Printed by Hunts Printing, 3 Kings Meadow, Osney Mead, Oxford OX2 0DP
Tel: 01865 253700 Fax: 01865 253701 email: print@hunts.co.uk www.hunts.co.uk

VOLUME 21, No 1
Spring 2001

GREEK ECONOMIC REVIEW

CONTENTS

Published by the
SOCIETY FOR ECONOMIC RESEARCH

Each volume comprises two issues, with occasional Supplements on specific themes.

The subscription rate (including ordinary postage) is £35 per volume. Cheques should be made payable to the *Greek Economic Review* and send directly to the *Greek Economic Review*, Brasenose College, Oxford OX1 4AJ, U.K.

GREEK ECONOMIC REVIEW

VOLUME 21 | NUMBER 1 | SPRING 2001

Editor: Anthony S. Courakis

CONTENTS

GREEK ECONOMIC REVIEW, Vol. 21, No. 1, Spring 2001, pp. 37-51

SITUATIONAL DETERMINANTS OF RISK-TAKING IN A LOTTERY RACE GAME

By Daniel John Zizzo*

I. INTRODUCTION

This paper presents a novel experimental setting, which I call a Lottery Race Game, to test some situational determinants of risk-taking behavior that have been neglected by most economists. How does the situation a subject is in affect her willingness to take risks? Some shifts in risk-taking behavior might be explainable purely in terms of the strategic incentives characterizing the decision problem. Others, however, may require a deeper study of how the game is being 'categorized', i.e. perceived and represented by the decision-maker. For example, it is possible that the behavior of subjects may change according to whether they reach a target level - the *aspiration level* in Selten's (1996) and Palomino and Vega-Rodondo's (1999) terminology - or whether they do not. The aspiration level may also be determined relative to a reference group, i.e. a set of similar items (Kahneman and Varey, 1991). Both of these situational effects are discussed below, and constitute object of experimental investigation in this paper.

While our focus is on situational effects, it is important to recognize that a variety of other factors may affect decision under uncertainty. Substantial variability in risk-taking behavior is due to intrinsic heterogeneity of preferences among people: economic theory has traditionally been able to model this heterogeneity pretty straightforwardly - for example, with different degrees of curvature of the utility functions. The role of wealth has also been considered: it is usually thought that absolute risk aversion decreases with wealth (e.g., Deaton and Muellbauer, 1980). At least in empirical work by experimental economists, somewhat less attention has been paid to how the way subjects perceive the decision problem affects their risk-taking behavior (the 'categorization' of the decision problem). The obvious exception which has received plenty of attention is the difference in behavior when risks are framed in terms of gains relative to when they are framed in terms of losses: this has been one of the motivations behind prospect theory, which considers subjects risk averse in the domain of losses but risk loving in that of gains[1] (Kahneman and Tversky, 1979; Tversky and Kahneman, 1992).

According to prospect theory, there are two phases in the choice process: 'editing' and 'evaluation'. Editing consists in a preliminary analysis and simplification of the decision problem: it is the way in which, in prospect theory, the categorization of the

*Thanks to Liz Beaumont-Bissell for experimental assistance, to Anthony Courakis for his patience and encouragement as Editor of this Review and to Michael Bacharach, Lola Lopes, Matthew Mulford, Andrew Oswald, Jennifer Reinganum and an anonymous referee for help, advice or encouragement at various stages of this project. The usual disclaimer applies. Financial support from the George Webb Medley Fund, Oxford University, is gratefully acknowledged.

1. Prospect theory has been generalized to choice under certainty under the label of reference-dependent utility (Tversky and Kahneman, 1991), for which some potential support has recently been found using neurobiological evidence (Zizzo, forthcoming A).

decision problem occurs. Evaluation consists in choosing the edited prospect of highest value. One aspect of editing is that prospects are coded relative to a reference point, which is usually considered the *status quo* (hence the name 'loss aversion' assigned by Shafir and Tversky, 1995, to risk-loving in the domain of losses). However, Kahneman and Tversky (1979, p. 274) also note that 'the location of the reference point... can be affected by the formulation of the offered prospects, and by the expectations of the decision maker'. In other words, they admit the possibility of situational effects not dependent just on whether an outcome may be considered a gain or a loss relative to the initial wealth.

Lopes (1987) and Lopes and Oden (1999) make this more specific by explicitly adding an aspiration level term to a standard weighted utility term similar to that in Tversky and Kahneman (1992). Calling α the aspiration level, for any given lottery outcome ν the aspiration level term A takes the form:

$$A = \acute{\rho}(\nu \geq \alpha) \quad (1)$$

In other words, A is determined by the probability ρ that ν is at least as large as α: extra weight is given to the desirability of outcomes above the aspiration level. Hence Lopes and Oden introduce a distinction between a reference level interpreted as *status quo* wealth, and an aspiration level that may be dependent on different situational effects[2].

In this paper we consider an experiment where four subjects are asked to bet repeatedly, while being informed about the scores of the other players. As already hinted above, we hypothesize the existence of two situational effects. First, the aspiration level may depend and adapt according to experience (Selten, 1996; Palomino and Vega-Rodondo, 1999). For example, Palomino and Vega-Rodondo (1999) discuss an evolutionary model of the Prisoner's Dilemma in which agents have an 'aspiration level' of payoff: those who do not achieve it switch actions at a rate increasing in the magnitude of the gap between actual payoff and current aspiration level. Intuitively, this is related to the Win-Stay-Loss-Shift strategy that Nowak and Sigmund (1993) found as being more successful than Tit-for-Tat[3] (Axelrod, 1984). We hypothesize that previous experience may affect the aspiration level: in other words, the aspiration level is assumed to be *history-dependent*. We shall label this *the history-dependence effect.*

Second, we hypothesize that the aspiration level is dependent on the scores of the other players. This is because they constitute a reference group in relation to which the aspiration level is determined. This could be given a purely cognitive interpretation: Kahneman and Varey (1991) discuss how people often tend to evaluate things in comparison to related experienced others; for example, a face in a photo may be considered as virtually neutral when standing on its own but, when seen after a photo with a strongly emotional face, be evaluated as displaying a contrasting emotion (Russell and Fehr, 1987). The dependence of the aspiration level on a reference group could also be

2. For some specific evidence for Lopes and Oden's (1999) theory, see Lopes and Schneider (1986) and Schneider and Lopes (1986).

3. TFT is the strategy for which, in the iterated Prisoner's Dilemma, the player cooperates in the first round, and then does whatever the opponent has done in the previous round. Instead, the WSLS strategy player replicates whatever was successful in the previous move, while she switches strategy if she was unsuccessful.

related to the body of evidence on interdependent preferences: assume that people have interdependent preferences, i.e. they care not only about their own material payoff, but also positively or negatively about that of other people (say, because of altruism, envy or fairness). Among others, Bolton and Ockenfels (2000), Fehr and Schmidt (1999) and Levine (1998) show that interdependent preferences can explain a substantial body of experimental evidence from games as diverse as ultimatum and market games[4]. We hypothesize that, either because of the relative coding of experience or because of relative utility effects (or both), economic agents that get behind relative to their reference group are going to be more risk-seeking[5]. This can be thought in terms of a prospect theory model where the reference level is not just a proxy for *status quo* wealth, and with convex preferences below this reference level. It can also be thought, more explicitly but also perhaps less familiarly for many economists, in terms of Lopes and Oden's (1999) aspiration level: as we saw, their utility function puts an extra prize for achieving the aspiration level. We shall label this *the relativity effect.*

There is only sparse experimental evidence in studies on decision under uncertainty in relation to the situational effects considered in this paper. It is known that subjects that lose in a series of consecutive bets tend to make riskier choices (Morgan, 1983). In an experiment without monetary incentives, Lopes and Schneider (1986) showed that attempts at manipulating the adaptation level produced shifts in risk-taking behavior. Lopes and Casey (1994) did use some monetary rewards and suggested that some of their experimental subjects playing a gambling game in pairs might be motivated not simply by doing better, but by doing better relative to others. Zizzo (1997, 1998) described a small-scale paper-and-pencil betting game experiment that is the ancestor of the Lottery Race Game of this paper, and which also gave very preliminary evidence on the situational impact of interdependent preferences on risk-taking.

The Lottery Race Game experiment presented in this paper tests the power of the history-dependence effect and the relativity effect. Sections II and III describe the experiment and the results, respectively. Section IV concludes and draws methodological and policy implications.

II. THE EXPERIMENT

II.1 Description and Design

The experiment was conducted in Oxford between July 23 and August 1, 1998. The Lottery Race Game was part of a larger experiment, which involved a further stage (for details, see Zizzo, 2000). 32 sessions of 4 subjects were planned, but for no show-ups and technical reasons, five sessions were run with three subjects. An extra session was run in the condition most penalized by these problems. Therefore, the final number of sessions

4. There is also other evidence for interdependent preferences: reviews can be found in Zizzo (1998, 2000) and Zizzo and Oswald (forthcoming), where it is also shown that it is unclear that rational choice models of interdependent preferences are actually adequate to explain the data.

5. See Brenner (1987) for a relative utility model that achieves this result under definite conditions.

was 33, and the sample size was of 127 subjects. Subjects were mostly students (including graduates). The mean age of the participants was 24.39, with a S.D. of 4.77 years; the minimum was 17 (one case), the maximum was 41. Subjects could participate for one session only, and were not told anything in advance about the stage after the Lottery Race Game.

The experimental currency was the 'doblon'. Each doblon was convertible at the end of the experiment in U.K. pounds at the rate of 0.6 pence for doblon. Subjects were paid three pounds plus the gains from the experiment, if any. Excluding the 3 pounds for participation, the average gains at the end of the Lottery Race Game were 5.49 pounds in the Prize condition and 8.22 pounds in the Non Prize condition (the Prize manipulation will be described below).

The practice stage plus the Lottery Race Game took 20-25 minutes, according to the speed of the participants (the overall experiment was about 45 minutes long). Every effort was made to ensure anonymity among players. The possibility of two subjects knowing each other was minimized in a variety of ways (for example, undergraduates from the same Oxford college were not paired). Subjects were seated as soon as they arrived, and screens prevented view among them. A player number (1, 2, 3 or 4) corresponded to each seat, and seats were assigned according to the alphabetical order of the participants.

The experiment started with a practice stage, and continued with the Lottery Race Game.

Practice Stage. In each of the ten rounds of the practice stage, players received 100 doblons, and had to choose how much of the 100 doblons to bet (i.e., a number between 0 and 100). The computer then randomly generated a number between 1 and 3. If a 1 was drawn, subjects kept the original amount and gained twice the amount they had bet. If a 2 or 3 were drawn, they lost the amount they had bet. The screen reported the cumulative score of the subject after each round, i.e. the amount he had gained so far. No information on the scores of the other players was reported. The amounts gained in the practice stage did not count towards final actual gains, and this was common knowledge.

Lottery Race Game. The Lottery Race Game was identical to the practice stage except for two things: 1) the scores of *all* players (labelled as 1, 2, 3 and, if any, 4) were displayed on each screen and updated at the end of each of the ten rounds; 2) there was an experimental manipulation affecting the way money was distributed. In half of the sessions - the Prize (P) condition - all subjects were assigned 100 doblons per round, but they were also told that the top two earners at the end of the ten rounds[6] would receive a prize of 30% of their current earnings + 500 doblons. In the other half of the sessions - the Non Prize (nP) condition -, subjects 1 and 2[7] received (and could bet up to) 130 doblons each round rather than the 100 of the other players, and this was common knowledge. Technically speaking, these sessions were not games (in the sense that they did not involve strategic interaction among players) unless subjects had interdependent preferences.

In the experiment, it was straightforward to measure whether a choice was less or more risky. The more the proportion of doblons out of the amount (100 or 130 doblons) received each round, the more risky the decision was. We shall call such proportion 'bet ratio'. Rank was measured by assigning an ordinal value of 1 to the subject with the highest score, 2 to the subject with the 2nd highest score and so on. Two measures were devised according to the treatment given to the five sessions with three subjects. According to one measure (Rank1), a value of 2 was given to the top ranked, 3 to the 2nd ranked and 4 again to the 3rd ranked; according to Rank2, in these sessions a value of 1 was given to the top ranked, 2.5 to the 2nd rank, and 4 to the 3rd. For both measures, a *positive* correlation between the rank measure and average bet ratio would indicate a *negative* correlation between rank and risk-taking behavior, and vice versa.

6. Only the top earner in sessions with three subjects.
7. Only player 1 in sessions with only three subjects.

II.2 Situational Hypotheses and Design

We can now relate the history dependence and relativity effect hypotheses to the experimental design.

History-dependence effect. Subjects play the practice stage before playing the Lottery Race Game. They are aware that the practice stage is only for practice and not for real money, unlike the following stages, and so that they will start off the Lottery Race Game with zero doblons, not their score at the end of the practice stage. However, if the history-dependence hypothesis is correct, we would expect that the score at the end of the practice stage may change the risk-taking behavior of the subjects in the Lottery Race Game, by affecting their aspiration level: a higher score in the practice stage will lead to a higher aspiration level. If this hypothesis were correct, we would expect a positive correlation between final score in the practice stage and risk-taking in the Lottery Race Game. Note that this is a prediction on the relation between practice stage and Lottery Race Game, rather than on the dynamic evolution of the Lottery Race Game: this is because from one round to the following during the race itself the effects of changes in wealth and those in aspiration level are confounded together, whereas this is not the case in moving from the practice stage to the Lottery Race Game.

Relativity effect. The main prediction we are making is that subjects that get behind relative to their reference group will bet more. This should apply not only to the P but also to the nP condition, i.e. even regardless of any prize for actually getting first or second. Two auxiliary predictions can also be made. First, we would expect a negative correlation between winning one round and betting the following round for both conditions (see Morgan, 1983). Second, in the nP condition, where half of the subjects earn 130 doblons, the scores of the other subjects will be higher on average. It follows that we would expect a higher aspiration level and, therefore, greater betting than in the P condition. This last result is rather counterintuitive, for it is in the P and not in the nP condition that there is a monetary prize for arriving first or second: it follows that we would expect greater risk-taking in the P condition as a typical result of winner-take-all markets, where prizes induce an over-investment in the strategic variable that increases the probability of getting the prizes (Frank and Cook, 1995). Therefore, the prediction that, if anything, we would expect more betting in the nP rather than in the P condition is a particularly stringent test of the hypothesis of relativity effects.

Finally, one has to acknowledge that any observed correlational results between rank and betting may be confounded and distorted by the type of individual-specific risk attitudes held by the subjects. For example, it is a trivial albeit implausible corollary of theories based on a monotonically concave utility function in the domain of gains that we should observe subjects always prefer the sure thing, and hence bet zero, at least in the nP condition. Similarly, a monotonically convex utility function in the domain of gains should bring people to always bet all, both in the P and the nP condition.

A more plausible confounding effect arises from the likely heterogeneity in risk attitudes in the population. Assume that people have different risk attitudes. If we correlated the average bet undertaken and rank, we might then find a u-curve relationship, with higher average bet ratios for people with top and bottom ranks, since they are the ones most likely to lead to extreme ranks. We can ameliorate, though not quite solve, the problem to some extent by correlating rank one round with the average bet made on the following round (this can be done from round 2, of course, so we lose an observation per subject). This will be done in the data analysis on rank presented below. Note that, since the u-curve relation is symmetrical, if we tried to fit a linear correlation between average bet ratio and rank, we should find it insignificantly different from zero. Hence, with individual-specific effects of this kind, we should still be able to detect evidence for the relativity effect.

III. RESULTS

III.1 Situational Effects

Figure 1 shows the histogram with the density function of the average bet ratios. The data appears non-normally distributed and the usage of nonparametric tests such as the Mann-Whitney or correlation measures such as the Spearman's ρ appears warranted. Only

FIGURE 1: HISTOGRAM OF DISTRIBUTION OF AVERAGE BET RATIO IN ENTIRE SAMPLE

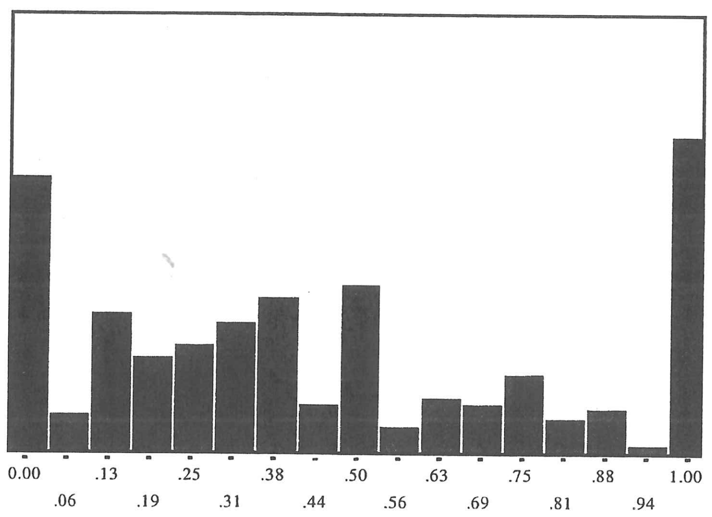
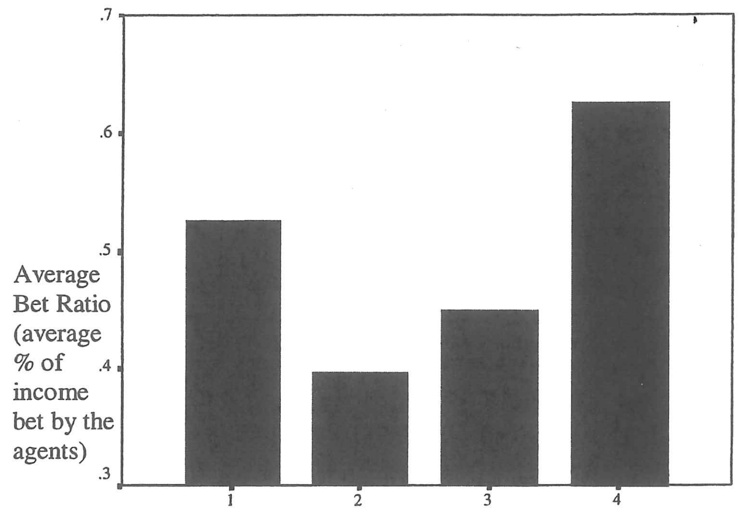
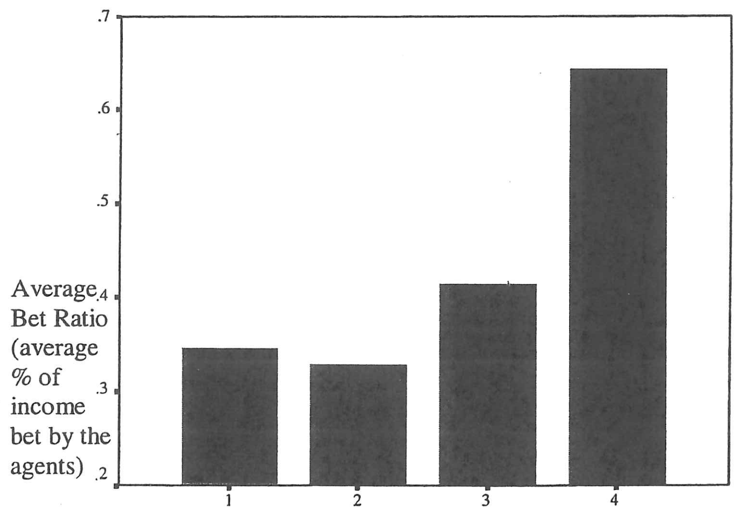


FIGURE 2: POSITION IN THE RACE AND BETTING IN THE NON PRIZE CONDITION



Relationship between rank at the start of the round and average bet ratio in the Non Prize condition (the condition *without* final prizes to the best performers in the race). Higher numbers correspond to lower ranks (in the case of the five sessions with three subjects, the highest ranked is assigned a value of 2, the second ranked 3 and the third ranked 4).

FIGURE 3: POSITION IN THE RACE AND BETTING IN THE PRIZE CONDITION



Relationship between rank at the start of the round and average bet ratio in the Prize condition (the condition *with* final prizes to the best performers in the race). Higher numbers correspond to lower ranks (in the case of the five sessions with three subjects, the highest ranked is assigned a value of 2, the second ranked 3 and the third ranked 4).

two subjects out of 127 made constantly polar decisions, one always choosing to bet 100, the other 0, so this possible source of confounding appears to have played no role in our data.

There is a significant positive correlation between score in the practice stage and average bet ratio in the Lottery Race Game. The Spearman's ρ=0.13 (P≅0% in a two-tailed test; Pearson's r=0.142, P≅0%). The higher the practice stage score , the higher the average bet ratio. The relationship can be shown to apply both to the P and the nP condition. Hence, there is evidence for the history-dependence effect.

Figures 2 and 3 show the relationship between average bet ratio and rank (using the Rank1 measure) at the end of the previous round for the nP and P conditions, respectively. Figure 2 presents a u-shape suggesting the relevance of individual-specific heterogeneity in risk attitudes; however, the u-shape is asymmetric, with greater risk-taking by bottom ranked subjects. For the nP condition, the Pearson r is 0.119, while the nonparametric equivalent, the Spearman's ρ, is 0.109 (P=0.005 and P=0.01 in two-tailed tests, respectively): since with the rank indexes a higher rank is represented by a lower number, a positive correlation here implies a negative correlation between betting and rank. The correlation is robust to the usage of Rank2 rather than Rank1. Hence, while there is some evidence for individual-specific heterogeneity, there is nevertheless evidence for the relativity effect. For the P condition, Figure 3 shows the complete lack of a u-shape relationship and, again, greater risk-taking by bottom ranked subjects. The Pearson correlation between Rank1 and average bet ratio is 0.337, the Spearman's ρ=0.3 (P≅0% in two-tailed tests in both cases).

Another prediction of the relative utility effect hypothesis is a negative correlation between having won one round and betting the following round. This prediction receives strong support: the average bet ratio for non-winners in the previous round was 52.9%, while it was only 36.58% for winners. A two-tailed Mann-Whitney test yields Z=7.359, P≅0%[8]. In the subsample of the nP condition subjects, the gap is only slightly less: 55.92% for non-winners in the previous round, 40% for winners. In a two-tailed Mann-Whitney test, Z=5.286, P≅0% (similarly with a t test).

Finally, the relative utility effect makes a prediction of greater betting in the nP than in the P condition. Figures 4 and 5 show the average bet ratio across rounds in the nP and P condition, respectively.

In both cases, there appears a large increase in average bet ratio in the first few rounds. In the nP condition, the increase is larger and is followed by a plateau at about 0.5-0.55: overall, the correlation coefficients are insignificant. In the P condition, an increase is apparent both in the first and in the last rounds: Pearson's r=0.14 (P≅0%) while Spearman's r=0.111 (P=0.005). Notwithstanding the increase also towards the end of the game, only in the last round does the average bet ratio of the P condition exceed the corresponding value in the nP condition (see Figures 4 and 5).

Overall, the average bet ratio was 43.39% in the P condition and 49.32% in the nP condition. A two-tailed t test yields t=3.028 (P=0.003); a Mann-Whitney test gives

8. A t test not assuming equality of variances (which is rejected using a Levene's test) gives t=7.747; a standard t test gives t=7.491. Either way, P≅0%.

FIGURE 4: AVERAGE BET RATIO PER ROUND IN THE NON PRIZE CONDITION

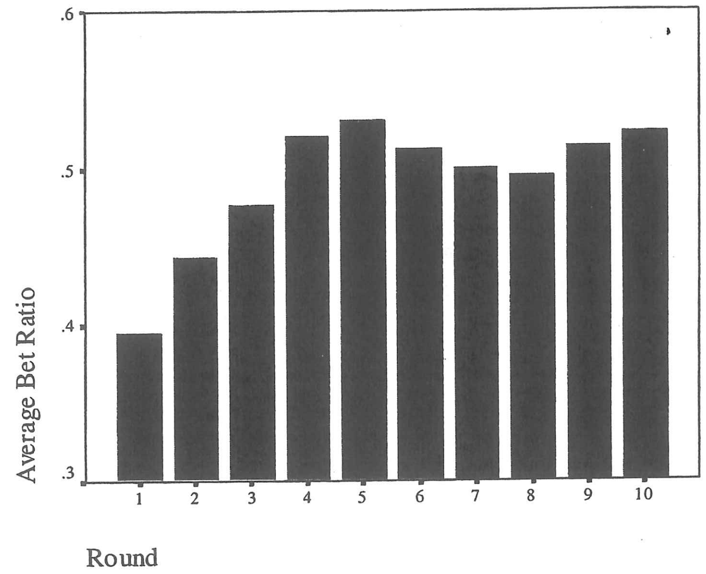
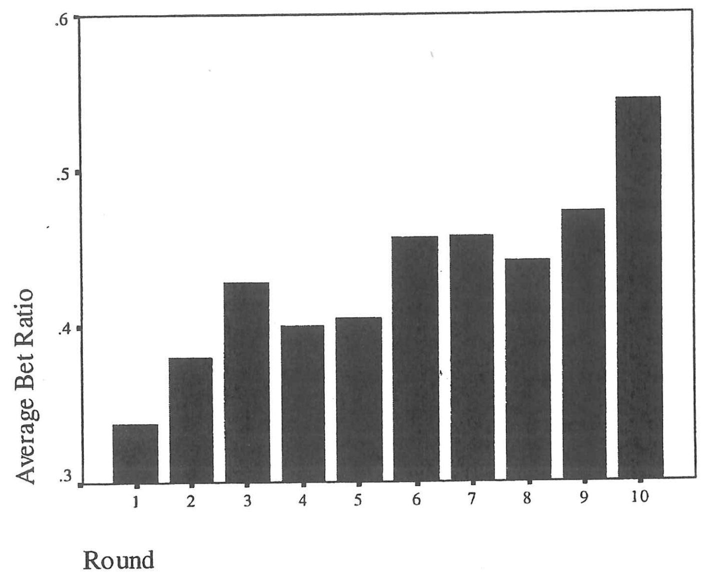


FIGURE 5: AVERAGE BET RATIO PER ROUND IN THE PRIZE CONDITION



Z=2.837 (P=0.005). Either way, there is statistically significant evidence that there was greater average risk-taking in the nP rather than the P condition. This is striking when one thinks that in the P condition a significant prize - equivalent to some 80% of the expected gains - was offered for good performance, while all that there was in the nP condition was a small discrimination between subjects receiving 100 doblons per round and subjects receiving 30% more.

Some cleaner results on what may be going on can be obtained by looking at the sample of all the subjects who gain 100 subjects each round. We can do this by removing the 31 gainers of 130 doblons per round from the sample. The average bet ratio of the 100 doblons gainers drops to 49.03% in the nP condition, vs. the 43.39% of the P condition. A two-tailed t test for the equality of means is significant (t=2.327, P=0.02), and so is a two-tailed Mann-Whitney test (Z=2.074, P=0.038). So it appears that, even among subjects gaining on average the same amount per round, being in an nP condition brings about greater risk-taking.

III.2 Other Results

How to interpret the statistically significant positive correlation between round and betting in the P condition? One possible interpretation might be that a wealth effect is at work, since we would expect richer subjects to be more risk-loving. However, wealth effects would predict a positive correlation between rank and average bet ratio, and a positive correlation between winning a round and betting the following round: as we saw in the previous section, the reverse correlations were actually obtained. Moreover, 130 doblons gainers in the nP condition do not appear to bet more, as they should given that they are wealthier on average. This negative evidence suggests that wealth effects are unlikely to play a meaningful role in our data.

This is even truer because there is at least one another potential explanation of the positive time trend in betting in the P condition. It might be ascribable to a strategic effect to capture the prize: this is what occurs with tied competitors in a patent race setting, both in theory (Harris and Vickers, 1987) and in practice (Zizzo, forthcoming B). Since the Lottery Race Game is only loosely related to the Harris and Vickers (1987) model, this is obviously just a conjecture, though potentially an attractive one. The strategic incentives in the P condition might also explain the greater size of the negative correlation between rank and betting relative to the nP condition (compare Figure 1 and 2). However, as we discussed earlier, they would also predict greater betting in the P than in the nP condition: our opposite result testifies to the strength of the relativity effect.

IV. CONCLUSIONS

This paper presents data from a Lottery Race Game showing that significant shifts in risk attitudes occur as the result of situational factors. More specifically, we found that risk-taking behavior is *history-dependent* and *relative*. It is dependent on the past betting history regardless of wealth effect considerations; it is also relative to the score of the

other players in own's own reference group, regardless of whether there is a financial incentive to get first or second that might lead to strategic behavior. Subjects falling behind tended to bet more; there was a negative correlation between winning one round and amount bet in the following round; subjects bet more when there was not than when there was a prize, since the reference group was made by richer people on average in the condition without a prize. Subjects also took more risk when they had had a good practice score. There is some evidence for individual-specific differences in risk attitude and for some strategic behavior in the condition with a prize for the best performer(s) at the end of the race; there is no unequivocal evidence for wealth effects, and virtually none for a monotonically concave or convex utility function.

Taken together, this evidence suggests that risk preferences may be more context-sensitive than it is usually thought. We can interpret the results either by assuming that the reference level in prospect theory (Kahneman and Tversky, 1979) is dependent on situational factors such as history-dependence and relativity; or, alternatively, by using the concept of aspiration level (e.g., Lopes and Oden, 1999; Selten, 1996; Palomino and Vega-Rodondo, 1998) and assuming that the aspiration level is what is dependent on the reference level. The evidence suggests that the way the decision problem at hand is categorized might matter substantially in determining risk-taking behavior.

These findings imply both good news and bad news. The bad news is for economists trying to measure risk attitude in a decision task or setting and wanting to use this measure in a different task or setting: a poor fit may be due not only to measurement error but also to the differences between the two settings, leading (say) to a different determination of the aspiration level. The good news is for policy-makers or professional betting, lottery or insurance companies, who may want to try - and to some extent may succeed - to alter risk-taking behavior by modifying the way the decision is perceived in specific settings. For example, some advertising campaigns by Camelot for the U.K. National Lottery might be interpreted as systematically targeted at raising the aspiration level, i.e. to induce to take a chance 'to become a millionaire'. Obviously those who believe that similar lotteries work by and large as taxes placed on the less wealthy sections of the population may not consider this as good news after all.

Christ Church College, Oxford University, U.K.
Contact email: **daniel.zizzo@economics.ox.ac.uk**

REFERENCES

Axelrod, R. (1984) *The Evolution of Cooperation*, (New York: Basic Books).

Bolton, G.E. and Ockenfels, A. (2000) 'ERC: A Theory of Equity, Reciprocation and Competition', *American Economic Review*, 90: 166-193.

Brenner, R. (1987) Rivalry: *In Business, Science, Among Nations*, (Cambridge: Cambridge University Press).

Deaton, A. and Muellbauer, J. (1980) *Economics and Consumer Behavior*, (Cambridge: Cambridge University Press).

Fehr, E. and Schmidt, K. (1999) 'A Theory of Fairness, Competition, and Cooperation', Quarterly Journal of Economics, 114: 817-868.

Frank, R.H. (1985) *Choosing the Right Pond: Human Behavior and the Quest for Status*, (New York and Oxford: Oxford University Press).

Frank, R.H. and Cook P.J. (1995) *The Winner-Take-All Society*, (New York: Free Press).

Harris, C. and Vickers, J. (1987) 'Racing with Uncertainty', *Review of Economic Studies*, 54: 1-22.

Kahneman, D. and Tversky, A. (1979) 'Prospect Theory: An Analysis of Decision Under Risk', *Econometrica*, 47: 263-291.

Kahneman, D. and C. Varey (1991), 'Notes on the Psychology of Utility', in J. Elster and J. Roemer (eds.), *Interpersonal Comparisons of Well-Being*, (Cambridge: Cambridge University Press).

Levine, D.K. (1998) 'Modeling Altruism and Spitefulness in Experiments', *Review of Economic Dynamics*, 1: 593-622.

Lopes, L.L. (1987) 'Between Hope and Fear: the Psychology of Risk', *Advances in Experimental Social Psychology*, 20: 255-295.

— and Schneider, S.L. (1986), 'Risk Preference and Aspiration Level'. Manuscript, University of Wisconsin, Madison.

— and Casey, J.T. (1994) 'Tactical and Strategic Responsiveness in a Competitive Risk-Taking Game', *Acta Psychologica*, 85: 39-60.

— and Oden, G.C. (1999) 'The Role of Aspiration Level in Risky Choice: A Comparison of Cumulative Prospect Theory and SP/A Theory', *Journal of Mathematical Psychology*, 43: 286-313.

Morgan, R.L. (1983) 'Risk Preference as a Function of the Number of Wins and the Amount Won', *American Journal of Psychology*, 96: 469-475.

Nowak, M. and Sigmund, K. (1993) 'A Strategy of Win-Stay, Lose-Shift that Outperforms Tit-for-Tat in the Prisoner's Dilemma Game', *Nature*, 364: 56-58.

Palomino, F. and Vega-Rodondo F. (1999) 'Convergence of Aspiration and (Partial) Cooperation in the Prisoner's Dilemma', *International Journal of Game Theory*, 28: 465-488.

Russell, J.A. and Fehr, B. (1987) 'Relativity in the Perception of Emotion in Facial Expressions', *Journal of Experimental Psychology: General*, 116: 223-237.

Schneider, S.L. and Lopes, L.L. (1986) 'Reflection in Preferences Under Risk: Who and When May Suggest Why', *Journal of Experimental Psychology: Human Perception and Performance*, 12: 535-548.

Selten, R. (1996) 'Aspiration Adaptation Theory', Discussion Paper No. B-389, Universitat Bonn Sonderforschungsbereich 303.

Shafir, E. and Tversky, A. (1995) 'Decision Making', in E.A. Smith and D.N. Osherson (eds.), *Thinking: An Introduction to Cognitive Science*, vol. 3, (Cambridge, MA and London: MIT Press).

Tversky, A. and Kahneman, D. (1991) 'Loss Aversion in Riskless Choice: A Reference-Dependent Model', *Quarterly Journal of Economics*, 106: 1039-1061.

Tversky, A. and Kahneman, D. (1992) 'Advances in Prospect Theory: Cumulative Representation of Uncertainty', *Journal of Risk and Uncertainty*, 5: 297-323.

Zizzo, D.J. (1997) *Relativity-Sensitive Behavior in Economics: An Overview with New Experimental Evidence*, M.Phil. Economics thesis, Oxford University.

— (1998) 'If Interdependent Preferences May Depend on Cognition', in M.W. Evens (ed.), *Proceedings of the Ninth Midwest Artificial Intelligence and Cognitive Science Conference (MAICS-98)*, (Menlo Park, CA: AAAI Press).

— (2000) *Money Burning and Stealing in the Laboratory: How Conflicting Ideologies Emerge*, Discussion Paper No. 40, Department of Economics, Oxford University.

— (forthcoming A) 'Neurobiological Measurements of Cardinal Utility: Hedonimeters or Learning Algorithms?', *Social Choice and Welfare*.

— (forthcoming B) 'Racing with Uncertainty: A Patent Race Experiment', *International Journal of Industrial Organisation*.

— and Oswald, A.J. (forthcoming) 'Are People Willing to Pay to Reduce Others' Incomes?', *Annales d'Economie et de Statistique*.

APPENDIX

STAGE 1 INSTRUCTIONS

In this experiment you will use the computer to read information and make decisions.
Typically you will be asked to enter a number in one or more cells - such as that on the bottom-left corner of this screen - and to click some buttons. To input or change numbers, click the mouse pointer in the cell. You will then be able to type or erase numbers in the cell using the keyboard. Please always remember to type numbers as digits (say, 50) rather than as letters (say, fifty). You can give commands to the computer by clicking on the grey buttons at the appropriate times. Examples on the current screen are OK, Confirm, Cancel and Help. Note that only Help is currently highlighted, meaning that you can only click on Help right now (but please wait until you have read these instructions!). To press a button, click on it with the mouse pointer. Always click on Help to pass to the next screen of instructions.
IMPORTANT: please do NOT try to exit the experiment program even temporarily. Do NOT tamper with the computer in any other way (such as turning it off or removing the floppy disk). On various occasions you will be asked to click a button to check whether the other players have made their choices and the computer has made the necessary computations. Please, do NOT click the button continuously. Wait at least 10 seconds between attempts. You are NOT allowed to speak to any other participant in the experiment at any time. Further, if you need to speak to the experimenter, you should do quietly. If you have a query which the instructions are unable to solve, please raise your hand and we'll do our best to solve it - either on a piece of paper or with a low voice.
The above rules are essential for a smooth and speedy completion of the experiment. If you violate them, you may force everyone to lose much additional time, and you may be asked to leave the room and lose ALL gains AND the participation token. Thanks a lot!!!
The experiment is divided into four stages. The first stage is for practice. The second and third are the real experiment. The fourth stage is for the payment. We are going to use an experimental currency, the doblon. Your final doblon gains (except those of the practice stage) will be converted into UK pounds in the payment stage, at the rate of 0.6 pence per doblon. Unlike those earned later in the experiment, the doblons earned in the practice stage will NOT count towards your final gains and will NOT be convertible for money - the practice stage is only for practice, not to let you earn money! However, the doblons gained in the real experiment (stages 2 and 3) and which you still have by the end of stage will be converted into UK pounds in the payment stage. During the experiment

your gains may go down as well as up. However, no player's balance will ever be allowed to fall below zero.
Moreover, whatever your final doblon gains from stage 2 and 3, you will be given an additional payment of 3 pounds for participation in stage 4.

WELCOME TO THE PRACTICE STAGE!

There are 10 rounds. Each round you receive 100 doblons for practice and you can choose to bet any amount of them, i.e. you can choose to bet between 0 and 100 doblons each round. Please write your choice in the left-down box of this screen.
To go ahead with your choice, press the OK button of the main screen and then Confirm. If you are not sure about your choice, even after having pressed OK, but before having pressed Confirm, press Cancel. After having pressed OK and Confirm, the computer randomly generates a number between 1 and 3. If you get 2 or 3, you lose the money you bet. If you get a 1, you win: you keep the original amount of money you bet and gain double the amount (for ex., if you bet 100, you get 00 overall).
Example 1: Jill receives 100 doblons. She bets 50 doblons. Assume she wins. Then she retains the 50 doblons she bet (50), plus the money she did not bet (50), plus she earns 2x50=100 doblons more. So she earns a total of 200 doblons from the round. Now assume she loses. Then she is left with only the money she did not bet, that is with 50 doblons.
Example 2: Jamie receives 100 doblons. He bets 0 doblons. He wins 2x0 if a 3 is drawn, and loses 0 otherwise, so, whatever the number, he is left with 100 doblons.
Jane receives 100 doblons. She bets all of them. She wins 2x100 if a 3 is drawn, and loses 100 otherwise. So her overall winning from the round is 300 if she wins, and 0 otherwise.
Click Help to make this screen disappear and the first round start. Click Help another time to make the instructions appear again. Note: while these instructions are in view, you won't be able to take decisions.

STAGE 2 INSTRUCTIONS.

WELCOME TO STAGE 2 OF THE EXPERIMENT!!! In this stage you will play bets for real money, and this is why your score is 'restarting' from zero.
Non Prize Conditions Only: Players have been assigned a number according to the alphabetical order of their last names.
If 3 Subjects Only: Player 1 gets 130 doblons each round. Players 2 and 3 get 100 doblons each round. Each round you can bet from 0 up to the amount you receive in that round (100 or 130). Put the number of doblons you are betting in the box in the bottom-left corner of the screen.
If 4 Subjects Only: Players 1 and 2 get 130 doblons each round. Players 3 and 4 get 100 doblons each round. Each round you can bet from 0 up to the amount you receive each round (100 or 130). Put the number of doblons you are betting in the box in the bottom-left corner of the screen.

All players are given 100 doblons each round. Each round you can bet from 0 up to the amount you receive each round (100). Put the number of doblons you are betting in the box in the bottom-left corner of the screen.

Prize Conditions Only:
If 3 Subjects Only: The player who at the end of all ten rounds will have the highest overall winnings, will get a prize equal to 30% of her earnings plus an additional 500 doblons.
If 4 Subjects Only: The two players who at the end of all ten rounds will have the highest overall

winnings, will get a prize equal to 30% of their earnings plus an additional 500 doblons.
[If two (or more) players are tied for one prize, who gets the prize between them will be decided entirely randomly].

To go ahead with your choice, press the OK button and then Confirm. If you are not sure about your choice, even after having pressed OK, but before having pressed Confirm, press Cancel. You can NOT change your choice for the round after having pressed BOTH OK AND Confirm.
After having pressed OK and Confirm, the computer randomly generates a number between 1 and 3. If a 1 is drawn, you win: you keep the money you bet and earn double the amount. If you get 2 or 3, you lose the money you bet.
To pass to the next screen, press the Help button.

There are ten rounds. After having pressed Confirm, and before passing to the following round, the computer will check whether the other players have made their choices. Once everybody has made her choice, the updated winnings of each player will appear on the screen.
Example: Jill receives 100 doblons. She bets 50 doblons and wins. Therefore she retains the 50 doblons she bet (50), plus the money she did not bet (50), plus she earns 2x50=100 doblons more. So she earns a total of 200 doblons from the round. Now assume she loses. Then she is left with only the money she did not bet, that is with 50 doblons.

Non Prize Conditions Only:
In the meanwhile, Jamie receives 130 doblons. He bets 0 doblons. He wins 2x0 if a 1 is drawn, and loses 0 otherwise, so, whatever the number, he is left with 130 doblons.
Jane receives 130 doblons. She bets all of them. She wins 2x130 if a 1 is drawn, and loses 130 otherwise. So her overall winning from the round is 390 if she wins, and 0 otherwise.
Assume that Jill wins and Jane loses. Then, before passing to the following screen, on Jane's screen the new amounts, identified by number, of the other players will appear. For example, if Jamie is Player 1, it will appear that Jamie got 130 doblons more by the end of the round.

Prize Conditions Only:
If 3 Subjects Only:
In the meanwhile, Jamie bet 0 doblons and so retains his 100 doblons; Jane bets 100 doblons and loses, so she is left with 0 doblons.
Assume now that after the 10 rounds of play, Jill has 1200 doblons, Jamie 1050, and Jane 950. Then Jill wins a further prize equal to the 30% of 1200 (i.e., 360) plus 500 doblons - a total of 860 doblons.
If 4 Subjects Only:
In the meanwhile, Jay made the same bet but lost, so is left with 50 doblons; Jamie bet 0 doblons and so retains his 100 doblons; Jane bets 100 doblons and loses, so she is left with 0 doblons.
Assume now that after the 10 rounds of play, Jill has 1200 doblons, Jamie 1050, Jane 950 and Jay 800. Then Jill wins a further prize equal to the 30% of 1200 (i.e., 360) plus 500 doblons - a total of 860 doblons -, while Jamie gets a prize of 815 doblons.

Click Help to make this screen disappear; a small label reminding your income per round will appear and you'll be able to start. Click Help again to make the instructions appear again. Note: while these instructions are in view, you won't be able to take decisions.

GREEK ECONOMIC REVIEW

Contributions, editorial communications and books for review should be addressed to:

Anthony S. Courakis,
Editor,
Greek Economic Review,
Brasenose College
Oxford, OX1 4AJ,
United Kingdom

NOTES TO CONTRIBUTORS

1. All manuscripts submitted for publication must be in English. Three copies are required. They should be typed on one side of the paper only, using double spacing with wide margins, and contain the full name(s) and affiliation(s) of the author(s). All submissions must be accompanied by a separate abstract not exceeding 100 words.

2. Footnotes should be numbered in sequence throughout the text with superscript figures and collected at the end of the manuscript in the same order.

3. Reference to literature in the text should be quoted by last name of author and year, i.e. Brown (1978) or (Brown, 1978), and a page reference should be also given where necessary. If more than one publication by the same author in the same year is cited, 1978a,b, etc. should be used. The list of references should be given at the end of the manuscript in alphabetical order, and conform to the style used in the *Review*.

4. Tables and diagrams should be numbered consecutively in the text in arabic numerals and placed on separate sheets; their position should be clearly indicated in the manuscript. Tables should be clear and easy to read. Units of measurement, base periods for index numbers and sources should be clearly stated. Originals of the figures drawn in a form suitable for reproduction should be submitted if the article is accepted.

5. When mathematical expressions are used, authors are asked to follow the notation adopted in mathematical articles published in the *Greek Economic Review*. Equations should be numbered consecutively in the text on the right-hand side of the page. Where it would help referees, authors should provide supplementary mathematical workings, which will not be published.

6. Authors are responsible for the correction of galley proofs. Because of the costs and delays involved in making corrections to proofs, alterations must be kept down to a minimum. Contributors will be provided with thirty free offprints of each article; additional off-prints may be ordered at cost when proofs are returned.