No guts, no glory: An experiment on excessive risk-taking[*]

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We study risk-taking behavior in tournaments where the optimal strategy is to take no risk. By keeping the optimal strategy constant, while varying the competitiveness in the tournaments, we are able to investigate the relationship between competitiveness and excessive risk-taking. In the most competitive tournament, less than 10% of the subjects played the optimal strategy in the first rounds. The majority playing dominated strategies increased their risk-taking during game of play. When we removed feedback about winner's decisions each round, and when we reduced the number of contestants in the tournaments, subjects significantly reduced their risk-taking. We also find strong peer group effects. In particular, the winner's decision in round t-1 had a strong and significant effect on the competitor's risk-taking in round t.

Keywords: Experiment; risk-taking; tournaments; peer effects

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1. Introduction

Some economic principles are so well established that they turn into proverbs. The relationship between risk and return is perhaps the most paraphrased of them all: Nothing ventured, nothing gained; no guts, no glory; or to quote the famous Naval Officer John Paul Jones: "It seems to be a law inflexible and inexorable that he who will not risk cannot win."

In the wake of this insight, some might choose to take more risk than they should if their objective is to maximize long-term profit. The case of excessive risk-taking is particularly relevant in tournament situations where agents compete against each other. We see this in finance, where investment banks and mutual funds sometimes take excessively risky positions in order to make year-end lists of "top performers" (Brown et. al, 1996, Chevalier and Ellison, 1997, Goriaev et al. 2003 and Huang et al. 2012). We see this among entrepreneurs, where seemingly over-optimistic entry decisions cause most businesses to fail within a few years (Dunne et al, 1988 and Baldwin, 1995). And we see this in sports, where clubs almost go bankrupt in their attempt to win (Solberg and Haugen, 2010).

In the literature, there are basically two explanations for excessive risk-taking. One is related to moral hazard problems and the challenge of designing efficient incentives (Hvide, 2002 Taylor, 2003, and Palomino and Prat, 2003). Economic agents are fully rational and have standard preferences, but their second-best incentives are not perfectly aligned with the interests of the shareholders. Another explanation is based on overconfidence. Investors or entrepreneurs who are overconfident about their relative abilities or about the precision of their knowledge may under diversify their portfolios (Odean, 1998) or start businesses that are not worthwhile (Camerer and Lovallo, 1999).

Both overconfidence and incentive problems are plausible explanations for excessive risk-taking, but they are not exhaustive. In this paper we consider an additional explanation.

We hypothesize that competitions *per se* induce risk-taking: In competitive situations, like tournaments, people may take risk even if there do not exist any risk preferences that can justify their decisions. In other words, people may take risk even if they have no monetary incentives to do so. Our hypothesis is based on the idea that some people might take risk simply because they believe it is the right thing to do in a tournament situation. If we are fed with proverbs and stories about risk and success, our rules of thumb might say that we have to take risk in order to win. A bias towards excessive risk-taking in tournaments is closely related to the so-called availability heuristic. According to Tversky and Kahneman (1973), a person is said to employ the availability heuristic "whenever he estimates frequency or probability by the ease in which instances or associations could be brought to mind." If success is more associated with risk-taking than with safe-playing, then the availability heuristic may lead contestants in tournaments to take excessively risky positions.

Although the availability heuristic has inspired our hypothesis, the goal with this paper is to identify *whether* there exists a causal relationship between competition and excessive risk-taking, not why this relationship exists. Our research strategy is thus to run controlled laboratory experiments where subjects participate in tournaments in which the optimal strategy is to take no risk. By keeping the optimal strategy constant, while varying the competitiveness in the tournaments, we are able to investigate the relationship between competitiveness and the degree of *excessive* risk-taking. We vary the "competitive feel" in the tournaments by varying the number of contestants and by varying the feedback subjects receive about the winners' behavior.

The structure of the tournament is as follows: Contestants start out with an endowment w of experimental currency units (ECU) and can increase or reduce their endowment by betting an amount b in a lottery. For each contestant there is $1/m$ chance of winning bx ECU in the lottery, ending up with $w-b+bx$ (where $x>1$). There is $(1-1/m)$ chance of losing the amount invested in the lottery, ending up with $w-b$. The one with the highest amount of ECU after the lottery draw receives a monetary prize. The others receive nothing. With more than one subject on top, the winner is chosen by drawing lots. Now, with $1/m$ chance of winning, but only $n<m$ contestants, the optimal strategy for each subject is to bet a lower amount than the other contestants. Hence, the only rationalizable strategy is to bet zero. Moreover, for any (out of equilibrium) strategies the opponents choose, it is (weakly) optimal to bet zero.

In each of the treatments, the tournament game was played 15 independent rounds. We kept the winning probability in the lottery constant ($m=5$), but varied the number of contestants ($n = 2$ or 4), the lottery outcome multiplier ($x=4$ or 10), and the extent to which subjects were informed about the number of ECU that the winner achieved each round. Variations in number of contestants clearly affect the competitiveness of the tournament. Feedback about winners each round, such as for instance, "The winner this round ended up with 250 ECU" also gives contestants a more competitive feel than no feedback. Variations in x should not affect the competitive feel of the tournament, but may affect the contestants' understanding of the game.

Our main results are as follows: The more competitive the tournament is, the higher the degree of excessive risk-taking: Increasing the number of contestants and giving feedback about the tournament winners' decisions increases the degree of excessive risk-taking. In the most competitive tournament, less than 10% of the subjects played the optimal strategy in the first rounds. This increased steadily during the 15 rounds to just above 30% in the last round. Those playing dominated strategies tend to increase risk-taking during game of play, in particular in the treatments where subjects received information about the winner. We also find strong peer effects. The amount of ECU that a tournament winner achieved in round $t-1$ had a strong and significant effect on the other competitors' risk-taking in round t.

Relationship to the literature: Since the seminal work on tournament theory by Lazear and Rosen (1981), most papers testing tournament theory in the laboratory have focused on optimal effort choices (e.g. Bull et al. 1987; Harbring and Ihlenbush 2003; Orrison et al., 2004; Eriksson et al., 2006; Sutter and Strassmair, 2009; and Eriksen et al, 2011). Several papers have examined risk-taking in tournaments, both theoretically and empirically (as cited above), but there are surprisingly few experimental papers on the subject. We count five: James and Isaac (2000), studying experimentally how tournament incentives affect pricing in asset markets, Nieken (2010) investigating the relationship between effort choice and risk, Nieken and Sliwka (2010), focusing on how relative interim positions in tournaments affect risk-taking, Eriksen and Kvaløy (2014) studying myopic risk-taking in tournaments, and Dijk et al. (2014) focusing on how tournament incentives and social competition affect portfolio choice.

In contrast to the cited papers, we investigate risk-taking in a dominance solvable game where iterated elimination of dominated strategies leads to a unique Nash Equilibrium in which everyone bet zero in the lottery. But iteration typically requires sophistication, and the experimental literature on dominance solvable games has demonstrated that people have limited strategic sophistication (see Camerer, 2003, for an overview). People typically perform just a couple of steps of iterated thinking. Our result, showing that only 10 percent plays the equilibrium strategy in the first round, may thus be the result of limited strategic sophistication. However, in contrast to the dominance solvable games typically studied[1], the unique equilibrium strategy in our game is weakly optimal for any out of equilibrium strategy that the other players might choose. Once you understand that you maximize the probability of winning by betting lower than your opponents, you have no incentives to bet anything else than zero.

Our paper is thus also related to the experimental literature investigating overbidding in auctions, particularly the dominance solvable second price auctions. In these auctions, bidding one's own value is a weakly dominant strategy. This theoretical prediction holds irrespective of bidders' risk attitudes, the number of rival bidders, symmetry in the value distributions and so on. In laboratory experiments, however, subjects are found to exhibit a consistent pattern of overbidding (See Kagel, 1995 and Kagel and Levin, 2009 for surveys).

The game we introduce in this paper differs from the second auction games in several respects. First, the kind of errors in reasoning differs. In second price auctions, bidders (seemingly) fail to see that bidding above own valuation improves the probability of winning only in cases where it reduces the

[1] In the much-studied beauty contest game (or guessing game), the equilibrium strategy is optimal only if everyone else plays the equilibrium strategy. See Nagel (1995) for a first experimental study of this game.

expected profits from winning.[2] This is more subtle than in our simple experiment, where higher betting always reduces the probability of winning, and where the winner price is given.[3] (Kagel, 1995, also argues that the dominance strategy is far from transparent in second price auctions). Second, the framing is obviously different, since our experiment is about lottery decisions, and hence the feeling of "risk-taking" is more profound. Our results also clearly differ from the results in auctions. No auctions, as we know of, have documented the same extent of deviations from the dominant strategy (90% in the first round). Second, we find that more competition increases risk taking, in contrast to second price auctions, where number of bidders seems not to have a significant effect (Kagel and Levin, 1993).

Finally, our paper is related to the literature on risk-taking and peer-group effects, see e.g. Hong et al. (2004) and Cooper and Rege (2011). Like them, we find that individuals' investment decisions strongly depend on choices made by their peers. The effects we demonstrate are interesting also since learning from peers in our experiment often leads to inferior decisions.

The paper is organized as follows: In Section 2 we present the experimental design and procedure. In Section 3 we present the results. In Sections 4 we discuss implications of our results, while Section 5 concludes.

2. Experimental design and procedure

Our experimental strategy was to construct a situation in which the optimal strategy was to take no risk, regardless of the subjects' risk preferences, and then vary the competitiveness of the tournament. We here present instructions for one of the treatments and then describe the other treatments.

"You will be divided into groups of four participants in each group. The groups are randomly formed and will be the same throughout the entire experiment. You will not be told who else is in your group.

The experiment consists of 15 rounds. In each round all the group participants start off with 100 ECU each, where ECU = Experimental Currency Unit. You will then have the opportunity to win more ECU by betting in a lottery. ***After the lottery draw the round ends and the one who has the most ECU gets 100 Norwegian kroner. Those who come in second, third or fourth place receive nothing, i.e. 0 Norwegian kroner.***

The lottery is the same in all rounds and for all participants and is as follows:

[2] Alternative explanations for overbidding in second price auctions are based on non-standard preferences such as "joy of winning" and "spite", see Andreoni et al. (2007), and Cooper and Fang (2008).

[3] In this respect our game is more similar to a common value auction, where winner prices are given. Common value auctions also typically yield overbidding. But these auctions are not dominance solvable. Moreover, the winner price is unknown, and overbidding happens because bidders fail to adjust their price estimate, conditional on winning (known as the winner's curse).

With 4/5 (80%) probability you lose the ECU bet.

With 1/5 (20%) probability you win 4 times the ECU bet.

You can bet between 0 and 100 ECU in the lottery. If you choose to bet X ECU, you receive 100-X ECU if you lose, and 100-X + 4∗X ECU if you win.

Examples:

If you e.g. bet 0 ECU in the lottery and lose, you are left with 100-0 = ***100 ECU.*** *If you win you are left with 100 + 0∗4 =* ***100 ECU.***

If you e.g. bet 20 ECU in the lottery and lose, you are left with 100-20 = ***80 ECU.*** *If you win you are left with 80 + 20∗4 =* ***160 ECU.***

If you e.g. bet 70 ECU in the lottery and lose, you are left with 100-70 = ***30 ECU.*** *If you win you are left with 30 + 70∗4 =* ***310 ECU.***

The computer performs the lottery draws, which are random and independent. This means that the other participants' lottery outcomes, in addition to lottery outcomes in previous rounds, do not affect your chance of winning in the lottery.

After each round, the one in the group who has the highest amount of ECU will receive 100 Norwegian kroner. If there are several at the top who have the same amount of ECU, just one is drawn to receive 100 kroner.

The game will be played 15 times. At each new round you start with a new 100 ECU. You do not carry over ECU from the previous round. Your combined income in Norwegian kroner will be paid out in cash when the experiment is over."

In addition to these instructions, the subjects were given lucid instructions on the screen while making their decisions.

The instructions presented above are for the treatment we call NoInfo4. That is n=4 contestants, and no feedback about winner's behavior. We ran three more treatments: The NoInfo2 treatment is exactly the same as NoInfo4, except that there were only 2 contestants. To keep the expected earnings the same, the winner won 50 kroner each round in NoInfo2. The WinInfo4L treatment is the same as NoInfo4 except that now the contestants received information about the winner each round. This was also made clear in the initial instructions, saying: *"You get to know how many ECU the winner ended* *up with each round*". Finally, we had a treatment called WinInfo4H which is identical to WinInfo4L except that a lottery gain now gave 10 times the amount invested instead of 4.

Optimal strategy: How easy is it to figure out the optimal strategy even if one does not have basic knowledge of probability thinking? Once you even consider the idea of betting lower than the others, you know that you will win the tournament if none of your competitors win in the lottery. With n=4, the probability of winning after betting lower than the others is $\left(\frac{4}{5}\right)^3 \approx 0{,}51$. However, the most naïve thinking would be to just add the competitors' probability of winning, which in reality overestimates the probability of at least one winning. With 20% chance of winning and 3 competitors (4 contestants), the naïve overestimated chance that at least one will win in the lottery is 20*3= 60% and thus 40% chance that you end up winning the tournament. Comparing this to the probability of winning in the lottery (20%), the optimal strategy is clearly to bet zero. If everyone bet zero, then there is still 25% chance of winning the tournament. Hence, if one does not choose the optimal strategy, it is likely that one does not even consider it.

Time constraints are of course important when making decisions that require mental effort. After the instructions were read out loud to all the subjects in the session, they had 5 minutes to study the instructions before we started the experiment. During these 5 minutes they could ask the experimenter (not in plenary) if they had questions about the instructions (only a few did). When the experiment started, the subjects had no time constraints, although some peer pressure may exist since the experiment did not go forward before everyone had made a decision.

Altogether 192 students from the University of Stavanger, Norway, participated in the experiment. They were recruited by E-mail and told that they had the opportunity to participate in an economic experiment where they could earn a nice sum of money. The experiment was computerized using Z-tree (Fischbacher, 2007). We had 56 subjects in each of the win info treatments and 40 subjects in each of the no info treatments. All treatments consisted of two sessions each.

3. Results

In this section we present the main experimental findings. As can be seen in Table 1, the average bet is considerably above zero in all treatments, and the figures indicate a positive relationship between betting and the degree of competition in the tournaments. The average bet in WinInfo4H and WinInfo4L are both above 50, while it is 36.7 in NoInfo4. In the least competitive treatment, Noinfo2, the average bet is only 17.8.

Table 1: Summary statistics

	Mean (st.dev)	Median	Bets equal to zero	Bets equal to 100	# obs. (subjects)
WinInfo4H	52.1 (38.8)	50	18 %	25 %	840 (56)
WinInfo4L	50.5 (41.2)	50	20 %	30 %	840 (56)
NoInfo4	36.7 (37.7)	20	28 %	12 %	600 (40)
NoInfo2	17.8 (30.9)	0	63 %	6 %	600 (40)
All treatments	41.3 (40.0)	30	30 %	20 %	2880 (192)

Note: The table presents mean and median bet by treatment, as well as the proportion of bets that was either zero or one hundred.

Table 1 also shows how often subjects choose the optimal bet of zero, and how often they choose the maximum bet of 100. Around 70 % of all choices are positive and thus not equal to the optimal choice. If we only look at the first round, as many as 93% and 89% (WinInfo4L and WinInfo4H, respectively) of the subjects deviated from the dominant strategy in the high competitive tournaments. In the two no-info treatments the number is lower, but still 80% (NoInfo4) and 65% (NoInfo2) of the subjects deviate from the optimal strategy in round 1.

Looking at all fifteen rounds, we find clear and significant treatment differences in the proportion of bets equal to zero. The proportion of choices equal to zero in WinInfo4L and WinInfo4H are significantly different from NoInfo4, which in turn is significantly different from NoInfo2.[4] The reversed pattern is found for bets equal to the maximal amount. Here 25% and 30% of the subjects chose to bet the maximal amount in WinInfo4H and WinInfo4L, respectively, while the figure is only 12% in NoInfo4 and 6% in NoInfo2. These differences are also significant.[5]

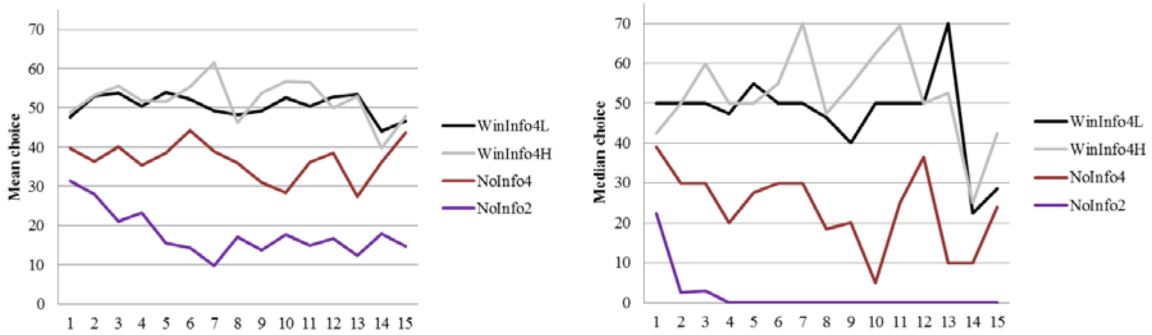
In Figure 1 we present mean and median bet over time. [6] We observe a clear and consistent relationship between risk-taking and the degree of competition. Comparing the four-player tournaments with the two-player tournament, we see that bets are higher in all four-player tournaments, in all rounds. We also see that bets are consistently higher in the two win-info treatments, where information about the winner's actions was available, than in the Noinfo4 treatment where this information was not available.

[4] z- and p-values from a test of the equality of proportion of bet equal to zero. For WinInfo4H vs. WinInfo4L, z=1.31 and p=0.19. For WinInfo4H vs. NoInfo4, z=-4.68 and p<0.01. For WinInfo4L vs. NoInfo4, z=-3.47 and p<0.01. And for NoInfo4 vs. NoInfo2, z=12.12 and p<0.01.

[5] z- and p-values from a test of the equality of proportions of bet equal to 100. For WinInfo4H vs. WinInfo4L, z=2.40 and p=0.02. For WinInfo4H vs. NoInfo4, z=-5.99 and p<0.01. For WinInfo4L vs. NoInfo4, z=-8.03 and p<0.01. And for NoInfo4 vs. NoInfo2, z=-3.49 and p<0.01.

[6] See Table A1 in the appendix for mean and standard deviation by round and treatment.

Figure 1: Mean and median bet over time



The two win info treatments also exhibit the same time pattern. The difference in ECU-multipliers seems not to affect the average betting significantly in any round. One possible critique of the design is that subjects might be confused about the aim of experiment, and erroneously try to maximize ECU rather than the cash prizes. If this is true one should expect to observe a difference between the two win-info treatments. In WinInfo4L any investments are multiplied by a factor of four if the subject wins the lottery, while in WinInfo4H the multiplier is 10. Thus, if subjects try to maximize ECUs, this is clearly more attractive in WinInfo4H, and one should expect higher investments here. But as shown in Figure 1 and Table 1 (and in table A1 in appendix), we observe no difference in average bets between WinInfo4L and WinInfo4H. The Mann-Whitney U-test for differences in bets between the two treatments also turns out insignificant, with z=-0.17 and p=0.86.

While the ECU multiplier does not play a role, information does. Recall that the only difference between NoInfo4 and WinInfo4L is that in the latter, subjects receive feedback on how many ECU the winner achieved during the previous round, while this information is not available in NoInfo4. One could then think that since subjects in WinInfo4L receive information about winning bets[7] and successful strategies, they would learn to play the optimal strategy more quickly, and the average bet should thus be lower in WinInfo4L compared to NoInfo4. But we observe the exact opposite. The average bet in NoInfo4 is significantly lower than in WinInfo4L (and WinInfo4H). Thus, the feedback effect seems to make subjects bet more in the lottery instead of pulling it in the direction of zero.

[7]Subjects receive information about the winner's bet indirectly through the information about the winner's ECUs.

Table 2: Mann-Whitney U-test for differences in bet

	WinInfo4L vs. z- vaule	NoInfo4 p- value	NoInfo2 vs. z- vaule	NoInfo4 p- value
Round 1	1.312	0.19	-1.272	0.204
Avg. Bet round 1 - 5	2.557	0.011	-2.314	0.021
Avg. Bet round 6 - 10	2.29	0.022	-3.472	<0.001
Avg. Bet round 11 - 15	1.992	0.046	-3.402	<0.001
Avg. Bet round 1 - 15	2.56	0.011	-3.387	<0.001

Note: The table presents z-value and p-value for differences in betting between WinInfo4L and NoInfo4, and between NoInfo2 and NoInfo4. The unit of measure is the average bet within rounds 1 - 5, 6 - 10, 11 - 15 or 1 - 15, respectively. Thus, we have only one observaion per subject. Number of observations: 56 for WinInfo4L and 40 for NoInfo2 and NoInfo4.

Table 2 presents Mann-Whitney U-tests for differences between WinInfo4L and NoInfo4, as well as between NoInfo4 and NoInfo2. [8] We look at average bet in round 1, early rounds (round 1 – 5), mid rounds (6 – 10), final rounds (round 11 – 15) and the average for all fifteen rounds. The difference between WinInfo4L and NoInfo4 is significant for all time periods except in round 1. There is also a significant difference between NoInfo4 and NoInfo2 for all time periods, except for round 1. These results are consistent with our hypothesis that competition per se induces risk-taking in the form of increased bets.

Time may trigger learning. One should expect that some subjects learned the optimal bet as they played more rounds and got more experienced, and moreover that this would be easier in the information treatments. But from Figure 1 and Table A1 in the appendix, it is not easy to see evidence for a general trend of lower bets, nor for an information effect of more learning in WinInfo4L or WinInfo4H. The only treatment where it is clear that subjects have reduced their betting is in NoInfo2. In the other treatments there may be a tendency of lower average bets in later rounds, but the patterns are not clear. However, Figure 2 shows that in all treatments more subjects chose to bet zero in later rounds compared to earlier rounds, indicating that (at least) some subjects learn to play the optimal strategy. For the two win info treatments there is a steady increase in bets equal to zero, starting from around 10% in round 1 and increasing to 21% (WinInfo4H) and 34% (WinInfo4L) in round 15. In the least competitive tournament, NoInfo2, 35% of the subjects chose zero in round 1 and by round 15 as many as 75% of the subjects chose zero. The smallest increase in zeroes is found in NoInfo4, where the proportion of zeroes goes from 20% in round 1 to 28% in round 15. The increase in zeroes observed in all treatments could indicate that subjects learn to play the optimal strategy and, as seen in Table 3, the proportion of bets equal to zero is significantly higher in later rounds (rounds 11 – 15) compared to early rounds (rounds 1 – 5) in all treatments but NoInfo4.

[8] See Table A2 in appendix for test results for all combinations of treatments.

Table 3 also presents Mann-Whitney tests comparing bets in rounds 1 – 5 with bets in rounds 11 – 15 within treatment. Here the only significant difference is found in NoInfo2. This is consistent with Figure 1, where we saw that average bets do not change much during the experiment.

Figure 2: Proportion of bets equal to zero, by treatment and over time.

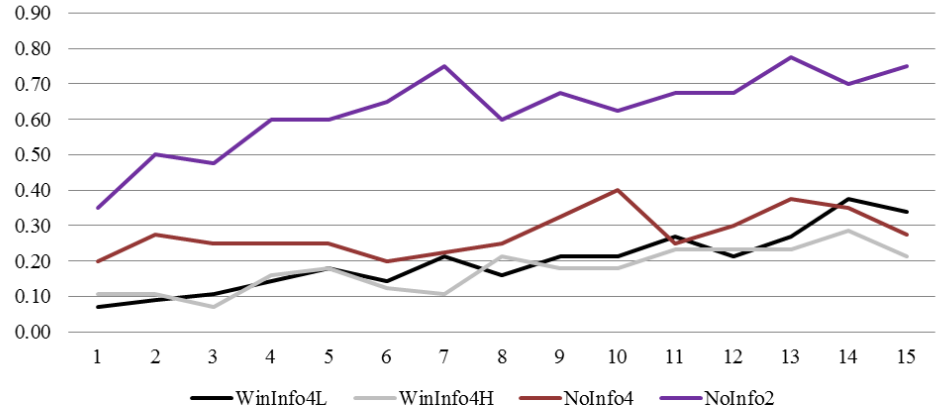


Figure 3: Proportion of bets equal to 100, by treatment and over time.

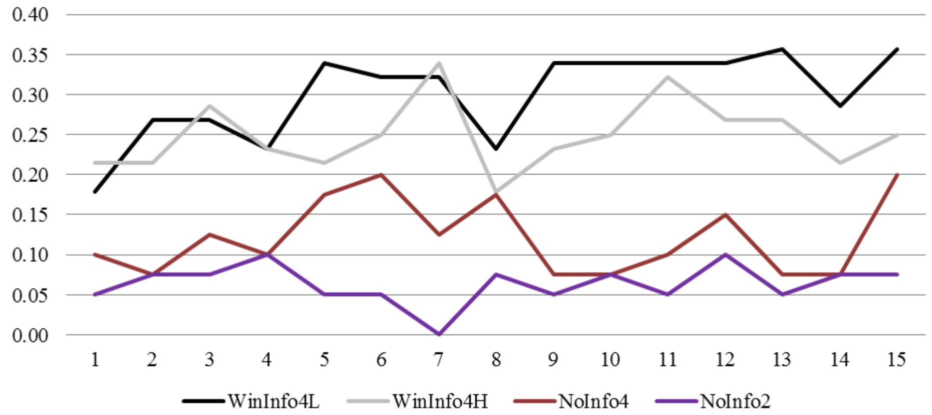


Table 3: Proportion of bets equal to zero in early- and late rounds.

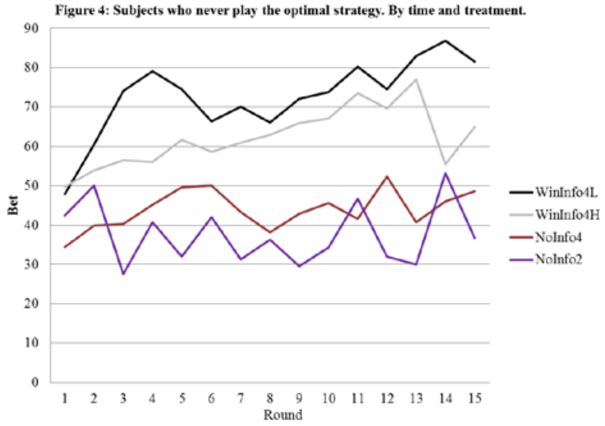
	Test of equality of proportions				Mann-Whitney U-test			
	Proportion of bet = 0 in:				Average bet in:			
	Round 1 - 5	vs. Round 11 - 15	z-value	p-value	Round 1 - 5	vs. Round 11 - 15	z-value	p-value
WinInfo4H	0.13	0.24	3.50	<0.01	52.20	49.42	-0.46	0.64
WinInfo4L	0.12	0.29	5.13	<0.01	51.67	49.42	-0.35	0.73
NoInfo4	0.25	0.31	1.45	0.15	37.93	36.36	-0.72	0.47
NoInfo2	0.51	0.72	4.31	<0.01	23.77	15.28	-2.43	0.02

Note: The table presents tests of equality of proportions for the four treatments. The right hand side of the table present within treatment differences in average bet and corresponding Mann-Whitney U-test. For the Mann-Whitney U-test we use one observation per subject and number of observations are 56 for WinInfo4H and WinInfo4L and 40 for NoInfo2 and NoInfo4.

Figure 3 presents the share of subjects that chose to bet the maximum amount of 100. We see that bets of 100 increase over time in WinInfo4L, while there is not a clear tendency in the other three treatments. Table A3 (in the appendix) shows that the proportion of bets equal to the maximal amount is significantly higher in rounds 11 - 15 than in rounds 1 – 5 in WinInfo4L (test of equality of proportions; z=2.04, p=0.02). For the three other treatments the difference in proportions are insignificant. However, as presented earlier, we find significant differences in the proportion of bets equal to 100 between treatments. While some subjects eventually start to bet zero during the experiment, some subjects increase their betting as time goes. In total, more than half of the subjects in WinInfo4H (54%) never played the optimal strategy. The percentage of subjects never betting zero in WinInfo4L is lower, at around 26%, while in NoInfo4 38% of the subjects never played the optimal strategy. In NoInfo2, as many as 90% played the optimal strategy at least once during the experiment.

In Figure 4 (and Table A4 in appendix) we see how subjects that never play the optimal strategy actually increase their bets during the 15 rounds of the experiment. The pattern is most profound in the two win info treatments, and we find significant differences between the win info treatments and the no info treatments.[9] In WinInfo4L the average bet by subjects who never play the optimal strategy is 67.2 in the first five rounds, while it is 81.2 in the final five rounds (significant difference at p=0.053).[10]

Figure 4: Subjects who never play the optimal strategy. By time and treatment.



In Table 5 we present random effects Tobit regressions where we account for the panel nature of our data and the restrictions we have on the choice variable *bet* due to the experimental design. In Model (A) through Model (D) we make use of data from all four treatments, while in Model (E) we focus on WinInfo4L and WinInfo4H.

The following covariates are used in the five different model specifications: the treatment dummies *WinInfo4H, NoInfo4 and NoInfo2*, leaving WinInfo4L as the reference; *# of tournaments won,* which

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[9] z- and p-values from a Mann-Whitney U-Test for differences in bets among subjects that never played the optimal strategy: WinInfo4H vs. WinInfo4L, z=1.29 and p=0.20. WinInfo4H vs. NoInfo4, z=2.16 and p=0.03. WinInfo4L vs. NoInfo4, z=2.82 and p<0.01. Test is not performed for NoInfo2 due to few observations. The unit of measure is the average bet within rounds 1 – 15. Thus, we have only one observation per subject. Number of observations: 14 in WinInfo4L, 30 in WinInfo4H and 15 in NoInfo4.

[10] For WinInfo4H the average bet by subjects who never play the optimal strategy is 55.6 in the first five rounds, while it is 68.9 in the final five rounds. Mann-Whitney U-test: z=1.696, p=0.090. In both comparisons we use only one observation per subject.

indicates the accumulated number of tournaments an individual has won. We also include dummies for whether a subject won in the lottery in the previous round, and a dummy for whether a subject won the tournament in the previous round. Important controls such as the gender variable *Male* and the time variables *Block2* and *Block3* are also included. The time variables are constructed by dividing the 15 rounds of the experiment into blocks of five rounds. Thus Block2 is a dummy for rounds 6 – 10, while Block3 is the corresponding dummy for rounds 11 – 15. This leaves rounds 1 – 5 as reference. In order to further investigate the behavior of subjects that never played the optimal strategy, we included the dummy variable *Dummy: never bet = 0*. This variable equals one if the subject never played the optimal strategy during the 15 rounds, and zero if the subject played bet equal to zero at least once during the experiment. We also interact this variable with the time dummies to investigate the effect of time on betting behavior in subjects that always choose to bet a positive amount in the lottery. Finally, we add the variable *ECU winner in t-1,* which gives the amount of ECU's of the tournament winner in the previous round. We also included the interaction *ECU winner in t-1 x WinInfo4H* to see if there were treatment differences in how observing winning ECUs affected betting.

Table 5: Random effects Tobit regression on bets for full sample and for the two win-info treatments

	Model (A)		Model (B)		Model (C)		Model (D)		(E) WinInfo4L & WinInfo4H	
Bet in round t :	Coef.	st.err	Coef.	st.err	Coef.	st.err	Coef.	st.err	Coef.	st.err
WinInfo4H	0.397	9.603	-15.785*	8.888	-15.836*	8.805	-15.884*	8.865	-12.743	9.704
NoInfo4	-30.610***	10.547	-37.962***	9.628	-38.072***	9.538	-37.974***	9.603	-	-
NoInfo2	-79.943***	10.798	-65.545***	9.996	-63.301***	10.012	-64.626***	10.075	-	-
ECU winner in t-1	-	-	-	-	-	-	-	-	0.050***	0.018
ECU winner in t-1 x WinInfo4H	-	-	-	-	-	-	-	-	-0.034*	0.018
Dummy: won lottery t-1	-	-	1.419	3.393	1.409	3.395	1.149	3.375	-9.359*	4.954
Dummy: winner tournament t-1	-	-	-14.544***	3.169	-13.636***	3.227	-13.103***	3.213	-9.895**	4.478
# of tournaments won	-	-	-4.723***	0.849	-6.223***	1.317	-5.710***	1.321	-5.066***	1.844
Dummy: never bet = 0	-	-	53.791***	7.518	53.742***	7.448	38.432***	8.292	54.971***	9.068
Male	-	-	-6.585	7.045	-6.129	6.987	-6.385	7.034	7.113	9.210
Block2	-	-	-	-	2.952	3.269	-1.719	3.859	4.103	4.204
Block3	-	-	-	-	6.610	4.437	-6.637	5.011	4.194	5.704
Block2 x Dummy: never bet = 0	-	-	-	-	-	-	11.477**	5.818	-	-
Block3 x Dummy: never bet = 0	-	-	-	-	-	-	32.395***	5.927	-	-
Constant	55.256***	6.78	57.112***	6.805	56.194***	6.842	61.426***	6.998	41.581***	7.988
# subjects	*192*		*192*		*192*		*192*		*112*	
# observations	*2880*		*2688*		*2688*		*2688*		*1568*	
# uncensored	*1449*		*1317*		*1317*		*1317*		*823*	
# left censored	*858*		*826*		*826*		*826*		*305*	
# right censored	*573*		*545*		*545*		*545*		*440*	
Log likelihood	*-8958.372*		*-8140.201*		*-8139.077*		*-8123.428*		*-5092.687*	
σ_u^2	*48.461****	*3.081*	*42.539****	*2.889*	*42.077****	*2.873*	*42.442****	*2.891*	*40.942****	*3.603*
σ_i^2	*51.667****	*1.094*	*51.736****	*1.151*	*51.748****	*1.152*	*51.332****	*1.142*	*52.711****	*1.487*
ρ	*0.468*		*0.403*		*0.398*		*0.406*		*0.376*	

* Significance at the 10 percent level.
** Significance at the 5 percent level.
*** Significance at the 1 percent level.

Model (A) is simply a Tobit regression using only the treatment dummies as covariates. As expected we see that the coefficients of both NoInfo4 and NoInfo2 are negative and significant. A Wald test for equal coefficients confirms that NoInfo4 is different from NoInfo2 (Chi2=18.07, $p<0.001$). The regression confirms that bets in WinInfo4L and WinInfo4H are higher than bets in NoInfo4, and that bets in NoInfo4 are higher than those in NoInfo2.

In Model (B) we include controls for gender, whether subjects won the lottery or tournament in the previous round, the accumulated number of tournament wins and the dummy for subjects who never played the optimal strategy. First we notice that there is no significant difference between males and females. This is interesting since it is often found that women are more risk averse than men, and also that men are more competitive than women (Charness and Gneezy, 2012, Croson and Gneezy, 2009). We also find a negative and significant effect of winning the tournament in the previous round. Subjects who won the tournament in a given round tend to reduce their betting in the next round. The same is not true for subjects who won in the lottery; here the coefficient is insignificant. We also see that there is a relationship between betting and the number of times an individual has won the tournament. Subjects who have won the tournament many times bet less than subjects who have won fewer times or not at all. The dummy variable indicating whether subjects have chosen to bet zero or not during the experiment is, not surprisingly, positive and highly significant. This finding is consistent with what we saw in Table A4 and Figure 4. In Model (D) we see that subjects who never bet zero also tend to increase their bets as time goes. This can be seen by the positive and significant interaction terms between time and the dummy for never choosing zero. For subjects who do play the optimal bet of zero at least once, there is no significant effect of time on bet**.**

Finally, we look at Model (E) and especially how the winner's amounts of ECU's affect the opponents' betting. The coefficient is positive and significant, and one interpretation is that subjects increase their bets more if the winner in the previous round achieves a high amount of ECU compared to a low ECU. Thus, there exists a positive relationship between the amount of ECU the winner of the previous tournament had, and how many ECU the other subjects bet in the following round. But there is also a treatment difference, with the effect being stronger in WinInfo4L than in WinInfo4H, as can be seen by the significant interaction variable *ECU winner in t-1 x WinInfo4H*.

The significance of the ECU variable indicates that subjects are affected by their peers and that some individuals may learn the optimal strategy by observing successful peers. But there are also some subjects that do the opposite. Additionally, as seen in Model (D), subjects who never bet zero tend to increase their bets in later rounds. Thus, we observe both good and bad learning in our data.

In Table 6 we present Random effects Probit regressions where the likelihood of choosing bet equal to zero is our dependent variable. First, the probability of observing bets equal to zero is significantly higher in NoInfo2 compared to WinInfo4L, while there is no difference between WinInfo4L and

WinInfo4H or NoInfo4. But there are clear differences within treatments. It is more likely that subjects bet zero in rounds 6 – 10 than in rounds 1-5, and the probability is even higher in rounds 11 – 15. This pattern is the same for all four treatments, and is consistent with what we saw in Figure 2. [11] We also find gender effects. From Model (B) we see that overall, male subjects are more likely to bet equal to zero compared to women. But in a model specification where we interact male by treatment we find that the gender effect is only significant for NoInfo2. [12]

Table 6: Random effects Probit regression on bet equal to zero, full sample and win-info treatments

	(A) full sample		**(B) full sample**		**WinInfo4L & WinInfo4H**	
P(bet=0)	Coef.	st.dev	Coef.	st.dev	Coef.	st.dev
WinInfo4H	-0.435	0.297	-0.407	0.277	-0.342	0.246
NoInfo4	0.207	0.318	-0.002	0.298	-	-
NoInfo2	1.825***	0.314	1.448***	0.299	-	-
Bet t-1	-	-	-0.008***	0.001	-0.007***	0.001
Dummy: won lottery t-1	-	-	-0.003	0.100	0.010	0.137
Dummy: winner tournament t-1	-	-	0.172*	0.088	0.328**	0.129
Rounds 6 - 10	-	-	0.263***	0.091	0.247**	0.126
Rounds 11 - 15	-	-	0.608***	0.091	0.633***	0.125
Male	-	-	0.571***	0.219	0.381	0.265
Dummy: observe ECU =100	-	-	-	-	0.464***	0.132
Constant	-1.243***	0.205	-1.344***	0.220	-1.457	0.224
# subjects	*192*		*192*		*112*	
# observations	*2880*		*2688*		*1568*	
Log likelihood	*-1121.773*		*-983.767*		*-542.022*	

* Significance at the 10 percent level.
** Significance at the 5 percent level.
*** Significance at the 1 percent level.

The time variables Block2 and Block3 are positive and significant, indicating that more subjects play the optimal strategy in later rounds. In the rightmost column we present a Probit regression where we only include data from WinInfo4L and WinInfo4H. Again we find a positive and significant time effect, where the probability of choosing zero increases over time. Since subjects in the win info treatments receive information about the winner's ECU, we include a dummy which is equal to one if subjects observe ECU = 100 (corresponding to a bet of zero), and zero for all other ECU-values. This coefficient is positive and significant, indicating that subjects learn from their peers, or at least are more likely to choose the optimal strategy if they observe someone else doing this.

[11] We found no significant difference in a model specification where we included the interaction between block2/block3 and the different treatments.

[12] See appendix Table A5 for regression results.

Concluding remarks

We construct tournaments in which subjects make lottery choices in order to win the tournament, but where the only rationalizable strategy is to bet zero in the lottery. Betting in the lottery appears to be a risky strategy, but it has no gain in terms of higher expected profits. Hence, our experimental subjects are induced to take risk, but in reality they do not. We still choose to label bets above zero as excessive risk-taking, since the (majority of) subjects apparently bet in order to win the tournament. Moreover, we can be sure that bets above zero really are "excessive", since there do not exist any risk preferences that can justify these decisions. Finally, by keeping the optimal strategy constant, while varying the competitiveness in the tournaments, we are able to investigate the relationship between competitiveness and the degree of *excessive* risk-taking, i.e. we do not need to take into account how changes in tournament type change the real risk, because they do not.

Accepting this notion of excessive risk-taking, we present evidence that competition per se induces excessive risk-taking. Increasing the number of contestants and giving feedback about the tournament winners' decisions increases the degree of excessive risk-taking. In the most competitive tournament, less than 10% of the subjects played the optimal strategy in the first rounds. This increased steadily during the 15 rounds to just above 30% in the last round. We also find strong peer effects. The amount of ECU that a tournament winner achieved in round t-1 had a strong and significant effect on the other competitors' risk-taking in round t. But these peer effects where not only positive. Those playing dominated strategies tend to increase risk-taking during game of play, in particular in the treatments where subjects received information about the winner, indicating learning from peers may lead to inferior decisions.

Our experiment identifies a causal relationship between competitiveness and excessive risk-taking, but we cannot give a definite answer for why we see this relationship. Our conjecture is that people are prone to use simple heuristics when taking risk in tournaments: No guts no glory, et cetera. To some extent this is supported by the way subjects respond to variations in lottery type (x). One potential mistake is to pay attention to the lottery outcome instead of the tournament outcome, i.e. to focus on the expected amount of ECU rather than the probability of winning the tournament. If this is important, we should expect significantly higher betting levels when the ECU gain is higher, i.e. when x=10 rather than when x=4. Interestingly, the value of x had a surprisingly small effect, implying that subjects focused on winning the tournament, not winning the lottery. This correct focus did not prevent the large majority from playing dominated strategies, supporting the idea that subjects take risk as "a rule of thumb". However, in order to nail this explanation, more research is needed.

APPENDIX

Table A1: Mean and standard deviation for all rounds, by treatment.

	WinInfo4H		WinInfo4L		NoInfo4		NoInfo2	
Round	Mean	St. dev	Mean	St. dev	Mean	St. dev	Mean	St. dev
1	48.88	36.46	47.52	31.28	39.73	33.84	31.30	32.90
2	53.23	36.26	52.88	37.23	36.23	34.76	27.88	34.88
3	55.54	37.54	53.79	36.68	40.03	37.12	21.00	31.79
4	51.70	38.17	50.30	38.41	35.25	35.76	23.20	34.75
5	51.66	40.01	53.86	41.96	38.40	36.82	15.45	28.99
6	55.39	37.87	52.09	40.29	44.28	42.60	14.33	28.59
7	61.48	36.95	49.27	42.29	38.83	37.74	9.63	22.46
8	46.29	37.37	48.18	40.42	35.90	39.57	17.00	30.02
9	53.70	37.64	49.27	43.66	30.95	34.94	13.73	27.50
10	56.68	37.28	52.61	43.27	28.40	37.06	17.68	30.92
11	56.55	41.84	50.29	44.35	36.15	37.09	14.93	27.73
12	50.04	41.31	52.80	42.75	38.48	39.70	16.70	33.13
13	53.00	41.00	53.36	44.85	27.33	35.35	12.25	28.53
14	39.63	39.90	43.96	45.60	36.13	40.96	17.83	34.32
15	47.88	41.24	46.70	45.29	43.73	43.37	14.68	31.80
Total	52.11	38.77	50.46	41.15	36.65	37.73	17.84	30.88
Number of subjects:	56		56		40		40	
Male/female:	17/39		16/40		20/20		20/20	

Table A2: Mann-Whitney U-test for differences in bet

	WinInfo4L vs. WinInfo4H		NoInfo2 vs. WinInfo4H		WinInfo4H vs. NoInfo4		WinInfo4L vs. NoInfo2	
	z- vaule	p- value	z- vaule	p- value	z- vaule	p- value	z- vaule	p- value
Round 1	0.053	0.958	2.519	0.012	1.243	0.214	-2.666	0.008
Avg. Bet round 1 - 5	-0.096	0.924	4.493	<0.001	2.212	0.027	-4.744	<0.001
Avg. Bet round 6 - 10	-0.839	0.402	6.175	<0.001	2.941	0.003	-5.733	<0.001
Avg. Bet round 11 - 15	0.023	0.981	5.077	<0.001	1.724	0.085	-5.170	<0.001
Avg. Bet round 1 - 15	-0.172	0.864	5.717	<0.001	2.583	0.010	-5.891	<0.001

Note: The table presents z-value and p-value for differences in betting between WinInfo4L and WinInfo4H, NoInfo2 and WinInfo4H, WinInfo4H and NoInfo4, and between WinInfo4L and NoInfo2 The unit of measure is the average bet within period 1 - 5, 6 - 10, 11 - 15 or 1 - 15, respectively. Thus, we have only one observaion per subject. Number of observations: 56 for WinInfo4L and WinInfo4H; 40 for NoInfo2 and NoInfo4.

Table A3: Proportion of bets equal to one hundred in early and late rounds.

	Test of equality of proportions			
	Proportion of bet = 100 in:			
	Round 1 - 5	vs. Round 11 - 15	z-value	p-value
WinInfo4H	0.26	0.34	2.04	0.04
WinInfo4L	0.23	0.26	0.88	0.38
NoInfo4	0.12	0.12	0.16	0.88
NoInfo2	0.07	0.07	0.00	1.00

Note: The table presents within treatment differences of equality of proportions for the four treatment:

Table A4: Betting behavior over time by subjects who never play the optimal strategy.

Round	Bet = 0 during exp.	Bet > 0 in all rounds	Bet = 0 during exp.	Bet > 0 in all rounds	Bet = 0 during exp.	Bet > 0 in all rounds	Bet = 0 during exp.	Bet > 0 in all rounds
1	47.88	49.73	47.38	47.93	42.88	34.47	30.06	42.50
2	52.46	53.90	50.36	60.43	34.04	39.87	25.42	50.00
3	54.42	56.50	47.00	74.14	39.84	40.33	20.28	27.50
4	46.73	56.00	40.69	79.14	29.32	45.13	21.25	40.75
5	40.08	61.70	46.95	74.57	31.64	49.67	13.61	32.00
6	51.62	58.67	47.31	66.43	40.84	50.00	11.25	42.00
7	62.12	60.93	42.33	70.07	36.12	43.33	7.22	31.25
8	27.12	62.90	42.19	66.14	34.52	38.20	14.86	36.25
9	39.50	66.00	41.64	72.14	23.80	42.87	11.97	29.50
10	44.62	67.13	45.52	73.86	18.08	45.60	15.83	34.25
11	36.92	73.57	40.31	80.21	32.92	41.53	11.39	46.75
12	27.38	69.67	45.55	74.57	30.16	52.33	15.00	32.00
13	25.42	76.90	43.50	82.93	19.28	40.73	10.28	30.00
14	21.38	55.43	29.67	86.86	30.16	46.07	13.89	53.25
15	28.15	64.97	35.10	81.50	40.76	48.67	12.22	36.75
1 - 15	40.39	62.27	43.03	72.73	32.29	43.92	15.64	37.65
Number of subjects:	26/56	30/56	42/56	14/56	25/40	15/40	36/40	4/40

Note: The first column within each treatment give the average bet by subjects that played the optimal strategy at least once during the experiment. The second column gives the average bet for subjects that never played the optimal strategy.

Table A5: Random effects Probit regression on bet equal to zero, gender interactions.

	Model (A)	
P(bet=0)	Coef.	st.err
WinInfo4H	-0.404	0.327
NoInfo4	0.161	0.383
NoInfo2	0.994***	0.376
Bet t-1	-0.008***	0.001
Dummy: won lottery t-1	-0.005	0.100
Dummy: winner tournament t-1	0.172*	0.089
Rounds 6 - 10	0.263***	0.091
Rounds 11 - 15	0.609***	0.091
Male	0.372	0.412
Male x WinInfo4H	0.023	0.595
Male x NoInfo4	-0.0246	0.608
Male x NoInfo2	1.039*	0.609
Constant	-1.283***	0.239
# subjects	*192*	
# observations	*2688*	
Log likelihood	*-981.306*	

* Significance at the 10 percent level.
** Significance at the 5 percent level.
*** Significance at the 1 percent level.

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