JENA ECONOMIC RESEARCH PAPERS

2010 – 004

Preference towards Control in Risk Taking: Control, No Control, or Randomize?

by

Li King King

www.jenecon.de

ISSN 1864-7057

The JENA ECONOMIC RESEARCH PAPERS is a joint publication of the Friedrich Schiller University and the Max Planck Institute of Economics, Jena, Germany. For editorial correspondence please contact markus.pasche@uni-jena.de.

Impressum:

Friedrich Schiller University Jena
Carl-Zeiss-Str. 3
D-07743 Jena
www.uni-jena.de

Max Planck Institute of Economics
Kahlaische Str. 10
D-07745 Jena
www.econ.mpg.de

Jena Economic Research Papers 2010 - 004

Preference towards Control in Risk Taking: Control, No Control, or Randomize?

Li King King*

Aug 2010

Abstract

This paper experimentally investigates preference towards different methods of control in risk taking. Participants are asked to choose between different ways for choosing which numbers to bet on for a gamble. They can choose the numbers themselves (control), let the experimenter choose (no control), or randomize. It is found that in addition to the more conventional preference for control, some participants prefer not to control, or randomization. These preferences are robust as participants are willing to pay a small amount of money to implement their preferred method. Most of the participants believe that the winning probability under different methods is the same. Thus, their preferences are not driven by bias in probability belief such as those induced by illusion of control. Participants tend to invest less in the risky gamble when they are not offered their preferred method.

Keywords: Preference towards control, illusion of control, preference for randomization

JEL Codes: C91, D81

* Strategic Interaction Group, Max Planck Institute of Economics, Kahlaische Straße 10 D-07745 Jena, Germany; Tel: +49 3641 686 631; Fax: +49 3641 686 667; Email: Kingli@econ.mpg.de. I thank Syngjoo Choi, Jean-Philippe Lefort, Toru Suzuki, Chew Soo Hong, and especially Gary Charness for helpful comments and discussions.

1. Introduction

Standard economic theories assume that choice under risk can be completely described by consequences and the underlying probability. Individuals are assumed to be consequentialists who only care about the consequences of an event but not the underlying procedure. Little research has been done to understand individuals' preferences on the procedures generating the outcomes. This paper fills the gap in the literature by experimentally investigating if individuals have preference over procedures in risk taking that differ in degree of control but have the same probability distribution. Three types of preference towards control are investigated, namely preference for control, preference for no control, and preference for randomization. We study if these preferences affect risk taking behavior (e.g., will individuals reduce investment in risky assets when they are not offered their preferred method of control?). We also investigate the reasons behind such preference to understand if they are mainly driven by preference or bias in probability belief such as illusion of control.

In a hypothetical game, Langer (1975) finds that individuals have a higher valuation of lottery tickets if they can choose their own numbers than when they are assigned random numbers. The author attributes the difference in valuation to illusion of control, which refers to the belief that the probability of winning is higher when one can choose the numbers oneself. This observation represents a challenge for the validity of the expected utility theory (von Neumann & Morgenstern, 1944), which predicts that an individual should be indifferent between these methods because the probabilities of winning are objectively the same. However, it is also possible that individuals prefer to choose their own numbers because of source preference (Abdellaoui, Baillon, Placido, & Wakker, 2009; Chew & Sagi, 2008; Tversky & Wakker, 1995) rather than illusion of control. More specifically, an individual is said to exhibit source preference if she prefers one source of uncertainty (e.g., choosing numbers herself) to another (e.g., numbers randomly generated by the computer), even when she believes the probability of winning is equally likely.

On the other hand, some individuals may exhibit preference for no control (e.g., let others to choose the numbers) even when they believe the probability of winning is the same. Again, for these individuals, their preference seems more compatible with source preference rather than the

expected utility theory (von Neumann & Morgenstern, 1944) or a subjective belief in probability (subjective expected utility theory (Savage, 1954)). Furthermore, some individuals may strictly prefer to randomize between different methods of control, which is a puzzle for decision theory as it violates both the independence and the betweenness axiom assumed by expected utility theory and most non-expected utility theories.

To the best of our knowledge, there is no existing study which shows that some economic agents prefer not to control the process or have preference for randomization, instead of the more conventional preference for control. Charness and Gneezy (2010) is the most closely related experimental study. The authors investigate if individuals exhibit illusion of control and if such illusion influences the level of investment in a risky gamble. In their experiment, subjects need to decide how much to invest in a risky asset whose payoff will be contingent on the outcome of a dice roll. They use different treatments dependent on who rolls the dice: (1) subject rolls, (2) experimenter rolls, (3) freedom to choose whether subject or experimenter, (4) subjects need to pay a small amount of money if they want to roll the dice themselves. The authors find that subjects do exhibit illusion of control (prefer to roll the dice themselves), while such illusion does not influence the level of investments. However, they assume that the fact that subjects prefer to roll the dice is due to illusion of control. Since they do not elicit subjects' probability belief, it remains unclear if individuals prefer to control because of illusion of control or source preference.

One possible reason for the "no difference" result of Charness and Gneezy (2010) is that they are averaging across two different groups of subjects: those who prefer to control and those who prefer not to control. More specifically, in their "subject rolls" treatment individuals who prefer to control will invest more, but those preferring to let the experimenter roll will invest less. On the other hand, in the "experimenter rolls" treatment, individuals who prefer not to control will invest higher amounts. Hence, a comparison across treatments not conditional on preference may not reveal much difference. In fact, in our experiment analyzing the investment level conditional on the preferences of subjects, we show that illusion of control does affect investment levels.

We elicit subjects' probability belief on the winning probability towards different methods of control and can thus discriminate between the following theories for explaining preference towards control: expected utility (von Neumann & Morgenstern, 1944), subjective expected

utility (Savage, 1954), source preference (Abdellaoui, et al., 2009; Chew & Sagi, 2008; Tversky & Wakker, 1995), and illusion of control (Langer, 1975).

This paper makes four contributions. First, we show that individuals exhibit three different types of preference towards control: preference for control, preference for no control, and preference for randomization. These preferences are quite robust in the sense that some individuals are willing to pay a small amount of money to use their preferred method of control. We also find that individuals tend to invest more under their preferred method of control, implying that they are less risk averse when using their preferred method.

Second, we propose and identify two forms of preference for randomization which violates the independence and the betweenness axiom.

Third, we show that for most individuals preference towards control is not driven by bias in probability belief. In particular, their preference towards control is not due to bias in probability belief such as illusion of control as they hold the belief that the winning probability remains the same when they have less control.

Fourth, we find that gender and religious belief are important determinants of preference towards control. When it is costless to choose between the methods, females prefer to control more than males. Religious individuals are more likely to prefer the randomized method.

The rest of the paper is organized as follows. Sections 2 to 4 present the experimental design and the results. Section 5 discusses the overall analysis, the findings on gender differences, and the influence of religiousness on preference towards control. Section 6 concludes.

2. Experiment 1: Control vs. No Control

Overview and Method

To test the hypothesis that individuals have preference towards control, we designed a set of experiments, in which subjects are endowed with 10,000 points (1,000 points = 0.5 euro) each, are asked how much they will allocate to a risky gamble, and are required to choose between two different methods of control when picking three numbers to bet on. The outcome of the gamble depends on which ball is drawn from an urn that contains 10 balls numbered from 1 to 10.

Participants win 2.5 times of the amount bet if the ball drawn is one of the three numbers chosen. In experiment 1a, subjects are free to choose between picking their own numbers or let the experimenter choose them; in experiment 1b, subjects need to pay 0.1 euro if they want to pick their own numbers; in experiment 1c, subjects need to pay 0.1 euro if they want to let the experimenter choose the numbers; in experiment 1d, investments under both methods are elicited using strategy method.

A total of 295 subjects participated in experiment 1, experiment 2, and experiment 3. All subjects were university students from Jena, Germany; they were randomly recruited from a poll of approximately 2,500 subjects using an e-mail recruitment system. The number of subjects in each treatment ranged from 28 to 30. Each subject participated only in one of the sessions. These were conducted in German and took place in a laboratory, where subjects were randomly seated in partitioned cubicles. Subjects were informed that their lotteries would be implemented privately and they would receive their payment privately at the end of the experiment. Each session lasted about 40 minutes. Subjects received a show-up fee of 2.5 euro.

Experiment 1a: Free to Choose

Method

Twenty-eight subjects participated in this experiment, in which each subject was free to choose between picking the numbers himself or let the experimenter pick them. After the experiment subjects filled in a questionnaire on how much they would invest under the other, non-chosen method.

Results

Figure 1 (panel a) shows that 19 out of 28 subjects (67.9 percent) chose to pick their own numbers. If subjects were indifferent, we should expect to observe 50 percent choosing either method. The binomial test shows the proportion of subjects choosing to pick the numbers themselves differs significantly from the random prediction, p-value = 0.04 (one-tailed test). It is also found that conditional on preferring to choose their own numbers, subjects invested 4,157.9 points under this method and would invest only 3,342.1 points if the numbers were chosen by the experimenter, and the difference is significant with p-value equal to 0.04. On the other hand, there is no significant difference for those preferring to let the experimenter choose.

Experiment 1b: Pay to Gain Control

In this experiment, we investigate whether subjects are willing to pay a small fee to have more control.

Method

Thirty subjects participated in this experiment, in which each subject chose between picking the numbers herself, costing 0.1 euro, or let the experimenter pick the numbers (free). After the experiment, subjects filled in a questionnaire on how much they would invest under the other non-chosen method, and on probability belief, gender, and religious beliefs.

Results

Nine out of the 30 subjects chose to pay 0.1 euro to have more control, see Figure 1a. Thus, the result suggests that preference for control is quite strong, and individuals are willing to pay a small fee to gain more control. Of the nine subjects, only one believed that choosing his own numbers would lead to a higher chance of winning. In fact, the remaining 29 subjects held the belief that the probability of winning was the same under the two methods. This suggests that for most individuals, their preference for control is not due to illusion of control, but by source preference.

Experiment 1c: Pay to Lose Control

Method

Thirty subjects participated in this experiment, in which each subject chose between picking the numbers himself (free) or let experimenter pick them (costing 0.1 euro). After the experiment, subjects filled in a questionnaire on how much they would invest under the other, non-chosen method, and on probability belief, gender, and religious beliefs.

Results

Seven out of 30 subjects chose to pay 0.1 euro to use the method involving less control, see Figure b. These seven subjects believed the probabilities of winning under the two methods were identical. Thus, their choices cannot be explained by subjective probability belief and are more compatible with the source preference hypothesis. Of the 23 subjects preferring to pick the numbers themselves, only one held the belief that there was a higher chance of winning.

Experiment 1d: Strategy Method

In experiments 1a to 1c, the investment amounts under the less preferred method were elicited by a non-incentivized questionnaire. To test the robustness of the finding, we employed the incentivized strategy method to elicit subjects' investment decision under both methods.

Method

Fifty-nine subjects participated in this experiment, in which each subject specified the investment amount when he chose the numbers versus when the experimenter chose them. Then a dice would be randomly rolled to determine which method to implement. After the experiment, subjects filled in a questionnaire on their preference ordering of the two methods, and on probability belief, gender, and religious beliefs.

Results

If we compare the investment amount across the two methods, there is no significant difference. However, if the comparison is made conditional on preference, it is found that those who preferred to control on average invested 13.5 percent less when the experimenter picked the numbers, p-value = 0.04 (one-tailed). Two outliers were not included in the analysis, one invested 700 percent more and another 93.33 percent more when experimenter chose the numbers. Eighteen subjects (30.6 percent) indicated in the questionnaire that they preferred to pick the numbers themselves, while 4 preferred to let the experimenter pick them, and 37 subjects were indifferent. Only two subjects believed that choosing the numbers themselves had a higher chance of winning, while all others believed the winning probability under the two methods was the same.

3. Experiment 2: Control vs. No Control vs. Randomization

Overview and Method

The objective of experiment 2 was to study preference for randomization. We conducted a set of three experiments, in which subjects are asked to choose between the three methods of control, method 1: picking the numbers themselves, method 2: let the experimenter pick them, or method

3: randomize between the two methods. If the randomized method is chosen, subjects first decide how much they will invest under methods 1 and 2, a dice will then be rolled to determine which method to implement. If the number rolled is 4 or above, method 1 will be implemented. If the number rolled is 3 or below, method 2 will be implemented. For all methods, if the ball drawn is one of the three numbers chosen, the subject wins 2.5 times the amount bet, losing the amount otherwise.

In experiment 2a, subjects could freely choose between the three methods; in experiment 2b, subjects needed to pay 0.1 euro if they wanted to pick their own numbers or let the experimenter pick them; in experiment 2c, subjects needed to pay 0.1 euro if they wanted to use the randomized method.

Preference for Randomization

Preference for randomization is a puzzle for decision theory as it violates both the independence and the betweenness axiom assumed by expected utility theory and most non-expected utility theories.

Weak Form of Preference for Randomization

Denote s as the lottery in which the subject chooses the numbers, e as the lottery in which the experimenter chooses the numbers. A decision maker is said to exhibit a *weak form* of preference for randomization if he is indifferent between s and e, but strictly prefers a mixture of s and e, implemented by a *random device* in which s will be implemented with probability p and e will be implemented with probability$1-p$, $p \in (0,1)$. That is, $ps + (1-p)e \succ s \sim e$. The preference relation is denoted $\sim$ and $s \sim e$ means that the decision maker is indifferent between s and e. The preference relation is denoted $\succ$ and $s \succ e$ means that the decision maker strictly prefers s to e.

Note that the preference violates the independence axiom. The preference ordering $\succsim$ satisfies independence if: $a \succsim b$ iff $pa + (1-p)c \succsim pb + (1-p)c, \forall p \in [0,1]$ where a, b, c are members of a possible choice set, X.

Strong Form of Preference for Randomization

A decision maker exhibits the *strong form* of preference for randomization if he prefers *s* to *e*, but strictly prefers a mixture of *s* and *e*, implemented by a random device, i.e., $ps + (1-p)e \succ s \succ e$. Similarly, the logic also applies to the case where $e \succ s$, i.e., $ps + (1-p)e \succ e \succ s$.

Note that the preference violates both the independence and the betweenness axiom. The preference ordering $\succsim$ satisfies betweenness if: $a \succ b \Rightarrow pa + (1-p)b \succ b$ and $\sim b \Rightarrow pa + (1-p)b \sim b$.

In the existing literature, preference of randomization is defined in relation to uncertainty aversion, in which probabilities of some lotteries are unknown (see Eichberger & Kelsey, 1996; Schmeidler, 1989) and which is thus different from the definition offered above. We denote PR-z as referring to preference for randomization defined in the existing literature. There are two different approaches to modeling PR-z: the Savage approach and Anscombe-Aumann approach (Anscombe & Aumann, 1963). In the Savage approach, ambiguity averse subjects have no preference for randomization (Eichberger & Kelsey, 1996). In the latter approach, Schmeidler (1989) shows that ambiguity averse subjects do have preference for randomization.

To the best of our knowledge, there is no empirical evidence which clearly shows that some individuals have preference for randomization over probabilistically identical lotteries and some individuals are willing to pay a small amount of money to use the randomized method. Dominiak and Schnedler (2009) experimentally investigate the relationship between preference for randomization (PR-z) and uncertainty aversion. Their main finding is that there is no significant relationship between these two attitudes. One important difference between Dominiak and Schnedler's (2009) and our study is that we focus on investigating preference for randomization when probability is known, while they focus on the case where some probabilities (of the lotteries associated with the Ellsberg urn in their experiment) are unknown.

Experiment 2a. Free to Choose

Method

Thirty subjects participated in this experiment, in which each subject was asked to choose between the three methods of control and specified the investment amount under the chosen method. After the experiment, subjects filled in a questionnaire on how much they would invest

under method 1 or method 2 for those who did not choose the randomized method, and on probability belief, gender, and religious beliefs.

Results

Nineteen subjects chose to pick their own numbers (method 1) and 11 subjects chose the randomized method, see Figure 1c. This supports our hypothesis that individuals have preference for randomization. Eight subjects exhibited the weak form of preference for randomization and 3 exhibited the strong form. Only two subjects believed method 1 had a higher chance of winning and chose it.

Experiment 2b. Pay to Gain Control or Lose Control

Method

The design is identical with experiment 2a except that subjects now needed to pay 0.1 euro for using method 1 or method 2. Twenty-nine subjects participated in this experiment.

Results

When methods 1 and 2 become costly, there are more subjects choosing the randomized method. Twenty-five subjects chose method 3, with 5 of them exhibiting the weak form of preference for randomization and 2 the strong form. Three subjects chose method 1, and one subject chose method 2. One subject believed there was a higher probability of winning under method 1.

Experiment 2c. Pay to Randomize

Method

The design is identical with experiment 2a except that subjects now needed to pay 0.1 euro for using the randomized method. Thirty subjects participated in the experiment.

Results

When the randomized method is costly, the percentage of subjects choosing this method does not drop to zero. Instead, we observed 13.3 percent of subjects willing to pay 0.1 euro to use this method, see Figure 1c. All subjects, except two subjects who chose method 1, believed the winning probability was identical under method 1 and method 2.

4. Experiment 3: Comparative vs. Non-Comparative Context

The third set of experiments was conducted to investigate if preference towards control influences the investment amount when subjects are only aware of one method of control when making their investment decision.

Method

Thirty subjects participated in experiment 3a, in which they decided on the investment amount and picked their own numbers. In experiment 3b, 28 subjects decided on the investment amount and the experimenter would pick the numbers. After the experiments, subjects filled in a questionnaire on their preference for picking their own numbers versus the experimenter picking the numbers, and also on how much they would invest if the experimenter picked the numbers (in experiment 3a) and if they picked their own numbers (in experiment 3b).

Results

If we compare the investment amounts observed in experiment 3b with those observed in experiment 1d committed under the condition that the numbers would be chosen by the experimenter, it is found that the average investment amount in experiment 3b is significantly higher than the average investment amount in experiment 1d (experimenter chose condition), *p*-value = 0.04 (excluding four outliers who invested 10,000 points). This suggests that the difference in investment amount under different methods of control is induced by comparative context. On the other hand, there are no significant differences between experiment 3a and experiment 1d (subjects chose condition).

5. Overall Analysis

Preference for Control and Illusion of Control

Only 10 (4.8 percent) out of 208 subjects (experiment 1b to experiment 2c, in which probability beliefs are elicited) believe that the probability of winning is higher when the numbers are chosen by themselves. However, 9 out of these 10 subjects prefer to control. Thus, it appears that

subjects holding such belief are more likely to exhibit illusion of control. Interestingly, these subjects on average invested 3,244.4 points when they chose their own numbers versus 2,300 points when the experimenter chose the numbers. The difference is significant at the 1 percent level. This suggests that illusion of control does affect the investment amount.

As for the remaining 198 subjects, 93 of them prefer to control. Thus, most subjects preferring to control are not driven by illusion of control. For subjects who prefer to have less control, none thinks that to let the experimenter choose will lead to a higher winning probability.

In summary, analyzing the information on probability belief, we find that for most subjects preference towards control is not driven by probability belief. Our findings suggest that the source preference theory (Chew & Sagi, 2006, 2008) better explains the majority of subjects' preference for control than the illusion of control theory (Langer, 1975), expected utility theory (Savage, 1954), and subjective expected utility (von Neumann & Morgenstern, 1944).

Preference for Control and Investment Amount

Pooling the observations from all experiments and comparing the investment amounts, we find that subjects preferring to control on average invested 10.3 percent less when the experimenter chose the numbers. The difference in investment amount is significant at the 1 percent level, suggesting that those preferring to control will invest significantly less under the less controlling method.

Preference for No Control and Investment Amount

For the group preferring not to control we find that they on average invested 1.7 percent less when they had to pick their own numbers. The finding is weakly significant with p-value = 0.10 (one-tailed).

Gender Differences

We also find that females are more likely to exhibit preference for control. In experiment 1d, we found that females were more likely to prefer picking their own numbers than males. Forty-two percent (16 out of 38 subjects) of females preferred to pick their own numbers while only 9.5 percent (2 out of 21 subjects) of male showed this preference. The difference in proportion is significant at the 1 percent level. However, in experiment 2b when it becomes costly to have

control, a higher proportion of male than female subjects chose to pick their own numbers. The difference in proportion is significant with *p*-value = 0.08 (one-tailed).

On the other hand, females are also less likely to exhibit preference for randomization. In experiment 2a, 58.3 percent of male subjects (7 out of 12 subjects) chose the randomized option while only 22.2 percent (4 out of 18 subjects) of females did so. The difference in proportion is significant at the 5 percent level.

In addition, females appear to reduce their investment amount more strongly than males when they have to let the experimenter pick the numbers while they prefer to pick their own numbers. In experiment 1a, conditional on preferring to control, females on average reduced their investment amount by 28.1 percent when the experimenter chose the numbers (significantly different from zero with *p*-value equal to 0.02), which is higher than the 6.25 percent observed for males (not significantly different from zero). The difference is significant with *p*-value equal to 0.09. If we pool the observations with percentage change in investment less than 100 percent (three outliers are excluded) across all experiments, we find that conditional on choosing to control, females on average invested 13.7 percent less when the experimenter picked the numbers, with males on average investing 5.2 percent less in this case. The difference is significant with p-value equal to 0.05 (one-tailed).

Finally, we find that females tend to invest lower amounts than males. For example, in experiment 1d, in which participants could choose the numbers, males on average invested 4,310 points, which is higher than the 2,677.24 points for females, and the difference is significant, *p*-value = 0.03. When the experimenter chose the numbers, males invested 4,429.05 points, which is higher than the 2,609.21 points observed with females. The difference is significant with *p*-value = 0.02. If we make the comparison with observations where subjects chose to pick the numbers or let the experimenter pick them, the gender difference is still significant at the 5 percent level. These results agree with the finding in the existing literature that females tend to be more risk averse (see Croson & Gneezy, 2009, for an extensive literature review).

Religiousness Difference

We find that more religious subjects are also more likely to prefer the less controlling method (let the experimenter choose). Subjects with high religiosity are those who pray more than once a

day, once daily, a couple of times a week, once a week, or less than once a week. Subjects with low religiosity are those who never pray. In experiment 1d, we found that 21.4 percent of subjects in the high religiosity group preferred not to control, which is higher than the 2.7 percent observed in the low religiosity group. The difference in proportion is significant with *p*-value equal to 0.03.

6. Discussion

Standard economic theories assume that choices under risks can be completely described by consequences and the underlying probability. Individuals are assumed to be consequentialists who only care about the consequences of an event but not the underlying procedure. Using laboratory experiments, we show that individuals have preference over procedures in risk taking that differ in degree of control but generate the same probability distribution.

Three types of preference towards control are found: preference for control, preference for no control, and preference for randomization. These preferences are quite strong, and some individuals are willing to spend a small amount of money to use their preferred method of control. Moreover, preference towards control appears to influence the investment decision, and individuals tend to invest lower amounts (i.e., are more risk averse) when they are not offered their preferred method of control.

We find that most subjects' preferences are not driven by bias in probability belief. In particular, most subjects believe that the probability of winning is identical when they choose numbers themselves or the experimenter chooses the numbers. This result contributes to the literature by clarifying that for most individuals who exhibit preference for control, their preference is not due to illusion of control. Thus, the illusion of control (Langer, 1975), expected utility theory (von Neumann & Morgenstern, 1944), and subjective expected utility theory (Savage, 1954) cannot explain a majority of individuals' choice of control versus no control. It appears that the source preference (Chew & Sagi, 2008) theory can explain these preferences better. Our experiment also reports evidences of preference for randomization.

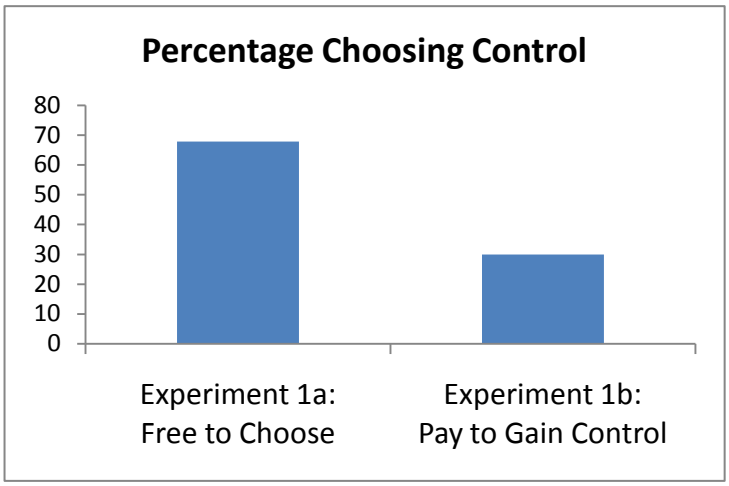
Moreover, we show that gender and religious belief are important determinants of preference towards control. We find that females are more likely to prefer to control when free to do so. But

when it is costly, males are more likely to pay the price. On the other hand, more religious individuals are also more likely to exhibit preference for no control.

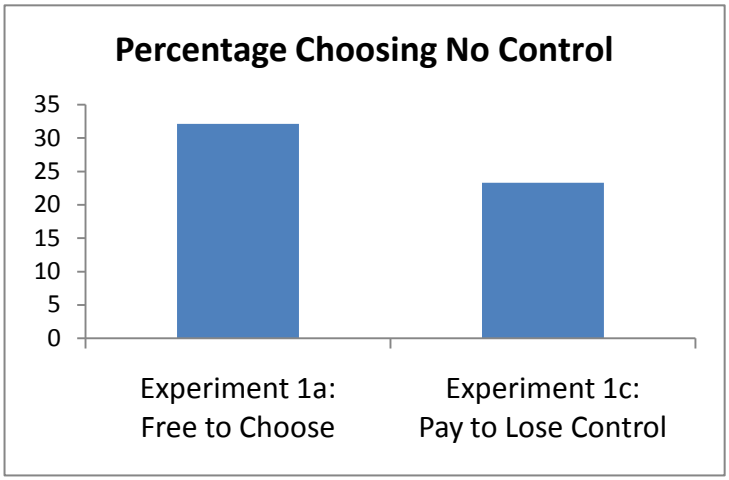
Several questions may be may be worth pursuing in the future. First, it will be interesting to test the implications of preference towards control in market behaviors. For example, firms may increase sales by offering consumers more control. Strategies such as providing a dominated product as a choice may increase consumers' willingness to pay for the more preferred product. Second, it will be intriguing to investigate preference towards control in a context involving social preferences. One example is Machina's Mom problem (Machina, 1989). In this example, the mom has one daughter, one son, but only one candy. The mom is indifferent between giving the candy to either son or daughter but strictly prefers to use a coin to randomly determine who will receive the candy. In this context, the mom may prefer to flip the coin because she thinks it is a fair procedure. The finding on the strong form of preference for randomization in this paper suggests that the mom may prefer to use a coin to decide who will get the candy even when she strictly prefers the son (or the daughter) to get it.

Figure 1: Preference towards Control

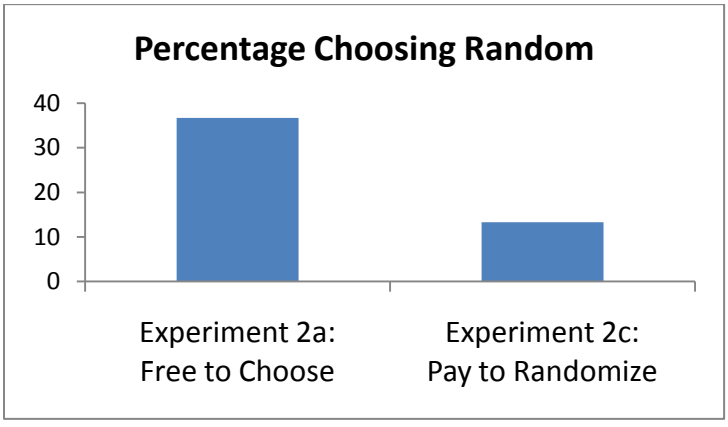
Panel 1a.



Panel 1b.



Panel 1c.



References

Abdellaoui, M., Baillon, A., Placido, L., & Wakker, P. (2009). The rich domain of uncertainty. *American Economic Review*(forthcoming).

Anscombe, F., & Aumann, R. J. (1963). A definition of subjective probability. *Annals of Mathematical Statistics, 34*(1), 199-205.

Charness, G., & Gneezy, U. (2010). Portfolio Choice and Risk Attitudes. *Economic Inquiry, 48*(1), 133-146.

Chew, S. H., & Sagi, J. S. (2006). Event exchangeability: Probabilistic sophistication without continuity or monotonicity. *Econometrica, 74*(3), 771-786.

Chew, S. H., & Sagi, J. S. (2008). Small worlds: Modeling attitudes toward sources of uncertainty. *Journal of Economic Theory, 139*(1), 1-24.

Croson, R., & Gneezy, U. (2009). Gender differences in preferences. *Journal of Economic Literature, 47*(2), 448-474.

Dominiak, A., & Schnedler, W. (2009). Attitudes towards Uncertainty and Randomization: An Experimental Study. *Working Paper*.

Eichberger, J., & Kelsey, D. (1996). Uncertainty aversion and preference for randomisation. *Journal of Economic Theory, 71*(1), 31-43.

Langer, E. J. (1975). The illusion of control. *Journal of Personality and Social Psychology, 32*(2), 311-328.

Machina, M. J. (1989). Dynamic Consistency and Non-Expected Utility Models of Choice Under Uncertainty. *Journal of Economic Literature, XXVII*(December), 1622-1668.

Savage, L. J. (1954). *The Foundations of Statistics*. New York: Wiley.

Schmeidler, D. (1989). Subjective probability and expected utility without additivity. *Econometrica, 57*(3), 571-587.

Tversky, A., & Wakker, P. (1995). Risk attitudes and decision weights. *Econometrica, 63*(6), 1255-1280.

von Neumann, J., & Morgenstern, O. (1944). *Theory of Games and Economic Behavior*. New York: Princeton University Press.

Appendix: Instructions

The experiment was conducted in German language, and the original instructions were also in German (available upon request).The treatment titles were not shown in the original instructions.

Instructions *(experiment 1a)*

Welcome to our experimental study on decision-making. The experiment will take about 30 minutes. Each participant will receive a show up fee of 2.5 Euro at the end of the experiment. In addition, each participant will have the chance to earn more money according to the instructions below.

You are endowed with 10000 points (1000 points = 0.5 Euro). You can choose to invest any point between 0 and 10,000 on **one** of the following two possibilities (but not both).

Possibility I. You choose the numbers

There is an urn which contains 10 balls that are numbered from 1 to 10. You will be asked to choose 3 numbers from 1 to 10. Then, the experimenter will randomly draw a ball from the urn in front of you. You will win 2.5 points for every point invested if the ball drawn belongs to one of the numbers you chose, otherwise you loss the points invested.

Possibility II. Experimenter chooses the numbers

There is an urn which contains 10 balls that are numbered from 1 to 10. The experimenter will choose 3 numbers for you and distribute the numbers to you after you choose your investment level. Then, the experimenter will randomly draw a ball from the urn in front of you. You will win 2.5 points for every point invested if the ball drawn belongs to one of 3 numbers you have, otherwise you loss the points invested.

You will be paid in cash for the points you have at the end of the experiment.

If you win, your payoff will be equal to

$$10000 + 2.5x$$

where x is the number of points invested.

If you lose, your payoff will be equal to

10000 – x

You will be paid in cash for each point you have at the end of the experiment.
We now ask you to indicate your decision.

I wish to choose possibility I / II.

Please proceed to A in below if you choose possibility I.

Please proceed to B in below if you choose possibility II.

A. Possibility I. You choose the numbers

I wish to invest ____ points.

I would like to choose the following 3 numbers (please mark).

1	2	3	4	5
6	7	8	9	10

B. Possibility II. Experimenter chooses the numbers

I wish to invest____ points.

Instructions *(experiment 1b)*

Welcome to our experimental study on decision-making. The experiment will take about 30 minutes. Each participant will receive a show up fee of 2.5 Euro at the end of the experiment. In addition, each participant will have the chance to earn more money according to the instructions below.

You are endowed with 10000 points (1000 points = 0.5 Euro). You can invest any point between 0 and 10,000 using investment method I or II. However, if you use choose to use method I, you need to pay 0.1 Euro (deduct from your show up fee).

Method I. You choose the numbers
There is an urn which contains 10 balls that are numbered from 1 to 10. You will be asked to choose 3 numbers from 1 to 10. Then, the experimenter will randomly draw a ball from the urn

in front of you. You will win 2.5 points for every point invested if the ball drawn belongs to one of the numbers you chose, otherwise you loss the points invested.

Method II. Experimenter chooses the numbers
There is an urn which contains 10 balls that are numbered from 1 to 10. The experimenter will choose 3 numbers for you and distribute the numbers to you after you choose your investment level. Then, the experimenter will randomly draw a ball from the urn in front of you. You will win 2.5 points for every point invested if the ball drawn belongs to one of 3 numbers you have, otherwise you loss the points invested.

If you win, your payoff will be equal to

$$10000 + 2.5x$$

where x is the number of points invested.

If you lose, your payoff will be equal to

$$10000 – x$$

You will be paid in cash for each point you have at the end of the experiment.

Your Decisions:

I choose Method I / Method II (please circle).

The decision sheets for method I and method II are put inside two separate envelopes, labeled I and II. Please open the envelopes and write down your decisions. After that, please put back the decision sheet to the corresponding envelope.

Instructions *(experiment 1c)*

Same as instruction in EXPERIMENT 1B, but participants need to pay 0.1 Euro for using method II, and using method I is free.

Instructions *(experiment 1d)*

Welcome to our experimental study on decision-making. The experiment will take about 30 minutes. Each participant will receive a show up fee of 2.5 Euro at the end of the experiment. In addition, each participant will have the chance to earn more money according to the instructions below.

You are endowed with 10000 points (1000 points = 0.5 Euro). You can invest any point between 0 and 10,000 on each of the following two possibilities, yet **only one** of them will be implemented. After we collect your decisions for each possibility, the experimenter will roll a

dice and possibility I will be implemented if the number is greater than or equal to 4. Possibility II will be implemented if the number is equal or smaller than 3.

Possibility I. You choose the numbers
There is an urn which contains 10 balls that are numbered from 1 to 10. You will be asked to choose 3 numbers from 1 to 10. Then, the experimenter will randomly draw a ball from the urn in front of you. You will win 2.5 points for every point invested if the ball drawn belongs to one of the numbers you chose, otherwise you loss the points invested.

Possibility II. Experimenter chooses the numbers
There is an urn which contains 10 balls that are numbered from 1 to 10. The experimenter will choose 3 numbers for you and distribute the numbers to you after you choose your investment level. Then, the experimenter will randomly draw a ball from the urn in front of you. You will win 2.5 points for every point invested if the ball drawn belongs to one of 3 numbers you have, otherwise you loss the points invested.

If you win, your payoff will be equal to

$$10000 + 2.5x$$

where x is the number of points invested.

If you lose, your payoff will be equal to

$$10000 – x$$

You will be paid in cash for each point you have at the end of the experiment.

We now ask you to indicate your decision for each possibility
The decision sheets for possibility I and possibility II are put inside two separate envelopes, labeled I and II. Please open the envelopes and write down your decisions. After that, please put back the decision sheet to the corresponding envelope.

Possibility I. You choose the numbers

I wish to invest ____ points if the numbers are chosen by myself.

I would like to choose the following 3 numbers (please mark).

1	2	3	4	5
6	7	8	9	10

Possibility II. Experimenter chooses the numbers

I wish to invest____ points if the numbers are chosen by the experimenter.

Instructions *(experiment 2a)*

Welcome to our experimental study on decision-making. The experiment will take about 30 minutes. Each participant will receive a show up fee of 2.5 Euro at the end of the experiment. In addition, each participant will have the chance to earn more money according to the instructions below.

You are endowed with 10000 points (1000 points = 0.5 Euro). You can invest any point between 0 and 10,000, using either method A or method B. You need to choose which method to use. Both methods are explained in below.

Method A

There are two possibilities, yet **only one** of them will be randomly implemented. After we collect your decisions for each possibility, the experimenter will roll a dice and possibility I will be implemented if the number is greater than or equal to 4. Possibility II will be implemented if the number is equal or smaller than 3.

Possibility I. You choose the numbers

There is an urn which contains 10 balls that are numbered from 1 to 10. You will be asked to choose 3 numbers from 1 to 10. Then, the experimenter will randomly draw a ball from the urn in front of you. You will win 2.5 points for every point invested if the ball drawn belongs to one of the numbers you chose, otherwise you loss the points invested.

Possibility II. Experimenter chooses the numbers

There is an urn which contains 10 balls that are numbered from 1 to 10. The experimenter will choose 3 numbers for you and distribute the numbers to you after you choose your investment level. Then, the experimenter will randomly draw a ball from the urn in front of you. You will win 2.5 points for every point invested if the ball drawn belongs to one of 3 numbers you have, otherwise you loss the points invested.

If you win, your payoff will be equal to

$$10000 + 2.5x$$

where x is the number of points invested.

If you lose, your payoff will be equal to

$$10000 - x$$

You will be paid in cash for each point you have at the end of the experiment.

Method B
The rule is the same as method A except that now you can choose your favorite method (i.e., you choose the three numbers or let the experimenter chooses).

Summary
In summary, in method A, we will randomly determine whether you or the experimenter will choose the numbers. In method B, you can choose your favorite way of investing.

Your Decisions:

I choose Method A / Method B (please circle).

The decision sheets for method A and method B are put in three different envelopes.

If you have chosen to use method A, please note that the decision sheets for Method A possibility I and possibility II are put inside two separate envelopes, labeled AI and AII. You need to fill-in for possibility I and possibility II.

If you have chosen to use method B, the decision sheet for Method B is put inside the envelope labeled B.

Please open the corresponding envelopes for your chosen method and write down your decisions. After that, please put back the decision sheet to the corresponding envelope.

Method A

Possibility I. You choose the numbers

I wish to invest ____ points if the numbers are chosen by myself.

I would like to choose the following 3 numbers (please mark).

1	2	3	4	5
6	7	8	9	10

Method A
Possibility II. Experimenter chooses the numbers

I wish to invest____ points if the numbers are chosen by the experimenter.

Method B

Please circle your choice:

1. I wish to choose the numbers by myself.
2. I wish to let the experimenter to choose the numbers.

If you have chosen to choose the numbers by yourself, please choose the investment amount and choose the 3 numbers now (please mark).

I wish to invest ____ points.
I would like to choose the following 3 numbers (please mark).

1	2	3	4	5
6	7	8	9	10

If you have chosen to let the experimenter to choose the numbers, please choose the investment amount.
I wish to invest____ points.

Instructions *(experiment 2b)*

Same as instruction in T5, but participants need to pay 0.1 Euro for using method B, and using method A is free.

Instructions *(experiment 2c)*

Same as instruction in EXPERIMENT 2A, but participants need to pay 0.1 Euro for using method A, and using method B is free.

Questionnaire *(experiment 1a, for players who have chosen possibility I)*

Thanks for your participation. Now we have one more question for you. Please answer it carefully. Your answer will **not** influence your final payoff.

Now, suppose the **experimenter** will choose the numbers for you, how many points will you invest?
I will invest ____ points out of 10000 points.

Questionnaire *(experiment 1a, for players who have chosen possibility II)*

Thanks for your participation. Now we have one more question for you. Please answer it carefully. Your answer will **not** influence your final payoff.

Now, suppose **you** will choose the numbers yourself, how many points will you invest?

I will invest ____ points out of 10000 points.

Questionnaire *(experiment 1d)*

Thanks for your participation. Now we have some questions for you. Please answer them carefully. Your answers will **not** influence your final payoff.

Q1. Do you prefer to choose the three numbers by yourself or by experimenter? (Circle one)

1. I prefer to choose the numbers by myself.
2. I prefer to let the experimenter to choose the numbers for me.
3. I am indifferent.

Q2. Which of the following is the right description of your thinking on probability of winning? (Circle one)

1. I believe the probability of wining is higher if I can choose the numbers by myself.
2. I believe the probability of winning is higher when the experimenter chooses the numbers for me.
3. I think there are no differences in winning probability between choosing the numbers by myself or let the experimenter to choose the numbers for me.

Q3. What is your gender?

1. Male
2. Female

Q4. What is your age?

I am ____years old.

Q5. And what about your religious background? Thinking about the present, how often do you pray?

1. More than once a day
2. Once daily
3. A couple of times a week
4. Once a week
5. Less than once a week

6. Never

Questionnaire ***(experiment 1b, for players who have chosen method I)***

Identical as experiment 1d, except that Q1 is modified as follows:

Q1. Now, suppose the **experimenter** will choose the numbers for you (and you need to pay 0.1 Euro for using this method), how many points will you invest?

I will invest ____ points out of 10000 points.

Questionnaire ***(experiment 1b, for players who have chosen method II)***

Identical as experiment 1d, except that Q1 is modified as follows:

Q1. Now, suppose **you** will choose the numbers for yourself (and there is no charge on using this method), how many points will you invest?

I will invest ____ points out of 10000 points.

Questionnaire ***(experiment 1c, for players who have chosen method I)***

Identical as experiment 1d, except that Q1 is modified as follows:

Q1. Now, suppose the **experimenter** will choose the numbers for you (and there is no charge on using this method), how many points will you invest?

I will invest ____ points out of 10000 points.

Questionnaire ***(experiment 1c, for players who have chosen method II)***

Identical as experiment 1d, except that Q1 is modified as follows:

Q1. Now, suppose **you** will choose the numbers for you (and you need to pay 0.1 Euro for using this method), how many points will you invest?

I will invest ____ points out of 10000 points.

Questionnaire ***(experiment 2a, for players who have chosen method A)***

Identical as experiment 1d, except that Q1 is modified as follows:

Q1. Suppose you can only choose between choosing the three numbers by yourself or by experimenter (i.e., without method A), what is your preference? (Circle one)

1. I prefer to choose the numbers by myself.
2. I prefer to let the experimenter to choose the numbers for me.
3. I am indifferent.

Questionnaire ***(experiment 2a, for players who have chosen method B and choose the numbers by himself)***

Identical as experiment 1d, except that Q1 is modified as follows:

Q1. Now, suppose the **experimenter** will choose the numbers for you, how many points will you invest?

I will invest ____ points out of 10000 points.

Questionnaire ***(experiment 2a, for players who have chosen method B and let the experimenter to choose the numbers)***

Identical as experiment 1d, except that Q1 is modified as follows:

Q1. Now, suppose **you** will choose the numbers yourself, how many points will you invest?

I will invest ____ points out of 10000 points.

Questionnaire ***(experiment 2b, for players who have chosen method A)***

Identical as experiment 1d, except that Q1and Q2 is modified as follows, Q3 to Q6 is identical to Q2 to Q5 in experiment 1d.

Q1. Suppose you can only choose between choosing the three numbers by yourself or by experimenter (i.e., without method A and there is no charge), what is your preference? (Circle one)

1. I prefer to choose the numbers by myself.
2. I prefer to let the experimenter to choose the numbers for me.
3. I am indifferent.

Q2. Suppose there is no charge for using method B, which method will you choose? (Circle one)

1. I prefer to use method A.
2. I prefer to use method B.
3. I am indifferent.

Questionnaire ***(experiment 2b, for players who have chosen method B and choose the numbers by himself)***

Identical as experiment 1d, except that Q1 is modified as follows:

Q1. Now, suppose the **experimenter** will choose the numbers for you, how many points will you invest?

I will invest ____ points out of 10000 points.

Questionnaire ***(experiment 2b, for players who have chosen method B and let the experimenter to choose the numbers)***

Identical as experiment 1d, except that Q1 is modified as follows:

Q1. Now, suppose **you** will choose the numbers yourself, how many points will you invest?

I will invest ____ points out of 10000 points.

Questionnaire ***(experiment 2c, for players who have chosen method A)***

Identical as experiment 1d, except that Q1 is modified as follows:

Q1. Suppose you can only choose between choosing the three numbers by yourself or by experimenter (i.e., without method A and there is no charge), what is your preference? (Circle one)

1. I prefer to choose the numbers by myself.
2. I prefer to let the experimenter to choose the numbers for me.
3. I am indifferent.

Questionnaire ***(experiment 2c, for players who have chosen method B and choose the numbers by himself)***

Identical as experiment 1d, except that Q1 is modified as follows:

Q1. Now, suppose the **experimenter** will choose the numbers for you, how many points will you invest?

I will invest ____ points out of 10000 points.

Questionnaire ***(experiment 2c, for players who have chosen method B and let the experimenter to choose the numbers)***

Identical as experiment 1d, except that Q1 is modified as follows:

Q1. Now, suppose **you** will choose the numbers yourself, how many points will you invest?

I will invest ____ points out of 10000 points.