DO GROUPS FALL PREY TO THE WINNER'S CURSE? *

Marco Casari

Christine Jackson

Jingjing Zhang

December, 2009

Abstract

In an experiment, we studied how small groups tackle a company takeover game, a task where participants deciding in isolation frequently exhibit the winner's curse. We found that groups of three members, who could exchange opinions and chat, substantially reduced the winner's curse and generally placed better bids than individuals. We report that risk attitude cannot account for the group improvement and that learning from simply observing others' bids improved group performance only marginally. We examined the decisional processes that drove the improvement in group performance, including a detailed content analysis of group communication. When there was disagreement within a group, what prevailed was not the best but the median opinion. Hence, although groups in this task underperformed with respect to a "truth wins" benchmark, they outperformed individuals deciding in isolation.

JEL Classifications: C91, C92, D03, D81

Keywords: winner's curse, takeover game, group decision making, communication, experiments

* 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; C. Jackson, Purdue University, Krannert School of Management, 403 W. State St., W. Lafayette, IN 47906-2056, jackson2@purdue.edu; J.Zhang, McMaster University, Department of Economics, 1280 Main St. West, Hamilton, ON, L8S 4M4, Canada, jjzhang@mcmaster.ca. We thank Anya Savikhin for valuable research assistance, Tim Cason for comments on an earlier version of the paper as well as seminar participants at the IMEBE meeting in Alicante, Spain, the 2008 ESA meeting in Tucson, AZ, and Bocconi University, Italy.

1 Introduction

This paper reports the results of an experimental study of decision-making procedures of individuals versus groups when facing a "winner's curse" situation. The winner's curse is a behavioral bias, in which the decision maker seems to fail to consider the informational content of their opponent's actions. As a consequence of this bias, and against theory predictions, many agents systematically and voluntarily enter into loss-making purchases (Samuelson and Bazerman, 1985). The winner's curse has been identified in a variety of situations, including mineral right auctions (Mead et al., 1984, Hendricks et al., 1987), bidding for book publishing rights (Dessauer, 1981), baseball's free agency market (Belcherman and Camerer, 1998), IPOs pricing (Levis, 1990) and corporate takeovers (Roll, 1986).

The first academic claim of the winner's curse was made by three petroleum engineers, who argued that oil companies bidding in mineral right auctions suffered unexpected low profit rates in the 1960's and 1970's (Capen et al., 1971). This bias has since been replicated many times in experiments where individuals bid in common value auctions (Kagel and Levine, 2002). This paper studies the ability of groups to successfully bid in a company takeover game, a negotiation task where individuals deciding in isolation frequently exhibit the winner's curse. Company takeovers capture the essential features of the winner's curse phenomenon with the advantage of a much simpler setting than common value auctions.[1] Specifically, in a company takeover game a buyer is considering making an offer for a target company. The buyer has a well-defined expectation that the company will be worth more under its management than under the present ownership. The buyer, though, is uncertain about the ultimate value of the company. Target management, on the other hand, has an accurate estimate of value and so shares none of the buyer's uncertainty. In these circumstances, the question becomes "what final price offer should the buyer make for the target?" (Samuelson and Bazerman, 1985). Ball et al. (1991) have attempted to identify conditions under which the winner's curse in this type of negotiations disappear, but have found that this deviation from rational behavior is remarkably robust. Grosskopf et al. (2007) and Bereby-Meyer and Grosskopf (2008) have reported similar results.

We introduce several novel viewpoints to studying the winner's curse phenomenon in company takeover experiments. First, we propose that individuals working in a group may be more successful in tackling this task than individuals working alone. This research question is particularly important given that in most business settings, a panel of experts is employed to

[1] The game is simpler because it has only one bidder; hence there is no role for beliefs or strategic interaction with subjects in the same role. In our experiment the seller is a deterministic robot making the profit maximizing choice.

make or recommend a decision regarding a company takeover, or large auction bidding, rather than any single person. To the best of our knowledge, this is the first experiment with group decision makers in the company takeover game. In the present study, we found that groups of three members, who reached an unanimous bid via chat communication, placed better bids than individuals (Results 1, 2, and 3). In addition to this research question, we explore possible reasons why groups outperform individuals. In particular, we examine whether the superiority of groups over individuals stems from the aggregation of risk attitude in group decisions, observational learning, or the aggregation of individual bid proposals within a group. Thus, this paper opens the black box of group decision making by looking at what factors drove the improvement in performance and report several findings.

First, in theory a prudent shift in the risk attitude of groups in comparison to individuals may well account for the better group performance in the company takeover game. In practice, our findings suggest that we can rule out this explanation for this experiment (Result 4). Second, our findings also suggest that learning from simply observing others' bids improves group performance only marginally. Specifically, from a treatment where a bidder could see the choices of two other persons but decide independently and without the possibility of communication, we found that there was no significant difference in performance in comparison with the individual treatment (Result 5). Third, our findings further suggest that the way in which the group aggregated individual opinions substantially contributed to the superiority of group treatment over the individual treatment (Result 6). The management literature suggests the “truth wins” norm as a benchmark (i.e., the group achieves a correct answer if at least one member has achieved it in isolation) (Lorge and Solomon, 1955). Our evidence is against the “truth wins” norm and in favor of a median rule. That is, when there was disagreement among group members, the proposal of the median member prevailed in 75% of the cases. Thus, although groups could have theoretically performed better than they actually did, we found that they placed better bids than individuals choosing in isolation.

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

The present study draws from both the literature on the winner's curse and group decision-making in order to support our proposition that individuals working in a group are likely to fall victim to the winner's curse than individuals working alone. We will review both literatures relevant to this proposition, starting with the winner's curse. The main experimental finding of the common value auction literature is that the winner's curse is a robust phenomenon in many auction formats (Kagel and Levine, 2002). The literature further argues that such persistent losses (or below-normal profits) are not part of any equilibrium behavior with fully rational bidders and that the winner's curse would eventually correct itself given sufficient time and the right kind of information feedback. In practice, though, most of the adjustment toward the rational strategy happens through *market* learning as the less skilled firms and bidders go bankrupt and exit the market (Casari et al., 2007, Kagel and Levin, 1986). The brutal force of market selection intervenes because *individual* learning is much slower than market forces. One way around this intervention could be to study group decision makers in the absence of market selection. This paper examines under what conditions groups will eventually learn to avoid the winner's curse in the setting of a company takeover. Table 1 lists the findings of experimental studies that have utilized the company takeover game in the economics and management literature. 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. 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.

For the experimental design of the present study, we adopted what we believe are the best design features of the existing studies on company takeover games. First, we avoided placing the equilibrium bid at the corner of the choice space, either at 0% or 100%, or in the middle at 50% (Holt and Sherman, 1994, Selton et al., 2005). We did this to avoid classifying noisy players as mostly out of equilibrium or mostly at equilibrium. Second, we simplified the task by adopting a discrete and small set of company values for the seller following Charness and Levine (2006). The reason we simplified the task was that 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. Third, we had participants repeat the task 26 times, which allowed us to

detect learning. 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. Fourth, we used robot sellers as all studies do, with the exception of Carroll et al. (1990, treatments 5 and 6 only). Fifth, we administered a personality test, as well as collected measures of participants' school ability (ACT, SAT). In the reviewed studies in Table 1, no one collected personality information and only Charness and Levine (2006) measured ability using a Bayesian task at the end of the session. They found a strong correlation between performance in the Bayesian task and actual bids.

The group decision-making literature can provide insights into why groups may outperform individuals may be less likely to fall victim to the winner's curse, and thus more likely to be successful on a task such as the company takeover game. 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. An example of this task is choice under risk (Stoner, 1961), ultimatum games (Bornstein and Yaniv, 1998) and the dictator game (Cason and Mui, 1997). 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 (Cooper and Kagel, 2005). Available research on intellective tasks suggests that the absolute performance of groups is superior to the performance of individuals (Laughlin, 1996, 1999; Laughlin et al., 2002; Laughlin et al., 2003).

We argue that the company takeover game is closer to an intellective task because once a subject understands what the optimal bid is; it is straight forward to explain it to others. In comparing individual and group performance, 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 correct solution, the probability that in a randomly selected group of n persons at least one knows it is $1 - (1-p)^{n}$. The truth wins benchmark sets a higher standard for the group superiority than absolute performance. While assessing evidence of group performance in the psychology literature, Davis (1992) documents that freely interacting groups very rarely exceed and usually fall below the truth wins standard.

In Cooper and Kagel (2005), teams of two faced a signalling game where there were strategic opportunities. It is one of the few studies where groups outperformed the truth wins norm. In addition, Cox and Hayne (2006) reported experiments where group decision makers bidded in a common value auction in which each of five group members got either an identical signal of the value of the auctioned item (one-signal treatment) or a shared independently-drawn signal (five-signal treatment) and was asked to submit a single group bid after within-group face-to-face communication under an endogenously-determined decision rule. They found that groups were neither less nor more rational than individuals with one signal and groups overbid more than individuals with five signals. Notice that explaining to another subject the rationale for the optimal bid in a common value auction is more difficult than in the company takeover game because of the need to consider the bids of other potential buyers. Kocher and Sutter (2005) studied a beauty-contest game which can be classified as an intellective task and reached similar conclusions, although they report a faster learning rate for groups over individuals.

Taken together, these results suggest that when a group's interaction is structured, group performance is most likely to improve. However, even with the right conditions in place, there are reasons to believe that groups may fall victim to the same judgmental biases as individuals. In a review of individuals' and groups' resistance to judgmental biases, Kerr and his colleagues found that groups may actually amplify rather than suppress judgmental biases regarding errors in how information is used, errors caused by overlooking useful information, and errors caused by a reliance on mental rules of thumb that oversimplify the decision (Kerr et al., 1996a, 1996b).

3 Predictions, Experimental Design and Procedures

The experiment is framed as a company takeover game where there is 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 she rejects and b if she accepts. The payoffs for the buyer are 0 if the seller rejects and $(1.5s - b)$ if 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.

Hence, the task is a bilateral bargaining problem with asymmetric information and valuations. The informational disadvantage of the buyer is 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 2 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 $0.6 \cdot (1.5 \cdot 111.6 - 90) = 46.44$. 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 2). 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.

The possible company values for the present study were chosen to satisfy some requirements. First, to make the task easier to tackle, it has only a discrete number of company values; two pilot experiments suggested that with three values the task was too easy for our subject pool and with one hundred values it was too difficult. Second, in order to ensure that the participants were engaged in the task, it was necessary to have an RNNE bid with a substantial probability of acquiring the company. In our design, this probability was set to 40%. Third, to ensure that the naïve bid was higher than the rational 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).[2] Third, we avoided placing the RNNE and the naïve bids at the extremes values (i.e., 38 or 240). Sellers were simulated by a computer accepting only when the bid *b* was greater than or equal to *s*. This simplified game allows us to isolate the origins of the winner's curse from possible explanations such as complicated strategic interactions between sellers and buyers and misunderstanding of the game.

We manipulated the decision making process in a company takeover task using three treatments: Individual decision making (*Individual*), individual decision making when observing the bids of two other people (*Signal*), and group decision making (*Group*). Each session included four parts (1) individual risk attitude elicitation using a multiple price list design for one period; (2) group risk attitude elicitation using a multiple price list design for one period; (3) individual company takeover game for six periods; (4) company takeover game with procedures differing by treatment for twenty periods. In addition, there was a pre and post session personality questionnaire. Our main interests are with parts 3 and 4; however, parts 1 and 2 provided a benchmark to evaluate results. We will now describe each part in detail.

There were a total of 15 participants in each session. In part 1, we measured participants' risk attitude with fifteen binary choices between lotteries. Although, no study in Table 1 did it, the elicitation of risk attitudes may help in the interpretation of choices in the company takeover game. The overall incentive structure was similar to that in Holt and Laury (2002). Participants chose between a "safe" Option A and a "risky" Option B. The payoff of Option A was deterministic (50 tokens) and the payoffs for Option B were either 150 or 0. On the first decision, the probability of the high payoff (150) for Option B was zero. In subsequent choices, the probability of the high payoff increased by 1/20 each line, {0, 1/20, …, 14/20}. A risk neutral person would choose A in lotteries one through seven and then switch to B in lottery eight. Risk seeking agents may switch to option B earlier than lottery 7 and risk averse agents may switch later than lottery 7. Any rational agent should choose option A over option B in the first lottery (50 vs. 0 francs always) and later on eventually switch to B. Multiple switches would be a signal of confusion. We gave a payout for only one of the fifteen decisions, chosen randomly at the end of the session. Random choices were all implemented through drawings from a bingo cage.

In part 2, participants were randomly divided into groups of three and faced the same task as part 1. Hence, there were five groups in each session. In this group version, for each of the

[2] According to objective (2), with a fifth company value of at least 183, a 60 and 90 bids yield equal "profits"; with a 240 value, the "profit" distance is 7.5%.

fifteen lottery choices, there was a proposal phase, a chat phase, and a group choice phase. In the proposal phase, all group members simultaneously made an individual proposal about each of the fifteen lottery choices, followed by immediate feedback regarding disagreements. At this point, participants could switch to a chat window and had two minutes to send free-format messages to others in their group. 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. Messages were recorded. In the chat window, participants received an id number 1-3 in the order they sent messages in that specific period. After about two minutes, everyone had to submit a choice for the group decision. A group choice had to be unanimous (i.e., for the specific decision line, choices of all three group members must be identical). If there was unanimity on all fifteen choices, then part 2 was over. Otherwise, the line(s) with disagreement was (were) highlighted again, and all three group members were invited to submit a new proposal. If there was still disagreement, there was another final round of proposals. At this point, part 2 was over even if disagreement remained. Participants were paid for only one of the fifteen decisions, which was chosen randomly at the end of the session. Random choices were all implemented through drawings from a bingo cage. If the group was still in disagreement by the end of part 2, then the group earned zero for part 2.

In part 3, all participants faced six periods of the company takeover game as potential buyers. Participants started part 3 with a 200 token endowment. There was a practice period with forced input. Every period the computer drew 15 company values in each session, one for each participant. To favor learning, each participant observed the company value that was drawn both when the company was acquired and when it was not, and were required to write it along with their bid and period profit on a record sheet. Participants were paid for all six periods based on their performance. 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."

Part 4 comprised twenty periods of the same company takeover game they faced as individuals in Part 3. At the beginning of Part 4, each participant received an endowment of 300 tokens. Rules for Part 4 differed from treatment to treatment as described below.

For the *Group treatment*, in part 4, participants faced the company takeover game in groups of three members. Groups were the same as in part 2 and every period they had a proposal phase, a chat phase, and a bidding phase. In each period, participants initially shared their proposals with others, in particular: (1) a bid proposal (an integer between 0 and 360) (2) a confidence level in the bid (low, medium, high), and (3) a brief text with reasons for the choice of that bid (optional). This information was placed on a public board for all three group members to see. At that point, participants could switch to a chat window for up to two minutes after which they submitted a bid for the group decision without further possibility to chat. If the individual bids of all three group members were identical (unanimity), then it became the group bid and part 4 was over. Otherwise, all three group members were invited to submit new bids. If there was still disagreement, there was another final round of bidding. Disagreement implied that no bid was submitted. Every period the computer drew five company values for each session, one for each group.

For the *Individual treatment*, in part 4, the task was identical to part 3 except for minor procedural changes. When submitting a bid, participants had to submit (1) their confidence level in the bid (low, medium, high) and (2) a brief text with reasons for the choice of that bid (optional). In the Individual treatment, only the experimenter could observe this information. Every period the computer drew five company values for each session, one for each group of three persons that was formed in part 2.

For the *Signal treatment*, part 4 was identical to the Individual treatment except for one element. Participants chose individually their bid level and *were informed about the bids of two other people*. More precisely, we used the data from the individual treatment sessions (part 4) and displayed, period by period, the bids independently placed by two people. To make the decisional process more comparable across treatments, we employed the same random draws realized in the individual treatment sessions.[3] When submitting a bid, participants were required to submit (1) their confidence level in the bid (low, medium, high) and had the option to submit (2) a brief text with reasons for the choice of that bid (optional).

[3] More precisely, consider a group of three members formed in part 2. In the signal treatment each group member received the same random draw. For "signal" member 1 we displayed the bids of "individual" members 2 and 3. For "signal" member 2 we displayed the bids of "individual" members 1 and 3. For "signal" member 3 we displayed the bids of "individual" members 1 and 2. Session dates were 27 Sep, 23 Oct (Individual), 28 Oct (a), 28 Oct (b) (Signal), 25 Sep, 2 Oct, 4 Oct, 11 Oct (Group). For the signal session Oct 28(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 Oct 23.

For all parts of the design, we distributed written instructions, which were read aloud. The experiment was performed with a z-tree application (Fishbacher, 2007). No person participated in more than one experimental session. We guaranteed a minimum payment of $5 for everyone showing up on time, left the experiment, or participated but earned overall less by the end of the session. We converted each experimental token to actual dollars at the rate of $0.03. A session lasted on average about 2 hours and average earnings per person were about $20. We conducted eight experimental sessions with 15 participants for a total of 120 people; 60 people were in the Group treatment and 30 each in the Individual and Signal treatments. Participants were recruited from the undergraduate campus population of Purdue University (USA).

4 Main Results

Before presenting the main results, we report the bidding of participants in isolation in the company take over game (Table 3, part 3 in all treatments). Note that when aggregated across all sessions, 28.1% of bids were optimal and 23.1% were winner's curse bids.

Table 4 puts forward various probit regressions to explain when an individual's bid was optimal or when it was a winner's curse bid in part 3, across all treatments, for periods one through six. Regressors included past company values, risk attitude, measures of skill, demographic characteristics, personality traits from questions asked during the session, a trend dummy (1/period), and session dummies.

In terms of risk attitude, risk seeking participants have r_seeking set to 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 r_averse equals one. Hence, r_averse identifies participants with a very high degree of risk aversion, rather than every risk-averse participant. Skill proxies were successfully answering all quiz questions related to the company takeover game (quiz2=1) and the SAT scores obtained from the university Registrar's Office. SAT 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 high ability was set at the top quartile of the distribution and for low ability it was set at the lower quartile. The cutoff values were the average between male and female national tables. Note that gender and skill are accounted for in interaction terms. Other demographic variables we included were economics and business major and science and engineering major. The third class of regressors

codes five personality traits using questionnaire 1 answers from a common personality assessment. The personality traits are designed based on the big five inventory by John et al. (1991). For example the variable "agree" measures agreeableness through the average rating on nine statements: "I am kind to almost everyone; I like to cooperate with others; I am helpful and unselfish with others; I have a forgiving nature; I am generally trusting; I tend to find fault with others; I start quarrels with others; I can be cold and aloof; I am sometimes rude to others." Participants circled a number 1 through 5, where 1 stands for "strongly disagree," 2 for "disagree," 3 for "neutral," 4 for "agree," and 5 for "strongly agree." The other personality traits coded are conscientiousness (consc), neuroticism (neur), openness to experience (open), and extroversion (extra).

In Table 4, two of the models (i.e., col. 1 and 3) include personality scores, while the other two do not (i.e., col. 2 and 4). The results show that science and engineering major placed optimal bids significantly more often than Economics & Business and other majors (Table 4, col. 1 and 2). As reported later in Table 5, the difference disappears in periods 7-27 (part 4). Hence, the advantage of being a science and engineering major is diminishing because others catch up. This result suggests either that general economics training does not give any advantage in handling the company takeover game or that our sample pool had not yet received extensive enough training to overcome the winner's curse. The results also show that when the company value was 60 in the last period, participants were less likely to place an optimal bid in the current period (Table 4, col. 1 and 2). When company value was 240 in the last period, participants were less likely to bid optimally and more likely to place a winner's curse bid in the current period. One conjecture is that participants may not understand that the optimal bid should be independent from the realized company value. But instead their bids were greatly influenced by extreme company values. The effects of gender and ability are significant but only when placing winner's curse bids (Table 4, col. 3 and 4). First, the results suggest that ability, captured by SAT scores, matters for both genders. Second, there is an asymmetry between genders, as high ability women place better bids than high ability men; in addition, low ability men place worse bids than low ability women. This result is at odds with findings by Casari et al. (2007) in a common value auction setting where they found that women performed worse than men. Regarding the personality traits, there was one significant effect from agreeableness. Specifically, highly agreeable participants were found to be less likely to bid optimally and more likely to fall prey to the winner's curse (Table 4, col. 1 and 3). Agreeable individuals tend to be trusting, generous,

and kind (Costa & McCrae, 1992). These individuals strive to maintain group harmony, and generally put the group's interest above their own; thus they may be less assertive or more timid in making recommendations that they think may go against the group, and more likely to go with what the group says in general.

The individual treatment supplies a benchmark outcome (Result 1) to measure performance changes with groups (Results 2 and 3). The next section will report explanations for the main results (Results 4, 5, and 6).

Result 1*: In the individual treatment of the company takeover game, there was no significant learning over time in the following measures of performance: (1) the fraction of optimal bids, (2) the fraction of winner's curse bids, and (3) the fraction of dispersed bids.*

Support for Result 1 is reported in Table 3. Overall, a minority of bids were at the optimal value of 60. There were 35.6% optimal bids in part 3 and 37.5% optimal bids in part 4. This difference was not significant according to a Wilcoxon signed-rank test.[4]

As sub-optimal bids were the majority of bids placed, we present two other measures of performance. Sub-optimal bids may yield profits or losses. Winner's curse bids are those that yield an expected loss, which are in the intervals (57, 60), (73.5, 90), or (94, 360). A subject is better off to bid 0, rather than placing a winner's curse bid. In part 3, about 20.0% of the bids were winner's curse bids and 18.3% in part 4. This difference was not significant according to a Wilcoxon signed-rank test (N=30, p=0.50). Finally, any bid in between 0 and 360 is weakly dominated by 38, 60, 90, 130, or 240. Even if unable to identify the optimal bid, participants should recognize that bids different from the ones above are dominated. 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. No dispersed bids should be placed in equilibrium. The fraction of dispersed bids declined from 9.4% in part 3 to 4.8% in part 4. This difference was not significant according to a Wilcoxon signed-rank test (N=30, p=0.66).

Table 5 presents probit regressions to explain when an individual's bid was optimal or when it was a winner's curse bid from the individual treatment of periods 7-27, part 4. In comparison to Table 4, Table 5 includes two new dummy regressors, which were whether the subject had low or high confidence in the bid placed (lowconfidence=1 or highconfidence=1). Participants were asked to indicate the confidence level only in part 4 of all treatments. Neither

[4] N=30, p=0.32 when considering all periods of Part 4; N=30, p=0.32 when restricting to the last 6 period of Part 4.

dummy shows any statistically significant effect. Contrary to Table 4 result, company values in the last period did not have significant effects. Moreover, high ability men were more likely to place an optimal bid and less likely to place a winner's curse bid (Table 5, col. 1, 2, and 3). Results for low ability subjects show incoherence. These results suggest that SAT scores may not fully measure individual ability in solving this task. In addition, participants who correctly completed a quiz on the company takeover game (quiz2) were less likely to place winner's curse bids (Table 5, col. 3 and 4). Lastly, more neurotic subjects are more likely to place winner's cursed bids (Table 5, col. 3). Neurotic individuals tend to be tense, insecure, and nervous (Costa & McCrae, 1992). Neurotic individuals are thus generally suspicious of others' motives and tend to have irrational thoughts and may be reluctant to provide information to others due to their insecurity. Thus, individuals high on neuroticism may also be reluctant to make suggestions regarding a bid or provide justification for their bid due to their insecurity.

Result 2*: In the group treatment of the company takeover game, there was significant learning in the following measures of performance: (1) the fraction of optimal bids, (2) the fraction of winner's curse bids, and (3) the fraction of dispersed bids.*

Table 3 and Figures 1, 2, and 3 provide support for result 2. The fraction of optimal bids in part 3 was 30.6% and increased to 50.5% in part 4. This difference was significant according to a Wilcoxon signed-rank test (N=60, p=0.0004). The fraction of winner's curse bids in part 3 was 18.3% and declined to 9.75% in part 4. This difference was significant according to a Wilcoxon signed-rank test (N=60, p=0.0321). The fraction of dispersed bids was 11.1% in part 3 and it basically disappeared in part 4 (0.2%). Also, this difference was significant according to a Wilcoxon signed-rank test (N=60, p=0.0016). Result 2 holds also when we account for limited liability issues. One can see that for low cash balances (below 23.25 tokens) it is optimal for a subject to bid 240 instead of 60.[5] At some point, five participants had low cash balances and bidding 240 was optimal. These occurrences involve only 1.2% of all bids. Removing these observations did not change Result 2, because the issue affected part 4 relatively more than part

[5] 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 actuall loss (i.e. 240 minus the value of the company) and the cash balance. If the cash balance is below y the 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 a $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.

3, and the group treatment relatively more often than the individual treatment (Table 3). To avoid confounding effects, we dropped these observations from all regression analysis.

For the group treatment, part 4, we studied in more detail the process of making proposals in the group. Results are presented in Table 6, which considers the same regressors as in Table 5. There are two major results. First, participants who had low confidence in their proposals were less likely to make optimal bids and more likely to make winner's curse bids, while participants who had high confidence were less likely to make winner's curse bids (Table 6, col. 1, 3 and 4). Second, there is a significant improvement of the fraction of optimal bid proposals over time (negative coefficient in Table 6, col. 1 and 2), which is in contrast with the absence of improvement recorded in the individual treatment (Table 5).[6] There was no significant effect of either skill or gender on the likelihood to place an optimal bid. Instead, high ability women were less likely to place a winner's curse bid. Regarding personality trait, more neurotic participants were less likely to place optimal bids. The significant negative relationship between risk averse and likelihood to fall prey to winner's curse conforms our conjecture that more risk averse participants would choose to bid 38, while risk seeker may bid 90. Yet, we will discuss later that aggregated group risk preference cannot account for group improvement over individual bids, as groups are closer to risk neutral rather than risk averse decision makers.

Result 3*: The group treatment outperformed the individual treatment in the fraction of winners' curse bids and the fraction of dispersed bids.*

Table 3 provides support for Result 3. We conducted a series of Mann-Whitney tests on cross-treatment comparisons for part 4. The group treatment exhibited less winners' curse bids (n=30, m=60, p=0.0584) and less dispersed bids (n=30, m=60, p= 0.0073) than the individual treatment.[7] There is no reason to believe that this better performance comes from more high skilled participants participating in the group treatment than in the individual treatment sessions. In fact, in part 3 the group treatment had no significantly different levels of optimal bids, dispersed bids and winner's curse bids (n=30, m=60, p= 0.9279 for optimal bids, p= 0.1181 for dispersed bids, and p= 0.0798 for winner's curse bid). Also, in part 4, there were more optimal

[6] Moreover, we report that when participants saw the company value was 130 and 240 in the previous period, they were less likely to place a winner's curse bid in the current period (Table 6, col. 3 and 4). A significant coefficient may denote gambler's fallacy or learning from experience.

[7] An observation is the fraction of bids in the relevant category for each subject in all part 4 periods. 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= 0.0062) than the signal treatment.

bids in the group treatment than in the individual treatment, but the difference was not significant (n=30, m=60, p= 0.1678).

5 Explanations of the Main Results

Why do groups outperform individuals? In order to answer this question, we look at three possible aspects regarding how groups decided on their bids: aggregation of risk attitude in group decisions, observational learning, and the aggregation of individual proposed bids within the group.

Can patterns of risk attitude explain the winner's curse phenomenon? Not in this experiment. Risk attitudes explained neither the point predictions of the individual treatment nor the comparison across individual treatment and group treatment. While for the buyer, the Risk Neutral Nash Equilibrium (RNNE) bidding strategy is to bid 60, participants which were risk averse 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 differences in individual risk attitude we observed from part 1 cannot explain the winner's curse phenomenon. Less than six percent of the participants showed risk seeking behaviour in part 1, and hence 94% of bids should be either 38 or 60 (Table 1A). Instead, in the individual treatment, they were 47.5% (Table 3, part 4).

The shift in risk attitude cannot explain the better performance of groups than individuals. A potential explanation for group improvement is a prudent shift in risk attitude when individuals decide in a group instead of in isolation. As reported below in Result 4, this does not seem to be the case. Hence, we can rule out risk attitude as an explanation for the observed individual-group differences in bidding.

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. In lottery choices, groups are closer to a risk neutral decision maker compared to individuals.*

Tables 4 and 1A, and Figure 4 provide support for Result 4. Notice that Table 4 reports no significant effect of risk attitude on the likelihood of placing either an optimal bid or a winner's curse bid in part 3. Hence, risk attitude does not appear to be a major factor in bid choice.

Table 1A reports the choices of participants in the lottery task both as individual and group decision makers. Figure 4 illustrates the lottery choices in part 2 of 120 participants

divided into 40 groups. Each group made 15 choices for a total of 1800 individual decisions. In 73.5% of the group decisions, everyone was in agreement. We focus exclusively on those decisions where there was disagreement. Disagreement is defined by comparing individual choices (part 1) and group choices (part 2). There were 465 group decisions with disagreement as illustrated by the line in Figure 4. What rule governed conflict resolution within a group in disagreement? Most of the time, the median member determined the group decision (76.8% of cases), while in other cases, there was a risky shift (16.8%), and in other cases there was a prudent shift (6.5%). The data on choices over lotteries suggest that the median member choice is the most widespread aggregation rule. However, there is a nontrivial amount of group decisions that are more risky than the decisions taken by the median member. [8]

When assuming that participants are characterized by a constant level of relative risk aversion (CRRA) (i.e., have a utility function $u = \pi^{(1-r)}/(1-r)$), one can infer their levels of CRRA from the choices over lotteries in Table 1A. Given that lottery choices are discrete, we were restricted to only bracketing the actual level of r.

In our sample pool, the fraction of risk seeking groups was 2.6%, which was lower than the fraction of risk seeking individuals, 5.7% (prudent shift). A two-sample Kolmogorov-Smirnov test did not show a significant difference though (p=0.875). Moreover, this explanation for the improved group performance is weak because it is counterbalanced by a massive opposite shift—risky shifts (Figure 4). Overall, we found that group choices were closer to the behavior of a risk neutral agent than individual choices.

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

Table 3 and Figures 1, 2, and 3 provide support for Result 5. In Table 3, part 4 of the signal treatment, there were 29.7% of optimal bids, 18.3% of winner's curse bids, and 4.7% of dispersed bids (Table 3). According to a series of Mann-Whitney tests, they were not significantly different from the individual treatment (n=30, m=30, p=0.2575 for optimal bids, p=0.6704 for winner's curse bids and p=0.4049 for dispersed bids). However, in the group

[8] Baker et al., (2007) show that groups choose significantly more low-risk lotteries than the mean choice of the individual group members in a within-participants design (Individual-Group-Individual). Yet, in a between-subject design (participants play as an individual or group, not both) they find no significant difference, but the groups tend to make decisions that are more consistent with risk neutral preferences in the lowest and highest risk lotteries. We also find that groups are more close to risk neutral choices than individuals in our design.

treatment, participants achieved a significantly higher frequency of optimal bids (n=60, m=30, p=0.0062) than in the signal treatment. This poor performance in the signal treatment may be partly due to less capable participants showing up for that treatment.[9] In fact, in part 3 of the signal treatment there are significantly less optimal bids than in the corresponding part of both the individual and group treatments (n=30, m=30, p=0.0115 for comparison between signal and individual treatments; n=60, m=30, p=0.0043 for comparison between signal and group treatments).

A pool of participants with lower skills participated in the signal treatment. It is interesting to measure how much they benefited from observing the bids of other, higher skilled participants. The evidence about the learning from part 3 to part 4 was weak. According to a series of Wilcoxon signed-rank tests the improvement in the fraction of optimal bids and winner's curse bids is significant only at a 10% level ((N=30, p=0.064; N=30, p=0.094) and there was no significant difference in terms of dispersed bids (N=30, p=0.366).

An econometric analysis of the signal treatment is presented in the Appendix Table 2A. In addition to the regressors listed in Table 5, we included four dummies: whether at least one of the signals is optimal bid; whether both signals are optimal bids; whether at least one of the signals yields negative expected profits, and whether both signals yield negative expected profits. Participants did not seem to strongly react to the observed signals, with the exception of column 2 in Table 2A, where participants are more likely to place an optimal bid as long as at least one signal from two other participants was an optimal bid and column 4 in Table 2A, where participants were less likely to place a winner's curse bid when both signals were winner's curse bids. This latter effect has a small magnitude and direction is the opposite than one would have expected. And the significance disappears when we account for personality traits. There was a significant improvement of bids over time.

Based on our results, 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*

[9] Mann Whitney tests on the SAT/ ACT across treatments indicate that high ability participants in the individual and group treatments have significantly higher scores than the ones in signal treatment. This superiority is not observed in the low ability participants across treatments though.

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.

Tables 3A and 7 provide support for Result 6. A key feature of the group treatment in part 4 is to ask for individual bid proposals before the group discussion; hence there is a complete record of ex-ante agreement or disagreement among group members. At the proposal stage, group members unanimously agreed 46.25% of the time. In all other instances, there was disagreement (i.e., at least one member placed a proposal different from the group bid). Hence, there was lively disagreement within groups; especially in the initial periods. At the group bid stage, all groups eventually reached an unanimous group decision.

We focus on the subsample where there was disagreement on individual proposals in order to understand how the group dynamic aggregated diverging opinions. Table 3A reports the results from probit regressions on the disagreement subsample. The dependent variable was 1 when an individual proposal became a group choice, 0 otherwise. After controlling for confidence level, major, gender and skills, we also included a dummy for participants with low cash balance, a dummy for a median proposal that was also a majority proposal, a dummy for a median proposal that was not a majority proposal, and a dummy for the best proposal in a group which yielded the highest expected payoff. Period dummies were also included but not reported in the table. Three models with data in period 1, periods 2-12 and periods 13-20 were examined. While choices in period 1 were independent, later on there may have been individual adjustments in light of others' proposals. This adjustment may reflect either a better understanding of the task of conformity to the group majority. The interpretation of regressions over periods 2-20 should take this factor into account.

In a nutshell, the main result from Table 3A is that *the median proposal was the strongest determinant of group choice no matter whether it was a majority proposal or not*. 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 first period, more risk averse participants, who majored in Economics & Business or Science & Engineering, and were male, were more likely to convert their proposals to group choices. These significant effects disappeared after period 1 though. High confidence proposals were more likely to prevail as group choices in periods 13-20. Ability did not seem to be an important factor. [10]

[10] Another set of probit regressions on solving disagreement is reported in Table 4A in the appendix. Instead of using two dummies for the median proposal and a dummy for the best proposal, Table 4A includes a dummy for a median proposal that is a winners curse bid, a dummy for a median proposal that is an optimal proposal, and a

In intellective tasks, such as the company takeover game, one smart subject who knows the optimal bidding strategy can simply explain it in the chat to the other two group members and hence prove them the superiority of her proposal. 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 3).

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 7). 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 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. Table 8 shows simulations run 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

---

dummy for a median proposal that is a dispersed bid. Other regressors remain the same. We find that a median proposal that is a winner's curse bid or a dispersed bid is less likely to prevail as a group choice while a median proposal that is an optimal bid has an opposite effect. The influences of risk attitude, confidence and major do not change. The significant positive effect of gender disappears in period 1. High ability participants become less convincible in periods 2-12.

for each period. When comparing the actual results from Table 3 to the simulation results in Table 8, 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% (Table 8). This reduction is similar to the actual result for the part 4 group treatment (9.7%, Table 3). 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.

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 3) is slightly better than the simulated median bid in the individual treatment (44.4%, Table 8). 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 evidence on group dynamics 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).[11] A total of 1150 units of messages fit this criterion. We randomly selected

[11] 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.

one tenth of the messages to develop a coding scheme which classifies messages into 22 categories (see Table 9). Two coders trained separately, independently coded the messages according to the coding scheme.[12] The reliabilities of the coding for each category are reported in Table 9.[13]

Table 9 provides a summary of the coded messages during the twenty periods of the takeover game.[14] Group discussions were primarily focused on the task, as about 70% of the messages were coded as task focused. Of these messages, participants talked mostly about numerical proposal's (25.44%) or simply expressed agreement to any particular proposal (25.79%). Groups also spent a decent amount of time discussing how to find the best bidding strategy (11.96%+2.13%+3.4%) and how to aggregate conflicting proposals (6.39%+1.61%+0.65%). Statements of threat of disagreement by individual group members were modestly common (6.0%), while an explicit mention of veto power was less common (0.26%+0.13%). 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 (1.88%).[15]

To see the effects of the various categories of messages, we report regression results in Table 10. 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). The dependent variable is whether or not an individual proposal prevailed with 1 representing an individual proposal that became the group choice and 0 otherwise. In the first two regressions, we pooled

[12] 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 (93.39%), under two categories 6.09% of the time, and rarely coded under three categories (0.52%). Coding instructions are attached in the appendix.

[13] 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.

[14] 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.

[15] 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.

data from periods 1 to 6 where participants learned how to play the game in a faster rate than the latter periods. The third and fourth regressions are based on data from periods 7-20. The comparison between the regressions using the first 6 and the last 14 periods allowed us to examine the change of the determinants of group outcome across time. Besides the common independent variables included in all regressions, specification (a) 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 (b) 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 10 with proposal being winner's curse or optimal because of multicollinearity issues.

There are a number of notable findings regarding specification (a). First, in periods 7-20, 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 was majoritarian bid, it was more likely to prevail. In contrast, the best proposal among the three individual group member proposals did not have a better chance of prevailing in the first six periods and even marginally less likely to prevail in fact, during the last 14 periods. This again provides evidence that truth wins norm does not apply in this environment. In addition, neither the self-reported confidence interval of a proposal nor the cognitive skills of the proposer seemed to matter. Specifically, self-rated high confidence proposals were not more likely to prevail nor were the proposals of proposers who had SAT/ACT scores in the top 25%. Moreover, the proposals of both economic and business majors and engineering majors in Table 10 were less likely to prevail. 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 group member's proposal was more likely to prevail when a group member used reinforcement as a means to justify their proposal and when a group member provided concrete numerical bids as proposal suggestions. 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 being prevailed is observed when the group member discussed the best strategies for determining the group's final bid choice.

In specification b, all the significant variables have a negative effect on the likelihood of the prevalence of a proposal except messages about concrete numerical bids and reinforcement. These include proposals that are winner's cursed bids or optimal bids, proposals made by risk-averse participants or participants with economics and business or engineering major. The effects of the chat coding are similar to what we observed in specification (a).

7 Conclusions

We investigate whether small groups are better than individuals in handling the winner's curse. The winner's curse is a behavioral bias and a severe departure from equilibrium predictions. Notwithstanding this focus, the present conclusions are relevant for everyone who is interested in group decision-making processes.

We report the results of an experiment on a company takeover game with a treatment where individuals decide in isolation and a treatment where a group of three individuals need to reach an unanimous group decision after pre-play chat communication. In the individual treatment, many bids yielded an expected loss (winner's curse) and participants showed little improvement even after repeated exposure to the same task (Result 1), which replicates the results reported in the literature. The outcome of the individual treatment provides a benchmark to evaluate group performance. In the group treatment, group bids were significantly better than in the individual treatment. For instance, the occurrence of the winner's curse was consistently and significantly reduced (Results 3).

The present study's design allowed us to pin down some key elements of the group dynamics that drove this improvement in performance. We can rule out that groups are superior to individual because of changes in risk attitude due to the group interaction. The evidence from risk attitude elicitation of both individuals and groups does not provide support for this explanation (Result 4). Moreover, we can rule out that the benefit of group interaction stems mostly from observing and, eventually imitating, the bids proposed by others. The supporting evidence comes from a third treatment, individuals informed of two other bids from past sessions and placing bids alone did not outperform the individual treatment (Result 5). According to this study the added value of group interaction is generated by the interplay of three main factors: a

median aggregation rule for proposals, faster learning of groups than single individuals, and pressure to conform.

First, our design allows us to detect the initial agreement or disagreement among group members before they chat with each other. From the instances of disagreement in proposals among the group members, one can identify the norm adopted to solve disagreement. When there was disagreement, the median proposal in the group prevailed in 75% of the cases. Given that winner's curse proposals were less than one third of all proposals, a median aggregation rule substantially reduced their likelihood to become the group choice. Notice that the best proposal was not more likely to prevail; hence groups did not match the performance of the "truth wins" norm. Yet, the results suggest that group decision making is still a valuable tool in handling the winner's curse problem.

Second, contrary to the individual treatment, there was significant learning over time in the group treatment (Result 2). There is evidence that such learning comes from the active group interaction through the chat and not simply by the casual observation of the bid proposals of others (Result 5). Thus, there is additional value of group dynamics via chat communication.

Third, we find that groups put pressure on dissenting individuals to confirm to the majority opinion. In a group of three, when a majority of two agreed on a bid and the third member disagreed, it was very hard for the third member to convince the others, even if her proposal yielded higher expected profits. Moreover, the dissenting member used veto power to block the group decision less frequently than optimal, letting the group place winner's curse bids in a number of cases. The pressure to conform hindered the ability of a group to reach even better decisions. Detailed content analysis of chat messages revealed that when a group member used reinforcement as a means to justify their proposal or provided concrete numerical bids as proposal suggestions, his or her proposal was more likely to prevail as a final group choice.

When generalizing the above group dynamics, one should account for relevant dimensions such as group size, group decision rule, and format of group interaction. If indeed groups aggregate opinions through a median norm, a replication of the present experiment with different group sizes will more likely to succeed in groups of five members (i.e., Cox and Hayne, 2006) than in groups of two members. Moreover, the pressure to conform to the group majority is certainly larger in groups of five than in groups of two members. In our design, groups deliberate with unanimity or they do not place any choice. Existing studies of group decision making greatly differ on this point, which crucial affects the incentives for communicating with

others and for convincing them of one's opinion (Zhang and Casari, 2009). Recall that group learning is one of the virtuous outcomes of group interaction, which relies on the internal exchanges among group members. Also, the format of group interaction whether via rich communication (i.e., chat messages or face-to-face communication) or restricted communication (i.e., signals, pre-specified messages, one-side communication, communication every three periods instead of every period) is likely to make a difference both in the effectiveness of the communication and on the pressure to conform. Another aspect of our design is that information exchange was greatly facilitated by eliciting initial opinions from individual members and revealing them to the group as public information. When this feature is not present, either communication time is used up for putting forward proposals or some group members may not have the ability to share their opinions with others or may not even have shaped an initial opinion.

Finally, there are no large effects of the demographics. Among personality traits, agreeable and neurotic people generally placed worse bids. There was some effect of major, but not always consistent. There were also some skill effects. No robust gender effects were detected.

This study increases further understanding of human abilities to engage in strategic thinking applied to negotiation settings. Our findings suggest that one way a company can overcome the winner's curse is to employ decision-making units that are groups rather than individuals. In addition, our findings suggest that to gain the most advantage of groups, companies should encourage the groups to discuss the problem at hand and to make an unanimous group decision. This would be in contrast to assigning an individual decision-maker to obtain suggestions from others and then making a decision alone, as our results suggest that group dynamics appear to be contributing to the reduction in winner curse occurrences. Future research will need to further examine under what conditions groups outperform individuals, as well as under what conditions, groups may or may not underperform relative to the "truth wins norm".

References

Baker, R. J., Laury, S. and Williams, A. W. (2007), Comparing Small-Group and Individual Behavior in Lottery-Choice Experiments, CAEPR Working Paper No. 2007-018.

Ball, S. B., Bazerman, M. H. and Carroll, J. S. (1991), An Evaluation of Learning in the Bilateral Winner's Curse, *Organizational Behavior and Human Decision Processes*, 48, 1-22.

Bornstein, G. and Yaniv, I. (1998), Individual and Group Behavior in the Ultimatum Game: Are Groups More "Rational" Players? *Experimental Economics*, 1, 109-118.

Bereby-Meyer, Y. and Grosskopf, B. (2008), Overcoming the Winner's Curse: An Adaptive Learning Perspective, *Journal of Behavioral Decision Making*, 21(1), 15 – 27.

Blecherman, B. and Camerer, C. F. (1998), Is There a Winner's Curse in the Market for Baseball Players? Mimeograph, Brooklyn Polytechnic University, Brooklyn, NY.

Capen, E. C., Clapp, R.V. and Campbell, W. M. (1971), Competitive Bidding in High-Risk Situations, *Journal of Petroleum Technology*, 23, 641-653.

Carroll, J. S., Delquie, P., Halpern, J. and Bazerman, M.H. (1990), *Improving Negotiators' Cognitive Processes*, Working Paper, MIT, Cambridge, MA.

Casari, M., Ham, J. and Kagel, J. (2007), Selection Bias, Demographic Effects and Ability Effects in Common Value Auctions Experiments, *American Economic Review*, 97(4), 1278-1304.

Cason, T. N. and Mui, V.-L. (1997), A Laboratory Study of Group Polarization in the Team Dictator Game, *Economic Journal*, 107(444), 1465-1483.

Charness, G. and Levin, D. (2009), The Origin of the Winner's Curse: A Laboratory Study, *American Economic Journal: Microeconomics*, 1 (1), 207-236

College Board of Education (2006), SAT Percentile Ranks for Males, Females, and Total Group, College-Bound Seniors—Critical Reading + Mathematics + Writing. Retrieved May 29 2007. http://www.collegeboard.com/prod_downloads/highered/ra/sat/SATPercentileRanksCompositeCR_M_W.pdf

Cooper, D. J. and Kagel, J. H. (2005), Are Two Heads Better than One? Team Versus Individual Play in Signaling Games, *American Economic Review*, 95 (33), 477-509.

Costa, P. T., Jr. and McCrae, R. R. (1992). *Revised NEO Personality Inventory Manual*, Odessa, FL: Psychological Assessment Resources.

Cox, J. C. and Hayne, S. C. (2006), Barking Up the Right Tree: Are Small groups Rational Agents? *Experimental Economics*, 9(3), 209-222.

Davis, J. H. (1992), Some Compelling Intuitions about Group Consensus Decisions, Theoretical and Empirical Research, and Interpersonal Aggregation Phenomena: Selected Examples, 1950-1990, *Organizational Behavior and Human Decision Processes*, 52, 3-38.

Dessauer, J. P. (1981), Book Publishing: What It Is, What It Does, NY: R. R. Bowker.

Fischabcher, U. (2007), z-Tree-Zurich Toolbox for Readymade Economic Experiments, *Experimental Economics*, 10 (2), 171-178.

Grosskopf, B., Bereby-Meyer, Y., and Bazerman M. (2007). On the Robustness of the Winner's Curse Phenomenon, *Theory and Decision*, 63(4), 389-418.

Hendricks, K., Porter, R. and Boudreau, B. (1987), Information and Returns in OCS Auctions, 1954-1969, *Journal of Industrial Economics*, 35, 517-42.

Holt, C. A. and Laury, S. K. (2002), Risk Aversion and Incentive Effects, *American Economic Review*, 92, 1644–1655.

Holt, C. A. and Sherman, R. (1994), The Loser's Curse, *American Economic Review*, 84 (3), 642-652.

John, O. P., Donahue, E. M., and Kentle, R. L. (1991). The Big Five Inventory. Berkeley, CA: University of California, Berkeley.

Kagel, J. H. and Levin, D. (1986), The Winner's Curse and Public Information in Common Value Auctions, *American Economic Review*, 76, 894-920.

Kagel, J. H. and Levin, D. (2002), Common Value Auctions and the Winner's Curse, Princeton: Princeton University Press.

Kerr, N. L., MacCoun, R. J., and Kramer, G. P. (1996a), Bias in Judgments: Comparing Individuals and Groups, *Psychological Review*, 103, 687-719.

Kerr, N. L., MacCoun, R. J., and Kramer, G. P. (1996b), When Are N Heads Better (or Worse) Than One? Biased Judgments in Individuals and Groups, In E. H. Witte & J. H. Davis (Eds.), Understanding Group Behavior: Consensual Action By Small Groups, 1, 105-136, Mahwah, NJ: Erlbaum.

Kocher, M. G. and Sutter, M. (2005), The Decision Maker Matters: Individual versus Group Behavior in Experimental Beauty-Contest Games, *Economic Journal*, 115, 200-23.

Laughlin, P. R. (1996), Group Decision Making and Collective Induction, In E. Witte & J. Davis (Eds.), Understanding Group Behavior: Consensual Action By Small Groups, 1, 61-103, Mahwah, NJ: Erlbaum.

Laughlin, P. R. (1999), Collective Induction: Twelve Postulates, *Organizational Behavior and Human Decision Processes*, 80, 50-69.

Laughlin, P. R., Bonner, B. L., and Miner, A. G. (2002), Groups Perform Better Than the Best Individuals on Letters-to-numbers Problems, *Organizational Behavior and Human Decision Processes*, 61, 94-107.

Laughlin, P. R., Zander, M. L., Knievel, E. M., and Tan, T. K. (2003), Groups Perform Better than the Best Individuals on Letters-to-numbers Problems: Informative Equations and Effective Strategies, *Journal of Personality and Social Psychology*, 85, 684-694.

Levis, M. (1990), The Winner's Curse Problem, Interest Costs and the Underpricing of Initial Public Offerings, *Economic Journal*, 100, 76-89.

Lorge, I. and Solomon, H. (1955), Two Models of Group Behavior in the Solution of Eureka-Type Problems, Psychometrika, 20 (2), 139-148.

Mead, W. J., Moseidjord, A. and Sorensen, P. E. (1984), Competitive Bidding under Asymmetrical Information: Behavior and Performance in Gulf of Mexico Drainage Lease Sales, 1954- 1969, *Review of Economics and Statistics*, 66, 505-08.

Roll, R. (1986), The Hubris Hypothesis of Corporate Takeovers, *Journal of Business*, 59, 197-216.

Samuelson, W. (1984), Bargaining Under Asymmetric Information, Econometrica, 52(4), 995-1006.

Samuelson, W. F. and Bazerman, M. H. (1985), The Winner's Curse in Bilateral Negotiations, in V.L. Smith (ed.), *Research in Experimental Economics*, 3, Greenwich, CT: JAI Press.

Selton, R., Abbink, K. and Cox, R. (2005), Learning Direction Theory and the Winner's Curse, *Experimental Economics*, 8 (1), 5-20.

Stoner, J. A. F. (1961), A Comparison of Individual and Group Decisions Under Risk, Unpublished Master's Thesis, Massachusetts Institute of Technology, School of Management.

Zhang, J. (2009), Communication in Asymmetric Group Competition over Public Goods, Working Paper, McMaster University.

Zhang, J. and M. Casari (2009), How Groups Reach Agreement in Risky Choices: An Experiment, Working Paper, University of Bologna.

DO GROUPS FALL PREY TO THE WINNER'S CURSE? - Tables and Figures

Table 1: Experimental studies of the company takeover game

Paper	Treatments	Value for the seller		Continuous set?	Value multi-plier 50%?	Equilibrium bid in choice set	No. Periods
		Lower bound	Upper bound				
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 (2006)	*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: 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 2: Buyer's profit for selected bidding strategies

Bid, *b*	Actual profits depending on the company value					Expected profits for the buyer
	s = 38	*s* = 60	*s* = 90	*s* = 130	*s* = 240	
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 3: Descriptive statistics for company takeover game

	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
Actual profits per period with optimal bid (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: Distribution of bid signals for (g) is the same as (b)

Table 4: Probit regressions on individual bids (part 3)
All treatments

Dependent variable	Optimal bid (1)	Optimal bid (2)	Winner's curse bid (3)	Winner's curse bid (4)
Company value was 60 in the last period	-0.11**	-0.12**	0.03	0.03
	(0.05)	(0.05)	(0.05)	(0.05)
Company value was 90 in the last period	-0.03	-0.04	0.00	0.00
	(0.05)	(0.05)	(0.05)	(0.05)
Company value was 130 in the last period	-0.02	-0.02	0.01	0.02
	(0.05)	(0.05)	(0.04)	(0.04)
Company value was 240 in the last period	-0.10**	-0.12***	0.13**	0.13**
	(0.04)	(0.04)	(0.06)	(0.06)
Risk averse (switch point>13)	0.06	0.06	0.00	-0.03
	(0.08)	(0.09)	(0.08)	(0.07)
Risk seeking (switch point<7)	-0.08	-0.12	-0.05	-0.06
	(0.10)	(0.09)	(0.08)	(0.08)
All answers are correct in quiz 2	0.03	0.01	-0.06	-0.03
	(0.05)	(0.05)	(0.06)	(0.05)
Demographics				
Economics and Business Major	0.09	0.10	-0.02	-0.06
	(0.10)	(0.09)	(0.08)	(0.08)
Science and Engineering Major	0.19**	0.19**	-0.12	-0.13
	(0.09)	(0.09)	(0.09)	(0.09)
Male who is above 75 percentile SAT/ACT	0.11	0.08	0.05	0.06
	(0.08)	(0.08)	(0.09)	(0.09)
Female who is above 75 percentile SAT/ACT	-0.09	-0.07	-0.22***	-0.23***
	(0.10)	(0.12)	(0.03)	(0.03)
Male who is below 25 percentile SAT/ACT	-0.08	-0.09	0.24**	0.23**
	(0.07)	(0.07)	(0.11)	(0.11)
Female who is below 25 percentile SAT/ACT	-0.03	-0.08	0.10	0.16
	(0.10)	(0.09)	(0.11)	(0.11)
Missing demographic data	-0.02	-0.01	0.06	0.03
Personality traits				
Agreeableness	-0.11**		0.10**	
	(0.04)		(0.05)	
Conscientiousness	0.03		-0.02	
	(0.05)		(0.05)	
Neuroticism	0.02		0.01	
	(0.05)		(0.04)	
Openness	-0.02		-0.04	
	(0.06)		(0.05)	
Extroversion	-0.03		-0.02	
	(0.05)		(0.04)	
1/period	-0.06	-0.07	-0.08	-0.08
	(0.07)	(0.07)	(0.06)	(0.06)
Number of obs., Number of subjects	717, 30	717, 30	717, 30	717, 30
Pseudo R-squared	0.120	0.101	0.145	0.131
Log likelihood	-378.5	-386.7	-336.9	-342.4

Notes: Marginal effects from probit regression with robust errors on individuals. Observations with low cash balance were excluded from the regression (limited liability issue). The period one value for value_was60, value_was90, value_was130, value_was240 (company value was 60, 90, 130 or 240 in the last period) were set to zero. 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 5: Probit regressions on individual bids (part 4)
Individual treatment

Dependent variable	Optimal bid (1)	Optimal bid (2)	Winner's curse bid (3)	Winner's curse bid (4)
Company value was 60 in the last period	-0.08	-0.07	0.01	0.01
	(0.06)	(0.06)	(0.05)	(0.05)
Company value was 90 in the last period	0.08	0.07	0.02	0.02
	(0.07)	(0.07)	(0.05)	(0.05)
Company value was 130 in the last period	0.08	0.08	-0.05	-0.06
	(0.07)	(0.06)	(0.05)	(0.05)
Company value was 240 in the last period	-0.03	-0.03	0.09	0.07
	(0.06)	(0.06)	(0.07)	(0.07)
Risk averse (switch point>13)	^	^	^	^
Risk seeking (switch point<7)	^	^	^	^
All answers are correct in quiz 2	0.05	0.11	-0.11*	-0.16**
	(0.09)	(0.11)	(0.06)	(0.06)
Low confidence	-0.03	-0.03	0.05	0.02
	(0.08)	(0.09)	(0.06)	(0.06)
High confidence	0.08	0.11	-0.09	-0.09
	(0.11)	(0.11)	(0.07)	(0.07)
Demographics				
Economics and Business Major	0.12	0.06	0.07	0.00
	(0.17)	(0.12)	(0.10)	(0.08)
Science and Engineering Major	0.12	0.10	0.03	0.03
	(0.13)	(0.13)	(0.09)	(0.09)
Male who is above 75 percentile SAT/ACT	0.49***	0.50***	-0.15**	-0.11
	(0.14)	(0.11)	(0.07)	(0.07)
Female who is above 75 percentile SAT/ACT	(-)	(-)	(-)	(-)
Male who is below 25 percentile SAT/ACT	0.16	0.33**	-0.07	-0.08
	(0.17)	(0.15)	(0.08)	(0.08)
Female who is below 25 percentile SAT/ACT	0.24	0.38***	-0.16***	-0.15***
	(0.22)	(0.14)	(0.04)	(0.03)
Missing data	-0.21*	-0.12	0.19	0.23
	(0.13)	(0.10)	(0.18)	(0.15)
Personality traits				
Agreeableness	0.10		0.00	
	(0.14)		(0.08)	
Conscientiousness	-0.11		0.03	
	(0.12)		(0.06)	
Neuroticism	0.04		0.10*	
	(0.11)		(0.06)	
Openness	0.18		-0.01	
	(0.11)		(0.07)	
Extroversion	-0.14		0.09	
	(0.11)		(0.08)	
1/period	1.40	1.35	-0.08	-0.08
	(1.04)	(1.04)	(0.69)	(0.67)
Number of obs., Number of subjects	569, 30	569, 30	569, 30	569, 30
Pseudo R-squared	0.210	0.178	0.135	0.118
Log likelihood	-300.0	-311.9	-237.9	-242.5

Notes: see notes to Table 4. (-) stands for a structural zero in the regression. In particular, there is a perfect and negative correlation between the dependent variable and the regressor. (^) everyone in this treatment is risk neutral or moderately risk averse.

Table 6: Probit regressions on individual bid proposals (part 4)
Group treatment

Dependent variable	Optimal bid (1)	Optimal bid (2)	Winner's curse bid (3)	Winner's curse bid (4)
Company value was 60 in the last period	-0.02	-0.01	-0.01	-0.01
	(0.05)	(0.05)	(0.02)	(0.02)
Company value was 90 in the last period	-0.05	-0.04	-0.02	-0.02
	(0.04)	(0.04)	(0.02)	(0.02)
Company value was 130 in the last period	-0.04	-0.05	-0.06***	-0.06***
	(0.04)	(0.04)	(0.02)	(0.02)
Company value was 240 in the last period	-0.01	-0.02	-0.04**	-0.04*
	(0.05)	(0.05)	(0.02)	(0.02)
Risk averse (switch point>13)	-0.08	-0.06	-0.07**	-0.06**
	(0.13)	(0.15)	(0.03)	(0.03)
Risk seeking (switch point<7)	^	^	^	^
All answers are correct in quiz 2	-0.13	-0.09	-0.00	-0.01
	(0.10)	(0.09)	(0.03)	(0.03)
Low confidence	-0.15**	-0.09	0.09**	0.08**
	(0.08)	(0.07)	(0.04)	(0.04)
High confidence	-0.02	0.00	-0.06**	-0.07**
	(0.07)	(0.08)	(0.03)	(0.03)
Demographics				
Economics and Business Major	0.09	0.17	0.05	0.04
	(0.14)	(0.14)	(0.08)	(0.08)
Science and Engineering Major	0.14	0.15	0.01	0.00
	(0.15)	(0.14)	(0.06)	(0.07)
Male who is above 75 percentile SAT/ACT	-0.05	-0.08	0.05	0.06
	(0.20)	(0.17)	(0.08)	(0.09)
Female who is above 75 percentile SAT/ACT	-0.11	-0.24	-0.07**	-0.06**
	(0.18)	(0.17)	(0.03)	(0.03)
Male who is below 25 percentile SAT/ACT	-0.06	-0.16	0.01	0.03
	(0.17)	(0.13)	(0.05)	(0.05)
Female who is below 25 percentile SAT/ACT	0.15	0.06	-0.03	-0.02
	(0.21)	(0.19)	(0.04)	(0.05)
Missing data	-0.17	-0.18	0.07	0.08
	(0.13)	(0.15)	(0.12)	(0.13)
Personality traits				
Agreeableness	-0.02		0.00	
	(0.12)		(0.03)	
Conscientiousness	-0.04		-0.01	
	(0.09)		(0.04)	
Neuroticism	-0.22***		0.02	
	(0.08)		(0.02)	
Openness	-0.12		0.01	
	(0.10)		(0.03)	
Extroversion	-0.07		0.02	
	(0.07)		(0.02)	
1/period	-1.91**	-1.74**	-0.01	-0.03
	(0.77)	(0.73)	(0.27)	(0.28)
Number of obs., Number of subjects	1166, 60	1166, 60	1166, 60	1166, 60
Pseudo R-squared	0.113	0.0771	0.101	0.0959
Log likelihood	-716.2	-745.4	-347.3	-349.4

Notes: see notes to Table 4. (^) no subject was risk seeking. The risk attitude regressors (risk averse and risk seeking) are coded using the group decision in the lottery task.

Table 7: Aggregation of individual proposal into group choice – veto power

Veto power	Group Choice		Total
	Not winner's curse bid	Winner's curse bid	
No winner's curse proposals	909	3	912
All winner's curse proposals	0	18	18
There is only one winner's curse proposal	162	54	216
There are two winner's curse proposals	12	42	54
Total	1,083	117	1,200

Table 8: 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 9: message coding of groups facing winner's curse proposals

Code	*Category Description*	*Kappa*	*Z*	*Frequency % coder1*	*Frequency % coder2*	*Average frequency*
	a - talk about numerical bids, 16+19+20+21					**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 2,3, 5,6,8,9					**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) - 10, 11, 18					**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 – 12					**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 4+7					**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 13,14					**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, 15					**0.65**
15	Talking about taking turns among participants in determining group choice	0.7987	27.08	0.52	0.78	
	h - agreement 17					**25.79**
17	Agreement with someone else's proposals	0.9296	31.52	25.57	26	
	i - other irrelevant words 1,22					**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. Prob>K is 0.000 for all lines.

Table 10: Probit regressions on solving disagreement among group proposals (chat)
Group treatment

Dependent variable: *1=individual proposal became group choice, 0= otherwise*	Periods 1-6 (a)	Periods 7-20 (a)	Periods 1-6 (b)	Periods 7-20 (b)
Proposal is median and majority	0.94***	0.66***		
	(0.03)	(0.14)		
Proposal is median but not majority	0.07	0.40***		
	(0.21)	(0.14)		
Among group proposals, it yields the highest expected profit	-0.23	-0.28*		
	(0.15)	(0.17)		
Proposal is winner's curse			-0.42***	0.02
			(0.15)	(0.12)
Proposal is optimal: 60 or 61			-0.27**	-0.07
			(0.12)	(0.15)
Low cash endowment, below limited liability threshold	(^)	-0.08	(^)	-0.14
		(0.12)		(0.10)
Subject is risk averse (switch point>13)	-0.21	0.31**	-0.33*	0.11
	(0.27)	(0.13)	(0.19)	(0.16)
High confidence proposal	-0.34	-0.06	-0.08	-0.00
	(0.21)	(0.13)	(0.18)	(0.13)
Demographics				
Economics and Business major	-0.23	-0.39***	-0.44***	-0.46***
	(0.26)	(0.11)	(0.16)	(0.09)
Science and Engineering major	-0.37**	-0.26	-0.42**	-0.28**
	(0.16)	(0.16)	(0.18)	(0.12)
Top 25% SAT/ACT score	-0.06	-0.23	-0.24	-0.26
	(0.18)	(0.17)	(0.15)	(0.18)
Male	0.45***	-0.14	0.12	-0.17
	(0.11)	(0.11)	(0.12)	(0.14)
Missing demographic data	0.22*	0.03	0.07	-0.22
	(0.11)	(0.23)	(0.27)	(0.22)
Chat message coding				
Numerical	0.01	0.14***	-0.00	0.11***
	(0.07)	(0.03)	(0.05)	(0.03)
Think	-0.07	-0.19**	-0.03	-0.23***
	(0.09)	(0.08)	(0.05)	(0.07)
Pressure	-0.02	0.05	-0.05	0.08
	(0.18)	(0.03)	(0.09)	(0.05)
Reinforcement	-0.09	0.41***	0.12	0.46***
	(0.19)	(0.12)	(0.15)	(0.14)
Loss	-0.24	0.05	0.16	0.09
	(0.19)	(0.13)	(0.12)	(0.11)
Aggregate	0.06	(^)	-0.04	(^)
	(0.14)		(0.14)	
Rotate	0.39	-0.48**	0.15	-0.45*
	(0.47)	(0.24)	(0.35)	(0.25)
Agreement	-0.19**	-0.05	-0.24***	-0.03
	(0.08)	(0.07)	(0.08)	(0.06)
Irrelevant	-0.05	-0.05**	-0.05	-0.03
	(0.05)	(0.02)	(0.04)	(0.03)
Number of obs., Number of subjects	101, 39	176, 36	101, 39	176, 36
Pseudo R-squared	0.542	0.372	0.245	0.182
Log likelihood	-32.05	-76.63	-52.82	-99.74

Notes: Probit regression with robust standard errors (clusters on groups). Significance levels *** p<0.01, ** p<0.05, * p<0.1. The regressions 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

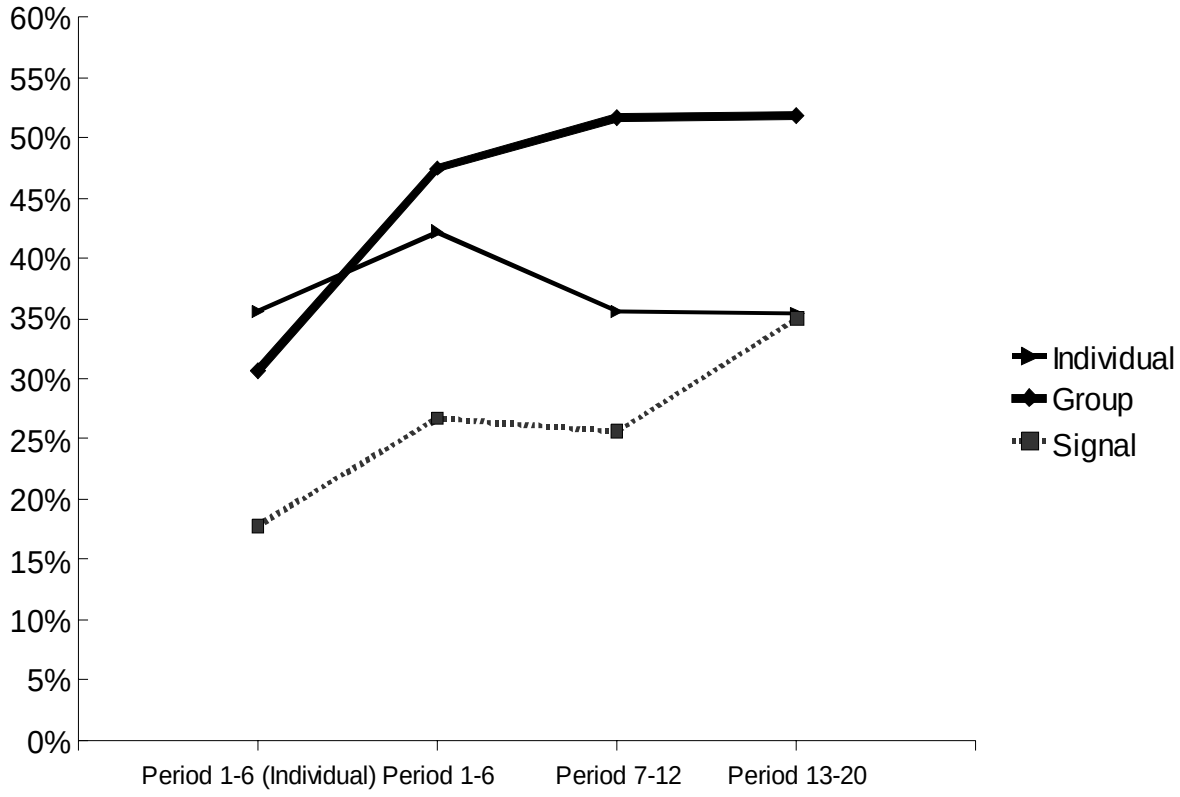


Figure 2: Fraction of winner's curse bids over time

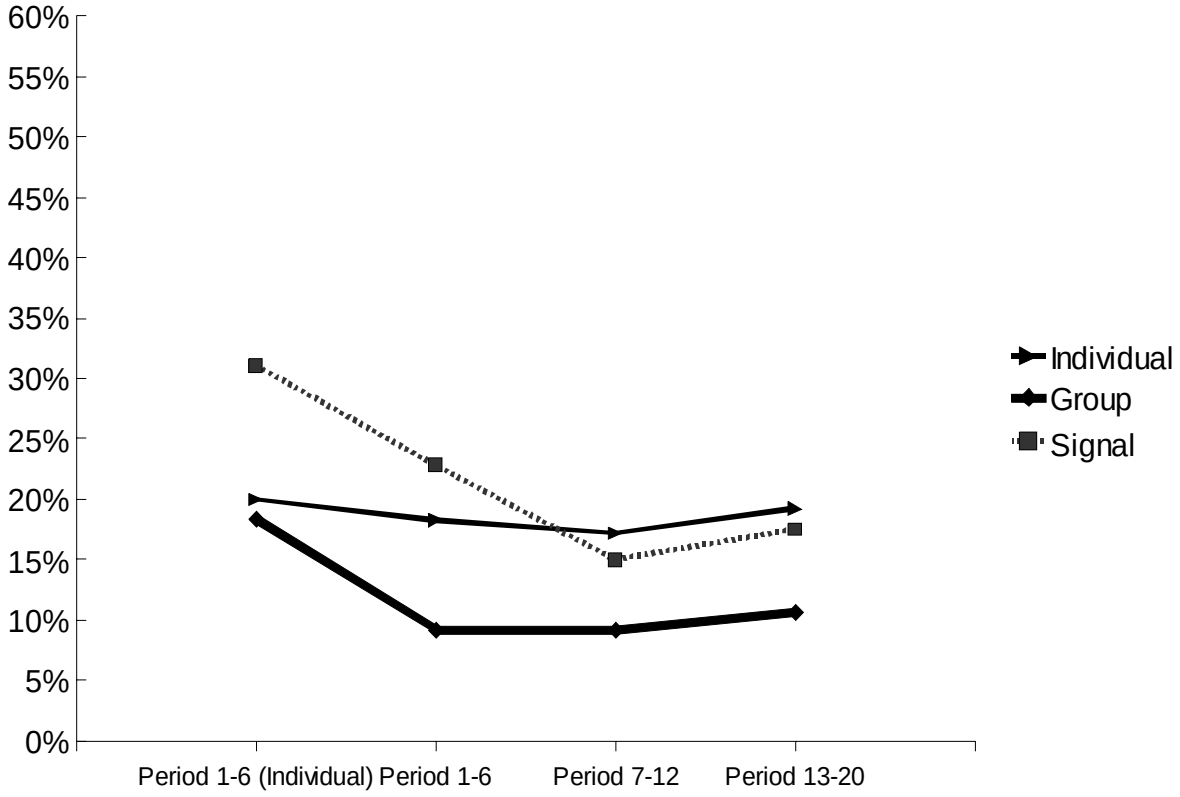


Figure 3: Fraction of dispersed bids over time

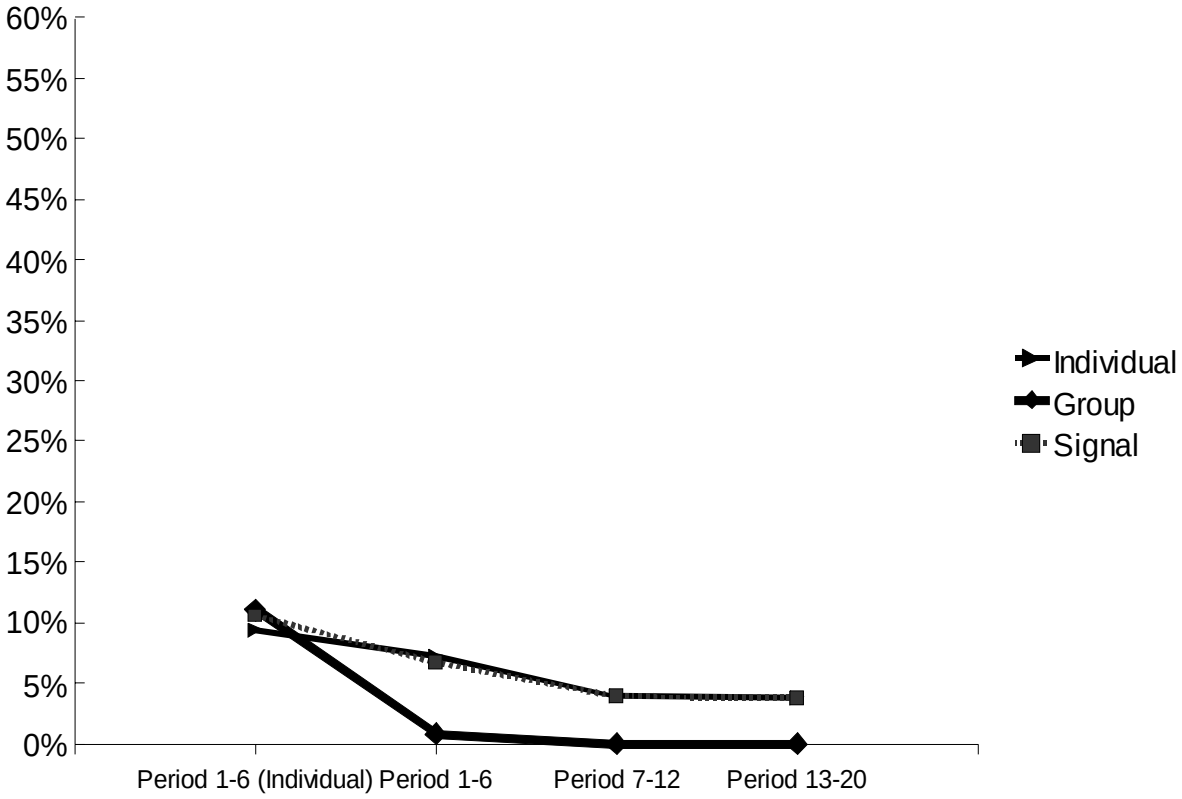
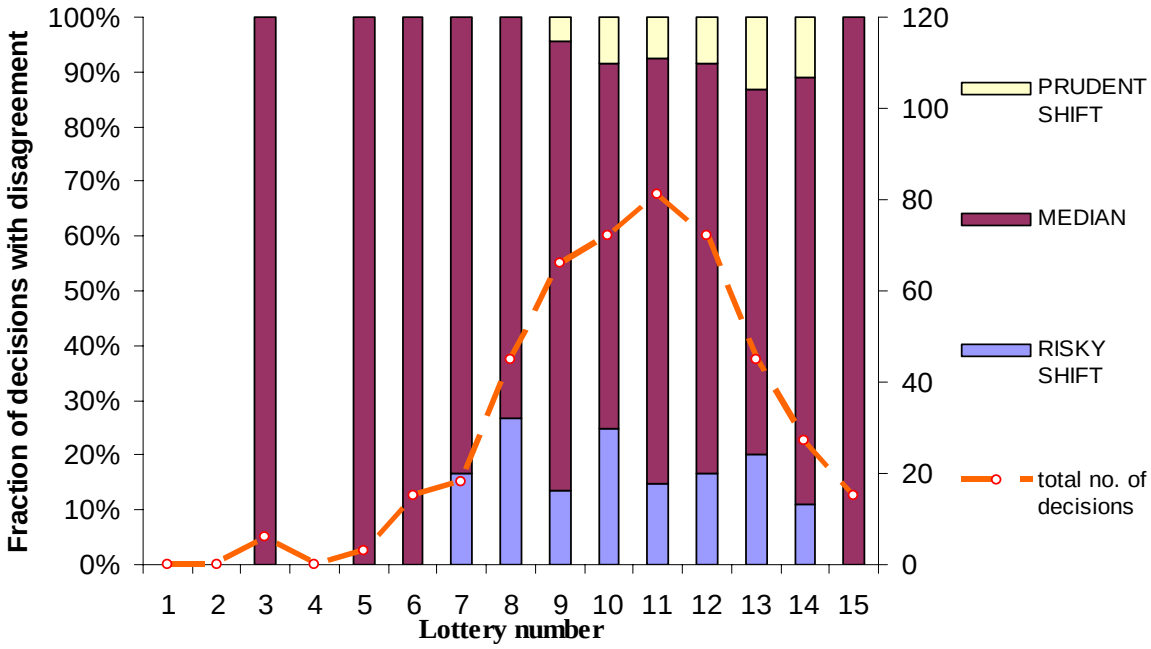


Figure 4: Lottery choices in group (part 2)



Additional Tables:

Table 1A: 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 2A: Probit regressions on individual bids (part 4) Signal treatment

Dependent variable	Optimal bid (1)	Optimal bid (2)	Winner's curse bid (3)	Winner's curse bid (4)
Company value was 60 in the last period	-0.10**	-0.11**	0.03	0.05
	(0.04)	(0.05)	(0.03)	(0.04)
Company value was 90 in the last period	0.02	0.00	-0.00	-0.00
	(0.06)	(0.06)	(0.02)	(0.04)
Company value was 130 in the last period	-0.11**	-0.12**	-0.01	0.01
	(0.05)	(0.05)	(0.02)	(0.04)
Company value was 240 in the last period	0.02	0.01	-0.02	-0.04
	(0.06)	(0.06)	(0.02)	(0.03)
Risk averse (switch point>13)	0.17	-0.18*	-0.03	0.35
	(0.24)	(0.11)	(0.03)	(0.27)
Risk seeking (switch point<7)	^	^	^	^
At least one signal from two other subjects is optimal bid	0.07	0.09*		
	(0.06)	(0.06)		
Both signals from two other subjects are optimal bids	0.12	0.08		
	(0.09)	(0.09)		
At least one signal from two other subjects is winner's curse bid			0.01	0.02
			(0.01)	(0.03)
Both signals from two other subjects are winner's curse bids			-0.01	-0.06*
			(0.02)	(0.03)
All answers are correct in quiz 2	0.12	0.06	0.00	-0.02
	(0.13)	(0.10)	(0.03)	(0.05)
Low confidence	-0.07	-0.12	0.05*	0.07
	(0.07)	(0.08)	(0.03)	(0.06)
High confidence	-0.19***	-0.16***	0.13	0.25**
	(0.04)	(0.05)	(0.10)	(0.11)
Demographics				
Economics and Business Major	-0.23	-0.32**	0.45**	0.12
	(0.14)	(0.15)	(0.22)	(0.13)
Science and Engineering Major	-0.49***	-0.48***	0.30*	0.17
	(0.14)	(0.11)	(0.18)	(0.15)
Male who is above 75 percentile SAT/ACT	-0.14*	-0.18*	0.38**	0.16*
	(0.08)	(0.10)	(0.19)	(0.10)
Female who is above 75 percentile SAT/ACT	-0.10	0.07	0.08	-0.10***
	(0.14)	(0.19)	(0.12)	(0.03)
Male who is below 25 percentile SAT/ACT	-0.21***	-0.19***	-0.04*	-0.09***
	(0.07)	(0.06)	(0.02)	(0.03)
Female who is below 25 percentile SAT/ACT	-0.17*	0.00	0.04	-0.08*
	(0.09)	(0.13)	(0.09)	(0.04)
Missing data	-0.20***	-0.19**	0.18	0.09
	(0.06)	(0.08)	(0.20)	(0.12)
Agreeableness	-0.19**		-0.01	
	(0.09)		(0.01)	
Conscientiousness	0.22*		-0.18***	
	(0.12)		(0.04)	
Neuroticism	0.09		-0.15***	
	(0.09)		(0.04)	
Openness	0.04		0.08	
	(0.09)		(0.05)	
Extroversion	-0.04		0.02	
	(0.07)		(0.02)	
1/period	-1.89**	-1.69*	0.64*	0.99*
	(0.91)	(0.89)	(0.38)	(0.55)
Number of obs., Number of subjects	600, 30	600, 30	600, 30	600, 30
Pseudo R-squared	0.330	0.270	0.436	0.300
Log likelihood	-244.4	-266.5	-161.9	-201.1

Notes: see notes to Table 4. (^) no subject was risk seeking. The risk attitude regressors (risk averse and risk seeking) are coded using the group decision in the lottery task.

Table 3A: Probit regressions on solving disagreement among bid proposals (part 4)
Group treatment

Dependent variable: *1=individual proposal became group choice, 0= otherwise*	period 1 (a)	periods 2-12 (b)	periods 13-20 (c)
Proposal is median and majority	0.75***	0.62***	0.75***
	(0.11)	(0.05)	(0.05)
Proposal is median but not majority	0.54***	0.22**	0.42***
	(0.17)	(0.10)	(0.06)
Among group proposals, it yields the highest expected profit	0.05	0.03	-0.12
	(0.20)	(0.06)	(0.10)
Low cash endowment, below limited liability threshold	(^)	-0.13	0.12
		(0.38)	(0.22)
Subject is risk averse (switch point>13)	0.46**	0.04	0.04
	(0.19)	(0.11)	(0.14)
High confidence proposal	-0.02	-0.09	0.17*
	(0.21)	(0.07)	(0.10)
Demographics			
Economics and Business major	0.58*	-0.17	0.04
	(0.31)	(0.13)	(0.15)
Science and Engineering major	0.57*	-0.10	0.16
	(0.29)	(0.12)	(0.13)
Top 25% SAT/ACT score	0.04	-0.13	-0.04
	(0.24)	(0.09)	(0.14)
Male	0.38**	-0.04	-0.03
	(0.18)	(0.07)	(0.10)
Missing demographic data	0.06	0.12	0.09
	(0.41)	(0.11)	(0.14)
Number of obs., Number of subjects	56, 56	369, 54	219, 39
Pseudo R-squared	0.432	0.290	0.402
Log likelihood	-22.04	-180.5	-90.22

Notes: Probit regression with robust standard errors (clusters on groups). Significance levels *** p<0.01, ** p<0.05, * p<0.1. The regressions include all individual proposals unless all identical within the group in a given period (645 obs.). (^) for period 1 in specification (a), 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.

Table 4A: Probit regressions on solving disagreement, version 2 (part 4)
Group treatment

Dependent variable: 1=individual proposal became group choice, 0= otherwise	period 1 (a)	periods 2-12 (b)	periods 13-20 (c)
Median proposal is a winner's curse bid	-0.36*	-0.13*	0.07
	(0.19)	(0.08)	(0.10)
Median proposal is an optimal bid	0.12	0.12**	-0.05
	(0.17)	(0.06)	(0.09)
Median proposal is a dispersed bid	-0.42***	(^)	(^)
	(0.15)		
Low cash endowment, below limited liability threshold	(^)	-0.15	0.03
		(0.32)	(0.20)
Subject is risk averse (switch point>13)	0.36*	0.11	0.12
	(0.20)	(0.10)	(0.11)
High confidence proposal	-0.19	-0.00	0.14*
	(0.17)	(0.07)	(0.08)
Demographics			
Economics and Business major	0.60***	-0.09	-0.12
	(0.22)	(0.11)	(0.12)
Science and Engineering major	0.52**	-0.02	0.10
	(0.22)	(0.10)	(0.11)
Top 25% SAT/ACT score	0.15	-0.19**	-0.17
	(0.19)	(0.08)	(0.11)
Male	0.25	-0.03	0.11
	(0.16)	(0.07)	(0.08)
Missing demographic data	0.11	-0.05	-0.23*
	(0.32)	(0.10)	(0.13)
Number of obs., Number of subjects	56,56	355,54	208,39
Pseudo R-squared	0.195	0.0573	0.0764
Log likelihood	-31.22	-228.8	-130.9

Notes: Probit regression with robust standard errors (clusters on groups). Significance levels *** p<0.01, ** p<0.05, * p<0.1. The regressions include all individual proposals unless all identical within the group in a given period (645 obs.). (^) for period 1, 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. The regressor "median proposal is a dispersed bid" predicts failure perfectly and 14 observations dropped from the regressions for periods 2-12 and 11 observations dropped from the regressions for periods 13-20.