LOSS AVOIDANCE AS SELECTION PRINCIPLE: EVIDENCE FROM SIMPLE STAG-HUNT GAMES[†]

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December 2004

Abstract

We investigate experimentally the conjecture that loss avoidance solves the tension in stag-hunt games for which payoff dominance and risk dominance make conflicting predictions. Contrary to received textbook wisdom, money-losing outcomes do shift behavior, albeit not strongly, toward the payoff-dominant equilibrium.

Keywords: Loss avoidance, Selection principles, Stag-hunt games, Coordination games, Experiments

JEL Classification: C72; C91; D91; D84

[†] We thank Katarina Svitkova for research assistance, Petra Brhlikova, Eugen Kovac, Michal Ostatnicky, and Martin Vojtek for helping us run the experiments, Sarka Hadravova (Czech Technical University, Prague), Jiri Hlavacek (Faculty of Social Sciences, Charles University, Prague), and Viatcheslav Vinogradov (CERGE-EI, Prague) for letting us conduct the experiments during their lectures, and Bank Austria for providing the funds. We thank Gerard Cachon, Colin Camerer, Dirk Engelmann, Jan Hanousek, Charles Holt, Stepan Jurajda, and Nat Wilcox for very helpful comments.

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1. Introduction

Game theorists have proposed a variety of principles to select among multiple equilibria in coordination games. Cachon and Camerer (1996) investigate loss avoidance, a selection principle that guides people to avoid strategies resulting in certain losses if strategies with potential gains are available. The authors report that loss avoidance helped initiate coordination on Pareto-dominating equilibria in a median effort game, but failed to have this effect in a minimum effort modification unless forward induction came to the rescue. Cachon and Camerer conclude that framing payoffs as gains or losses is an important aspect of experimental design and implementation. As another example where such framing might matter they mention stag-hunt games for which payoff dominance and risk dominance make conflicting predictions. Specifically, they conjecture that loss avoidance might reverse the previously reported preference for the inefficient risk-dominant equilibrium (e.g., Cooper et al., 1992).[1]

We conduct an experiment to investigate Cachon and Camerer's conjecture. As depicted in Figure 1, participants choose either A or B for five symmetric 2x2 stag-hunt games. Game 1, a control treatment where payoff and risk dominance point to the same equilibrium (A,C), offers participants a choice between a safe but relatively unattractive strategy B and a risky but relatively attractive strategy A. In the remaining four games we move the risk-dominant equilibrium to (B,D) by increasing the relative attractiveness of

[1] See Camerer (2003), chapter 7, for a discussion of various psychological selection principles in, and the policy relevance of, the stag-hunt coordination games.

the safe strategy B.[2] For Games 3 and 5, however, this strategy results in certain losses which assigns loss avoidance its intended role.

2. Design and hypotheses[3]

Figure 1 illustrates that, except for control Game 1, the remaining Games 2-5 are affine transformations of each other, so they are formally equivalent. The four games vary neither in the degree of "risk" involved in choosing the payoff-dominant equilibrium (A,C), nor in the impact of several widely studied selection principles: payoff dominance, risk dominance, maximin, and level-one bounded rationality, the latter two here corresponding to risk dominance (see Haruvy and Stahl, 1998). We test whether, contrary to received textbook wisdom, the different psychological representation of Games 2-5 can influence subjects' propensity to coordinate on the efficient equilibrium (A,C).

--FIGURE 1 HERE--

We hypothesize that three interconnected selection principles will be in play: loss avoidance, risk aversion, and loss aversion. Loss avoidance prompts people to (expect that others) avoid strategies resulting in sure negative payoffs if other strategies with *potentially* positive payoffs are available (Cachon and Camerer 1996, footnote 2; see also Camerer 2003, p. 393). Thus loss avoidance should push participants toward the payoff-dominant equilibrium (A,C) in Game 3 relative to Game 2, and in Game 5 relative to

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[2] Recall that a risk-dominant equilibrium has a greater Nash product of deviation losses (NPDL). In Game 2, for example, NPDL equals (80-50)*(80-50)=900 for the (A,C) equilibrium and (50-10)*(50-10)=1600 for the (B,D) equilibrium, the latter thus being risk-dominant.

[3] For an expanded version of this section, see Rydval and Ortmann (2004b).

Game 4. Picking A in Games 3 and 5 would save them from the inevitable loss incurred by picking B, while the potential "extreme" loss associated with choosing A should be perceived as unlikely if loss avoidance were a salient selection principle.

In the positive-payoff domain, Holt and Laury (2002) observe increasing relative risk aversion when payoffs are scaled up dramatically (though Harrison et al., 2004, without disputing the essence of these results, argue that they were partly due to order effects). In our stag-hunt setting, although we scale up payoffs only modestly, increasing risk aversion might reinforce risk dominance and lead to less coordination on the payoff-dominant equilibrium (A,C) in Game 4 than in Game 2.

In the negative-payoff domain, although loss avoidance suggests that the "extreme" losses potentially incurred when choosing A in Games 3 and 5 are unlikely, loss aversion could make these losses more salient and hence counteract loss avoidance by pushing participants toward the safer but inefficient equilibrium (B,D). By comparing Games 3 and 5 we can observe whether scaling up negative payoffs changes the relative power of loss avoidance and loss aversion: while the sure losses associated with choosing B are similar in the two games, the "extreme" negative payoff in Game 5 – by far the largest negative payoff in the Experiment Sheet – could activate loss aversion more than in Game 3 and hence deter coordination on the efficient equilibrium (A,C).

Let ">" denote a higher proportion of A choices. We can then summarize our hypotheses, in terms of the statistical alternatives, as follows:

H_1: Game 2 > Game 4, if scaling up payoffs in the positive-payoff domain leads to greater risk aversion

H_2: Game 3 > Game 2, and Game 5 > Game 4, if in Game 3 and Game 5 negative payoffs activate loss avoidance more than loss aversion

H_3: Game 3 > Game 5, if scaling up payoffs in the negative-payoff domain leads to a greater increase in loss aversion than in loss avoidance

3. Implementation

We ran three sessions with inexperienced subjects who had not taken game theory classes (see the Appendix). Except for the numbering of games and the explanatory arrows between them, Figure 1 is what the participants saw on their Experiment Sheet.[4] We first read aloud the instructions and quizzed the participants for their understanding of the task. Then they were given five minutes to choose either action A or action B for each of the games on their Experiment Sheet, in any order they liked. After that we collected the Sheets and, as explained in the instructions, we randomly selected around 15% of pairs in each session who received an initial endowment plus their payoffs for one game picked at random from their Experiment Sheet.[5]

As to our enforcement of losses, Cachon and Camerer (1996) illustrate that eliminating the initial endowment could further increase the power of loss avoidance. However, one would then need to let subjects decide whether to participate in (or opt out

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[4] The first author was the experimenter. We conducted five sessions altogether: of the two sessions not reported here, one had subjects with game-theoretic background, and the other had a different paying off procedure that changed the nature of the game. The participants in fact made choices for seven games: the two games not reported here added no extra insights. We controlled for order effects by having subjects face various rotations of the Experiment Sheet. See Rydval and Ortmann (2004a) for the complete set of results and implementation details, and home.cerge-ei.cz/ortmann/instructions.html for the full set of instructions.

[5] The participants were informed about the paying off mode ex ante. The "winning pairs" were drawn immediately after the experiment and paid off privately. Their average realized earnings were $6, with the purchasing power about twice that. Two of the involved participants ended up making a loss of 50CZK (when Game 3 was selected). One never claimed his prize; the other was *ex post* given the option to pay up or not to pay up. Individual rationality suggests what happened.

of) the experiment, bringing in the confounding effect of another selection principle – forward induction. Hence we believe that our design makes losses salient to the extent possible.

4. Results

79.6% of subjects chose A in Game 1, significantly more than in the remaining four games, which is in line with previously reported choice behavior. The second highest percentage of A choices was 58.2% in Game 3, and it was even lower in Game 2 (48%), Game 4 (47.5%), and Game 5 (47.5%). Figure 2 displays the tests of differences in the proportion of A choices for the game pairs entertained in our hypotheses.

--FIGURE 2 HERE—

We find no statistical support for H_1 as subjects choose A in Games 2 and 4 with essentially the same frequency: scaling up payoffs in the positive-payoff domain does not seem to induce higher risk aversion. H_2 gains support in that the proportion of A choices is significantly higher in Game 3 than in Game 2, about 10 percentage points on average. By contrast, the proportion of A choices is identical in Game 5 and Game 4. To complete the picture we find support for H_3 in that the proportion of A choices is significantly higher in Game 3 than in Game 5. Hence in Game 5, unlike in Game 3, increasing loss aversion seems to counteract loss avoidance and to deter coordination on the efficient equilibrium (A,C).

Figure 3 sheds further light on the validity of our hypotheses. The transition matrices reveal that in each of the investigated game pairs our subjects exhibit two broad behavioral modes. For around 70% of subjects persistence dominates any other selection principle since they choose either A or B for both games in a game pair. For the remaining 30%, call them "switchers", we detect significant elasticity of changing behavior when presented with the loss possibility. The findings for the switchers confirm our previous results, with the qualification that they may be valid only for a subpopulation of subjects.[6]

--FIGURE 3 HERE—

Specifically, we observe equally frequent switching in both directions for Games 2 and 4, so increased risk aversion seems to have no relevance in our experiment (H_1). There are significantly more switchers from B to A between Game 2 and Game 3, but switching is equally frequent in both directions in Games 4 and 5 (H_2). Lastly, subjects switch more often from A to B between Game 3 and Game 5 (H_3). This again suggests that in Game 5 loss aversion tends to override the pro-coordination impact of loss avoidance observed in Game 3.

5. Discussion

Our results generally confirm the previously observed preference for the risk-dominant equilibrium in stag-hunt games where payoff dominance and risk dominance are in conflict. Loss avoidance partly mitigates the observed persistence in choice

[6] The subpopulation may be larger than 30%, however, since the binary nature of our stag-hunt games makes it difficult to quantify the changes in individual switching propensities across games. Hence our findings may understate the impact of loss avoidance and other selection principles, although switching rates in a range from 20% to 35% are very common in the lottery choice literature (see Ballinger and Wilcox, 1997). Further classifying subjects would require the inspection of choice patterns across all five (seven) games.

behavior and pushes subjects toward the payoff-dominant equilibrium, although loss aversion appears to override its impact when potential losses associated with coordination failure are high.

That loss avoidance triggers higher coordination is surprising, given that our stag hunts are unforgiving "weak-link" games for which coordination is generally hard to achieve (e.g., Goeree and Holt, 2001; Blume and Ortmann, 2004), and given that our subjects did not have feedback from which they could infer whether others obey the loss avoidance selection principle.

Our results contradict the received textbook wisdom that affine transformations do not matter, and enrich earlier analyses of focality concentrating on labeling strategies or correlating devices (e.g., Van Huyck et al., 1992). That affine transformations do matter, in a way partly consistent with loss avoidance, is a noteworthy reminder about the breadth of selection principles.

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Figure 1: The stag-hunt games and their relation to each other

Payoffs are in Czech Koruns (CZK). At the time of the experiment, 30CZK corresponded to roughly $1, the purchasing power being about twice that. The shaded games are the loss-avoidance games with money-losing strategy B (D).

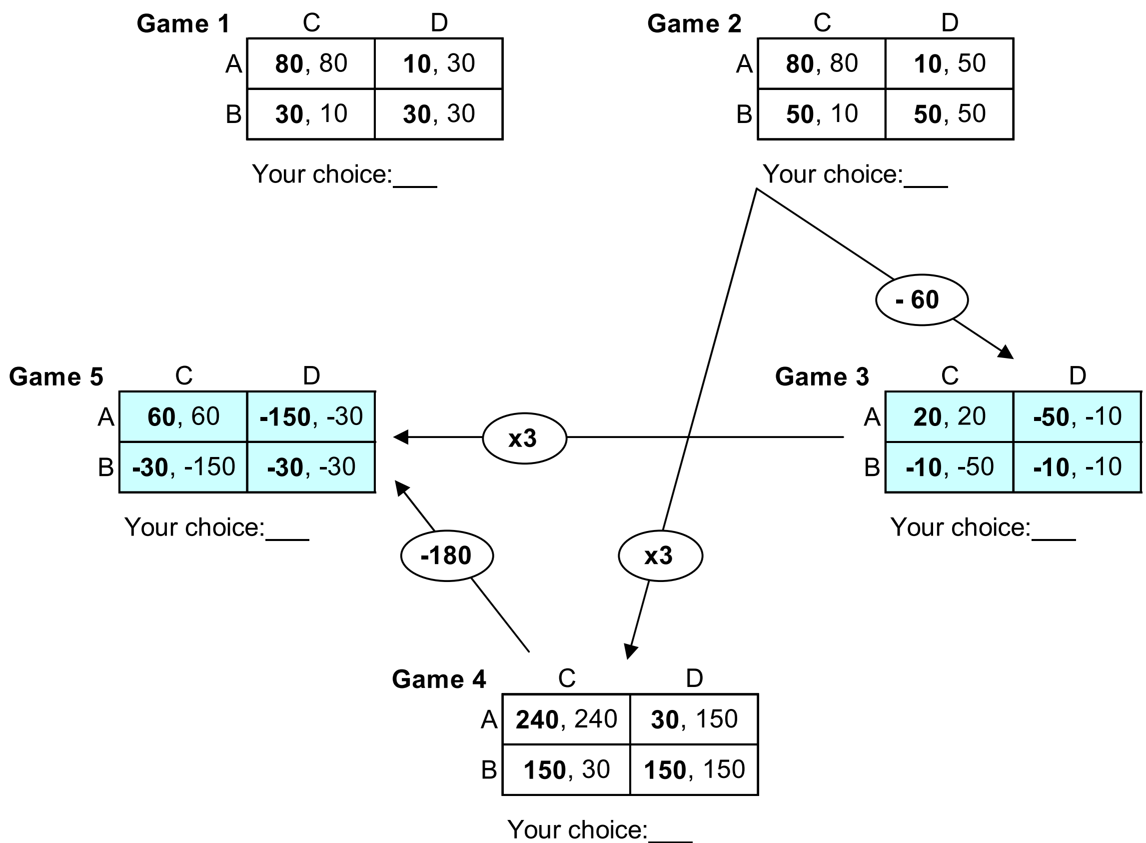
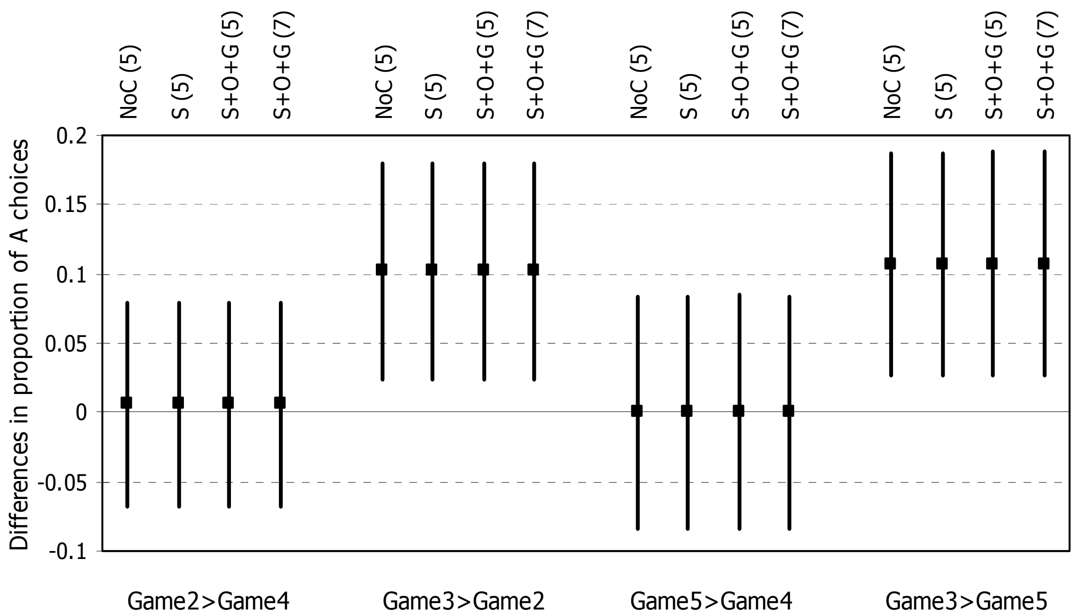


Figure 2: Differences in proportion of A choices between selected game pairs

Point estimates (small solid squares), accompanied by robust cluster-adjusted 95% confidence intervals (vertical lines through the squares), are from estimation with five (5) or all seven (7) games, with game dummies only (NoC), or controlling for session (S), order (O), and gender (G) effects.[7]



[7] We estimate linear probability specifications, but have checked that the results are qualitatively robust to alternative (nonlinear) probability models (e.g., Bertrand and Mullainathan, 2003). Game-session, game-order, and game-gender interactions are insignificant (at 10% level) and consequently not included. In Session 2 the percentage of A choices is in each game significantly lower than in the other sessions (at 5% level), about 18 percentage points on average. Besides the unlikely impact of several design features discussed in Rydval and Ortmann (2004a), a potential source of the variation is the elitist and competitive structure of the Faculty of Social Sciences from which Session 2 participants enrolled (see the Appendix). Gender effects are highly insignificant. Order effects are jointly insignificant (at 5% level), though we detect a pattern suggesting that subjects facing two negative-payoff games at the top of their Experiment Sheet (Game 3 and another game not displayed in Figure 1) choose A less often than subjects facing (clockwise) positive-payoff games at the top.

Figure 3: Transition matrices for selected game pairs

Each cell shows the percentage (rounded to 1 d.p.) of A and B choices made in the game aligned vertically *and* horizontally. Hence the off-diagonal cells display the percentages of subjects who switched from A to B and vice versa. McNemar asymptotic test statistics M indicates where the two switching rates significantly differ (*); the critical value of two-sided test at 5% level is 3.84. K_1 and K_2 are the lower and upper exact critical values for the corresponding small-sample McNemar test (**). Fisher exact test rejects the independence of rows and columns for each game pair (at 1% level).

Game 2 \ Game 4	A	B
A	35.6	12.4
B	11.9	40.1

M=0.02
K_1=15
K_2=28

Game 2 \ Game 3	A	B
A	39.0	9.0
B	19.2	32.8

M=6.48*
K_1=18**
K_2=32**

Game 4 \ Game 5	A	B
A	31.6	15.8
B	15.8	36.7

M=0.00
K_1=21
K_2=35

Game 3 \ Game 5	A	B
A	37.9	20.3
B	9.6	32.2

M=6.81*
K_1=19**
K_2=34**

APPENDIX

Table 1: Description of experimental sessions

	Subject Pool	Instructions language	Payment mode
Session 1 Oct 4, 2002	70 undergraduate students Czech Technical University, Prague	Czech	10 subjects paid out (in CZK) 200CZK participation fee
Session 2 Oct 6, 2002	73 undergraduate students Faculty of Social Sciences, Charles University, Prague	Czech	10 subjects paid out (in CZK) 100CZK participation fee
Session 3 Nov 13, 2002	34 graduate (first-year) students CERGE-EI, Prague	English	6 subjects paid out (in CZK) 100CZK participation fee