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Risk Aversion on Probabilities: Experimental Evidence of Deciding Between Lotteries

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Abstract In experiments individual risk attitudes can be induced by applying the binary lottery-technique (one can achieve a high or low payoff and influence only the probability of winning the high payoff). This also seems to be the only way to guarantee common knowledge of idiosyncratic risk attitudes, assumed in most economic game models involving risk. We report on experiments whose results support the hypothesis that behavior does not change much when playing for money or probability. When comparing decision alternatives one often seems to substitute final goals like monetary expectation by more easily accessible sub-goals like winning probability.

JEL Classification D14, D18, C3
Keywords risk preference, lottery choice, experiment, binary lottery technique

1. Introduction

Let us refer to actions implying positive probability for more than one monetary payoff level as lottery choices. Like in real life many experiments require to choose among lotteries. If in such situations one wants to unambi-

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guously define optimal behavior, one usually relies on commonly known risk attitudes.[1] Whatever one assumes: if experimental observations deviate from the benchmark solution, the question comes up: Can these deviations be explained by risk attitudes other than the assumed ones?

Some results exclude, of course, such explanations. If the responder in an ultimatum game rejects a positive offer, this contradicts any behavior based on the assumption that more money is better than less money.[2] But in social interaction involving risk many behavioral patterns may be consistent with expected utility maximization. If any risk attitude consistent with expected utility theory is possible, (commonly known) rationality is not very informative and may even become unfalsifiable.

To avoid the ambiguity of the normative solution and to counter the argument that deviations from solution behavior can be explained by individual risk preferences, in experiments one naturally would like to control for individual risk preferences, e.g. by inducing risk neutrality. This can be achieved by the *binary lottery technique*: A participant either can win a large or a small monetary payoff or prize. If actions influence monetary rewards only via the probability for winning the large prize, an optimal choice clearly has to maximize this probability regardless of one's risk preferences for money. It has to be assumed merely that the decision maker prefers more to less money and obeys the laws of probability theory, e.g. when deriving the overall winning probability in case of multiple chance moves.

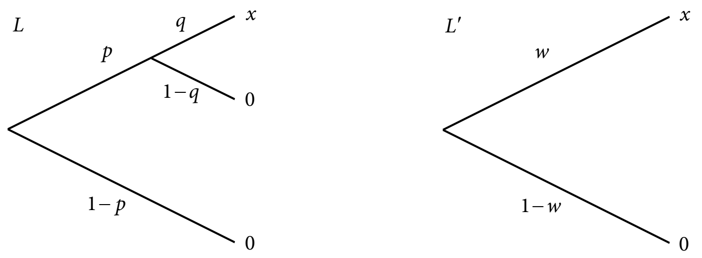
Of course, one can also induce other risk attitudes than risk neutrality in the same way, e.g. by letting participants earn a point score which is monotonically, but not necessarily linearly related to the probability of winning the large prize (see, for instance, in a financial setting, Dittrich et al., forthcoming). Since in our experiment we induce risk neutrality, this is not discussed here in more detail.

If choices assign positive probability to various events influencing the probabilities of winning the large prize, a participant in an experiment using the binary lottery technique has to choose among *compound lotteries* according to which success depends on more than one chance move. In our study we restrict attention to simple compound lotteries, namely where par-

[1] It is quite another matter that most game models (typically in auction theory, an exception are principal-agent models) and experimental benchmark solutions (see the relevant subchapters in Kagel and Roth (eds.), 1995) rely on identical risk preferences of all interacting parties, especially if any kind of asymmetry questions basic results, e.g. the equivalence of various auction forms.

[2] Note, however, that inequity aversion, another idiosyncratic preference aspect, can account for such behaviour (see Bolton and Ockenfels, 2000, and Fehr and Schmidt, 1999).

Figure 1 Basic choice setting, part 1



ticipants choose among a one or a two stage lottery. Whereas a one stage lottery simply assigns positive probability for at least two monetary prizes, the first stage of a two stage lottery offers a probability p-chance to win a lottery or nothing. In the second stage the lottery yields an amount x with a q-chance and nothing otherwise. Such a two-stage lottery will be denoted by L. Compare this to a one-stage lottery L' yielding x with a w-chance and nothing otherwise, see Figure 1.

According to Expected Utility Theory (EUT) this two-stage lottery is equivalent to the one-stage lottery if w is equal to pq. This equivalence is a direct consequence of the substitution principle, or more specifically of the axiom of reduction of compound lotteries. The basic choice paradigm in Figure 1 is important for quite a number of reasons.

The binary lottery technique was already suggested by Smith (1961). It has been used experimentally by Roth and Malouf (1979) who were interested in testing the axioms of the bargaining solution suggested by Nash (1953).[3] Let us demonstrate the idea with the help of lottery L' in Figure 1. Instead of receiving some amount x, subjects receive a w-chance of winning the amount x. In case they receive another w'-chance of winning the amount x their overall chance of winning is $w+w'$ (assuming $w+w'\leq 1$). According to EUT the expected utility of these prospects is $(w+w')u(x)+(1-w-w')u(0)$. Since utilities are only unique up to positive affine linear transformations, this utility can be renormalized into $w+w'$ by setting $u(x)=1$ and $u(0)=0$.

This demonstrates that in EUT risk considerations are expressed exclusively by the shape of the function $u(\cdot)$, i.e. by the evaluation of sure monetary wins. If $u(\cdot)$ is concave, the decision maker is risk averse, whereas risk loving requires convexity of $u(\cdot)$. EUT leaves no room for "evaluating" prob-

[3] It has recently been more thoroughly explored by Selten et al. (1999) where, like in our study, the focus is decision theoretic. The unique chance of inducing commonly known idiosyncratic risk attitudes by applying the binary lottery technique is not discussed at all.

abilities, e.g. in the sense of evaluating probabilities w by $v(w)$ according to some non-linear and monotonic function $v(\cdot)$. We refer to such functions $v(\cdot)$ as risk attitudes for winning probabilities (also in prospect theory, see Kahneman and Tversky, 1979, probabilities are transformed though this is not justified by "risk aversion"). In case of a concave evaluation function $v(\cdot)$ we speak of *risk aversion on probabilities*. Of course, EUT also claims that when using the binary lottery technique different individuals must decide in the same way between alternative prospects relying on the same probabilities.

Consider, for example, the choice between L and L' in Figure 1. Here the decision maker has a definite w-chance of winning versus a p-chance, i.e. a risky chance, of a q-chance of winning. According to EUT decision makers have to be indifferent between L and L' in case $w = pq$. The axiom supporting this is the axiom of reduction of compound lotteries, i.e. in a decision tree the probabilities can be multiplied through. Comparing lotteries L and L' offers a direct test of this axiom in the most simple settings. More importantly, the choice paradigm presented in Figure 1 allows to test whether the binary lottery technique induces risk neutral behavior and whether risk attitudes can be reflected by the evaluations of sure monetary wins alone or require also to evaluate winning probabilities by a function $v(\cdot)$ as described above.

The concept of ambiguity can also be related to the lotteries in Figure 1. In general ambiguity is defined as the uncertainty a decision maker has about his probability judgments. If a decision maker is averse towards this uncertainty he is said to be ambiguity averse. Ambiguity aversion is best presented in the famous Ellsberg paradox (Ellsberg 1961, see Camerer and Weber 1992 for an overview on ambiguity research). For the purpose of our analysis ambiguity can be related to the maximal number of successive chance moves. Thus a two stage-lottery is more ambiguous than a one stage-lottery. This could mean that one prefers the simple lottery L' over the two stage-lottery L in Figure 1 even when pq is larger than w. Theories based on second order probabilities weigh the possible probabilities of the second chance moves nonlinearly and thus exhibit risk aversion toward (second-order) probabilities (Camerer and Weber 1992, provide an overview on this approach). The choice problem in Figure 1 provides a direct test of ambiguity aversion in the sense of an aversion against more complex stochastic events.

In our experimental study subjects received two choice sets similar to those in Figure 1. The aim was to investigate to which degree subjects prefer a one-stage lottery over an equivalent two-stage lottery. Concerning the binary lottery technique our basic conjecture was that many decision makers will not change behavior at all. In particular they would still exhibit some form of risk aversion, if winning probabilities are used as payoffs instead of money.

After learning about their basic concerns experimental subjects seem to engage the task of making a reasonable choice. It is quite likely that this task is completed by some general problem solving algorithm like, for instance, aspiration adjustment. This could be operative regardless of the nature of the basic concerns, whether they be sure monetary wins or just winning probabilities.

Of course, the binary lottery technique can only address the concerns of those who are basically believers in the rationality of human decision making. They no longer can argue that one does not control for risk attitudes. For those (e.g. Selten et al., 1999), who doubt that human decision making is at all rational in the sense of the utility maximization paradigm (except for some rare situations), the binary lottery technique would only complicate the experimental design, e.g. by making it more complex and therefore also more ambiguous.

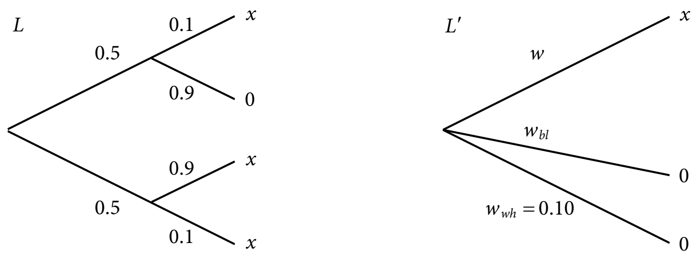
In case of merely a few choice alternatives one has to expect a considerable proportion of rational choices. We will show is that non-optimal choices are far from being rare and that certain circumstances provoke more such choices. These can no longer be explained by risk attitudes in the narrow sense of EUT. In our view, this finding validates our general claim that behavioral risk attitude is a much broader concept than suggested by utility theory (EUT). Apparently human problem solving operates such that we compare decision alternatives to sub-goals and rely on our usual concerns like "beware of risk!".

2. Experimental design

To test our hypotheses we used two choice settings. For the first setting, denoted by A, see the pair of alternatives presented in Figure 1. The amount x to be won was set to be DM 40 or hfl 50 depending on whether the experiment was run in Germany or in the Netherlands[4]. We have used two pairs of alternatives in setting A, denoted by A_1 and A_2, respectively, with the same probability w of winning for the one-stage lottery L' of 0.25. The two-stage probabilities of L were $p = 0.75$, and $q = 0.35$, thus $pq = 0.2625$ in case of A_1 and for A_2 also $p = 0.75$, but $q = 0.40$, thus $pq = 0.30$. With w less than pq, EUT predicts a clear preference for L' . We varied q to gain an understanding of the possible strength of risk aversion on probabilities. In the instructions,

[4] DM 40 (about 20 EUR) correspond to approximately hfl 45. At the time of the experiment the amount was equal to \$ 25. We used hfl 50 instead of hfl 45 as a money amount in order to put equal burden for calculation on both subject pools.

Figure 2 Basic choice setting, part 2



see Appendix A, we never directly spoke about probabilities. We simply described urns, number of coloured balls in urns and the winning colour.

In the second choice setting, denoted by *B*, we presented subjects with two pairs B_1 and B_2 of alternatives *L* and L' as shown in Figure 2. Both pairs of alternatives paid upon winning DM 20 or hfl 25, thus yielding a similar monetary expectation as those alternatives in choice setting *A*. Alternative *L* is a two-stage lottery: In the first stage a 50-50 lottery determines whether the winning probability in the second stage is 0.1 or 0.9. The one stage alternative L' offers a $w = 0.48$ of winning in setting B_1, and a $w = 0.40$ chance of winning in setting B_2. The probabilities of not winning (drawing a black ball: w_{bl}, drawing a white ball: w_{wh}) were $w_{b1} = 0.42$ and $w_{wh} = 0.10$ in setting B_1 and $w_{b1} = 0.50$ and $w_{wh} = 0.10$ in setting B_2. Again, the probability of winning in the two-stage lottery, equal to 0.5, was slightly larger than for the one-stage lottery in setting B_1 and considerably larger in setting B_2. Again one would expect a stronger defection from the rational choice L for B_1 than for B_2. Since the superiority of *L* over L' seems to be more obvious for Figure 2 than for Figure 1, we expected stronger risk aversion on probabilities for Figure 1 than for Figure 2. This, however, was not confirmed by our experimental data.

Each participant had to decide upon *one* pair of choice questions which was either A_1, A_2, B_1 or B_2. In addition to having subjects select one alternative which subsequently was played for real, we asked subjects to state their preference for all four choices (A_1, A_2, B_1, and B_2). We also asked the subjects to choose from a set of three alternatives: two one-stage lotteries and a sure amount[5]. This choice allowed us to classify subjects according to their risk aversion in the classical sense (of EUT).

[5] *Frankfurt*: Alternative 1: 0.25 vs. 0.75-chance of winning DM 80 or DM 8; Alternative 2: 0.25 vs. 0.75-chance of winning DM 96 or nothing; Alternative 3: Sure amount of winning DM 25. *Tilburg*: Alternative 1: 0.25 vs. 0.75-chance of winning hfl 80 or hfl 8; Alternative 2: 0.25 vs. 0.75-chance of winning hfl 110. or nothing; Alternative 3: Sure amount of winning hfl 20.

More specifically, the experiment was performed in two ways: Once participants first received their decision form (see Appendix A for A_1 and A_2 and Appendix B for B_1 and B_2) which confronted them with their only pair of choice alternatives. After collecting these decision forms they were asked to fill out the questionnaire (Appendix C) confronting them with the three alternatives, described in footnote 5, as well as with all four pairs of alternatives A_1, A_2, B_1 and B_2. Thus a participant encountered in the questionnaire among others also the same choice problem as on his decision form. The other procedure simply reversed the order of these two tasks, i.e. participants first answered the questionnaire of Appendix C before deciding for the only actual choice alternative A_1, A_2, B_1 or B_2.

Our design varies from other studies which have investigated risk aversion on probabilities. We use different probabilities, pay subjects, observe choices and, in addition, ask subjects for preference. Unrelated to the discussion about the binary lottery-technique there is quite a lot of research on ambiguity effects, however, most of this research does not explicitly consider second order probabilities, exceptions are Bernasconi and Loomes (1992) and Kahn and Sarin (1988), see Davis and Pate-Cornell (1994) for an overview and theoretical models. There is also research showing violations of the reduction of compound lottery axiom, see, for example, Kahneman and Tversky (1979). The binary lottery technique itself is also discussed by Rietz (1993) and Selten et al. (1999). We also do not try to induce other attitudes than risk neutrality like Dittrich et al. (forthcoming).

We ran two major studies, one in the Netherlands (Tilburg) and one in Germany (Frankfurt/M.). In addition we performed two pilot experiments where we used slightly different probabilities. In both pilot experiments our student subjects had already taken advanced economics classes. One major experiment in Tilburg was run with 34 undergraduate students of econometrics. The other in Frankfurt was run with 82 "unspoilt", undergraduate students. Subjects needed about 5 minutes to decide (for decision forms see Appendix A und B, respectively) and about 15 minutes to answer the questionnaire in Appendix C. At the end of the experiment one student was selected at random to perform the chance moves.

3. Results

3.1 *Tilburg experiment*

The results of the experiment in Tilburg are listed in Table 1. In the Tilburg-experiment all participants first were asked to decide and then to fill out the –

Table 1 Results of the Tilburg experiment

Setting	A_1		A_2		B_1		B_2	
Alternative	L'	L	L'	L	L'	L	L'	L
Winning Probability	0.25	0.2625	0.25	0.30	0.48	0.50	0.40	0.50
Hypothetical answers								
Decision Makers Only	0	10(8)	0	8(7)	0	9(9)	1(1)	6(5)
All subjects	5	29	2	32	2	32	8	26
Decisions	2	8	1	7	0	9	2	5

in this case post-experimental questionnaire. The labels L or L' correspond to those in Figure 1 and 2. The numbers in the rows "Decision Makers Only" are the hypothetical answers in the post-experimental questionnaire of those subjects who were actually confronted with this situation, "All Subjects" represent the hypothetical answers in the post experimental questionnaire of all subjects. The actual decisions are listed in the bottom line of Table 1. Numbers in bracket give the number of those decision makers whose decision is consistent in questionnaire and in real choice.

The results show a remarkable consistency with the reduction of compound lottery axiom. Subjects hardly show any risk aversion on probabilities. Altogether only 5 of 34 decisions were suboptimal. The relative proportion of suboptimal answers (17 of 136) is comparable. The results of Table 1 do not confirm our hypothesis of subjects being risk averse on probabilities. In addition we do not get any difference between either A vs. B or A_1 and B_1 vs. A_2 and B_2. This result was almost identical to the results of both pilot experiments where almost everyone chose the compound lottery with the higher probability of winning. Note the interesting effect that all subjects who made the "correct" choice in the real situation are consistent. Some of those who make the "wrong" choice when it is for money make the "correct" choice in the post-experimental questionnaire. Since the questionnaire came after the decision, this could be attributed to learning.

3.2 *Frankfurt experiment*

The experiments in Frankfurt were similar to the one in Tilburg except for one important detail. In Frankfurt we asked half of the subjects to fill out the questionnaire before the experiment and half of them after the experiment. The results of the Frankfurt study are presented in Table 2. The Table is similar to Table 1. The three rows labelled before (after) describe the data for

Table 2 Results of the Frankfurt experiment

Setting	A_1		A_2		B_1		B_2	
Alternative	L'	L	L	L'	L'	L	L'	L
Winning Probability	0.25	0.2625	0.25	0.30	0.48	0.50	0.40	0.50
Before								
Hypothetical answers								
Decision Makers Only	3(2)	8(8)	2(1)	8(6)	4(0)	6(5)	1(0)	9(7)
All subjects	14	27	7	34	27	14	12	29
Decisions	2	9	3	7	1	9	2	8
After								
Hypothetical answers								
Decision Makers Only	4(4)	7(6)	4(3)	6(6)	7(4)	3(3)	7(6)	3(2)
All subjects	20	21	12	29	28	13	25	16
Decisions	5	6	3	7	4	6	7	3

those subjects who did the decision before (after) the questionnaire.

A first glance at Table 2 shows that relatively more subjects have preferred the one-stage lottery over the two-stage lottery than in the Tilburg Experiment. Here 33% preferred L' and 67% preferred L. Remarkably this effect does not depend on the probability difference between one-stage and two-stage lotteries (if at all it depends in the wrong direction). For the small difference, i.e. A_1 and B_1, 29% preferred L' and 38% preferred L' for the larger difference, i.e. A_2 and B_2. These results are also reflected in the questionnaire data.

There is no apparent difference in the decision data between the *A*-setting (choosing between A_1 and A_2) and the B-setting (choosing between B_1 and B_2). However, the questionnaire data show that for the A-setting 32% of the subjects prefer the one-stage lottery. For the *B*-setting 56% of our subjects prefer the one-stage lottery with the lower chance of winning. This effect is driven by the decision data (one-stage: 25%) and the questionnaire data (one-stage: 67%) in the B_1-setting.

To further analyse the questionnaire data, it is interesting to check for effects of the order in which questionnaire and decision data were elicited. If the decision was done before the questionnaire, only 8 out of 41 subjects (19.5%) prefer the one-stage lottery. In case the questionnaire came first, 19 out of 41 subjects (46.3%) prefer the one-stage lottery (different with $p < 0.02$). It seems that making people think longer and confronting them with a variety of problems makes them *more* risk averse on probabilities.

The latter effect might be related to variety seeking in choice behaviour: When first confronting a new choice problem one more often selects the better alternative. When, however, having made similar (even hypothetical) choices before, one is more likely to display variety in decisions. Evolutionarily this could be related to betting on different states (of nature) in the theory of evolutionarily stable portfolios (see for an early study Blume and Easley, 1992, in a financial setting).

Finally we want to check whether there is some relation between the stated risk attitude in an EUT sense and the choice behavior observed in the experiment. Of course, the test is rather crude since participants could select only one of three alternatives presented in the questionnaire. But according to footnote 5, it seems justified to rank participants who in the questionnaire prefer Alternative 1 as risk neutral, those who prefer Alternative 2 as risk loving, and those choosing Alternative 3 as risk averse (according to standard EUT). According to this classification, we had 43 risk neutral, 9 risk loving, and 30 risk averse participants. The proportion of non-optimal choice, i.e. preference for the one-stage lottery with the smaller winning chance, is highest for risk lovers (44%), second highest for risk neutral participants (35%) and lowest for risk averse students (27%).[6] This clearly confirms our intuition that risk aversion is behaviorally a much broader concept: The more risk averse according to standard utility theory somebody is, the less likely he avoids the more ambiguous two stage lottery. Or from the opposite point of view: Wrong decisions (in the sense of avoiding the compound lottery) increase with an increasing willingness to accept risks in terms of standard utility theory.

4. Conclusion

In our study we investigated if subjects show some risk aversion towards the uncertainty in probabilities. We hypothesized that contrary to EUT subjects would prefer lotteries which appear more certain but offer a (slightly) lower chance of winning than others. Subjects who were trained in economics followed the prediction of EUT to high degree.[7] Contrary, for subjects with little

[6] In Tilburg 26% of all subjects prefered Alternative 1 (expected value 26), 65% preferred Alternative 2 (expected value 27.5), and 9% preferred Alternative 3 (sure pay-off 20) thus mostly showing risk neutrality or risk seeking. As subjects gave choice data which was highly consistent with EUT, we could not find any difference in consistency depending on the alternative chosen.

[7] In Tilburg, the experiment was done with students in econometrics at the end of the first year who are used to quantitative techniques. In Frankfurt subjects were not exposed to

training in economics the rate of violation of EUT was about one third. We found that the number of violations depended on whether subjects were first asked to evaluate the whole choice set by a questionnaire.

In the view of our results the following conclusions seem to be well supported:

(i) The binary lottery technique does not avoid that people's risk attitude matters. All what it excludes is risk attitude in the narrow sense of expected utility theory.

(ii) Economic education reduces significantly the share of suboptimal choices in simple decision tasks where participants usually invest considerable time for making just one decision.

(iii) To develop a behavioral theory of risk choices we need a richer theory which does not only depend on (winning) probabilities and (monetary) prizes but captures how such probabilities are determined (e.g. as one stage or two stage lotteries).

(iv) In strategic interaction involving risk there is no easy and straightforward alternative to the binary lottery-technique when common knowledge of idiosyncratic risk attitudes is crucial.

Our overall conclusion from all these points is that employing the binary lottery-technique is questionable (due to (i), (ii) and (iii)) but partly unavoidable (due to (iv)). Notice that for the binary lottery technique, as it was used in experiments, standard utility theory (EUT) can account for the non-optimal choices (the choice of L') only as behavioral noise which, furthermore, should be unrelated to the order of actually deciding and answering the questionnaire. As mentioned before the hypothesis that the order matters is, however, highly significant ($p < 0.02$). Human decision makers may be evolutionarily programmed to display variety in choices since it guarantees long run survival even though, in expected terms, one alternative may be preferable (see Blume and Easley, 1992).

For the actual choices the largest difference of non-optimal choices – between B_2, where 9 of 20 choices were wrong, and A_2 with only 6 wrong (of 20 choices) – is less dramatic. For all answers ("all subjects" in Table 2) the differences are, however, highly significant, e.g. for A_2 only 19 of 82 answers are wrong whereas for B_1 this number is 55 of 82 ($p < 0.001$). Furthermore, it is not clear why the correctness of EUT should be related to differences in

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econometric training before. Of course, such a conclusion denies the possibility of cross country effects which, in our view, are rather unlikely or minor compared to educational effects.

training and/or cultural background to account for the different results of the Tilburg- and Frankfurt-experiment. Altogether this shows that conclusion (i) is well-supported by our experimental results.

Especially conclusion (iii) will make it clear that a behavioral theory of risky choices will be strongly influenced by the psychological literature concerning such choices. In our view, many psychological theories lend themselves in a straightforward way to an explanation of our results. If, for example, a participant has chosen the suboptimal choice in the pre-experimental questionnaire he may repeat this choice in the experiment purely from an ego-defensive attitude to appear consistent. This combination of axiomatic approaches, psychological theory and experimental research should help us in the future to better understand people's decision making.

Appendix A

Instructions of Experiment A, Choice Pair A_1

Code No._____

Please take off the attached card which contains your code number. You need it to collect your earnings.

Instructions

Thank you for participating in our experiment. You have the chance of winning a monetary prize of: hfl 50

If you do not win this monetary prize, you receive no payment at all. Whether you receive this prize or not depends on the option that you choose and the actions taken by the selector. The selector is one of your fellow students. He has been appointed by chance.
You have two options with different implications for your prospects of winning this monetary prize:

If you choose *option XX*, you will win your monetary prize if out of an urn containing 100 balls of which 25 are green and 75 are black the selector randomly selects a green ball.

If you choose *option YY* instead, you will win your monetary prize in case of the following two events:

Firstly, the selector must randomly select a red ball out of an urn containing 20 balls of which 15 are red and 5 are blue.

Secondly, i.e. only in case that a red ball has been selected in this way, the selector must randomly select a green ball out of an urn containing 100 balls of which 35 are green and 65 are black.

....

Please, decide now by indicating appropriately:

I choose

option *XX*
option *YY*

Hand in this form immediately after deciding, but keep the attached card containing your code number.

Instructions of Experiment A, Choice Pair A_2

Code No.______

Please take off the attached card which contains your code number. You need it to collect your earnings.

Instructions

Thank you for participating in our experiment. You have the chance of winning a monetary prize of: hfl 50

If you do not win this monetary prize, you receive no payment at all. Whether you receive this prize or not depends on the option that you choose and the actions taken by the selector. The selector is one of your fellow students. He has been appointed by chance.

You have two options with different implications for your prospects of winning this monetary prize:

If you choose *option XX*, you will win your monetary prize if out of an urn containing 100 balls of which 25 are green and 75 are black the selector randomly selects a green ball.

If you choose *option YY* instead, you will win your monetary prize in case of the following two events:

Firstly, the selector must randomly select a red ball out of an urn containing 20 balls of which 15 are red and 5 are blue.

Secondly, i.e. only in case that a red ball has been selected in this way, the selector must randomly select a green ball out of an urn containing 100 balls of which 40 are green and 60 are black.

....

Please, decide now by indicating appropriately:

I choose:

option *XX*
option *YY*

Hand in this form immediately after deciding, but keep the attached card containing your code number.

Appendix B

Instructions of Experiment A, Choice Pair B_1

Code No.______

Please take off the attached card which contains your code number. You need it to collect your earnings.

Instructions

Thank you for participating in our experiment. You have the chance of winning a monetary prize of: hfl 25

If you do not win this monetary prize, you receive no payment at all. Whether you receive this prize or not depends on the option that you choose and the actions taken by the selector. The selector is one of your fellow students. He has been appointed by chance.

You have two options with different implications for your prospects of winning this monetary prize:

If you choose *option XX*, you will win your monetary prize if out of an urn containing 100 balls of which 48 are green, 42 are black, and 10 are white, the selector randomly selects a green ball.

If you choose option *YY* instead, you will win your monetary prize according to the following rules:

Firstly, the selector randomly selects between an urn__ and an urn__ by tossing a fair coin.

In case that urn__ has been selected in this way, the selector must randomly select a green ball out of urn__ containing 100 balls of which 10 are green and 90 are black. If urn__ has been selected, a green ball must be chosen out of urn__ containing 100 balls of which 90 are green and 10 are black.

....

Please, decide now by indicating appropriately:

I choose

option *XX*
option *YY*

Hand in this form immediately after deciding, but keep the attached card containing your code number.

Instructions of Experiment B, Choice Pair B_2

Code No.______

Please take off the attached card which contains your code number. You need it to collect your earnings.

Instructions

Thank you for participating in our experiment. You have the chance of winning a monetary prize of: hfl 25

If you do not win this monetary prize, you receive no payment at all. Whether you receive this prize or not depends on the option that you choose and the actions taken by the selector. The selector is one of your fellow students. He has been appointed by chance.

You have two options with different implications for your prospects of winning this monetary prize:

If you choose *option XX*, you will win your monetary prize if out of an urn containing 100 balls of which 40 are green, 50 are black, and 10 are white, the selector randomly selects a green ball.

If you choose *option YY* instead, you will win your monetary prize according to the following rules:

Firstly, the selector randomly selects between an urn__ and an urn__ by tossing a fair coin.

In case that urn__ has been selected in this way, the selector must randomly select a green ball out of urn__ containing 100 balls of which 10 are green and 90 are black. If urn__ has been selected, a green ball must be chosen out of urn__ containing 100 balls of which 90 are green and 10 are black.

....

Please, decide now by indicating appropriately:

I choose

option *XX*
option *YY*

Hand in this form immediately after deciding, but keep the attached card containing your code number.

Appendix C

Postexperimental questionnaire, C1

The answers of the following questions do not influence your earnings as long as you answer them completely. If you do not fill in this questionnaire, we, unfortunately, have to exclude you from the experiment.

Assume an urn containing 100 balls of which 25 are blue and 75 are yellow. Which of the following options would you choose?

According to this option you would win hfl 80 in case a blue ball is randomly drawn whereas you would only win hfl 8 in case of a yellow ball.

According to this option you would win hfl 88 in case a blue ball is randomly drawn whereas you would only win nothing in case of a yellow ball.

According to this option you would win hfl 20 regardless whether a blue or a yellow ball is randomly drawn.

I prefer __

Please, try to briefly indicate your reasons for your decision:

....

....

Appendix C: Postexperimental Questionnaire, C2

Please, indicate for the two different choice problems below whether you would prefer option __ or option __:

(1) In case of option__ you win a monetary prize of hfl 50 if out of an urn containing 100 balls of which 25 are green and 75 are black, the selector randomly selects a green ball.

In case of option __ you win the same monetary prize of hfl 50 only in case of the following two events:

Firstly, the selector must randomly select a red ball out of an urn containing 20 balls of which 15 are red and 5 are blue.

Secondly, i.e. only in case that a red ball has been selected in this way, the selector must randomly select a green ball out of an urn containing 100 balls of which 35 are green and 65 are black.

I prefer __

(2) In case of option__ you win a monetary prize of hfl 50 if out of an urn containing 100 balls of which 25 are green and 75 are black, the selector randomly selects a green ball.

In case of option __ you win the same monetary prize of hfl 50 only in case of the following two events:

Firstly, the selector must randomly select a red ball out of an urn containing 20 balls of which 15 are red and 5 are blue.

Secondly, i.e. only in case that a red ball has been selected in this way, the selector must randomly select a green ball out of an urn containing 100 balls of which 40 are green and 60 are black.

I prefer __

Please, try to briefly indicate your reasons for your decision:

....

....

Postexperimental Questionnaire, C3

Please, indicate for the two different choice problems below whether you would prefer option __ or option __:

(1) In case of option you win a monetary prize of f 25 if out of an urn containing 100 balls of which 48 are green and 42 are black, and 10 are white, the selector randomly selects a green ball.

In case of option __ you win the same monetary prize of hfl 25 according to the following rules:

Firstly, the selector randomly selects between an urn__ and an urn__ by tossing a fair coin.

In case that urn __ has been selected in this way, the selector must randomly select a green ball out of urn __ containing 100 balls of which 10 are green and 90 are black. If urn __ has been selected, a green ball must be chosen out of urn __ containing 100 balls of which 90 are green and 10 are black.

I prefer __

(2) In case of option __ you win a monetary prize of hfl 25 if out of an urn containing 100 balls of which 40 are green and 50 are black, and 10 are white, the selector randomly selects a green ball.

In case of option you win the same monetary prize of hfl 25 according to the following rules:

Firstly, the selector randomly selects between an urn __ and an urn __ by tossing a fair coin.

In case that urn __ has been selected in this way, the selector must randomly select a green ball out of urn __ containing 100 balls of which 10 are green and 90 are black. If urn __ has been selected, a green ball must be chosen out of urn__ containing 100 balls of which 90 are green and 10 are black.

I prefer __

Please, try to briefly indicate your reasons for your decision:

....

....

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