></tr>
<tr><td>Option A</td><td colspan="4">$3</td><td colspan="16">$10</td></tr>
<tr><td>Option B</td><td colspan="3">$5</td><td colspan="4">$7</td><td colspan="13">$8</td></tr>
</table>

Making Choices

Please make your choice on each of the five decision pages by clicking on Option A or Option B

Payoffs

After you make a decision on each of the five decision pages, **all** your chosen options will be played as follows. One numbered ball will be drawn from a bingo cage that contains balls numbered 1, 2, 3,…,20. The ball drawn determines your payoff from the option you chose on all five decision pages.

Your total payoff is one fifth of the sum of your payoffs from all five decision pages; all payoffs are determined by the one ball drawn.