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When Do Groups Perform Better than Individuals? A Company Takeover Experiment

Marco Casari
Jingjing Zhang
Christine Jackson

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Marco Casari

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Abstract

It is still an open question when groups will perform better than individuals in intellectual tasks. We report that in a company takeover experiment, groups placed better bids than individuals and substantially reduced the winner's curse. This improvement was mostly due to peer pressure over the minority opinion and to group learning. Learning took place from interacting and negotiating consensus with others, not simply from observing their bids. When there was disagreement within a group, what prevailed was not the best proposal but the one of the majority. Groups underperformed with respect to a "truth wins" benchmark although they outperformed individuals deciding in isolation.

JEL Classifications : C91, C92, D03, D81

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* Corresponding Authors: M. Casari, University of Bologna, Department of Economics, Piazza Scaravilli 2, 40126 Bologna, Italy, phone +39-051-209 8662, marco.casari@unibo.it; J. Zhang, Chair for Organizational Design, Department of Economics, University of Zurich, Blümlisalpstrasse 10, CH-8006, Zürich, jingjing.zhang@econ.uzh.ch; C. Jackson, Purdue University, Krannert School of Management, 403 W. State St., W. Lafayette, IN 47906-2056, jackson2@purdue.edu.

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A Company Takeover Experiment

1. Introduction

Many important economic, legal, political, and military decisions are made by groups. Can groups make better decisions than individuals in isolation? Existing empirical results are mixed. For instance, Cooper and Kagel (2005) report that small groups in strategic tasks deliver outcomes beyond the most optimistic expectations i.e., better than those from the most skilled individual in the group. In contrast, other studies report no difference or even worse performance of groups relative to individuals (Davis, 1992; Kerr et al., 1996; Sutter et al., 2009).

The aim of this study is to provide evidence of group superiority (or inferiority) to individuals in a well-known negotiation task, to shed light on the possible explanations of the differences between individual and group decisions, and to deliver punctual implications about when to employ groups rather than individuals in decision making. To fulfill this aim, we compare individual and group performances in a company takeover experiment.

Consider a company takeover as in Samuelson and Bazerman (1985), where a potential buyer wants to acquire a company because it will be worth more under his or her management than under the potential seller's management. The buyer makes a take-it-or-leave-it offer to a seller who can either accept or reject. The interaction is non-trivial because the seller has more accurate information than the buyer about the value of the company. In experiments individuals hardly place optimal bids and many individuals actually acquire the company but incur losses; moreover they fail to correct their choices over time. This behavioral phenomenon is known as winner's curse and should not occur if agents are rational. Yet it is remarkably robust both in laboratory and field situations (Kagel and Levin, 2002).[1] Understanding if groups overcome the winner's curse is relevant for a variety of situations, for instance common-value auctions and other negotiation contexts. The company takeover game is much simpler than a multi-person auction and hence may provide a cleaner view of bidders' decision making processes (Charness and Levin, 2009). While optimal bidding in auctions depends on involved calculations, belief about other's rationality, and on strategic uncertainty, such considerations are absent in this task.[2] To the best of our knowledge, this is the first experiment investigating groups' behavior in a company takeover game.

The experiment presents four innovative features. First, we isolate the group impact in performing the task from the group impact in shifting risk attitude. Second, we investigate what aspects of group decision-making affect performance, whether it is group communication and negotiation or the simple exposure to choices of others. Third, we perform a micro-level analysis of the group processes for reaching a consensual choice. Before the group discussed possible bids, each participant was required to post a bid proposal for the team to consider. This piece of information allows us to identify the precise aggregation rule that is used to determine a group's bid *within each group* and see if what emerged was the best proposal (truth-wins norm, Lorge and Solomon, 1955), the median proposal, the proposal of the majority, the worst proposal, a rotation scheme, or other rules. Fourth, every group member had veto power on the final bid. If

[1] Field evidence has been accumulated for a variety of economic situations, from mineral right auctions, eBay auctions, to baseball's free agency market, to IPOs pricing and to corporate takeovers (e.g., Bajari and Hortacsu, 2003). However, through laboratory experiments one can cleanly control the cost and information structure of the interaction in ways unfeasible in the field.

[2] "the origin of this phenomenon [winner's curse] must stem from some form of bounded rationality, such as the decision maker's failure to recognize that a "future" event, per se, is informative and relevant for their current decisions, compounded by poor updating when this idea is even considered." Charness and Levin (2009).

there was disagreement on the group choice, everyone in the group earned zero. This generated strong incentives to communicate and to negotiate within the group.[3]

We report that groups substantially reduced the winner's curse and generally placed better bids than individuals deciding in isolation. Groups did however underperform with respect to a "truth wins" benchmark, although they outperformed individuals. This result was attributed to both the effect of group learning *and* the aggregation rule within the group. When there was disagreement within a group, what prevailed was not the best but the opinion of the majority. This result is not an unconditional endorsement of the superiority of groups over individuals, but leads to punctual implications about when to employ groups and when to employ individuals in decision making.

The remainder of the paper is organized as follows. Section 2 reviews literature on the winner's curse and group decision-making. Section 3 describes theoretical predictions, experimental design and procedures for the present study, and Section 4 reports the main results of our study. Section 5 examines alternative explanations for the superiority of groups over individuals, while Section 6 analyzes the content of group communication during the company takeover task. Section 7 concludes with practical implications of the study findings.

2. Literature Review

Two experimental studies employed groups as bidders in auctions. Cox and Hayne

[3] Existing studies of group decision making greatly differ on this point, which crucially affects the incentives for communicating with others and for convincing others of one's opinion (Zhang and Casari, 2011). Cooper and Kagel (2005) randomly select one member's proposal as the group choice. Blinder and Morgan (2005) and Gillet et al. (2009) either implement a majority rule or give members no time limit to reach a unanimous decision. Kocher and Sutter (2007) is the most closely related paper with a veto power feature. In a gift-exchange game, Kocher and Sutter allowed groups of three up to 10 rounds to reach agreement. If there was no agreement in the 10^{th} round, each group member received only a show-up fee of $20. Only one group failed to reach an agreement. They didn't analyze the effect of such veto power though. Kagel et al. (2010) studied the veto power in a committee where only one of the three committee members is a veto player.

(2006) compare the performance of individuals and groups of five members in a sealed-bid common value auction. Groups performed better when the information was common to all group members rather than when there was a need of information sharing within the group. In the former case, individuals deciding within groups earned more than when deciding in isolation. In the latter case, earnings were roughly equivalent. Our design resembles to the treatment with common information among all group members, hence it relieves groups from the additional burden of information sharing. Sutter et al. (2009) compare the performance of individuals and groups of three members in an English auction with a private and a common value component. : They report that groups submitted more winner's curse bids and therefore earned lower profits than individual bidders. They attribute this findings to individual-group differences toward competition, i.e., groups competing with other groups are more aggressive than individuals competing with other individuals, which is absent in our design as there is just one buyer and the seller is a robot. Moreover, bidders can more easily explain to others the rationale for an optimal bid in our company takeover task than in a common value auction. One reason is that the optimal strategy does not depend on the bids of others.[4] In Section 7 we will come back to the above studies and interpret the results in light of our findings.

This study is also related to other company takeover experiments. We reviewed eight available experimental studies that have utilized the company takeover game in the economics and management literature.[5] In all of these studies, decision makers were individuals. In none of them, does the winner's curse disappear with a reasonable amount of experience and feedback.

[4] A typical quote on reasoning of the optimal bid in the company takeover game is: "let's not go with 90 because the only way we can make money is if its [the company value] 90. [the company value] might as well go with 60, it came out less times, and if 38 comes out we don't lose as much and 60 makes the most economic sense."

[5] Ball, Bazerman, Carroll (1991), Charness and Levin (2009), Holt and Sherman (1994), Selton, Abbink, and Cox (2005), Bereby-Meyer and Grosskopf (2008), Grosskopf, Bereby-Meyer, Bazerman (2007), Carroll, Delquie, Halpern, Bazerman (1990), Tor and Bazerman (2003). See detailed design comparison in Table A1.

Indeed, individuals in these studies failed to avoid the winner's curse even when they were paid for good performance, when their intellectual reputations were at stake, when they were given hints, and when unusually analytical participants were used.

In the current experiment, we followed the state-of-the art design features for company takeover studies. First, some studies place the equilibrium bid at the corner of the choice space, either at 0% or 100%, or in the middle at 50%. We changed this to avoid classifying noisy players as mostly out of equilibrium or mostly at equilibrium (Holt and Sherman, 1994, Selton et al., 2005). Second, most of the studies on the company takeover game found a very high share of sub-optimal bids, suggesting that the task is well beyond the ability of participants to solve it. Following Charness and Levin (2009), in our experiment the task was simplified by adopting a discrete and small set of company values for the seller. Third, existing studies have varied in repeating the task from 1 to 100 but generally have found that a very slow improvement in performance with repetition. We had participants repeat the task 26 times, which still allowed us to detect learning. Fourth, all studies used robot sellers, so do we, with the exception of Carroll et al. (1990, treatments 5 and 6 only).

Our company takeover game is closer to an intellectual task rather than a judgemental task because it is straightforward to explain to others once a subject understands what the optimal bid is.[6] In comparing individual and group performance in intellective task, Lorge and Solomon (1955) proposed to replace absolute performance of the group with the “truth wins” benchmark (i.e., the group should be able to achieve a correct answer if at least one member would have chosen it in isolation). Thus, if a fraction p of individuals working alone reaches the

[6] The psychological literature on group versus individual decision-making distinguishes between judgmental and intellective tasks. A judgemental task involves problems where there is no obvious “correct” action and individuals may legitimately differ on their choices because of their values or preferences.). In contrast, an intellective task has a demonstrably “correct” solution. While this solution may be difficult to discover, it is self-explanatory once discovered and can easily be demonstrated to others

correct solution, the probability that in a randomly selected group of n persons at least one knows it is $1 - (1\text{-}p)^n$. The truth wins benchmark sets a higher standard for the group superiority than absolute performance. While the management literature on intellective tasks suggests that the absolute performance of groups is superior to the performance of individuals (Laughlin et al., 2003), research on group performance in the psychology literature documents that freely interacting groups very rarely exceed and usually fall below the truth wins standard (Davis, 1992, Kerr et al., 1996).

Results from experimental economics on group performance in intellective tasks are more mixed. In a beauty-contest game, Kocher and Sutter (2005) found that groups of three subjects did not do more iterations of reasoning than individuals, but learned faster than individuals via face to face communication. In signalling games, Cooper and Kagel (2005, 2009) reported that teams of two play more strategically than individuals after exchanging messages in online chat rooms and a change in the meaningful context of the game stalled individual learning process but had no effect on the strategic play of teams. They conclude that teams outperformed the truth win benchmark using a simulation of team play based on randomly drawing two individuals from the individual treatment. Instead of relying on simulated data, our within-subject design allows us to count the instances in which the optimal proposal from the individual member prevailed to a final group choice. Also, we examined team play in groups of three rather than two, which permits interesting majority or minority behaviour.

3. Experimental Design

There were three treatments following distinct decision making processes: individual decision making (*Individual treatment*), group decision making (*Group treatment*) and a treatment with individual decision making where a subject observed the bids of two other people (*Signal treatment*). Every session had 15 subjects facing a series of lotteries (parts 1 and 2) and then a series of company takeover games (parts 3 and 4).

The lottery tasks measured participants' risk attitude through a series of binary choices between a "safe" and a "risky" option. The elicitation of risk attitudes with both individual and group decision making may help in the interpretation of choices in the company takeover game. For instance, if there is a shift of risk attitude toward more risk averse choices in group decision making, groups may perform better than individuals subject to overbidding. The incentive structure was similar to that in Holt and Laury (2002). Participants chose between a deterministic earning (50 tokens) and a lottery with either a 150 earning or 0. A first measurement was carried out at the individual level using a multiple price list design with fifteen decisions (part 1) and then the same choices were repeated in a randomly formed group of three members (part 2). Group members had to submit unanimous choices after chatting. Only one decision from part 1 and one from part 2 were randomly selected for payment at the end of the session. More details are available in Zhang and Casari (2010).

The company takeover task included six initial periods of individual decision making (part 3), identical in all treatments, and twenty periods with different decision making processes across treatments (part 4). In the company takeover game there are a buyer and a seller who move sequentially (Samuelson, 1984, Samuelson and Bazerman, 1985). The buyer makes a take-it-or-leave-it offer $b \in \{0, 1, 2, \ldots, 360\}$ to a seller whose company's value is s. The seller either rejects or accepts the bid. The payoffs for the seller are s if he or she rejects and b if he or she accepts. The payoffs for the buyer are 0 if the seller rejects and $(1.5s - b)$ if he or she accepts. The company can have five possible values, $s \in \{38, 60, 90, 130, 240\}$. When making a decision, the seller has private information about *s*, while the buyer knows that each realization of *s* has equal probability. In the experiment, all subjects faced the company takeover game as potential buyers. Sellers were simulated by a computer that accepted bids only when the bid *b* was greater than or equal to *s*. This simplified game reduced the complexity of the strategic interactions between sellers and buyers and the possible misunderstanding of the game.

To sum up, the task was a bilateral bargaining problem with asymmetric information and valuations. The informational disadvantage of the buyer was offset by an assumption that the buyer's value is 1.5 times the seller value, *s*. A rational buyer has the following objective function (1), where $I_{\{b\geq x\}}$ equals 1 when the bid $b \geq x$ and 0 otherwise:

(1) Rational objective:

$$\Pr(b \geq s)\left[1.5 \cdot \left(\frac{38 \cdot I_{\{b\geq 38\}} + 60 \cdot I_{\{b\geq 60\}} + 90 \cdot I_{\{b\geq 90\}} + 130 \cdot I_{\{b\geq 130\}} + 240 \cdot I_{\{b\geq 240\}}}{I_{\{b\geq 38\}} + I_{\{b\geq 60\}} + I_{\{b\geq 90\}} + I_{\{b\geq 130\}} + I_{\{b\geq 240\}}}\right) - b\right]$$

(2) Naïve objective:

$$\Pr(b \geq s)\left[1.5 \cdot \left(\frac{38 + 60 + 90 + 130 + 240}{5}\right) - b\right]$$

A bid of 60 is the risk-neutral Nash equilibrium (RNNE) strategy for the buyer and yields an expected profit of 5.4. Table 1 shows buyer’s profits for the RNNE strategy and other bidding strategies. Instead, an incorrect reasoning may lead some participants to bid 90 and earn an expected profit of 2.4, which is sub-optimal. We computed this prediction following the Holt and Sherman (1994) model of naïve bidding (2) in order to select a design for the experiment with a rational bid lower than the naïve bid. A naïve bidder does not condition the value of the company on the level of the accepted bid, rather, assumes that the value is always the expected value of *s*, which is 111.6. As illustrated by the objective (2), a naïve bidder erroneously thinks a bid of 90 would yield an expected profit of 0.6·(1.5·111.6 – 90)=46.44. Instead, when placing a bid of 90, the company is sold only for values *s* 38, 60, 90 but not for 130 and 240. As illustrated by (1), the expected value conditional on being accepted is not 111.6, but (38+60+90)/3 = 62.66. Thus, the expected profit is 2.4 (Table 1). When the buyer does not take into account that acceptance is itself an informative event, the buyer may overbid and even incur an expected loss.

In selecting the parameters, we avoided the extremes values (i.e., 38 or 240) for the RNNE bid and the naïve bid (90) and set the equilibrium probability of acquiring the company at 40% in order to ensure that the participants stayed engaged in the task. There were five possible company values to position the task at an intermediate level of difficulty for our subject pool; two pilot experiments suggested that with three values the task was too easy and with one hundred values it was too difficult.[7]

To favor learning, each participant observed the company value at the end of each period – even when the company was not acquired. There was a practice period with forced input. In all treatments, the initial six periods involved individual decision making and every period the computer randomly drew 15 company values, one for each participant (part 3).

The rules in the following twenty periods differed by treatment (part 4). In the *Individual treatment,* the company takeover task continued to be individual decision making except that while submitting a bid, subjects also stated their confidence level in the bid (low, medium, high) and could add a brief text with reasons for the choice of that bid, which only the experimenter could observe.

In the *Group treatment*, participants faced the company takeover game in fixed groups of

[7] Another consideration was to have a naïve bid higher than the RNNE bid. After fixing the lower four company values one needs to add a very high maximum company value; we decided that the maximum bid would be 240, in order to put a large enough profit distance between the RNNE and naïve bid. According to expression (2), with a fifth company value a 240 value, the "profit distance" between a 60 and 90 bids is 7.5%. Instead, with an alternative value of 183 such bids yield equal profits.

three members, which were randomly formed at the beginning of the session.[8] Every period included a *proposal* phase, a *chat* phase, and a *bidding* phase. In the proposal phase, subjects submitted an individual bid proposal (an integer between 0 and 360), a confidence level in their proposal (low, medium, or high), and could also send a brief text explaining the proposed bid. This information was placed on a public board for all three group members to see. Participants then could switch to a chat window and had two minutes to send free-form messages to others in their groups.[9] Messages were recorded. In the bidding phase, subjects had up to three rounds to reach a consensus on their group bid without further possibility to chat. If there still was no unanimity, no group bid was submitted and group members earned zero profits for that period.

The *Signal treatment* was identical to the Individual treatment except that before submitting their bids, each participant could *observe the bids of two other people*. More precisely, we used the data from the Individual treatment sessions and displayed two bids independently placed by different people in that specific period.

To make the decisional process more comparable across treatments, all treatments followed the same random draw procedure in part 4. That is, every period the computer randomly drew five company values, one for each group of three persons.[10] . In the *Signal treatment* we employed the same random draws realized in the *Individual treatment* sessions.[11]

Participants started with a 200 token endowment in part 3 and a 300 token endowment

[8] Hence, group composition was identical in the lottery task in part 2 and in the company takeover task in part 4.
[9] In the chat window, participants received an id number 1-3 in the order they sent messages in that specific period. We asked participants to follow two basic rules: to be civil to one another and not use profanities, and not to identify themselves in any manner.
[10] In individual and signal treatments, even though there was no group decision making in part 4, the same company value was given to each members of the groups that were formed in part 2.
[11] Session dates were 27 Sep 07, 23 Oct 07 (Individual), 28 Oct 07(a), 28 Oct 07(b) (Signal), 25 Sep 07, 2 Oct 07, 4 Oct 07, 11 Oct 07 (Group). For the signal session 28 Oct 07 (a) we used the random draws of individual session Sep 27 and for signal session Oct 28b we used the random draws of individual session 23 Oct 07. Member 1 in the signal treatment observed the bids of members 2 and 3 of the Individual treatment. Member 2 in the signal treatment observed the bids of members 1 and 3 of the Individual treatment. Member 3 in the signal treatment observed the bids of members 1 and 2 of the Individual treatment.

and in part 4. In equilibrium, the individual period earnings were identical in all treatments. Subjects were paid for all periods. [12] The experiment included eight sessions for a total of 120 people; 60 people participated in the Group treatment, 30 in the Individual and 30 in the Signal treatments. Participants were randomly recruited from the undergraduate campus population of Purdue University and nobody participated in more than one session. Instructions were read aloud and subjects received a written copy. Sessions were run on a z-tree application (Fishbacher, 2007) and lasted on average about 2 hours. A subject earned on average about $20, with a guaranteed minimum payment of $5. We paid $0.03 for each experimental token.

4. Main Results

Given that the majority of bids were not optimal, in addition to examining the fraction of optimal bids, we present other measures of performance. *Winner's curse bids* are those that yield an expected loss, which are in the intervals (57, 60), (73.5, 90), or (94, 360). In expectation a subject is better off bidding 0, rather than placing a winner's curse bid. *Dispersed bids* are bids different from 38, 60, 90, 130, or 240. Participants should recognize that any bid in between 0 and 360 is weakly dominated by one of the bids above. We call these bids "dispersed," but exclude from the definition 39, 61, 91, 131, and 241 in case participants did not understand the tie-breaking rule. A dispersed bid is not optimal for either a rational or naive bidder.

Result 1*: The group treatment outperformed the individual treatment in the fraction of winners' curse bids and the fraction of dispersed bids.*

Table 2 provides support for Result 1. The group treatment exhibited significantly less

[12] Note that when cumulative earnings were low, there was a problem of limited liability, which we will discuss in the Result section. The instruction explained: "What if my earnings are negative? They will be compensated with your other gains. More precisely, if you have a loss in a single period, it will decrease your cumulative earnings. If your cumulative earnings in this part are negative, they will decrease your earnings in other parts of the experiment. However, if at the end of the session your earnings are negative, you will receive $5."

winners' curse bids (Mann-Whitney tests on part 4: n=30, m=60, p=0.058) and less dispersed bids (n=30, m=60, p= 0.007) than the individual treatment.[13] In addition, optimal bids are more frequent in the group treatment than in the individual treatment, but the difference was not significant (n=30, m=60, p= 0.168). In the data analysis, both 60 and 61 are treated as *optimal bids*.

In some cases overbidding may be rational because of limited liability issues. For instance a subject with a low cash balance can expect to earn more by bidding 240 instead of the equilibrium bid of 60.[14] In the data, these occurrences involved a total of five participants and only 1.2% of all bids. Hence, removing those observations affected by limited liability issues does not affect the main results. However, to avoid confounding effects, we dropped these observations from all regression analyses.

Result 2*: In the group treatment, there was a significant improvement in performance over time in terms of the fraction of optimal bids, winner's curse bids, and dispersed bids.*

Table 2 and Figures 1-3 provide support for Result 2. The fraction of optimal bids increased from an initial level of 30.6% to 50.5% in the group treatment. This difference between part 3 and part 4 was significant according to a Wilcoxon signed-rank test (N=60, p=0.0004). The fraction of winner's curse bids declined from an initial level of 18.3% to 9.75%, while the fraction of dispersed bids declined from 11.1% to 0.2%. These differences between part 3 and

[13] An observation is the fraction of bids in the relevant category for each subject in all 20 periods in part 4. We get similar results if we treat a group of 3 as an observation instead of 3 observations. The group treatment has also significantly more optimal bids (n=30, m=60, p= 0.006) than the signal treatment. All p-values reflect two-tailed tests in this paper, unless otherwise stated.

[14] Bidding 240 yields a 120 profit with probability 0.2 and a loss y with probability 0.8.The variable y is the minimum between the actual loss (i.e. 240 minus the value of the company) and the cash balance. If the cash balance is below y=23.25 the eventual loss is inconsequential. When y<23.25 the expected profit from a 240 bid are higher than 5.4 i.e. the expected profits from a 60 bid. Two caveats are in order. First, we guarantee $5 minimum earnings, which translates into 166.6 tokens, hence the relevant threshold for cash balances is 189.9. Second, the reference cash balance includes the expected earnings from part 1 and 2 lotteries, the part 3 and 4 endowments and the cumulative profits from the company takeover game up to that period.

part 4 were both significant according to Wilcoxon signed-rank tests (N=60, p=0.032; and N=60, p=0.002, respectively).

The process of making proposals in the group provides useful insights. The following findings come from a series of probit regressions to explain when an individual proposal was optimal or winner's cursed in the group treatment (Table 3, columns e and f). Robust standard errors with clusters on groups are used to eliminate intragroup correlations that may arise due to interactions with group members. First, more risk averse subjects were significantly less likely to make winner's curse proposals. This finding is in line with our conjecture that more risk averse participants would fall prey to winner's curse less often. Notwithstanding, risk preferences cannot account for why the group treatment outperformed the individual treatment (Result 1), as we will discuss later. Second, participants with high confidence in their proposals were less likely to make winner's curse proposals. Third, the fraction of optimal proposals significantly increased over time (negative coefficient on trend dummy 1/period), which is in contrast with the absence of improvement observed in the individual treatment. Fourth, there was no significant effect of major, skill, or gender on proposals.

Result 3*: In the individual treatment, there was no significant improvement in performance over time in terms of fraction of optimal bids, winner's curse bids, and dispersed bids.*

Table 2 reports evidence for Result 3. Overall, a minority of bids were optimal. The fraction of optimal bids were at an initial level of 35.6% and remained about constant at 37.5% in the individual treatment (Table 2, columns a and b). This difference between part 3 and part 4 was not significant according to a Wilcoxon signed-rank test.[15] The fraction of winner's curse bids was at an initial level of 20.0% and remained about constant at 18.3%, while the fraction of

[15] N=30, p=0.316 when considering all periods of Part 4; N=30, p=0.316 when restricting to the last 6 period of Part 4.

dispersed bids declined from 9.4% to 4.8%. None of these differences between part 3 and part 4 were significant according to Wilcoxon signed-rank tests (N=30, p=0.50; and N=30, p=0.66, respectively).

To study the determinants of individual bids, we carried out a series of probit regressions with robust errors on individuals separately on the initial bids (part 3) and on the bids placed later on (part 4). The analysis on the initial bids included observations from all sessions (Table 3 columns a and b). None of these regressions detected significant improvement in performance over time. When was an individual bid optimal or winner's cursed? To address this question, we included regressors on risk attitude, levels of confidence for the proposal, measures of skill, demographic characteristics, a trend dummy (1/period), plus past company values and session dummies.[16] The results showed that science and engineering major placed optimal bids significantly more often than other majors. The results also showed that ability captured by SAT/ACT scores mattered in handling the company takeover game. Bottom quartile of the SAT/ACT takers was likely to place less optimal bids and more winner's curse bids. No gender effect was observed.

We also present probit regressions for later bids in the individual treatment (Table 3, columns c and d). The effects of demographics are different than in the initial bids, maybe because these analyses include only a subsample of subjects or because of experience. The results showed that science and engineering majors, as well as Economics & Business majors,

[16] In terms of risk attitude, risk seeking participants are coded as one when they switched from option A to B at question seven or earlier, while participants who switched at question 13 or later are coded with risk averse dummy equals one. Hence, risk averse dummy identifies participants with a very high degree of risk aversion, rather than every risk-averse participant. One dummy regressor coded whether the subject had high confidence in the bid placed. Participants were asked to indicate the confidence level only in part 4 of all treatments. Skill proxies were the SAT/ACT scores obtained from the university Registrar's Office. SAT/ACT scores were collected for 92.5% of the participants (missingdata=0), who are coded using the US nationwide distribution of the SAT-takers (College Board of Education, 2006). The threshold for low ability was set at the lower quartile. The cutoff values were the average between male and female national tables. Other demographic variables we included were gender, economics and business major and science and engineering major.

placed optimal bids significantly more often than other majors. Now men were more likely to place a winner's curse bid. There was no significant effect of SAT/ACT scores. These results differ from the findings in Casari et al. (2007) in a common value auction setting.

5. Explanations of the Main Results

Why do groups outperform individuals? This section discusses three possible explanations related to the aggregation of risk attitude in group decisions, observational learning, and the aggregation of individual proposals into a final group bid.

Depending of his or her risk attitude, a participant may bid differently in the company takeover task. The risk neutral Nash Equilibrium (RNNE) strategy for a buyer is to bid 60. Risk averse buyers may choose to bid 38 and risk seeking may bid 90. Bidding 130 or 240 yields negative expected payoff, and hence should never be chosen. The observed *levels* of risk attitude cannot explain the winner's curse phenomenon in the Individual treatment. Less than six percent of the participants showed risk seeking behaviour, and hence 94% of bids should be either 38 or 60 (see Table A3). Instead, they were 47.5% (Table 2, column b). This finding by itself is an important result for the winner's curse literature in general: *the origin of the winner's curse when participants decide in isolation is not in the risk attitude of participants*.

Even if taking into account risk attitude is not enough to deliver empirically accurate point predictions in the company takeover game, it may in principle explain the improvement from the Individual to the Group treatment. Suppose individuals for some unspecified reason place above optimal bids in the company takeover game. If there is a systematic tendency of individuals interacting in groups to take less risks (i.e., to behave in a more risk averse way), than the same individuals deciding in isolation, groups will lower their bids in the company takeover game. In theory, this shift in risk attitude may be attributed to the improvement in the performance of groups that we reported in the company takeover game. As stated in Result 4 below, the data did not support this view.

Result 4*: The shift in risk attitude generated by group decision-making cannot explain the better performance of groups over individuals in the company takeover game.*

Each group made 15 lottery choices for a total of 1800 individual decisions (part 2). We measured agreement by comparing individual choices in lotteries (part 1) and group choices (part 2). In 73.5% of the group decisions, there was unanimous agreement in the group. We focus now on those decisions where there was disagreement (465 group decisions). The data suggest that generally the median member dictated the group choice (76.8% of cases). However, there was a nontrivial amount of group decisions that were more risky than the decisions taken by the median member (16.8%). The opposite was less frequent (6.5%). Overall, we found that group choices over lotteries were closer to the behavior of a risk neutral agent than individual choices and did not detect a shift toward lower degrees of risk aversion in group decision making.[17]

We now discuss the impact of observational learning on group decisions:

Result 5: *When individuals could observe the bids placed by two other participants in the company takeover game, there was no significant improvement in performance in comparison with the individual treatment.*

Table 2 and Figures 1-3 provide support for Result 5. In the Signal treatment, each participant could *observe the bids of two other people* before submitting their bids. In comparison to the Individual treatment, we report no significant differences in terms of the fraction of optimal bids (29.7%), winner's curse bids (18.3%), or dispersed bids (4.7%, Table 2,

[17] The fraction of risk neutral and risk seeking groups was lower than the fraction of risk neutral and risk seeking individuals (2.5% vs. 5.8%). The bulk of the choices reflected risk averse behavior. A two-sample Kolmogorov-Smirnov test did not show a significant difference though (p=0.875).

part4, Mann-Whitney tests, n=30, m=30, p=0.258; p=0.670; p=0.405, respectively). In comparison with the group treatment, the Signal treatment has a significantly lower frequency of optimal bids (n=60, m=30, p=0.006).[18]

Table 3 presents probit regressions for the Signal treatment on who placed optimal or winner's curse bids (col. g and h). Regressors control for the type of bids subjects observed. More specifically, whether at least one of the observed bids, or both, were optimal; whether at least one of the observed bids, or both, yielded an expected loss. According to the regression results, participants did not strongly react to the observed bids and when they did react, it was sometimes in an unexpected direction. The regression shows an improvement in optimal bids over time.[19]

When comparing bids in the initial periods (part 3) with the later periods (part 4) for the Signal treatment, the differences in the fractions of optimal bids, winner's curse bids, or dispersed bids are not statistically significant (Wilcoxon signed-rank tests: N=30, p=0.064; N=30, p=0.094; N=30, p=0.366, respectively).

We argue that the reason for the superiority of groups over individuals lies in the way individual opinions were aggregated into a group choice, as explained below.

Result 6*: When there was disagreement among group members on what bid to place in taking over the company, the median proposal prevailed in 75% of the cases. The final group bids were better than the median proposal in 7% of the cases and worse than the median proposal in 17% of the cases. Groups underperformed with respect to a "truth wins" benchmark.*

[18] Mann Whitney tests on the SAT/ ACT across treatments indicate no significant difference across treatments. Thus the superiority is not due to less capable subjects showing up in the signal treatment. However, in part 3 of the Signal treatment there were significantly less optimal bids than in the corresponding part of both the individual and group treatments (n=30, m=30, p=0.011 for comparison between signal and individual treatments; n=60, m=30, p=0.004 for comparison between signal and group treatments).

[19] The estimated coefficients for High confidence proposal, bottom quartile SAT/ACT scores, Science and Engineering have sometimes a different sign than in the other treatments.

A key feature of the Group treatment was the individual bid proposals posted before the group discussion; hence there is a complete record of ex-ante agreement or disagreement among group members. A disagreement situation is when at least one member's initial bid proposal was different from the final group bid. In the experiment there was a lively disagreement within groups; especially in the initial periods. Overall, there was agreement about 46.2% of the times. At the group bid stage, all groups eventually reached a unanimous group decision.

We focus exclusively on the situations of disagreement in order to understand how the group dynamic aggregated diverging opinions. Probit regressions studies the subsample of groups in disagreement (Table 5, column a). The dependent variable was 1 when an individual proposal became a group choice, 0 otherwise. Regressors included risk attitude, confidence level, major, gender and skills, low cash balance, whether it was a median and majoritarian proposal, whether it was a median but not a majoritarian proposal, and whether it was the proposal in the group that yielded the highest expected payoff. Period dummies were also included but not reported in the table.

In the first regression, we pooled data from periods 1 to 6 where participants learned how to play the game at a faster rate than the latter periods. The second regression is based on data from periods 7-20.[20] The comparison between the regressions using the first 6 and the last 14 periods allowed us to examine the change in the determinants of group outcome across time. The main result from specifications (a) is that the median proposal was the strongest determinant of group choice, especially when it was a majority proposal. Such strong impact remains over time. *The best proposal had no significant effect on group choices,* which suggests that the "truth wins" norm does not apply to this experiment. In the early periods, more risk seeking

[20] We report another set of regressions in Table A4 which breaks down the periods by 1-10 and 11-20. Our main results are robust.

participants, who had bottom 25% SAT/ACT scores, were less likely to convert their proposals to group choices while male participants were more likely to influence the group choices. These significant effects disappeared after period 6 though. High confidence and major did not seem to be important factors. In intellective tasks, such as the company takeover game, one smart subject who knows the optimal bidding strategy can explain it in the chat to the other two group members and hence prove to them the superiority of his or her proposal.[21] In a well-working group, this may well happen but it did not in the experiment. Consider the following back-of-the-envelope calculation. About 30.6% of part 3 bids were optimal. Absent any learning, the chances that at least one group member proposed the optimal strategy were 66.4%. Actual optimal bids in group decisions of part 4 were 50.5%, which is considerably less than a "truth wins" norm (Table 2).

By design, every participant had veto power in group decisions. Recall each group had three rounds to reach a unanimous bid after the individual proposals were revealed and text messages were exchanged among them. If there was disagreement on the final bid, the group lost the opportunity to place a bid for the period and everyone in the group earned zero. The veto power could have been usefully employed by a subject every time others in the group wanted to place a winner's curse bid. For risk neutral and risk averse participants, a sure gain of zero is preferred to an expected loss. Did participants employ such veto power? Not much. First, there was no case where groups did not reach a final bid by the third trial. Second, the aggregation of winner's curse proposals did not differ from the aggregation of proposals in general (Table 4). When the proposal of one member was winner's curse bid and the other two were not, it prevailed in 25.0% of the cases. When the proposals of two members were winner's curse bids

[21] At the beginning of each period, subjects must make a proposal in the pre-discussion stage which worked as an open brick for their discussion and also saved their chat time which was up to 2 minutes. There were 15 periods involved. Thus the smart subject had 30 minutes in total to explain the strategy to other two group members.

and the other was not, it prevailed in 77.8% of the cases. These percentages are aligned with those stated in Result 6. In the hypothetical case that a subject with a non-winner's curse proposal always vetoed group decisions for a winner's curse bid, in the group treatment in part 4, only 1.5% of bids would have been winner's curse (and not 9.75%). In other words, a rational use of veto power could have substantially reduced the fraction of winner's curse bids. Participants simply did not employ it as much as they could. Our conjecture is that this is due to pressure to conform in group decision making.

One aspect that needs clarification is how group decisions strictly based on the median bid proposal could improve performance in the company takeover game. We ran simulations by taking the median bid among three randomly drawn individual bids among all the bids placed in a given treatment in each period. We consider averages of 6000 simulations for each period. When comparing the actual results from Table 2 to the simulation results, there are two main conclusions. First, simulation on the part 4 individual treatment data, show a reduction of about half of the frequency of winner's curse bids, from 18.3% to 9.4% (See Table A2). This reduction is similar to the actual result for the part 4 group treatment (9.7%, Table 2). Hence, a median aggregation rule in group decision would explain the better performance of groups compared to individuals with respect to placing winner's curse bids. Even if groups do not match the performance of the "truth wins norm", they are still a valuable tool in handling the company takeover task. The role of the group is to reduce the frequency of very high or very low bids entering into the market. While encouraging, this result may not extend to all possible intellective tasks. In particular, it may work in this setting where less than one third of the bids in any given treatment are winner's curse bids but may possibly fail with a more difficult company takeover task where a majority of bids are winner's curse bids.

In earlier experiments with auctions, groups did not seem to help much in overcoming the winner's curse or raising profits (Cox and Hayne, 2006, Sutter et al., 2009). Our findings do not contradict these results and may actually shed light on them. The task in the present study is easier than the task in previous studies. In Cox and Hayne (2006) the experimental task was difficult: "both individuals and groups are very subject to the winner's curse when they are inexperienced" (p.217). A similar issue applies to Sutter et al. (2009). If groups follow the median opinion of their members, in the above experiments one would expect groups to perform similarly or worse than individuals because a large majority of individual subjects failed to place near-optimal bids. More generally, results from previous experiments may be different from ours because they implement auctions not company takeover games. Different outcomes in terms of individual-group comparisons may originate from issues of information aggregation and competition with other potential buyers that are ruled out by design under company takeover games with robot sellers.

The second conclusion is that group decision processes cannot be simply reduced to a median-taking rule. This conclusion is based on the simulated and actual fraction of optimal bids. The actual fraction of optimal bids in the group treatment of 50.5% (Table 2) is slightly better than the simulated median bid in the individual treatment (44.4%). This comparison suggests that additional learning took place within groups, which did not take place for stand-alone individuals. At the same time, based on the simulated median bids on the group proposals one may have expected an even better group performance (60.1% vs. 50.5%). A similar conclusion derives from the fraction of winner's curse bids (3.5% vs. 9.75%). While the median proposal has a strong drawing power in group decision making, there are other forces at work, which make decisions worse than the median proposal.

6. Results: Content Analysis of Chat Messages

Additional insight into the group dynamics taking place in the Group treatment comes from the analysis of messages exchanged within each group through a chat function. Units of messages were coded for select groups and periods of the experiment in which there was a disagreement in the proposal stage, with at least one of the proposals being a winner's curse bid (282 observations) or when a group's final decision was a winner's curse bid even though none of the other proposal's were winner's curse bids (3 observations).[22] A total of 1150 units of messages fit this criterion. We randomly selected one tenth of the messages to develop a coding scheme, which classifies messages into 22 categories. Two coders trained separately, independently coded the messages according to the coding scheme.[23]

Group discussions were primarily focused on the task, as about 70% of the messages were coded as task focused. [24] Of these messages, participants talked mostly about numerical proposal's (25.4%) or simply expressed agreement to any particular proposal (25.8%). Groups also spent a decent amount of time discussing how to find the best bidding strategy (12.0%+2.1%+3.4%) and how to aggregate conflicting proposals (6.4%+1.6%+0.7%).[25] Statements of threat of disagreement by individual group members were modestly common

[22] Following the methodology utilized in Zhang (2009), a chat unit is defined as a message that was sent out by a subject in a given period during one intervention. Units could be a single word or several sentences entered by the subject before he or she hit the "enter" button to submit the message.

[23] Using binary coding, a message was coded as a 1 if it was deemed by a coder to represent one or more of the 22 categories and 0 otherwise. Each message could be coded under as many or as few categories as the coders deemed appropriate. Messages were coded under one category the majority of time (93.4%), under two categories 6.1% of the time, and rarely coded under three categories (0.5%). Coding instructions are attached in the appendix.

[24] All discussions of coding hereafter are based on the average of the two independent codings, unless otherwise stated. Specifically, the value of the coding is treated as 1 if two coders agreed that a message belongs to a given category; 0 if the two coders agreed that a message does not belong to a given category; 0.5 if two coders disagreed with each other. Table A5 provides a summary of the coded messages during the twenty periods of the takeover game. The reliabilities of the coding for each category are also reported.

[25] A typical quote is "I still like the 60. It's very safe, maximize our potential winnings with little risk."

(6.0%), while an explicit mention of veto power was less common (0.3%+0.1%).[26] There was little mention of losses (3.4%), as the frequency of a loss during the 20 periods of group interactions during the takeover game was low (1.9%).[27]

To see the effects of the various categories of messages, we report regression results in Table 5 (specifications b and c). The probit regressions with robust standard errors (clusters on groups) include all the observations when there is a disagreement in the proposal stage with at least one proposal being a winner's curse bid (282 observations) and when the final group decision was a winner's curse bid even though none of the proposals are winner curse bids (3 observations). Besides the common independent variables included in all regressions, specification (b) examines whether the median proposal or the proposal that yields the highest expected profit is more likely to prevail as the final group choice. Specification (c) examines whether the winners' cursed proposal or the optimal proposal is more likely to become the final group outcome. Regressors about a proposal being majoritarian or median could not be jointly estimated in Table 5 with proposal being winner's curse or optimal because of multicollinearity issues.

There are a number of notable findings regarding specification (b). First, in periods 1-20, the proposal that was more likely to become the group bid choice proposal was the median bid, especially if in addition it was the majority of the individual group member bid. In periods 1-6, as long as the proposal bid was shared by a majority, it was more likely to prevail. In contrast, the best proposal among the three individual group member proposals did not have a better

[26] A typical quote is "I'm going to bit [bid] 60 regardless of your consensus b/c it's the best choice, we win ["avoid winner's curse] if we are in disagreement".

[27] The chat pattern over time suggest that groups spent more time during the first six periods, and the next six periods to a lesser extent, trying to figure out how to succeed at the takeover game. In contrast, the frequency of occurrence for direct pressure and reinforcement was the highest during the first six periods and the last eight periods and dropped slightly during periods seven through twelve.

chance of prevailing. This again provides evidence that truth wins norm does not apply in this environment. In addition, the self-reported confidence interval of a proposal did not seem to matter. The proposals of both economic and business majors and engineering majors were less likely to prevail. The proposals of subjects who had SAT/ACT scores in the low 25% were less likely to prevail in periods 1-6 and more likely to prevail in periods 1-20. Finally, the proposals of males initially (i.e., within the first 6 periods) and of more risk averse participants later on (i.e., within the last 14 periods) were more likely to prevail.

In terms of the chat coding, they are more likely to affect the group outcome in the latter periods. An individual proposal from the member who talked last in the group was less likely to prevail. An individual group member’s proposal was more likely to prevail when a group member provided concrete numerical bids as proposal suggestions, when a group member used reinforcement as a means to justify their proposal, and when a group member pushed for consensus. An individual group member’s proposal was less likely to prevail when he or she discussed irrelevant issues that were unrelated to the takeover game. When people rotated to determine the final group choice, it also reduced the likelihood of a proposal to prevail. Also, when a group member explicitly agreed with a proposal suggested by another group member, his or her proposal was less likely to prevail. A puzzling negative effect on the likelihood of a proposal prevailing is observed when the group member discussed the best strategies for determining the group’s final bid choice.

In specification (c), proposals that are winner’s cursed bids and proposals from risk averse subjects in early periods had a negative effect on the likelihood of the prevalence of a proposal. The effects of gender and ability disappeared and the effects of majors and the chat coding were similar to what we observed in specification (b).

7. Discussion and Conclusions

We study the performance of individuals versus groups in a negotiation task subject to the winner's curse. The winner's curse is a widespread behavioral bias in common value auctions, company takeovers, and in other environments, where people systematically incur losses when trying to acquire a good. Our aim is not to find the origin of the winner's curse but to study whether deciding in groups reduces its magnitude and how this result is achieved.

We report that small groups made better choices than individuals in isolation and substantially reduced the frequency of winner's curse bids in a company takeover experiment (Result 1). Groups make better decisions due to a combination of learning and the process of aggregating individual proposals into a group choice. This study reports four main results. First, *groups learn faster than individuals*. In our experiment, as well as in most of the literature, there is no significant learning by individuals who bid in a company takeover game (Result 3). We report substantial learning by groups in terms of frequency of optimal bids, dispersed bids, and winner's curse bids (Result 2). This study makes clear that group learning does not come from the simple exposure to diversity of opinions but from engaging in communication and negotiation in search of a consensus. In fact, individual bidding is not significantly different if a subject can observe and imitate the bids of two other subjects without the possibility to chat with them or the need to reach consensus on a bid (Result 5). One contribution of this study is the clarification of what generates group learning.

Second, individual opinions are aggregated within the group largely by taking the *median opinion*. This result is novel. When in disagreement, 75% of groups' choices coincide with the opinion of the median member (Result 6). This percentage is even higher when the median is also the majority opinion (two against one, 80%). Other factors matter, such as risk attitude, some demographic characteristics, and the content of the messages exchanged. The counterintuitive result is that, controlling for all the above factors, the best proposal is *less* likely to emerge than other proposals. The internal dynamics in aggregating individual opinions into a single group choice provides no support for the truth-wins norm. Other papers compare group choices with simulations on individual choices (Cooper and Kagel, 2005, 2009). Instead, this study provides direct evidence by comparing each group choice with the individual proposals of all group members. If two people do not get the correct solution, bringing a smart guy into the group will not be enough, on average, to overturn the group decisions.

Third, there was some *herd behavior*. We provide indirect support on this point. When there was an initial disagreement, the median was more likely to prevail in two-against-one situations than with three distinct opinions (80% vs. 72.6%). While there was a group dynamic to converge to a middle ground as a compromise, this evidence suggests that there also existed another dynamic of herd behavior at play. Such behavior may take the explicit form of pressure from the majority or could be implicit, a self-retreat to conform to the majority. Some chat messages refer to statements or threats to disagree, but not many (6.4%, Table A5). A way to detect the role of minority opinion is to look at the use of veto power. The veto power could have been usefully employed by a subject every time others in the group wanted to place a winner's curse bid. For risk neutral and risk averse participants, a sure gain of zero is preferred to an expected loss. Subjects exerted veto power less often than optimal (Table 4). An optimal use of veto power in groups would have further reduced the frequency of winner's curse bids from 9.7% to 1.5%.

Fourth, we can rule out that the superiority of groups over individuals in the company takeover game is due to *shifts in risk attitudes generated by group processes*. Very few experiments on group decision making controlled for this possible confounding factor. [28]

Based on the above results we can draw three general lessons about group decision making on intellective tasks. First, *group size is a key variable*. Some group experiments are done with two members (Cooper and Kagel, 2005, 2009, Cason and Mui, 1997). If the group choice is generally the median opinion and there is herd behavior, we expect groups of two to behave very differently than groups of three.

Second, groups of three or more members produce a "*majority boost*." Groups outperform individuals in tasks where a (large) majority of individuals would choose the correct option when deciding in isolation. In those situations, which include our experiment, groups are likely to have a majority in favor of the correct option. An implication of this study is that in tasks where only a minority of individuals would choose the correct option, groups are expected to *underperform* individuals. The poor performance of groups in auction bidding in Cox and Hayne (2006) and in Sutter et al. (2009) could result from such majority boost. This out-of-sample prediction of underperformance of groups in comparison to individuals spurred the collection of new data from additional sessions, which we ran with a more difficult version of the company takeover game, where companies could have 100 different values instead of just 5. The data provides support for this prediction. With the more difficult task, the frequency of optimal bids is stable or increasing in the individual treatment (from 15.56% in part 3 to 22.67% in part 4, Wilcoxon signed-rank tests, N=15, p=0.11) while it is decreasing in the group treatment (from 22.22% in part 3 to 13% in part 4, Wilcoxon signed-rank tests, N=30, p=0.03). Instead, the frequency of winner's curse bids has a similar trend in the two treatments (from 70% to 65.67%

[28] An exception is Sheremeta and Zhang (2010). Following a similar group risk preference elicitation methods, they find groups are more risk averse than individuals yet risk-aversion does not have a significant effect on groups' bidding behavior in contests.

and from 64.44% to 60.50%, respectively).[29]

The majority boost also helps to answer a key question for management: *when should we adopt groups in problem solving?* The answer depends on how difficult the task is. We should adopt groups only if the majority of the people are already able to get the right answer when deciding in isolation, otherwise groups are unlikely to improve performance.

Third, *the big advantage of groups is in learning over time*. In a one-shot interaction groups of three are unlikely to beat the truth-wins benchmark. When the majority is correct, they will match the truth-wins benchmark; otherwise, they will likely underperform. Instead, in repeated interactions, groups may beat a truth-wins benchmark when group learning is relatively faster than individual learning. With repeated interaction there are two opposite forces at work: a median aggregation rule that may hinder groups from reaching a truth-wins benchmark and group learning that may more than compensate for it.

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[29] We ran 1 additional session in the individual treatment and 2 session in the group treatment. Possible company values are 21, 22, …, 120. The RNNE bid is 42 and the naïve bid is 63.75. Any bid above 63 generates an expected loss. There are significantly more optimal bids in the individual treatment relative to group treatment in part 4 (Mann-Whitney tests on part 4: n=15, m=30, p=0.01), where a bid is loosely classified as optimal when in the range [31, 53]. Detailed summary statistics can be found in Table A6. For a trough test of the majority boost conjecture one would need more observations. Yet, the data are in line with the results of previous studies on group bidding in auctions.

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When Do Groups Perform Better than Individuals?

A Company Takeover Experiment

Tables and Figures

Table 1: Buyer's profits for selected bids

	Actual profits depending on the company value *s*					Expected
Bid, *b*	*s* = 38	*s* = 60	*s* = 90	*s* = 130	*s* = 240	profits
38 (loss free)	19	0	0	0	0	*3.8*
60 (optimal)	-3	30	0	0	0	*5.4*
90(naïve)	-33	0	45	0	0	*2.4*
130	-73	-40	5	65	0	*-8.6*
240	-183	-150	-105	-45	120	*-72.6*

Table 2: Descriptive statistics for the company takeover bids

	Treatment						
	Individual		Group			Signal	
	part 3 (a)	part 4 (b)	part 3 (c)	part 4 bids (d)	part 4 proposals (e)	part 3 (f)	part 4 (g)
Bid distribution (percentages)							
38 (loss free) and 39	3.3	10	8.6	8.0	9.0	4.4	7.3
60 (optimal) and 61	35.6	37.5	30.6	50.5	48.5	17.8	29.7
90 (naïve) and 91	38.9	31.7	36.7	31.5	30.2	45	40.8
130 and 131	11.1	14	11.7	7.2	6.8	21.1	16.5
240 and 241	1.7	2	1.4	2.5	3.1	1.1	1
All others (dispersed bids)	9.4	4.8	11.1	0.2	2.5	10.6	4.7
Other measures of performance							
Winner's curse (percentage of bids with negative expected profits)	20	18.3	18.3	9.75	10.5	31.1	18.3
Actual profits per period (tokens)	-1.65	0.4	1.21	2.13	2.13	1.41	2.1
Simulated profits per period with optimal bids (tokens)	4.8	6.93	5.73	5.93	5.93	4.8	6.93
Fraction of obs. with low cash balances (limited liability)	0%	2%	0.8%	3.2%	--	0%	0%
Number of obs., Number of subjects	180, 30	600, 30	360, 60	400,60	1200,60	180, 30	600, 30

Notes to Table 2: Distribution of bid signals for (g) is the same as for (b)

Table 3: Who placed optimal bids and winners' curse bids

	All treatments (part 3 – Individual bids)		Individual treatment (part 4)		Group treatment Individual proposals (part 4)		Signal treatment (part 4)	
Dependent variable	Optimal bid (a)	Winner's curse bid (b)	Optimal bid (c)	Winner's curse bid (d)	Optimal proposal (e)	Winner's curse proposal (f)	Optimal bid (g)	Winner's curse bid (h)
Risk averse (switch point>13)	0.07 (0.09)	-0.04 (0.07)	(^)	(^)	-0.06 (0.14)	-0.06* (0.03)	(~)	(~)
Risk seeking (switch point<8)	-0.13 (0.08)	-0.08 (0.08)	(^)	(^)	(~)	(~)	-0.15 (0.11)	0.30 (0.26)
High confidence in bid or proposal	(-)	(-)	0.05 (0.14)	-0.09 (0.08)	0.02 (0.08)	-0.08*** (0.03)	-0.13** (0.06)	0.24* (0.13)
Demographics								
Economics and Business Major	0.10 (0.09)	-0.06 (0.08)	0.31*** (0.09)	-0.08 (0.06)	0.14 (0.13)	0.06 (0.09)	-0.24 (0.16)	0.10 (0.15)
Science and Engineering Major	0.20*** (0.08)	-0.11 (0.09)	0.40*** (0.11)	-0.10 (0.08)	0.13 (0.14)	0.02 (0.07)	-0.44*** (0.11)	0.16 (0.19)
Bottom 25percentile SAT/ACT	-0.10* (0.06)	0.24*** (0.08)	0.05 (0.14)	0.00 (0.08)	-0.01 (0.12)	0.01 (0.04)	-0.13* (0.08)	-0.09* (0.05)
Male	0.05 (0.06)	0.07 (0.06)	0.00 (0.14)	0.14*** (0.04)	0.02 (0.09)	0.05 (0.03)	-0.11 (0.08)	0.04 (0.09)
Missing demographic data	-0.02 (0.10)	0.06 (0.13)	-0.25*** (0.07)	0.22** (0.11)	-0.14 (0.16)	0.09 (0.14)	-0.18* (0.10)	0.06 (0.11)
1/period	-0.07 (0.07)	-0.08 (0.06)	1.20 (0.92)	-0.12 (0.65)	-1.69** (0.71)	-0.06 (0.29)	-1.49* (0.89)	0.98 (0.63)
At least one signal from two other subjects is optimal bid							0.08 (0.06)	
Both signals from two other subjects are optimal bids							0.04 (0.10)	
At least one signal from two other subjects is winner's curse bid								0.01 (0.04)
Both signals from two other subjects are winner's curse bids								-0.09** (0.04)
Number of observations, Number of subjects	717, 120	717, 120	589, 30	589, 30	1166, 60	1166, 60	600, 30	600, 30
Pseudo R-squared	0.098	0.098	0.090	0.071	0.058	0.086	0.233	0.249
Log likelihood	-387.8	-355.3	-354.1	-259.3	-760.5	-353.3	-279.9	-215.9

Notes to Table 3: Marginal effects from probit regression with robust errors on individuals. Observations with low cash balance were excluded from the regression (limited liability issue). Four dummies for the value taken by the company in the previous period were in the regression but not reported in the table, value_was60, value_was90, value_was130, value_was240 (company value was 60, 90, 130 or 240 in the last period); for period one they were set to zero value. (-) Across all treatments subjects were required to indicate the level of confidence on the bid in part 4 but not in part 3. (^) everyone in this treatment is risk neutral or moderately risk averse. (~) risk preference regressors are dropped because of collinearity Session dummies were included in the regression but not reported in the table. Robust standard errors are in parentheses. Significance levels are *** p<0.01, ** p<0.05, * p<0.1.

Table 4: Aggregation of individual proposals into a group choice

Group treatment, Part 4

Group classification based on individual proposals:	No. of proposals	Actual no. of winner's cursed bids	Expected no. of winner's cursed bids if subjects exercise veto power
No winner's curse proposals	912	3	0
There is only one winner's curse proposal	216	54	0
There are two winner's curse proposals	54	42	0
All winner's curse proposals	18	18	18
Total	1,200	117	18
Frequency of winner's curse (out of 1200)	10.6%	9.7%	1.5%

Table 5: Solving disagreement among individual proposals

Group treatment, Part 4

Dependent variable: 1=individual proposal became group choice, 0= otherwise	All obs. Periods 1-6 (a)	All obs. Periods 7-20 (a)	Periods 1-6 (b)	Periods 7-20 (b)	Periods 1-6 (c)	Periods 7-20 (c)
Proposal is median and majority	0.67***	0.69***	0.95***	0.73***		
	(0.120)	(0.069)	(0.02)	(0.13)		
Proposal is median but not majority	0.05	0.40***	0.15	0.39**		
	(0.123)	(0.081)	(0.16)	(0.16)		
Among group proposals, it yields	0.14	-0.11	-0.24*	-0.34*		
the highest expected profit	(0.123)	(0.086)	(0.13)	(0.19)		
Proposal is winner's curse					-0.45***	-0.01
					(0.13)	(0.15)
Proposal is optimal: 60 or 61					-0.19	-0.10
					(0.13)	(0.13)
Low cash endowment,	0.14	0.05	(^)	-0.19	(^)	-0.11
below limited liability threshold	(0.133)	(0.079)		(0.14)		(0.15)
Subject is risk averse	0.03	0.09	-0.20	0.35**	-0.42***	0.05
(switch point>13)	(0.118)	(0.087)	(0.21)	(0.15)	(0.13)	(0.20)
Subject is risk seeking	-0.31***	-0.06	-0.00	-0.17	0.12	-0.06
(switch point<8)	(0.075)	(0.110)	(0.22)	(0.19)	(0.17)	(0.18)
High confidence proposal	-0.13	0.06	-0.36	0.02	-0.00	0.07
	(0.136)	(0.078)	(0.24)	(0.13)	(0.21)	(0.14)
Demographics						
Economics and Business major	0.01	0.03	-0.17	-0.46***	-0.53***	-0.54***
	(0.080)	(0.186)	(0.31)	(0.12)	(0.17)	(0.08)
Science and Engineering major	0.05	0.09	-0.37**	-0.33**	-0.52***	-0.37***
	(0.080)	(0.159)	(0.18)	(0.15)	(0.17)	(0.10)
Bottom 25% SAT/ACT score	-0.19**	0.07	-0.40*	0.20**	-0.06	0.11
	(0.083)	(0.076)	(0.21)	(0.09)	(0.23)	(0.12)
Male	0.14*	-0.01	0.48***	-0.13	0.07	-0.16
	(0.087)	(0.074)	(0.12)	(0.12)	(0.13)	(0.15)
Missing demographic data	0.02	0.13	0.22*	0.13	0.07	-0.16
	(0.075)	(0.119)	(0.13)	(0.19)	(0.23)	(0.23)

To be continued on the next page

Table 5: Solving disagreement among individual proposals

Group treatment, Part 4-continued

Dependent variable: 1=individual proposal became group choice, 0= otherwise	All obs. Periods 1-6 (a)	All obs. Periods 7-20 (a)	Periods 1-6 (b)	Periods 7-20 (b)	Periods 1-6 (c)	Periods 7-20 (c)
Chat message coding						
I talked first (1 or 0)			-0.07	0.22	0.11	0.08
			(0.27)	(0.19)	(0.19)	(0.16)
I talked last (1 or 0)			0.03	-0.23**	-0.03	-0.16**
			(0.21)	(0.11)	(0.11)	(0.08)
Numerical			-0.00	0.13***	-0.00	0.10***
			(0.07)	(0.04)	(0.05)	(0.03)
Think			-0.07	-0.24**	-0.04	-0.25***
			(0.09)	(0.10)	(0.06)	(0.08)
Pressure			0.01	0.08*	-0.05	0.08
			(0.19)	(0.04)	(0.09)	(0.05)
Reinforcement			-0.11	0.47***	0.10	0.50***
			(0.16)	(0.13)	(0.13)	(0.13)
Loss			-0.18	0.11	0.12	0.13
			(0.17)	(0.12)	(0.09)	(0.08)
Aggregate			0.15	(-)	-0.16*	(-)
			(0.11)		(0.09)	
Rotate			0.49	-0.66***	0.23	-0.50**
			(0.41)	(0.22)	(0.34)	(0.24)
Agreement			-0.22**	-0.01	-0.25***	-0.02
			(0.10)	(0.06)	(0.09)	(0.06)
Irrelevant			-0.07*	-0.05*	-0.04	-0.02
			(0.04)	(0.03)	(0.04)	(0.03)
Number of obs., Number of subjects	240, 60	405, 60	101, 39	176, 36	101, 39	176, 36
Pseudo R-squared	0.370	0.325	0.564	0.405	0.246	0.187
Log likelihood	-104.1	-188.6	-30.48	-72.53	-52.79	-99.18

Notes to Table 5: Probit regression with robust standard errors (clusters on groups). Significance levels *** p<0.01, ** p<0.05, * p<0.1. Specifications (a) include all individual proposals unless all identical within the group in a given period (645 obs.) Specifications (b) and (c) include all the observations when there is a disagreement in the proposal stage with at least one proposal is a winners' cursed bid (282 obs.) and when the final group decision is winner's cursed bid even though none of the proposals are winner's cursed bids (3 obs.). (^) for periods 1-6, the limited liability regressor is a structural zero: it perfectly predicts failure (proposal does not prevail in group choice), one observation is dropped from the regression; (-) for period 7-20, chat message coding "aggregate" regressor perfectly predicts failure, 7 observation are dropped from the regression.

Figure 1: Fraction of optimal bids over time

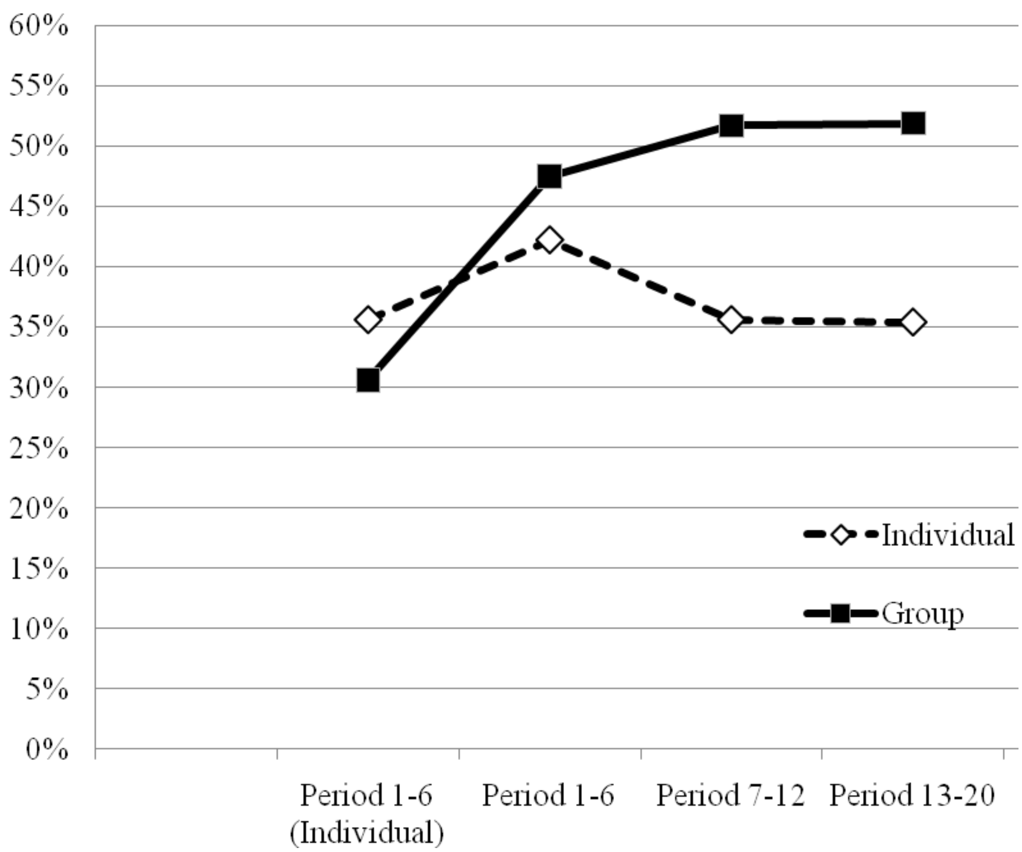


Figure 2: Fraction of winner's curse bids over time

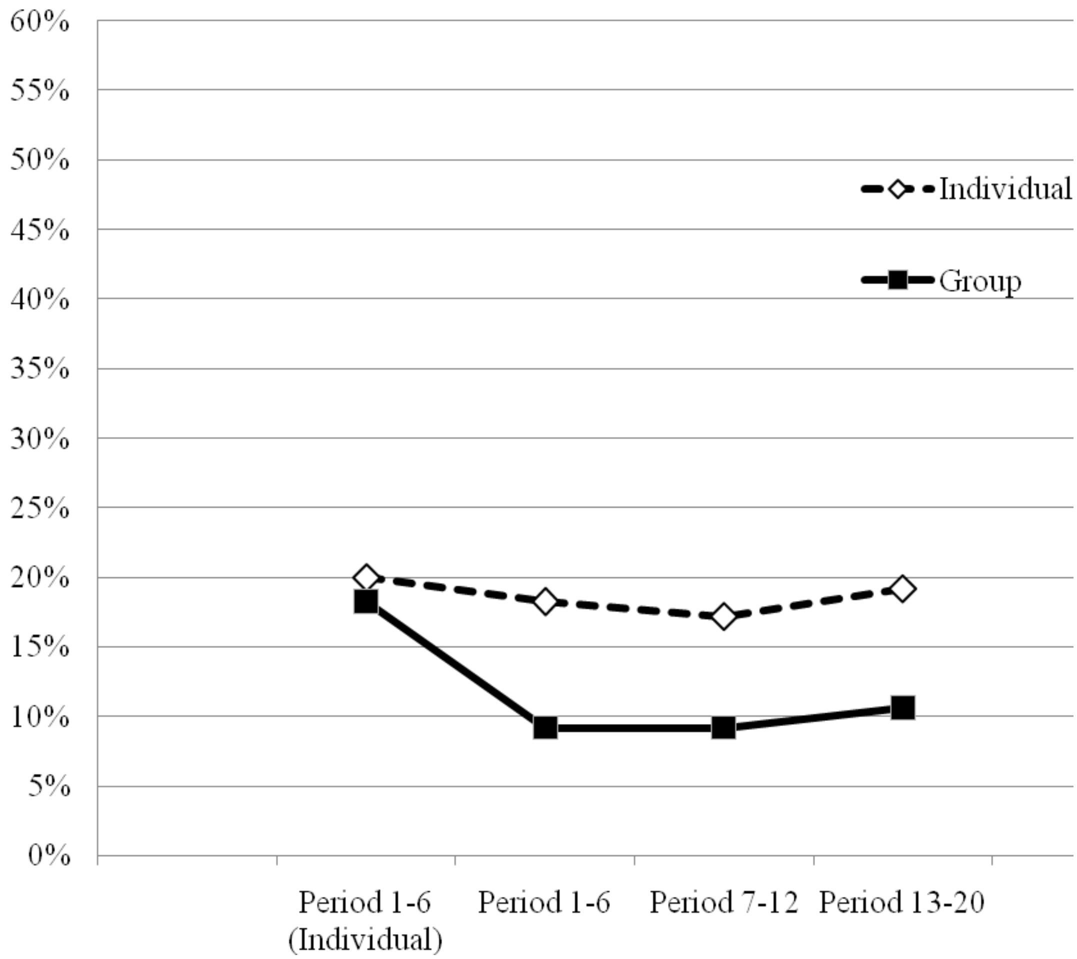
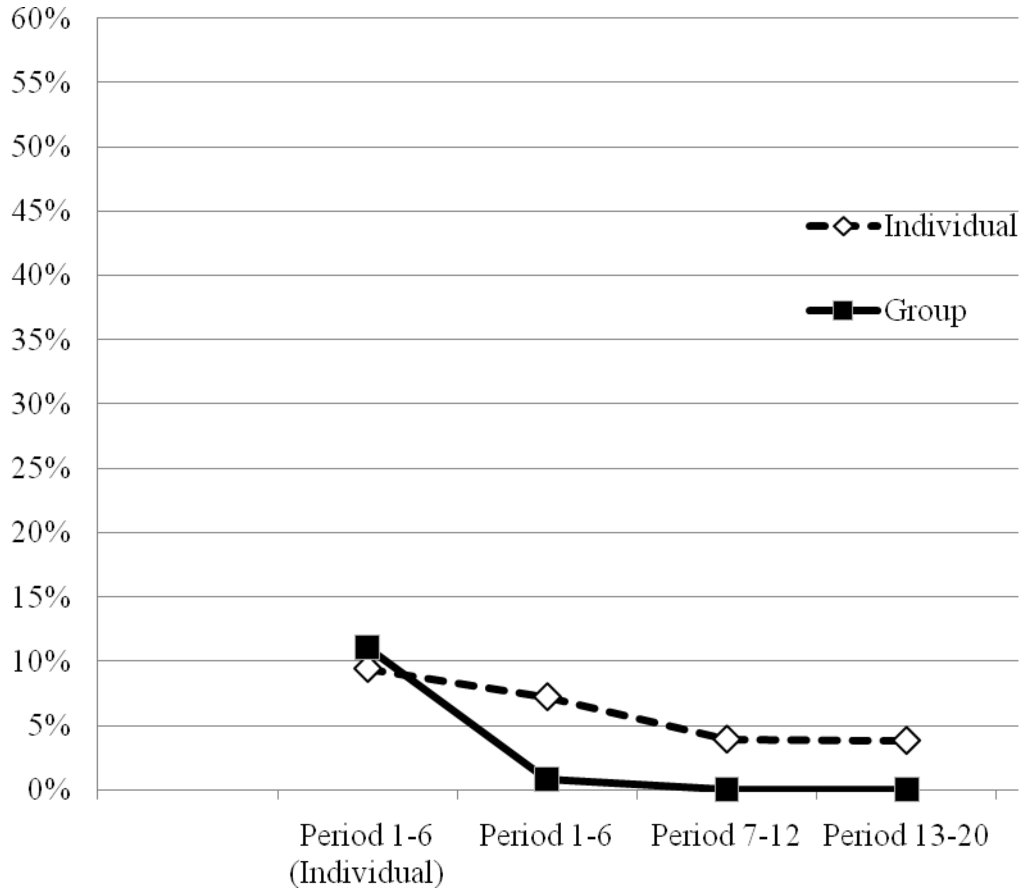


Figure 3: Fraction of dispersed bids over time



APPENDIX: Additional Analysis

NOT FOR PUBLICATION – FOR THE REFEREE ONLY

Table A1: Experimental studies of the company takeover game

Paper	Treatments	Value for the seller: Lower bound	Value for the seller: Upper bound	Continuous set?	Value multi-plier 50%?	Equilibrium bid in choice set	No. Periods
The present study		**38**	**240**		**Y**	**11%**	**26**
Ball, Bazerman, Carroll (1991)	*Baseline*	0	100	Y	Y	0%	20
	Role Reversal	0	100	Y	Y	0%	20
	Extended Trial	0	100	Y	Y	0%	20
Charness and Levin (2009)	*100 values*	0	99		Y	0%	60
	2 values	0	99		Y	0%	60
	4 values	0	99		Y	0%	60
Holt and Sherman (1994)	*Winner's Curse*	1.5	6	Y	Y	33%	30
	No Curse	1	3	Y	Y	50%	30
	Loser's Curse	0.5	1	Y	Y	100%	30
Selton, Abbink, and Cox (2005)	*Lower bound of 1*	1	99	Y		0-1%	100
	Lower bound of11	11	99	Y		11-13%	100
	Lower bound of 21	21	99	Y		26-27%	100
Bereby-Meyer and Grosskopf (2008)	*Control*	0	100	Y	Y	0%	100
	Yes-No Decision 1st	0	100	Y	Y	0%	100
	Average Full Feedback	0	100	Y	Y	0%	100
	Average Only	0	100	Y	Y	0%	100
	Gamble	0	100		Y	0%	100
Grosskopf, Bereby-Meyer, Bazerman (2007)	*Control*	0	100	Y	Y	0%	100, 5 parts
	Varying k	0	100	Y		0%, 100%	100, 5 parts
	Sym-Asym	0	100	Y	Y	0%, 51%	100, 5 parts
	Sym-Asym Compar.	0	100	Y	Y	0%, 51%	100, 5 parts
	Exper 2: Control	0	100	Y	Y	0%, 51%	80+20 switch
	Exper 2: Foregone	0	100	Y	Y	0%, 51%	80+20 switch
Carroll, Delquie, Halpern, Bazerman (1990)	*Control*	0	100	Y	Y	0%	1
	High Motives	0	100	Y	Y	0%	1
	Training (x4)	0	100	Y	Y	0%	1
	Exper. Mngrs	0	100	Y	Y	0%	1
	Exper. Bankers	0	100	Y	Y	0%	1
Tor and Bazerman (2003)		0	100	Y	Y	0%	1

Notes to Table A1: The subjects were undergraduate students except in the following studies. Ball, Bazerman, Carroll (1991) used 1st year Master students; Bereby-Meyer and Grosskopf (2008) used Boston area people, varied in education and background; Grosskopf, Bereby-Meyer, Bazerman (2007) used Boston area people, age 18 to 60; Carroll, Delquie, Halpern, Bazerman (1990) used 1st year Master's students in OBHR class , 2nd year Master's students in advanced Marketing class, Managers in a weeklong seminar and Master's graduates in investment banking; Tor and Bazerman (2003) used both graduate and undergraduate students. Other papers used standard undergraduate students as subjects.

Table A2: Descriptive statistics on simulated median bids

	Treatment					
	Individual		Group		Signal	
	part 3	part 4	part 3	part 4 (proposals)	part 3	part 4
Simulated median bid distribution (percentages)						
38 (loss free) and 39	0.71	3.53	4.17	3.24	0.86	1.85
60 (optimal) and 61	33.97	44.4	36.58	60.13	13.14	30.21
90 (naïve) and 91	51.21	40.16	47.1	32.86	62.46	53.68
130 and 131	5.08	7.55	6.1	2.83	14.66	8.23
240 and 241	0.18	0.27	0.12	0.53	0.1	0.14
All others (dispersed bids)	8.86	4.09	5.93	0.41	8.78	5.89
Other measures of performance						
Winner's curse (percentage of bids with negative expected profits)	12.04	9.36	9.94	3.46	22.76	9.41
Number of simulated observations	36000	120000	36000	120000	36000	120000

Notes: In the group treatment, part 4, the simulations were run on the individual proposed bids without regard for the experimental group membership.

Table A3: Lottery choice task

	Option A	Option B			Risk Preference	Individual Choices	Group Choices
Decision node	Payoffs	Probability of getting 150 tokens	Probability of getting 0 tokens	Expected payoff of option B	Range of CRRA If switch from A to B at this decision node	Frequency (%)	Frequency (%)
1	50	150	0	0			
2	50	150	0.05	7.5	r<-1.73	0	0
3	50	150	0.1	15	-1.73<r<-1.1	0	0
4	50	150	0.15	22.5	-1.1<r<-0.73	0	0
5	50	150	0.2	30	-0.73<r<-0.47	1.90	0
6	50	150	0.25	37.5	-0.47<r<-0.27	2.86	0
7	50	150	0.3	45	-0.27<r<-0.1	0.95	2.59
8	*50*	*150*	*0.35*	*52.5*	*-0.1<r<0.04*	*6.67*	*14.66*
9	50	150	0.4	60	0.04<r<0.16	10.48	4.31
10	50	150	0.45	67.5	0.16<r<0.27	8.57	14.66
11	50	150	0.5	75	0.27<r<0.36	27.62	25.00
12	50	150	0.55	82.5	0.36<r<0.45	11.43	17.24
13	50	150	0.6	90	0.45<r<0.53	10.48	10.34
14	50	150	0.65	97.5	0.53<r<0.6	8.57	6.03
15	50	150	0.7	105	0.6<r<0.66	3.81	2.59
		(subjects who never switched)			0.66<r	6.67	2.59

Notes: Everyone should choose option A in decision 1. Risk neutral subjects would switch to option B in decision 8 (italics). A switch in later decisions reveals risk aversion and a switch in earlier decisions reveals risk seeking behavior. Number of observations: 105 in part 3 and 116 in part 4 (non-monotonic choices are excluded).

Table A4: Solving disagreement among individual proposals

Group treatment, Part 4

Dependent variable: 1=individual proposal became group choice, 0= otherwise	All obs. Periods 1-10 (a)	All obs. Periods 11-20 (a)	Periods 1-10 (b)	Periods 11-20 (b)	Periods 1-10 (c)	Periods 11-20 (c)
Proposal is median and majority	0.63***	0.76***	0.67***	0.84***		
	(0.079)	(0.069)	(0.080)	(0.118)		
Proposal is median but not majority	0.24**	0.41***	0.31**	0.41***		
	(0.109)	(0.077)	(0.135)	(0.104)		
Among group proposals, it yields	0.04	-0.11	-0.03	-0.43**		
the highest expected profit	(0.111)	(0.119)	(0.149)	(0.176)		
Proposal is winner's curse					-0.39***	0.27*
					(0.085)	(0.158)
Proposal is optimal: 60 or 61					-0.19**	-0.05
					(0.088)	(0.277)
Low cash endowment,	0.06	0.02	(^)	-0.14		-0.10
below limited liability threshold	(0.196)	(0.087)		(0.213)		(0.240)
Subject is risk averse	0.07	0.08	-0.06	0.33**	-0.32***	0.07
(switch point>13)	(0.109)	(0.104)	(0.167)	(0.139)	(0.105)	(0.208)
Subject is risk seeking	-0.26***	0.02	-0.09	-0.05	-0.03	0.17
(switch point<8)	(0.069)	(0.130)	(0.144)	(0.219)	(0.176)	(0.145)
High confidence proposal	-0.13	0.17**	-0.09	-0.04	-0.06	0.17
	(0.108)	(0.074)	(0.122)	(0.137)	(0.141)	(0.179)
Demographics						
Economics and Business major	0.06	-0.02	-0.22	-0.48***	-0.31***	-0.67***
	(0.139)	(0.136)	(0.152)	(0.096)	(0.113)	(0.065)
Science and Engineering major	0.07	0.09	-0.26*	-0.38***	-0.28***	-0.45***
	(0.129)	(0.101)	(0.136)	(0.120)	(0.095)	(0.127)
Bottom 25% SAT/ACT score	-0.15	0.17**	-0.10	0.18	-0.07	0.15
	(0.101)	(0.074)	(0.137)	(0.142)	(0.137)	(0.178)
Male	0.07	-0.01	0.07	-0.02	0.01	-0.21
	(0.082)	(0.089)	(0.119)	(0.247)	(0.105)	(0.161)
Missing demographic data	0.00	0.25**	0.03	0.36***	-0.05	-0.17
	(0.114)	(0.096)	(0.218)	(0.096)	(0.239)	(0.264)

To be continued on the next page

Table A4: Solving disagreement among individual proposals

Group treatment, Part 4-continued

Dependent variable: 1=individual proposal became group choice, 0= otherwise	All obs. Periods 1-10 (a)	All obs. Periods 11-20 (a)	Periods 1-10 (b)	Periods 11-20 (b)	Periods 1-10 (c)	Periods 11-20 (c)
Chat message coding						
I talked first (1 or 0)			0.04	0.05	0.00	0.08
			(0.122)	(0.169)	(0.139)	(0.109)
I talked last (1 or 0)			-0.12	-0.21	-0.07	-0.14
			(0.137)	(0.204)	(0.098)	(0.139)
Numerical			-0.04	0.28***	-0.04	0.19***
			(0.067)	(0.106)	(0.057)	(0.060)
Think			-0.10**	-0.19	-0.09**	-0.29**
			(0.046)	(0.193)	(0.035)	(0.133)
Pressure			0.13**	-0.03	0.08	0.05
			(0.065)	(0.074)	(0.076)	(0.071)
Reinforcement			0.11	0.31**	0.23**	0.41**
			(0.105)	(0.155)	(0.118)	(0.165)
Loss			0.11	-0.09	0.15**	0.02
			(0.083)	(0.238)	(0.079)	(0.141)
Aggregate			-0.23*	(-)	-0.21	(-)
			(0.137)		(0.135)	
Rotate			-0.01	-0.36	0.10	-0.45***
			(0.257)	(0.227)	(0.318)	(0.142)
Agreement			-0.13**	-0.05	-0.16**	-0.06
			(0.055)	(0.099)	(0.065)	(0.082)
Irrelevant			-0.04	-0.04	-0.02	-0.03
			(0.031)	(0.026)	(0.037)	(0.032)
Number of obs., Number of subjects	369, 60	276,60	158,39	122,36	158,39	122,36
Pseudo R-squared	0.302	0.395	0.327	0.526	0.193	0.282
Log likelihood	-178.0	-115.1	-73.64	-39.94	-88.33	-60.55

Notes to Table A4: Probit regression with robust standard errors (clusters on groups). Significance levels *** p<0.01, ** p<0.05, * p<0.1. Specifications (a) include all individual proposals unless all identical within the group in a given period (645 obs.) Specifications (b) and (c) include all the observations when there is a disagreement in the proposal stage with at least one proposal is a winners' cursed bid (282 obs.) and when the final group decision is winner's cursed bid even though none of the proposals are winner's cursed bids (3 obs.). (^) for periods 1-10, the limited liability regressor is a structural zero: it perfectly predicts failure (proposal does not prevail in group choice), one observation is dropped from the regression; (-) for period 11-20, chat message coding "aggregate" regressor perfectly predicts failure, 4 observation are dropped from the regression.

Table A5: Messages in groups facing winner's curse proposals

Code	*Category Description*	*Kappa*	*Z*	*Frequency % coder1*	*Frequency % coder2*	*Average frequency*
	a - talk about numerical bids					**25.44**
19	Persuade other to bid 60	0.9275	31.45	3.74	3.74	
20	Persuade others to bid 90	0.8903	30.19	9.57	9.74	
21	Persuade others to place a very high bid (i.e., any bid above 94)	0.9528	32.31	10.09	10.43	
16	Argue in favor of their own bid	0.9255	31.39	1.74	1.83	
	b - thinking process of individual except mentioning losses					**11.96**
5	Talk about past random draws	0.6978	23.66	1.39	1.83	
6	Learning through trials and errors	0.9087	30.81	0.43	0.52	
8	Think through the potential payoffs of a given bid for alternative random draws	0.8885	30.13	0.43	0.35	
9	Stick to the same bid for several periods	0.9728	32.99	3.22	3.39	
2	Take risks, enjoyment of risky choices	0.9059	30.72	3.13	3.57	
3	Play safe, fear of risky choices	0.8892	30.15	2.7	2.96	
	c - direct pressure (statements or threats to disagree)					**6.39**
10	Threat to disagree with others in the final group decision	0.6662	22.59	0.09	0.17	
11	Talk about earning zero in case of disagreement	1	33.91	0.26	0.26	
18	Disagreement with someone else's proposals	0.9537	32.34	5.91	6.09	
	d - reinforcement					**2.13**
12	Explicitly refer to the success or failure of past bids in making the current group choices	0.854	28.96	1.83	2.43	
	e - talk of losses					**3.4**
7	Mention losses or avoiding losses	0.8077	27.39	1.48	1.74	
4	Talk about current losses being large or not being able to make them up. The experimenter cannot force the payment of losses at the end of the session.	0.8758	29.7	1.57	2	
	f - aggregating bids by median or majority					**1.61**
13	Pick the bid proposed by the majority	0.9519	32.28	0.87	0.96	
14	Pick the bid in the middle (median rule)	0.8741	29.64	0.61	0.78	
	g - rotating scheme					**0.65**
15	Talking about taking turns among participants in determining group choice	0.7987	27.08	0.52	0.78	
	h - agreement					**25.79**
17	Agreement with someone else's proposals	0.9296	31.52	25.57	26	
	i - other irrelevant words					**31.18**
1	I am not sure or I am confused about what to bid	0.8601	29.17	3.74	4.7	
22	Other	0.8675	29.42	28.26	25.65	

Notes: no. obs.: 1150 units in total. The Kappa statistic measures the degree of agreement between the variables above that expected by chance alone. It has a maximum of 1 when agreement is perfect, 0 when agreement is no better than chance, and negative values when agreement is worse than chance. In general, a Kappa less than 0.20 represents poor agreement, 0.40 represents fair agreement, 0.60 represents moderate agreement, 0.80 presents good agreement and 1.00 represents very good agreement. The p-value is the probability of rejecting the null hypothesis, that agreement between the variables is no better than chance, when it is in fact true. A significant p-value implies that the agreement between the variables is not just chance.Prob>K is 0.000 for all lines.

Table A6: Descriptive statistics for the company takeover bids—100 values [21,120]

	Treatment				
	Individual		Group		
	part 3 (a)	part 4 (b)	part 3 (c)	part 4 bids (d)	part 4 proposals (e)
Bid distribution (percentages)					
Loss free [21,30]	1.11	3.33	2.78	0.50	1.33
Optimal [31,53]	15.56	22.67	22.22	13	15
Naive [54,63]	13.33	8.33	10.56	26	23.83
Winner's curse [64,120]	70	65.67	64.44	60.50	59.83
Actual profits per period (tokens)	-2.83	-0.75	-0.50	-2.40	-2.40
Number of obs., Number of subjects	90, 15	300, 15	180, 30	600,30	600,30

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Alma Mater Studiorum - Università di Bologna
DEPARTMENT OF ECONOMICS

Strada Maggiore 45
40125 Bologna - Italy
Tel. +39 051 2092604
Fax +39 051 2092664
http://www.dse.unibo.it