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

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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.

Abstrakt

V tomto článku experimentálně zkoumáme, zda princip vyhýbání se ztrátám řeší napětí ve hrách typu Hon na jelena, ve kterých dominance zisku a dominance rizika dávají odlišné predikce. Navzdory učebnicovým moudrům ukazujeme, že zavedení ztrátových výstupů částečně posouvá chování směrem k Paretovsky efektivní rovnováze.

Keywords: Loss avoidance, Selection principle, Stag-hunt games, Coordination games, Experiment

JEL Classification: C72; C91; D91; D84

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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

[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.

increasing the relative attractiveness of 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

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).

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.[3] Thus loss avoidance

[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] To our knowledge, the closest-to-formal definition of loss avoidance is provided in Cachon and Camerer (1996, footnote 2) who introduced it as follows: "There are two variants of loss-avoidance: (i) subjects avoid strategies that have only negative payoffs (losing-strategy avoidance); (ii) subjects avoid strategies that have negative equilibrium payoffs (losing-equilibrium avoidance)." Camerer (2003, p. 393) argues that "loss avoidance is a selection principle applied to infer what others will do (and what others will expect you to do, and so on), not a principle of individual choice", as opposed to risk aversion and loss aversion.

should push participants toward the payoff-dominant equilibrium (A,C) in Game 3 relative to Game 2, and in Game 5 relative to 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.

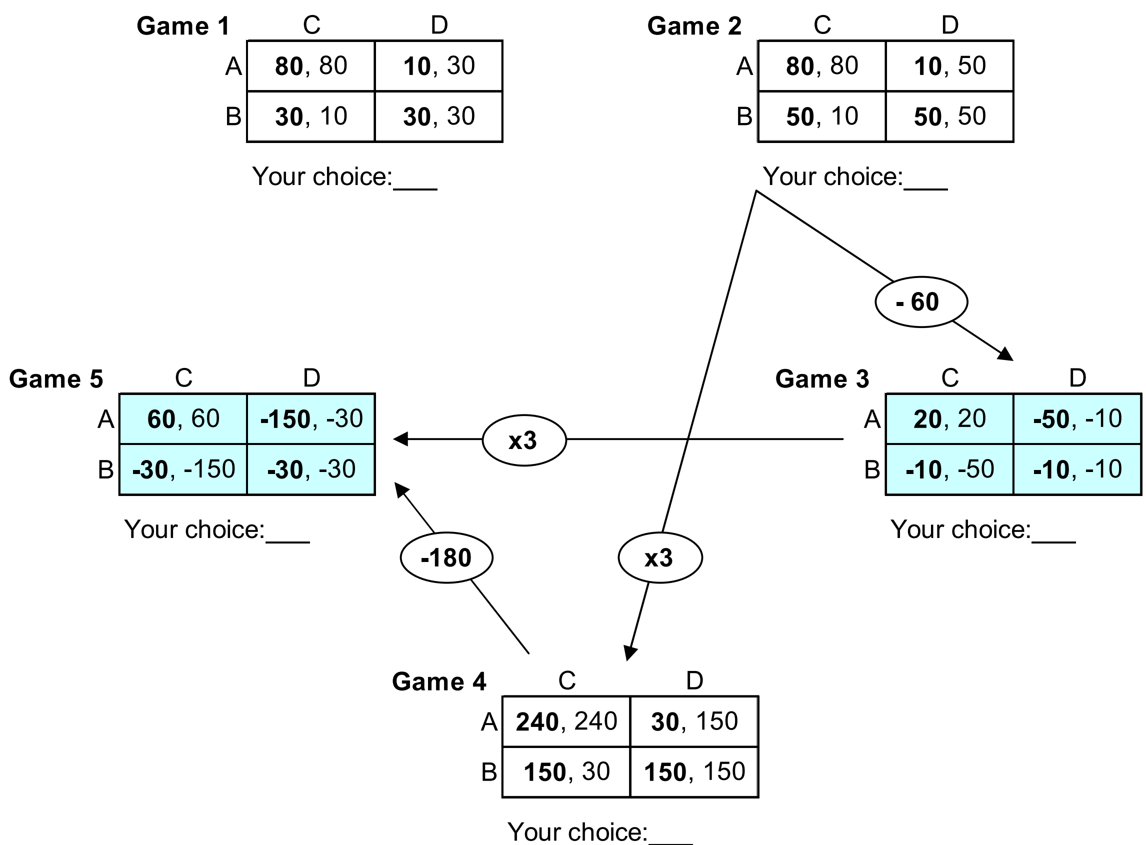

Figure 1: The stag-hunt games and their relation to each other
Payoffs are in Czech Koruns (CZK). At the time of the experiment, 30CZK corresponded to roughly $1, the purchasing power being about twice that. The shaded games are the loss-avoidance games with money-losing strategy B (D).

Since loss avoidance pertains to gains and losses and hence takes zero initial income as a fixed reference point, we assume that the payoffs of our stag-hunt games enter as the argument of subjects' value function $v(x)$.[4] Risk aversion could play a role when we scale up payoffs in the positive-payoff domain, i.e. in Game 4 relative to Game 2. In a lottery-choice experiment designed to measure risk aversion, Holt and Laury (2002) observe increasing relative risk aversion when payoffs are scaled up dramatically.[5] In our stag-hunt setting, although we scale up payoffs only modestly, increasing risk aversion might reinforce risk dominance, leading 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 dampen or even override loss avoidance. Schmidt and Traub (2002) generically define loss aversion as $v(x) - v(y) \leq v(-y) - v(-x)$ for all $x > y \geq 0$. The authors design a corresponding menu of paired lottery choices to infer the extent of loss-averse behavior, and report only mixed evidence for loss aversion. If this finding can be

[4] Cox and Sadiraj (2001) show that this assumption, commonly made in auction theory and other fields, underlies the expected utility of *income* (EUI) model of the expected utility theory, which has properties similar to the standard expected utility of *terminal wealth* (EUTW) model, and has the advantage of being able to incorporate loss aversion.

[5] Holt and Laury (2002) design a menu of paired lottery choices to infer the degree of risk aversion, as indicated by their subjects' tendency to switch from riskier to safer lotteries. The authors find considerable risk aversion even at small stakes, and increasing risk aversion when payoffs are scaled up by a factor of 20, 50, and 90. Harrison et al. (2004) argue, without disputing the essence of the results, that the latter finding is partly due to order effects.

generalized to our stag-hunt setting,[6] we should not expect loss aversion to extensively counteract loss avoidance by pushing subjects towards the safer but inefficient equilibrium (B,D) in Games 3 and 5.

Comparing Game 3 and its scaled-up version Game 5 enables a direct test of the power of loss avoidance and loss aversion when payoffs are scaled up. Cachon and Camerer (1996) do not tell us whether we should expect loss avoidance to be a more powerful selection principle when losses are more salient in Game 5 compared to Game 3, but the negligible difference between the sure losses associated with choosing A suggests that the impact of loss avoidance is unlikely to differ across the two games. Although Schmidt and Traub (2002) find no evidence of increasing loss aversion as stakes increase, we hypothesize that 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 propensity 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 the former games negative payoffs activate loss avoidance more than loss aversion

[6] Schmidt and Traub (2002) use rather low-powered incentives, namely a flat participation fee, which may preclude generalizability of their results.

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.[7] 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 earned an initial endowment plus the deserved payoffs for one game picked at random from their Experiment Sheet.[8]

We believe that our design induces losses to the extent possible. Cachon and Camerer (1996) illustrate that completely eliminating the initial endowment could

[7] 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-out 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 (2004) for the complete set of results and implementation details, and home.cerge-ei.cz/ortmann/instructions.html for the full set of instructions.

[8] The participants were informed about the paying-out 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.

further increase the power of loss avoidance.[9] However, this would come at a cost since another selection principle called forward induction would be in play. In particular, without initial endowment one would need to let subjects avoid the potential losses by opting out of the experiment in order to make the experimental procedure socially acceptable. But then, all participants not opting out would "signal" that they expect to earn a positive payoff, as opposed to earning nothing when opting out. Hence the forward induction principle would act as a coordination device in the same direction as loss avoidance. As a result, the opt-out option would preclude the identification of the sole impact of loss avoidance.

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.

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

[9] We note that if subjects perceived the initial endowment as their reference point, neither loss avoidance nor loss aversion would be broadly applicable in our experiment: only Game 5 in Session 1 would expose subjects to potential losses. However, our results suggest that both loss avoidance and loss aversion do play a role, and we observe no differences in choice behavior across sessions that could be attributed to differing initial endowments.

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 3 loss avoidance seems to dominate loss aversion and aids coordination on the efficient equilibrium (A,C), while in Game 5 the picture is reversed: increasing loss aversion dominates loss avoidance and deters coordination.

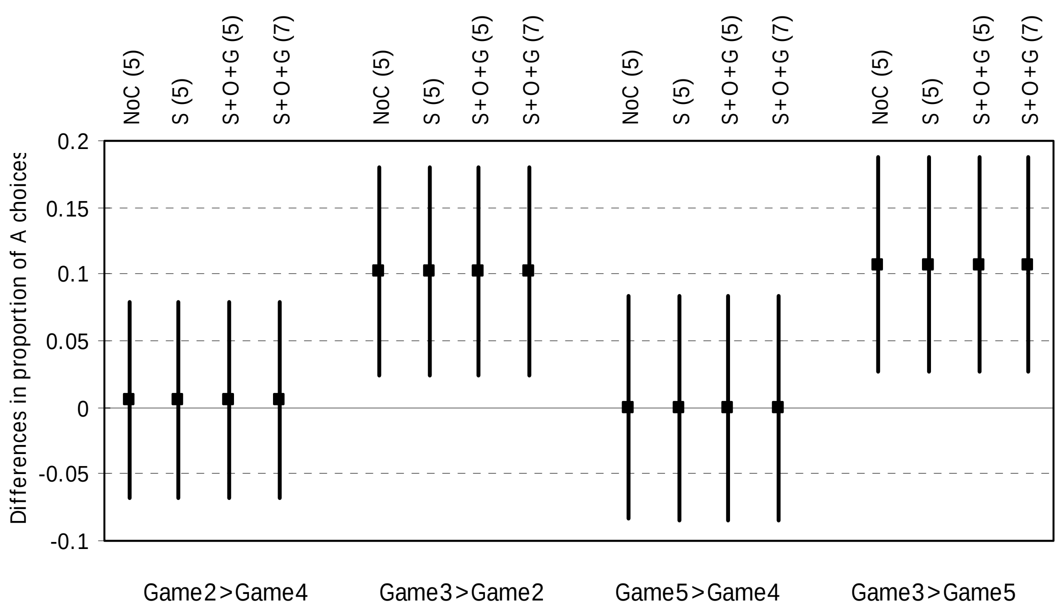

Figure 2: Differences in proportion of A choices between selected game pairs
Point estimates (small solid squares), accompanied by robust cluster-adjusted 95% confidence intervals (vertical lines through the squares), are from estimation with five (5) or all seven (7) games, with game dummies only (NoC), or controlling for session (S), order (O), and gender (G) effects.[10]

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[10] 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

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. As described below, the findings for the switchers confirm our previous results, with the qualification that they may be valid only for a subpopulation of subjects.[11]

Specifically, we observe equally frequent switching in both direction for Games 2 and 4, so risk aversion on its own has little power (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

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 (2004), 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.

[11] 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. On the other hand, switching rates in a range from 20% to 35% are very common in the lottery choice literature (see Ballinger and Wilcox, 1997). Notice that we do not argue that we have two distinct classes of subjects, because that would necessitate the problematic (in our case impossible) inspection of choice patterns across all five (seven) games. Between-game switching rates are partly the product of the covariance of strategy choice probabilities across games (when subjects are heterogeneous), so we would require information on within-game switching rates, which themselves would be partly determined by the variance of individual strategy choice probabilities across subjects (holding the game fixed).

Game 5 loss aversion tends to override the pro-coordination impact of loss avoidance observed in Game 3.

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**

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).

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 seems to partly mitigate the observed persistence in choice 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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APPENDIX

Table A: 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

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