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Risk aversion and framing effects

Louis Lévy-Garboua · Hela Maafi · David Masclet · Antoine Terracol

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Abstract We present a new experimental evidence of how framing affects decisions in the context of a lottery choice experiment for measuring risk aversion. We investigate framing effects by replicating the Holt and Laury's (Am. Econ. Rev. 92:1644–1655, 2002) procedure for measuring risk aversion under various frames. We first examine treatments where participants are confronted with the 10 decisions to be made either *simultaneously* or *sequentially*. The second treatment variable is the order of appearance of the ten lottery pairs. Probabilities of winning are ranked either in *increasing*, *decreasing*, or in *random* order. Lastly, payoffs were increased by a factor of ten in additional treatments. The rate of inconsistencies was significantly higher in sequential than in simultaneous treatment, in increasing and random than in decreasing treatment. Both experience and salient incentives induce a dramatic decrease in inconsistent behaviors. On the other hand, risk aversion was significantly

L. Lévy-Garboua · H. Maafi · A. Terracol
Paris School of Economics, Centre d'Economie de la Sorbonne, Université Paris 1 Panthéon-Sorbonne, Paris, France

L. Lévy-Garboua
e-mail: louis.levy-garboua@univ-paris1.fr

H. Maafi
e-mail: maafi@hec.fr

A. Terracol
e-mail: terracol@univ-paris1.fr

L. Lévy-Garboua · D. Masclet
CIRANO, Montreal, Canada

H. Maafi
GREGHEC-HEC School of Management, Paris, France

D. Masclet (✉)
CNRS-CREM-University of Rennes 1, Rennes, France
e-mail: david.masclet@univ-rennes1.fr

higher in sequential than in simultaneous treatment, in decreasing and random than in increasing treatment, in high than in low payoff condition. These findings suggest that subjects use available information which has no value for normative theories, like throwing a glance at the whole connected set of pairwise choices before making each decision in a connected set of lottery pairs.

Keywords Risk aversion · Lottery choice experiment · Framing effects · Experience effects · Incentive effects

JEL Classification C91 · C92 · D81 · D70 · M10

1 Introduction

Since the seminal work of Kahneman and Tversky on framing (e.g, Tversky and Kahneman 1986), economists have been aware that changes in the frame of questions may considerably affect decisions. Framing may induce choice inconsistencies and generate anomalous behavior.[1] How far will anomalies of choice persist in transparent settings? This is an empirical question because the normative equivalence of two separate decisions cannot be made perfectly transparent. Even in decision experiments where subjects make repeated *i.i.d.* decisions among pairs of lotteries without any alteration, non-negligible numbers of subjects report different decisions over repetition (Hey and Orme 1994; Loomes and Sugden 1998).[2] Choice inconsistencies of this sort are generally considered as “errors” adding noise to the results or merely discarded from further analysis (Camerer 1989; Starmer and Sugden 1989, and Wu 1994).[3] It is certainly true that people make errors by lack of attention. However, since the purpose of economic incentives is to boost attention, it is worth asking whether choice inconsistencies are not partly systematic anomalies.

In the present study, we aim at contributing to the existing literature by examining to what extent framing violates normative rationality, affecting both risk aversion and consistency of decisions, in a transparent setting: the well-known lottery random procedure elicited by Holt and Laury (2002) for measuring risk aversion. We chose to

[1] Given the fact that EU theory has rapidly become the standard in decision theory, a huge amount of theoretical and empirical effort has been devoted to test the robustness of EU and to develop alternative models to this theory (see Starmer 2000, for an extensive and interesting survey of key theoretical developments in the area). A large body of these studies has focused on the violation of independence axiom. Although the Allais (1953) paradox was initially designed to violate the independence axiom, Kahneman and Tversky made the more general point that the problem with EU theory lied with the postulate of presentation and procedure invariance. What choice anomalies have demonstrated is that individuals often exhibit preferences that deviate from normative preferences in systematic ways (Tversky and Kahneman 1981; Kahneman and Tversky 1984). Two normatively equivalent pairs of lotteries presented under different frames may give rise to different choices.

[2] For instance, Hey and Orme (1994) report that about 75% of subjects only made identical decisions when asked to choose repeatedly between the same lotteries.

[3] With the notable exception of Chew et al. (1991), Loomes (2005), Loomes et al. (2002) and Blavatskyy (2007), the stochastic nature of choice under risk and uncertainty has largely been ignored in most of decision theories.

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investigate the consistency of the Holt and Laury (HL)'s measure of risk aversion and its sensitivity to framing, because their method has been rapidly adopted in decision research and it lends itself easily to the manipulation of frames. In the original HL design, the subjects are confronted with ten choices among two bets yielding positive outcomes: R is a risky bet with payoffs \$3.85 and \$0.10; and S is a safe bet with payoffs \$2 and \$1.60. Probabilities of the higher payoffs are equal for the two bets (p) and vary by steps of 0.10 from 0.10 to 1.00. Subjects should normally switch only once from R to S, or from S to R, for an intermediate value of this probability and the latter determines their risk aversion in a simple way. The crossover or equivalent probability discrete index of risk aversion can then be converted into a CRRA[4] interval. This crossover probability is unique for consistent subjects, taking values between 0.10 and 1.00. In their experiment Holt and Laury found however that a non-negligible part of subjects exhibited inconsistency.[5]

In this experiment, we investigate whether changing the order of the probabilities of winning p and the presentation of the ten lottery-choices might influence the level of inconsistency. To do so, we replicate the HL's procedure for measuring risk aversion under various frames. Probabilities of winning p were presented either in *increasing*, *decreasing* or in *random* order. We also varied framing by presenting the ten lottery choices either *simultaneously* or *sequentially*. We conjecture that a sequential framing of choices might induce more inconsistencies and errors than a simultaneous framing by restricting the amount of information gathered before making decisions. We also suspect that variations in the order of presentation of win probabilities may also affect consistency by introducing either randomness—when probabilities are presented in a random order—or anchoring biases—when probabilities are ranked in monotonous order. If these conjectures are confirmed by the data, framing might also have an impact on the probability of choosing the safer lottery through its effects on the perception of probabilities and on the level of inconsistency.

To our knowledge, we are the first to study these questions in the context of the simple HL's procedure. A notable exception is Masclet et al. (2009) who also examined the effect of sequentiality on risk aversion. However this study was not aimed at testing the inconsistency of decisions.

The remainder of this paper is organized as follows. Our experimental design is presented in more detail in Sect. 2. Our results are shown in Sects. 3 and 4, examining successively the impact of frames on inconsistency and on risk aversion. Section 5 discusses our main findings. Finally we draw conclusions in Sect. 6.

2 Experimental design

2.1 Overview

The experiment was computerized and the scripts were programmed using the *z*-tree platform (Fischbacher 2007). We recruited 240 subjects at the University of Paris 1

[4] Constant Relative Risk Aversion.

[5] 20.4% of subjects exhibited inconsistency for low payoff treatment condition and 5.5% in high-payoff treatments.

Table 1 Payoff matrix for the SIMINC treatment

No.	Safe lottery (*S*)				Risky lottery (*R*)				Difference
	Prob.	Payoff	Prob.	Payoff	Prob.	Payoff	Prob.	Payoff	
1	10%	2,00	90%	1,60	10%	3,85	90%	0,10	1,17
2	20%	2,00	80%	1,60	20%	3,85	80%	0,10	0,83
3	30%	2,00	70%	1,60	30%	3,85	70%	0,10	0,50
4	40%	2,00	60%	1,60	40%	3,85	60%	0,10	0,16
5	50%	2,00	50%	1,60	50%	3,85	50%	0,10	−0,18
6	60%	2,00	40%	1,60	60°%	3,85	40%	0,10	−0,51
7	70%	2,00	30%	1,60	70%	3,85	30%	0,10	−0,85
8	80%	2,00	20%	1,60	80%	3,85	20%	0,10	−1,18
9	90%	2,00	10%	1,60	90%	3,85	10%	0,10	−1,52
10	100%	2,00	0%	1,60	100%	3,85	0%	0,10	−1,85

Note: Expected payoffs were not provided in the instructions to participants

and Rennes 1 (France). No subject participated in more than one session. None of the subjects had participated in a similar economic experiment.

Our design consists of 20 sessions (with 12 subjects each) of a lottery choice experiment. We ran different treatments by manipulating three variables in a factorial $2 \times 3 \times 2$ design: the presentation of the ten lottery-choices (*simultaneously* or *sequentially*), the order of the probabilities (*increasing*, *decreasing*, or *random order*) and the size of payoffs (low and high payoff condition in which all payoffs are multiplied by a factor of 10). Our Baseline treatment, called SIMINC, is a replication of HL "low real payoff" treatment in which we merely substituted Euros (€) for Dollars ($). In this treatment, the participants are confronted with ten simultaneous choices between two lotteries: a "safe" lottery *S* (payoffs of 2.00 € or 1.60 €) and a "risky" lottery *R* (payoffs of 3.85 € or $0.10 €) with *equal* probabilities of winning ranked from 10% to 100% in 10%-intervals (see Table 1). The SIMDEC and SIMRAND treatments are identical to the SIMINC treatment presented above except that the winning probabilities are ranked in the table in decreasing and in random order, respectively. In a fourth treatment called SEQINC, participants play exactly the same treatment as the baseline treatment except that the ten decisions are not presented simultaneously but given sequentially with probabilities ranked in a similar increasing manner from 10% to 100%. The SEQDEC and SEQRAND treatments are also designed in a sequential way but with probabilities ranked in decreasing or in random order respectively.

In each session, subjects were confronted with 3 or 4 successive treatments. To control for a potential order effect,[6] we varied the order of the treatment across sessions. Table 2 contains summary information about sessions of our $2 \times 3 \times 2$ ex-

[6]Previous results on the effect of prior experience on subsequent choices are mixed. Harrison et al. (2005) suggest that making decisions in the low payoff treatment has an effect on subsequent choices in the high payoff treatment (the order effect increases risk aversion); while Holt and Laury (2005) suggest that the order effect is not clear-cut.

Table 2 Characteristics of the experimental sessions

Session No.	No. of subjects	Location	Treatments Order 1	Order 2	Order 3	Order 4
1	12	Rennes	SIMINC	SIMRAND	SIMDEC	SIMINCx10
2	12	Rennes	SIMRAND	SIMINC	SIMDEC	SIMDECx10
3	12	Rennes	SIMDEC	SIMINC	SIMRAND	SIMRANDx10
4	12	Rennes	SEQINC	SEQRAND	SEQDEC	SEQINCx10
5	12	Paris	SEQRAND	SEQINC	SEQDEC	SEQDECx10
6	12	Paris	SEQDEC	SEQINC	SEQRAND	SEQRANDx10
7	12	Paris	SEQRAND	SIMRAND	SEQDEC	SEQDECx10
8	12	Paris	SIMRAND	SEQRAND	SIMDEC	SIMDECx10
9	12	Paris	SEQINCx10	SEQRANDx10	SEQDECx10	
10	12	Rennes	SEQRANDx10	SEQINCx10	SEQDECx10	
11	12	Paris	SIMINC	SIMDEC	SIMRAND	
12	12	Paris	SIMRAND	SIMDEC	SIMINC	
13	12	Paris	SIMDEC	SIMRAND	SIMINC	
14	12	Paris	SEQINC	SEQDEC	SEQRAND	
15	12	Paris	SEQRAND	SEQDEC	SEQINC	
16	12	Paris	SEQDEC	SEQRAND	SEQINC	
17	12	Paris	SEQDECx10	SEQINCx10	SEQRANDx10	
18	12	Paris	SEQDECx10	SEQRANDx10	SEQINCx10	
19	12	Paris	SIMINCx10	SIMRANDx10	SIMDECx10	
20	12	Paris	SIMDECx10	SIMRANDx10	SIMINCx10	

Read, for example: In session 4, 12 participants played successively SEQINC, SEQRAND, SEQDEC and SEQINCx10 treatments

perimental design. The first four columns indicate the session number, the number of subjects who took part in the session and the location. The three (or four) last columns of Table 2 indicate the treatment in effect in each segment of the session.

2.2 Procedures

Sessions 1–8 comprise four treatments, the first three being with low payoffs and the last one with high payoffs; and sessions 9–20 comprise three treatments, half of which are with low payoffs only and the other half with high payoffs only. In sessions 9–20, subjects were informed that three sets of lottery choices would be successively implemented. However, to control for wealth effects, subjects were informed that only one of the three treatment payoffs would be chosen for payment at the end of the experiment. Similar rules were implemented in sessions 1–8. In particular, subjects were not informed at the beginning of the experiment that an additional fourth treatment would be played. At the end of the third treatment, subjects were informed of their final payment for the experience chosen among the three treatment payoffs. Then subjects were asked to give up what they had earned in the previous treatments in order to participate in the high payoff treatment. Only one participant

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Table 3a Frequencies of inconsistent *subjects*

	Type of frame	Number of subjects	Number of inconsistent subjects	% inconsistent subjects
Low payoffs	SIM	*96*	*30*	31.3
	SEQ	*96*	*36*	37.5
	All low	168	62	36.9
High payoffs	SIM	72	7	9.7
	SEQ	96	25	26.0
	All high	168	32	19.0
All SIM		120	36	30.0
All SEQ		144	54	37.5
All data		240	86	35.8

declined to participate. On average, a session lasted for about an hour and 20 minutes, including the initial instructions and payment of subjects. Each participant earned 20 € on average.

3 Results on inconsistency

The HL procedure is based on a menu of lottery pairs that follow a regular pattern which can be made more or less transparent by changing the frame. Choice consistency implies here that the probability-set over which an individual chooses a risky lottery be connected and includes the 100%-winning probability. A consistent subject uniformly would prefer risk at high probabilities of winning and would usually switch to a safe choice at low probabilities of winning without ever switching back to the risky lottery. Thus, consistent individuals must choose the risky option if they are sure to win and cannot switch to the safe option more than once. Accordingly, we qualify all observed behaviors that violate either one of these two conditions of inconsistent. For instance, we consider inconsistent behaviors as the repetitive switches from one option (safe or risky) to the other. Subjects who first choose the safe (risky) option and then switch to the risky (safe) option before switching back to the safe (risky) option are inconsistent. Besides, we assume that subjects who always choose the safe option are inconsistent, as such behavior implies that they prefer less money to more with certainty (2 € instead of 3.85 €).

In line with previous results in the literature, we found that almost all subjects chose the safe option for small probability of the high payoff, and then switched to the riskier option when the probability of the high payoff increased sufficiently. However, our results also indicate that in all treatments a non negligible part of players exhibited inconsistent behavior. Tables 3a and 3b report the respective frequencies of subjects and choice sequences that exhibit inconsistency across treatments. We define a choice sequence as the set of ten choices a subject makes in a given treatment.

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Table 3b Frequencies of inconsistent choice *sequences*

	Type of frame	Number of choice sequences	Number of inconsistent choice sequences	% inconsistent choice sequences
Low payoffs				
Simultaneous presentation	SIMINC	72	17	23.6
	SIMDEC	84	11	13.1
	SIMRAND	96	21	21.9
	Low SIM	252	49	19.4
Sequential presentation	SEQINC	72	19	26.4
	SEQDEC	84	13	15.5
	SEQRAND	96	22	22.9
	Low SEQ	252	54	21.5
Probability ranking	Low INC	144	36	25.0
	Low DEC	168	24	14.3
	Low RAND	192	43	22.4
Order of presentation	Low Order 1	168	52	31.0
	Low Order 2	168	31	18.5
	Low Order 3	168	20	11.9
	All low	504	103	20.4
High payoffs				
Simultaneous presentation	SIMINC	36	3	8.3
	SIMDEC	48	2	4.2
	SIMRAND	36	4	11.1
	High SIM	120	9	7.5
Sequential presentation	SEQINC	60	11	18.3
	SEQDEC	72	15	20.8
	SEQRAND	60	6	10.0
	High SEQ	192	32	16.7
Probability ranking	High INC	96	14	14.6
	High DEC	120	17	14.2
	High RAND	96	10	10.4
Order of presentation	High Order 1	72	16	22.2
	High Order 2	72	10	13.9
	High Order 3	72	4	5.6
	All high	312	41	13.4
All SIM		372	58	15.6
All SEQ		444	86	19.4
All data		816	144	17.7

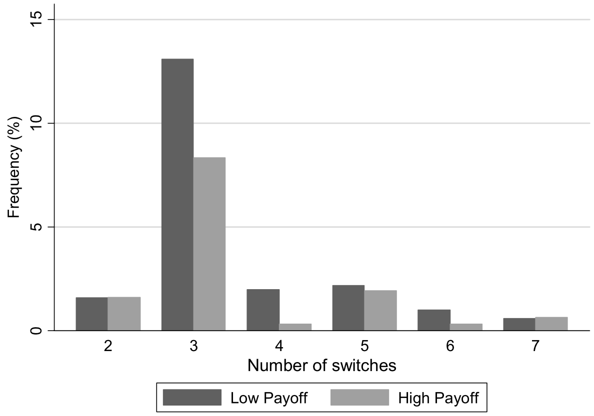

Fig. 1 Distribution of the number of switches for inconsistent choice sequences

Result 1 *The rate of inconsistency is lower under* (1) *a decreasing frame*, (2) *a simultaneous frame*, (3) *a high payoff condition and* (4) *with repetition.*

Support for result 1 Table 3b indicates that, on average, there are more inconsistencies under the INC frame than under the DEC frames. According to a Wilcoxon signed rank test on the fact of being inconsistent at the sequence level, the difference between the INC and DEC treatments is significant ($z = -2.722$; $p < 0.01$). No significant difference is found between the INC and the RAND treatments.[7] Tables 3a and 3b also indicate that in all sessions, 30 percent of subjects (and 15.6 percent of choice sequences) were inconsistent in the simultaneous frame. In the sequential frame, the corresponding figures are 37.5 percent of subjects (and 19.4 percent of choice sequences) who were inconsistent. According to a Mann-Whitney test and after controlling for order effects, these differences are statistically significant but for the high payoff condition only ($z = -1.723$; $p = 0.08$; two-tailed). Our data also indicate that inconsistency decreases over repetition. A Wilcoxon signed rank test shows that the difference of inconsistency is significant between order 1 and order 2 ($z = 3.571$; $p = 0.0004$) as well as between order 2 and order 3 ($z = 2.694$; $p = 0.0071$). Finally both Fig. 1 and Tables 3a and 3b indicate that subjects are more inconsistent under low incentive than under high payoff condition. Figure 1 displays the proportion of inconsistencies for low and for high payoffs. It shows that most inconsistencies consist of at least 3 switches and that the level of inconsistencies is smaller for high payoffs. Table 3a indicates that 36.9% of subjects were inconsistent under low incentives versus 19.0% under high incentives. Table 3b shows that 20.4% of choice sequences were inconsistent under low incentives versus 13.4% under high incentives. A Mann-Whitney test shows that these differences are statistically significant, ($z = 1.942$; $p = 0.0521$; two-tailed). The larger rate of inconsistency when incentives are weak could be interpreted as a lack of motivation and attention under the low payoff condition compared to the high condition.

[7] A significant difference is found between the DEC and RAND but only for the low payoff condition ($z = 1.768$; $p = 0.077$).

Table 4 Determinants of inconsistency

Dep var: being inconsistent	All treat.	
	REP[a]	Ord. P[b]
Model	(1)	(2)
Decreasing	Ref.	Ref.
Increasing frame	0.631^{***}	0.233^{**}
	(0.196)	(0.103)
Random frame	0.410^{**}	0.166^{*}
	(0.187)	(0.098)
Simultaneous frame	Ref.	Ref.
Sequential frame	0.404^{*}	0.205^{*}
	(0.227)	(0.121)
Low payoff	Ref.	Ref.
High payoff	-0.689^{**}	-0.378^{**}
	(0.283)	(0.158)
Order 2	-0.626^{***}	-0.244^{**}
	(0.178)	(0.098)
Order 3	-1.108^{***}	-0.442^{***}
	(0.208)	(0.102)
Order 4	−0.397	−0.117
	(0.360)	(0.195)
Male	0.022	0.038
	(0.238)	(0.123)
Demographics	*Yes*	*Yes*
	-1.604^{**}	
Constant	(0.780)	
Log-likelihood	−300.598	−595.083
N	816	816

High payoff ($\times 10$) is a dummy for scale effect; order 2, order 3 and order 4 are dummies for order; male is a dummy for gender, Demographics: dummies for age, degree and study field

[a]Random effect probit

[b]Ordered probit model with clustered standard errors. Standard errors in parentheses

$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.001$

To provide more formal evidence for results 1, we estimated regressions on the probability of being inconsistent. Table 4 consists of two models. The first model corresponds to a Random effect Probit model on the probability of being inconsistent. The dependent variable takes value 1 if a player is inconsistent and zero otherwise. The second model is an Ordered Probit model on the numbers of switches, at the sequence level. The independent variables include dummy variables for presentation (simultaneous or sequential), probability ranking (increasing, decreasing or random) and incentives (high or low payoffs). We also introduced variables that control for potential order effects. The variables order 2, order 3, and order 4 indicate the order in which treatments were played by the subject (order 1 is the reference).

Table 5 Average number of safe choices by treatment (consistent subjects)

Treatment	Number of subjects	Low number of safe choices per sequence	Number of subjects	High number of safe choices per sequence
SIM INC	54	5.9	33	6.7
SEQ INC	53	6.1	48	7.1
SIM DEC	71	5.9	44	6.9
SEQ DEC	70	6.5	54	7.3
SIM RAND	74	6.1	32	7.2
SEQ RAND	74	6.3	53	7.1

Table 4 shows that the decreasing win probability frame enhances consistency relative to an increasing or random frame. Another important result provided by Table 4 is that, after controlling for several other variables, the simultaneous frame tends to facilitate consistent choices relative to the sequential frame. The coefficient associated to the variable "high payoff" is negative and highly significant, confirming our previous findings that increasing payoffs reduces inconsistency level. Thus, it seems that strong pecuniary incentives help individuals pay more attention to each decision and make less error.

Finally Table 4 also provides interesting results concerning the effects of repetition of the tasks. Consistent with previous observations obtained from Table 3b, it shows that inconsistencies strongly decline with repetition.

4 Results: choosing the safe option

In this section, we investigate to what extent framing also affects the attitude of subjects toward risk. As mentioned above, framing might affect the propensity of choosing the safe option in two different ways. First, framing may have a direct impact on this propensity if subjects are sensitive to information brought about by the frame or by experience. Second, framing may also indirectly influence the proportion of safe choices through the induced level of inconsistencies. Following HL, we describe the risk attitude of subjects by the number of safe choices they made. Accordingly, we display the proportion of safe choices for low payoff and for high payoff and we analyze the effect of framing for each payoff level.

Table 5 shows the average number of safe choices by treatment.[8] The latter is always slightly higher in sequential than in simultaneous treatments, and in decreasing than in increasing probability treatments. It is also substantially higher with high payoffs than with low payoffs. The effects of framing on risk aversion are summarized in result 2.

[8] Averages are computed here on consistent subjects in order to facilitate comparisons with previous results in the literature.

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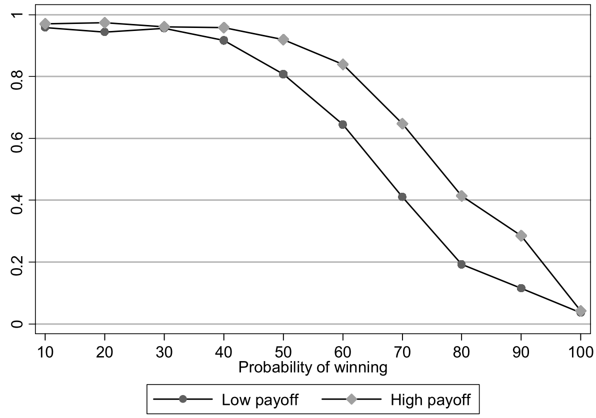

Fig. 2 The proportion of safe choices in each decision: low versus High payoff conditions

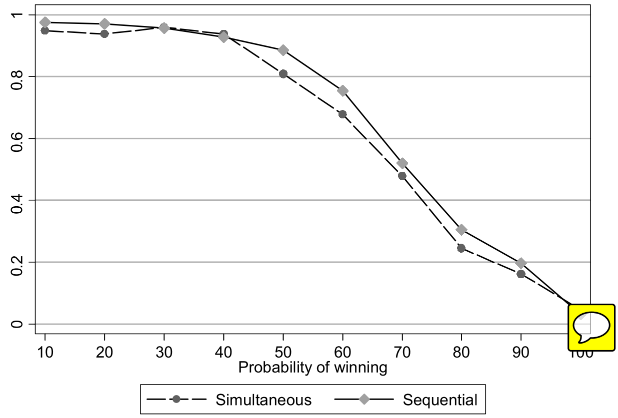

Fig. 3 The proportion of safe choices in each decision: simultaneous *vs* sequential frames

Result 2 *The proportion of safe choices is larger under* (1) *a sequential frame* (2) *a random frame and under a* (3) *high payoff condition. To a lesser extent, a decreasing frame also induces a higher proportion of safe choices.*

Support for result 2 Figure 2 shows the proportion of safe choices among subjects with the probability of winning the higher payoff in the low and high payoff conditions. It shows that the percentage choosing the safe option falls as the probability of winning the higher payoff increases. Consistent with previous studies, we find that individuals tend to exhibit higher risk aversion under the high payoff conditions. A Mann-Withney test between the low payoff and high payoff conditions reject the hypothesis that the proportion of safe choices are equal in the low and high payoff conditions ($z = -3.152$; $p = 0.0016$; two-tailed).[9]

Figure 3 shows that the proportion of safe choices increases under a sequential frame. A Mann-Whitney test on the total number of safe choices over ten periods rejects the null hypothesis of equal means between the simultaneous and sequential

[9] All tests on risk aversion are run on consistent players only.

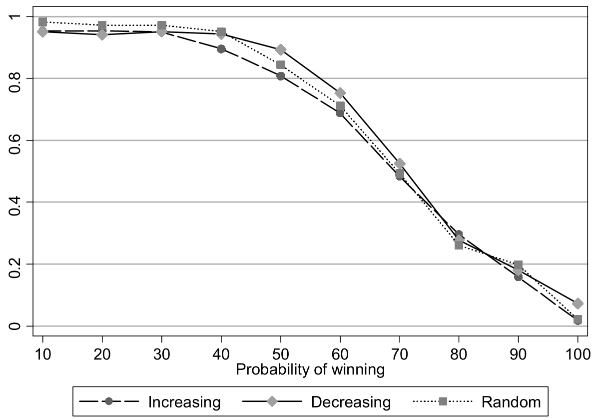

Fig. 4 The proportion of safe choices in each decision: Random, Increasing and Decreasing frame

treatments ($p \leq 0.1$; $z = -1.619$; two tailed). Figure 4 displays the proportion of safe choices in random, decreasing and increasing treatments. A Wilcoxon Signed rank test on the total number of safe choices rejects the null hypothesis of equal means between the increasing and decreasing treatment ($z = 2.315$, $p = 0.020$; two-tailed). This test provides similar results between the increasing and random treatments ($z = 2.000$; $p = 0.045$; two tailed).

In order to provide further evidence of a varying (elicited) risk-aversion across the frames, we estimated two structural models of probabilistic choice under risk. The first model is the Fechner (1860) model of random errors as used, for example, by Hey and Orme (1994). This model states that the Sure (S) lottery will be chosen over the Risky (R) lottery with probability

$$\Phi\left(\frac{U(S) - U(R)}{\sigma}\right)$$

where $\Phi(.)$ is the standard normal c.d.f, σ is the standard deviation of the random errors, and $U(.)$ is a vNM utility function.

The second—more recent—model is due to Blavatskyy (2010). His model has the advantage of satisfying first order stochastic dominance, weak stochastic transitivity, and also account for common behavioral regularities. Define lottery $S \wedge R$ as the lottery that is stochastically dominated by S and R, and such that no other lotteries at the same time is stochastically dominated by S and R but dominates $S \wedge R$ (see Blavatskyy 2010 for details). Then the probability of choosing S over R is given by

$$\frac{\varphi(U(S) - U(\mathrm{S} \wedge R))}{\varphi(U(S) - U(S \wedge R)) + \varphi(U(R) - U(\mathrm{S} \wedge R))}$$

where $\varphi(.)$ is a non decreasing function with $\varphi(0) = 0$, and $U(.)$ is again a vNM utility function.

In our estimations, we use a CRRA utility function for the outcomes $V(x) = \frac{x^{1-\rho}}{1-\rho}$ where ρ is the coefficient of relative risk aversion ($\rho \neq 1$). Moreover, following Blavatskyy (2010), we define $\varphi(x) = \exp(\lambda x) - 1$ where λ is a parameter to be estimated jointly with ρ. The estimations were performed using maximum likelihood.

Table 6 gives the estimated parameters for the coefficient of relative risk aversion. The top panel refers to the Blavatskyy (2010) model, while the bottom panel refers to the Fechner (1860) model. The three columns correspond to three different sub samples.

As can be seen from Table 6, our results are fairly robust across models and samples. They show that the sequential frame leads to a significantly higher coefficient of risk-aversion (16 to 19% higher than in simultaneous frames). The random and decreasing frame also lead to an increase in the coefficient of risk-aversion, but the effect is smaller (11 to 13%) than for the sequential frame. Moreover, the decreasing frame has an insignificant impact in two out of three sub samples.

Table 6 confirms and quantifies the respective effects of framing and incentives on the elicited risk aversion. Incentives, sequential choices and random or decreasing probabilities of winning tend to generate higher risk aversion.

One might argue that these results merely reflect the higher level of inconsistencies under sequential framing. To test this hypothesis, we replicated previous results for consistent subjects. These estimates show very similar patterns. Overall these findings seem to indicate that inconsistency is not the main reason behind higher risk aversion when framing induces less information.

5 Discussion

Previous results have shown the importance of framing effects that strongly influence both inconsistency and risk aversion levels. In this section we propose possible interpretations of these findings, underlying the role played by information, experience and incentives.

One main finding obtained in this study is that simultaneous frames induce significantly less inconsistency than sequential frames. How could we make sense of these results? A possible explanation may rely on the intuition that simultaneous framings convey "more information" than sequential framings by showing the whole menu of lottery pairs from the outset and making thus the regular pattern they form more transparent. This renders the pattern of subsequent choices particularly transparent under a simultaneous frame. Another possible interpretation of this finding is that subjects may understand they should switch only once but are uncertain of where to switch. While the simultaneous frame allows subjects to amend their previous choices before submitting their final choices, this is no more possible under a sequential framing, which may lead to higher inconsistencies.[10] Another important finding is that both repetition and high payoffs reduce inconsistency, significantly. It could be possible that subjects devote more attention to the tasks when payoffs are high and/or when they acquire experience through the repetition of identical choices.

Our data also indicate that the decreasing win probability frame generally enhances consistency relative to an increasing or random frame. This is an intriguing result because neither the amount of information conveyed by the treatment nor the lack of attention which may be caused by weak incentives should be affected by

[10] We thank an anonymous referee for this helpful remark.

Table 6 Structural estimations on risk aversion

	All	Not strongly inconsistent[a]	Consistent
Blavatskyy model			
Sequential frame	0.080*	0.080*	0.086*
	(0.048)	(0.047)	(0.049)
Random frame	0.058**	0.058**	0.052*
	(0.028)	(0.028)	(0.030)
Decreasing frame	0.056*	0.048	0.044
	(0.029)	(0.030)	(0.031)
High payoff	0.278***	0.273***	0.270***
	(0.047)	(0.046)	(0.047)
Inconsistent/non monotonic	−0.157**	−0.297***	
	(0.074)	(0.052)	
Intercept	0.493***	0.498***	0.500***
	(0.043)	(0.043)	(0.044)
Log-likelihood	−2679.446	−2443.066	−1763.167
Fechner model			
Sequential frame	0.083*	0.085*	0.093*
	(0.047)	(0.046)	(0.048)
Random frame	0.062**	0.062**	0.057*
	(0.028)	(0.028)	(0.030)
Decreasing frame	0.059**	0.049	0.046
	(0.030)	(0.030)	(0.032)
High payoff	0.272***	0.266***	0.262***
	(0.045)	(0.045)	(0.046)
Inconsistent/non monotonic	−0.088	−0.255***	
	(0.072)	(0.049)	
Intercept	0.486***	0.491***	0.491***
	(0.043)	(0.043)	(0.044)
Log-likelihood	−2669.066	−2437.240	−1766.651
N	8160	7850	6600

Clustered standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$
[a]Subjects may have more than one switch point. However, they do choose R when they are sure of winning (i.e. probability of winning = 1)

the use of an increasing or decreasing frame. However, a simple explanation can be found. This explanation relies on the idea that the first decision may give an anchor, which may be more or less strong, depending on the framing. In the decreasing probability frame, the anchor is obvious since subjects start with a *certain* win probability of 100% for which the "risky lottery" R should be an obvious choice. So subjects who begin with the risky bet in first decision should exhibit less inconsistent behavior over the rest of the sequence. The anchor is, to some extent, less obvious in the

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increasing frame where subjects start with a win probability of 10%.[11] Consequently, subjects may be less certain about their preferences in the increasing frame, which would induce more inconsistencies over the entire sequence.[12]

But why should a decreasing frame induce a higher estimate for risk aversion? Our findings indicate that the difference between *increasing* and *decreasing* framings is partly due to inconsistencies since the framing variable is no more significant for consistent players (see Table 6). A possible explanation could be the following. If subjects are more inconsistent under the *increasing* framing, they may opt for R too early under the increasing frame. Assume, for instance, that an individual is risk-neutral and should make four safe choices and six risky choices in the HL experiment. If uncertain about his preferences, he might opt for R too early under the increasing frame, say after only two safe choices, and revert to S for a win probability of 0.4. His menu of choices would then be: $SS/R/S/RRRRRR$, which generates a downward bias in estimated risk aversion for an increasing frame. Hence, the risk aversion estimate tends to be higher with decreasing probabilities than with increasing probabilities and the magnitude of this gap is a measure of an individual's degree of inconsistency.

6 Conclusion

Evidence for the role of framing effects in influencing behavior remains elusive. Framing effects are pervasive both in real life and in experiments, but they are usually ignored by economic analysis because they violate principles of normative rationality.

In this paper we have looked for effects of framing in the context of a random lottery procedure elicited for measuring risk aversion. This was done by replicating the well-known experiment by Holt and Laury (2002) under various framings. The lottery choices were presented either *simultaneously* or *sequentially*; the payoff probabilities were presented either in *increasing*, *decreasing*, or in *random* order.

We have three key findings.

First, we find that inconsistency is significantly higher in *sequential* than in *simultaneous* treatments, particularly for high payoff treatments. It is also higher in *increasing* than in *decreasing* treatments. One methodological implication of our work

[11] In the increasing frame, a symmetric situation would be a situation in which subjects would start with a *certain* win probability of 0 percent. This situation for which the "safe lottery" S would become the obvious choice was not available in the increasing frames.

[12] Our explanation in terms of anchoring effects requires that a majority of subjects makes a 'correct' choice in the first decision (i.e. the risky option when $p = 1$ in the decreasing frame and the safe option when $p = 0.1$ in the increasing frame). Our data indicate that this is the case since 'correct' first decision is observed in a 93% and 95% of cases in the decreasing and increasing frames, respectively. Surprisingly, less 'correct' first choices are observed in the decreasing frame. There might be several plausible explanations, like making purely random choices, a lack of attention, a misunderstanding of the significance of the probabilities associated to the outcomes (in particular for outcome associated to the zero probability in the decreasing frame), etc. However one should probably not pay too much attention to this finding since it concerns only very few people. More important is the fact that among the huge majority of choice sequences starting with a first 'correct' choice, the decreasing frame seems to give a stronger anchor for the rest of the sequence. Indeed we find that among these choice sequences, 17.9% were inconsistent in the increasing treatment and 10.5% only in the decreasing treatment.

is that combining a simultaneous presentation of the ten connected lotteries with a decreasing probability frame would probably add further consistency to the procedure by avoiding a few strongly inconsistent choices.

Second, the implicit experience acquired by subjects and more salient incentives induce a dramatic decrease in inconsistent behaviors.

Last, framing also strongly affects individual risk aversion. Indeed risk aversion levels are significantly higher in *sequential* than in *simultaneous* treatments and in *decreasing* and *random* than in *increasing* treatments. This does not only reflect differences of inconsistency levels, at least for the *sequential* and *random* frames, since similar results were found for consistent individuals. These findings thus contribute to the existing literature showing that framing affects behavior in the context of transparent lottery choice procedures.

There are a number of explanations of the framing-sensitivity of decisions. A possible explanation relies on the role of random errors on observed behavior. However randomness alone does not seem to be sufficient to predict systematic inconsistencies and their gradual elimination by experience. Another possible explanation of our results is that frames differ by their informational content. "Good" frames convey more information or make choices more obvious to individuals than "bad" frames and economize on experience and incentives. They help people make normatively consistent choices under risk, which means that they made inconsistent choices with a bad frame by lack of information.

Bringing imperfect information into the Expected Utility theory might probably help explain these observed anomalies.

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