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THE EFFECT OF KNOWING WHAT YOU DON'T KNOW

ASYMMETRIC INFORMATION IN LOTTERY-CONTESTS

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Abstract

This study experimentally investigates how individuals' behavior change in an imperfectly discriminating common-value lottery-contest under two different information structures. The participants engages in one symmetrical contest with incomplete information of the prize value, and one asymmetrical contest where the uninformed player has incomplete information of the prize value and the informed player has complete information of the actual prize value. The experimental design allows for anonymity and leaves the players unknowing of the outcome of the contests. The findings include that the symmetrical contests yield higher bids than the asymmetrical contests, and that females bid higher than males in the symmetrical contest. Our key finding is that the overall change of bids can be explained by the gender and the order of contests, but not by the information level. Concluding, we are unable to predict the behavior of a player if the player receives information regarding the actual prize value, but we argue that for players who receive no exact information regarding the prize value, we are able to predict the change in behavior.

Keywords: Contest, Experiment, Asymmetric Information, Incomplete Information

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1. Introduction

Infinite situations in business and in life can be viewed as contests. Sometimes we might not know what the contest is about, what the prize might be worth, or that we are part of a contest at all. In situations ranging from high school admission, to lobbying and spending resources on R&D, elements of contests can be identified (Tullock 1967; Cornes and Hartley 2005; Frank and Cook 2010; Vojnović, 2016) and we can try to apply the knowledge of game theory to investigate and predict the behaviors of the parties involved.

A contest is a situation where players spend some sort of effort to increase their probability to win a prize. The effort is unrecoverable once it has been spent, and most commonly effort regards to scarce resources such as time or money. In imperfectly discriminating lottery-contests every effort expended by the player relative to the effort expended by the competitors increases the probability of winning. There is no certainty however that the player who spends the most effort will win (Grosskopf, et al., 2010). The prize can be of common or different value between players. Furthermore, the individuals' valuation of the prize can be common or private knowledge.

Imperfectly discriminating contests are common in countless areas within society. Engaging effort in sports, elections, lobbying, rent-seeking and R&D can all be described as contests (Munster 2009; Epstein et al. 2011). However, spending more effort than the competition does not insure that you will win: the chance that you will be successful only increases. Since all participants expend effort to be part of the contest and there is often only one winner, the effort expended by the losing players could be viewed as a waste of resources. The resources could have been invested differently and been of greater value to the player, the organization or society in large.

There is plenty of theoretical research within the area of imperfectly discriminating contests, whereas the experimental research is more limited. Therefore, this paper aims to enrich the knowledge and perspectives regarding experimental lottery-contests. This paper experimentally investigates an imperfectly discriminating common-value lottery-contest. Participants will spend unrecoverable effort to increase their own probability of winning a lottery, where the prize is of uncertain but common value to the players. The behavior of the players is examined with two information structures: one symmetrical setting where both players know the distribution of the prize value, and one asymmetrical setting were the uninformed player knows the distribution of the prize value whilst the informed player knows the actual value of the prize.

The experimental design of this study allows for complete anonymity between the players, creating the possibility to investigate the spending behavior with limited interference from social influence. The design avoids any effect of learning between the contests, since no feedback is given regarding the effort expended or the winner of the previous contest. To our knowledge a set-up of a lottery-contest with different information structures under anonymity and without the players knowing the outcome of the contests has not been investigated before.

We test five different hypotheses to examine the behavior of the individuals. We compare the behaviors between and within the groups, as well as with the theoretical predictions of the equilibrium bids derived using the model of Wärneryd (2003). We investigate the effects on the change in behavior from the information structures, the order of the contests and the gender of the participant. The experiment includes 74 observations and contributes with significant results.

The thesis is structured as follows. Section 2 will provide definitions of concepts and the most important findings of previous research. Section 3 clarifies the research question. Section 4 presents the theoretical mathematical framework. Section 5 describes the experimental design and hypotheses. Sections 6 describes the results. Section 7 provides a discussion of the results. Section 8 concludes the thesis.

2. Previous Research

The previous research of imperfectly discriminating common-value lottery-contests concerns many different aspects. We will start with the imperfectly discriminating common-value lottery-contest and different information structures, and continue with discussing several theoretical and experimental findings.

2.1 The Imperfectly Discriminating Common-Value Lottery-Contest

A contest is a situation where players spend some type of effort to increase their probability to win a prize. Effort most commonly regards the expenditure of scarce resources such as time and money. The effort spent is unrecoverable and will be paid regardless of whether the player wins or not (Grosskopf, et al., 2010; Sheremeta, 2014).

In imperfectly discriminating contests, effort expended by the player relative to the effort expended by the competitors increases the probability of winning. The amount of effort expended is decided by the player (Grosskopf, et al., 2010). The winner is decided through a process where each player has the probability of winning as described below in Equation 2.1. As such, there is no certainty that the player who spends the most effort will win if the competitor spends more than zero.

$$p_i(x_1, x_2) = \frac{\phi(x_i)}{\phi(x_i) + \phi(x_j)} \tag{2.1}$$

Since the winner is decided with regards to the probabilities, the prize might be won without spending the full value of the prize, or even by spending little effort compared to the prize value. The total payoff for the players is the sum of the prize won if the player wins, less the effort spent to participate in the contest. The best-case scenario is when the player expends as little effort as possible and wins the prize. If the player wins, the payoff keeps being positive for all expended amounts until the break-even threshold for the winner. When the winner expends as much as the prize is valued, the effort expended is at the break-even threshold. Notice also, that the payoff might turn negative. The first case is when the player expends effort to participate but does not win the prize. The second case is when the player expends effort to participate and wins, but the prize is worth less than the effort expended. That is, the player overbids in relation to the prize value.

The prize of a contest can be of common value or be valued differently by the players. Some types of prizes are more easily valued, like monetary prizes – even though the utility of money can be of different value to individual players – and some prizes are more difficult to value, like a promotion or a business contract. The prize can also be of certain or uncertain value to all or some of the players. As with R&D for example, the firm spending money on new developments might not know if or how much revenue the investment might generate in the future. Some other firms might have made similar investments before, and therefore have more information on what the expected revenue might be.

2.2 Information Structures

The information held by players in a contest can vary. In a symmetric information setting all players have the same amount of information. This includes both the case of symmetric complete information, where all players are completely informed, and symmetric incomplete information, where all players are uninformed to some extent. Hence, a symmetrical information structure does not mean that there is no uncertainty in the contest, it simply means that all players have the same level of information (Eatwell, et al., 1989). In an asymmetric setting on the other hand, the players have different levels of information. The player with relatively more information is called the informed player, and the player with relatively less information is called the uninformed player.

2.3 Earlier Findings

The previous research regarding lottery-contests is mostly theoretical, but there is some experimental research as well. An interesting find when applying an asymmetric information structure to a theoretical lottery-contest, is that the uninformed player wins with strictly higher probability (Wärneryd, 2003). He also finds that the aggregate equilibrium expenditure may be strictly less in the asymmetric information structure, compared to the symmetrical setting. On the contrary, Grosskopf et al. (2010) experimentally examines a common-value lottery-contests with different information structures and find that in the asymmetrical contest the informed bidders win more than 50% of the time. However, consistent with the theory, they find that asymmetric information reduces the effort expended by the players. Moreover, Millner and Pratt (1989) find high volatility of the individuals spending in their investigation of a rent-seeking lottery-contest.

Many experimental research show overbidding (Millner and Pratt, 1989; Sheremeta, 2011). Brookins and Ryvkin (2014) experimentally examines expenditure in a contest under three different information structures – complete symmetrical, complete asymmetrical and incomplete symmetrical information – regarding the players' cost of effort spent. The results are compared with the theoretical predictions of Ryvkin (2010). The findings show that on average there are overbidding in all different information structures compared to the risk-neutral mathematically calculated equilibrium. They also find that the average bid is not significantly different across the different structures.

In the asymmetrical setting, the uninformed player cannot estimate the actual prize value as certainly as the informed player and is therefore potentially a victim of the winner's curse**.** The Winner’s curse occurs when a player places a bid above the break-even threshold and wins the prize, resulting in a negative payoff (Grosskopf et. al. 2010). In a lottery-contest, an uninformed player is only potentially a victim of what Wärneryd (2003) calls an "analogue" for the winner's curse. As there is no need for any player to spend at or above the break-even threshold to win, an uninformed player can win without over-bidding.

The reasons why the players overbid are many. Mago et al. (2014) exhibit a model where players try to maximize their relative payoff, and finds that the overbidding can be explained by both relative payoff maximization and the utility of winning. Moreover, the “hot hand fallacy”, the possibly deceptive belief that a player who experiences success with one random event will have a greater probability of winning in another random event, could contribute to overbidding (Parco, et al., 2005). A study by McKelvey et al. (1995) presents that players tend to make mistakes when noise is added to the contest, as for example with regards to the distribution of the prize value. Within the same area, Grosskopf et al. (2010) conducts an experiment where they give the informed players in an asymmetrical contest an interval for the prize value rather than the exact prize value. The overbidding that occurs on behalf of the informed players is then interpreted as overconfidence. The informed players bid increasingly higher above the break-even threshold repeatedly throughout the series of contests, compared to the uninformed players. The informed players act irrationally in an economical perspective when aware that they possess more information than the competitor (Millner and Pratt 1991).

Another find is that females tend to bid higher than males in the first round, but as they participate in several rounds females decrease their bids as males increase their bids (Grosskopf, et al. 2010). However, a study from Croson and Gneezy (2009) show that females tend to be more risk averse than males when it comes to economic situations involving an uncertain outcome, and that females are more likely to not enter a contest than males.

Research also suggest that overbidding can be explained by the components of the experimental design. Chowdhury, et al. (2014) investigate an experiment where the prize is either given to a winner who is decided probabilistically, or the prize is divided proportionally between all the contestants. They find that the probabilistically designed experiment results in an effort further away from the Nash Equilibrium compared to the proportional experiment. The number of sequences that the players engages in is proved to have an impact on the spending behavior and motivation of the player. Rentschler (2009) examines a theoretical model in which two contestants compete in a two-sequential imperfectly discriminating contest where the prize has an uncertain value, and the winner in the first round privately observes the actual prize value. The winner of the first round is found to be better off and will have more motivation to win in the next round. The losing player is strictly worse off and have less motivation in the second-round, and will spend less effort to win.

There is an inconsistency between the general overspending in lottery-contests and the proven risk aversion of participants in economical situations. Many theoretical examinations of lottery-contest assume that players are risk neutral (e.g Wärneryd, 2003; Rentschler, 2009). In an experimental set-up this assumption cannot be made since players do not act completely rationally. A study by Carlsson et al. (2005) show that most people are risk averse, and should therefore spend below the theoretical equilibrium in economical situations. The study of Millner and Pratt (1991) indicate that risk averse players have lower aggregated effort relative to less risk averse players. They also find that risk averse players of a lottery-contest show a lower aggregate effort relative to risk-neutral players. Therefore, although theoretical examinations of lottery-contests assume risk-neutral players, it appears that players are risk averse.

Kahneman interestingly states that "*For most people the fear of losing 100 dollars is bigger than the hope of gaining 150 dollars*" (Kahneman 2012, p. 223). When individuals make economic decisions, they set a reference point and consider the outcomes as losses and gains in relation to that reference point. The Prospect theory describes this situation, where the individual is choosing between probabilistic alternatives that involves risk and the outcome is unknown. According to this theory the individuals do so by evaluating the decisions depending on the potential losses and gains, rather than the final financial outcome. The editing phases creates a framing effect, which can be used in future economic decisions (Tversky and Kahneman, 1992). The theory contrasts many classical economic theories, aiming to analyze real life choices rather than the optimal economical outcome.

Regarding the players own perception, Dixit (1987) theoretically investigates lottery-contests where one of the players are offered to make a strategic pre-commitment to the level of effort.

He names the player who has a probability of winning the asymmetrical contest higher than 50% “the favorite” and other player “the underdog”, and finds that the effect of pre-commitment is quite small compared to the effect of the own created pressure: *"...The pressure on a favorite is of his own making, as is the relaxed mood of the underdog" (*Dixit 1987, p. 896*).* Within the same subject, the influence of signaling is relevant as the players of an asymmetrical contest are per definition distinguished from each other, assuming that the informational structure is common knowledge. The awareness of the different information levels is a clear signal amongst the players. This contributes to learning about each other’s differences, which can affect the outcome of the contest (Connelly et al., 2011).

Social influences play a major role in economic behavior. A laboratory experiment by Solnick and Schweitzer (1999) show that people tend to not maximize their pay-off when being influenced by social pressure and the appearance of the counterpart. They also find that the so called social distance, the emotional adjacency induced by a situation, affects the outcome. The theory of social distance suggests that a player in a contest tend to act in favor of someone that share the same social affinity (Bohnet and Frey, 1999). In many experimental set-ups researchers want to measure outcomes without disturbances such as social distance. Charness et al. (2007) investigate the effect of social influences through an experiment where some of the participants perform a test facing each other, and some participants perform a test online. The findings show that the effect of the social influences is larger when the participants face each other. Furthermore, Bohnet and Frey (1999) suggest that in a contest with anonymity the player have intrinsic motivation to win the prize and to behave in a truthful way. If players are facing each other, communicating is possible and the correspondence can create a biasedness.

To summarize, most studies on lottery-contest are theoretical. This creates value for additional experimental studies. The experimental investigations show overspending relative to the theoretical equilibrium. The information structure seems to affect the outcomes significantly, and the effort expended under asymmetrical information structure seems to be lower than the effort expended in the corresponding symmetrical structure. There are indications than men and women bid differently. The information given to the players seems to affect the spending behavior, and the motivation of the players seems to be affected by knowing the outcome of the contests. Furthermore, research show that social influence affect the individual’s economical behavior.

3. Specification of the Research Question

The research objective of this study is to examine how the individual player's spending behavior in imperfectly discriminating common-value lottery-contests change under different information structures.

This paper experimentally investigates an imperfectly discriminating common-value lottery-contest. The spending of the players is examined in an experiment with two information structures: one symmetrical setting where both players know the distribution of the prize value, and one asymmetrical setting were the uninformed player knows the distribution of the prize value whilst the informed player knows the actual prize value. The players have no knowledge of the outcome of the contests, avoiding any effect of learning between the contests. The social influence is limited as the experiment is carried out through an online-survey.

The aim of this paper is to investigate the research question:

How does the individuals' spending behavior in imperfectly discriminating common-value lottery-contests change under different information structures?

4. Theoretical Framework

The mathematical framework is from the model of Wärneryd (2003). This paper investigates an imperfectly discriminating lottery-contest with two players and a prize. The prize takes the values of either 20 SEK, 40 SEK, 60 SEK, 80 SEK and 100 SEK with equal probabilities. We apply two different information structures, one symmetrical and one asymmetrical structure. Below, the theoretical Nash equilibriums are derived mathematically.

4.1 Symmetrical Setting

In the symmetrical lottery-contest, two players (i and j) compete for a prize of common but uncertain value (y), which is distributed according to the continuous cumulative function F. In this theoretical set-up we assume that both players are risk neutral and the effort spent is expressed in SEK. Furthermore, we assume that the players value the prize to the same amount, so that $v_1 = v_2 > 0$. The probability p_i of player i to win is the effort spent by player i relative to the total expended effort of both players. This means that every effort spent by player i increases the probability of player i to win. Equation 4.1 displays the probability function.

$$p_i(x_i, x_j) = \frac{\phi(x_i)}{\phi(x_i) + \phi(x_j)} \tag{4.1}$$

Equation 4.1 is the contest success function (CSF), and it is assumed to be concave. Additionally, $\phi(0) = 0$. The CSF is not defined if both players expend zero effort. However, if one player expends zero effort, the other player will win with a probability of one for any effort expended. The probability of winning is as described in Equation 4.

$$p_i(x_i, x_j) = \begin{cases} x_i/(x_i + x_j) \ \ if(x_i + x_j) \ > 0 \\ 0 \ otherwise \end{cases} \tag{4.2}$$

In the symmetrical information structure, the expected utility of player i is as described in Equation 4.3:

$$u_i(x_i, x_j) := \int_{\underline{y}}^{\infty} p_i(x_i, x_j) y \, \mathrm{d}\, F(y) - x_i. \tag{4.3}$$

Since the players decide on how much effort to spend independently and unknowingly of the competitor’s effort, player i's best response will be:

$$\frac{du_i}{dx_i} = \frac{x_i}{(x_i + x_j)^2} v_i - 1 = 0 \tag{4.4}$$

$$x_i = \sqrt{v_i x_j} - x_j \tag{4.5}$$

$$x_i(y) = \begin{cases} 0 \; if \; y = 0 \\ \sqrt{v_i x_j} - x_j \; if \; y = v \end{cases} \tag{4.6}$$

Player *j'*s best response will be:

$$\frac{du_j}{dx_j} = \frac{x_i}{(x_i + x_j)^2} v_j - 1 = 0 \tag{4.7}$$

$$x_j = \sqrt{v_j x_i} - x_i \tag{4.8}$$

$$x_j(y) = \begin{cases} 0 \; if \; y = 0 \\ \sqrt{v_j x_i} - x_i if \; y = v \end{cases} \tag{4.9}$$

The Nash equilibrium in the symmetrical contest is therefore for all players:

$$x^* = \frac{(n-1)}{n^2} v \tag{4.10}$$

In a contest with two players, both players will spend ¼ of the prize value. For example, in a symmetrical contest with two players where the value of the prize is $v = 20$, the equilibrium expenditure for the players will be:

$x^* = 5$, as shown in Equation 4.11:

$$v = 20 \; ; \; x^* = \frac{(2-1)}{2^2} 20 = 5 \tag{4.11}$$

4.2 Asymmetrical Setting

In the asymmetrical lottery-contest, the same principles as in the symmetrical setting in Section 4.1 applies, with some adjustments. The uninformed player *(u)* only knows the distribution of the prize value and the informed player *(I)* knows the actual prize value.

The informed player's rational economic expenditure is:

$$u^I = \frac{x_I}{x_I + x_u} v_I - x_I \tag{4.12}$$

The informed player's utility is dependent on the prize value and the relative effort in relation to the competitor's as in Equation 4.13:

$$\mathrm{u}(x_I) = \int_{\underline{y}}^{\infty} \mathrm{u}\big(x_I(y)\big) \, \mathrm{d} F(y) \tag{4.13}$$

The equilibrium in the asymmetrical contest depends on the prior distribution of the prize value. In our experimental design the distribution is:

$$v = \begin{cases} p = 0{,}2 \; v = 20 \\ p = 0{,}2 \; v = 40 \\ p = 0{,}2 \; v = 60 \\ p = 0{,}2 \; v = 80 \\ p = 0{,}2 \; v = 100 \end{cases} \tag{4.14}$$

The uninformed player's utility function is:

$$u^u = \sum_{0}^{1} 0{,}2 \frac{x_u}{x_I + x_u} v_u - x_u \tag{4.15}$$

Given our distribution:

$$\begin{aligned} u^u = {} & 0{,}2 \frac{x_u}{x_I(20) + x_u} 20 - x_u + 0{,}2 \frac{x_u}{x_I(40) + x_u} 40 - x_u \\ & + 0{,}2 \frac{x_u}{x_I(60) + x_u} 60 - x_u + 0{,}2 \frac{x_u}{x_I(80) + x_u} 80 - x_u \\ & + 0{,}2 \frac{x_u}{x_I(100) + x_u} 100 - x_u \end{aligned} \tag{4.16}$$

To find the expenditure that maximizes the utility for the uninformed player, Equation 4.16 is derived and set to zero to find the point where the utility is maximized:

$$\frac{du_u}{dx_u} = 0{,}2\frac{x_I(20)}{(x_I(20)+x_u)^2}20 + 0{,}2\frac{x_I(40)}{(x_I(40)+x_u)^2}40 + 0{,}2\frac{x_I(60)}{(x_I(60)+x_u)^2}\,60 + 0{,}2\frac{x_I(80)}{(x_I(80)+x_u)^2}80 + 0{,}2\frac{x_I(100)}{(x_I(100)+x_u)^2}100 \; - \; X_u \; = 0 \tag{4.17}$$

To find the equilibrium, a value where the informed players' payoff is positive must be found. Therefore, we must detect a value where the informed player spends something positive for every value in the distribution including the lowest value of 20 SEK. Eventually, x_u is solved for. If x_u is less than 20 SEK, there is an equilibrium. If x_u is larger than 20 SEK, then the informed player would not spend any effort since the payoff would be negative for all prize values. On the other hand, under the assumption that the informed player always spend effort, the prize values respectively give the following Equations:

$$x_I(20) = \sqrt{20\,x_u} - x_u \tag{4.18}$$

$$x_I(40) = \sqrt{40\,x_u} - x_u \tag{4.19}$$

$$x_I(60) = \sqrt{60\,x_u} - x_u \tag{4.20}$$

$$x_I(80) = \sqrt{80\,x_u} - x_u \tag{4.21}$$

$$x_I(100) = \sqrt{100\,x_u} - x_u \tag{4.22}$$

$$x^u \; = 0{,}2\frac{\sqrt{20\,x_u} - x_u}{20x_u}20 + 0{,}2\frac{\sqrt{40\,x_u} - x_u}{40x_u}40 + 0{,}2\frac{\sqrt{60\,x_u} - x_u}{60x_u}60 + 0{,}2\frac{\sqrt{80\,x_u} - x_u}{80x_u}80 + 0{,}2\frac{\sqrt{100\,x_u} - x_u}{100x_u}\;100 = 0 \tag{4.23}$$

$$0{,}2(\sqrt{20\,x_u} + \sqrt{40\,x_u} + \sqrt{60\,x_u} + \sqrt{80\,x_u} + \sqrt{100\,x_u}) - \; x_u \; = x_u \tag{4.24}$$

$$x_u \approx \; 14.0527 \tag{4.25}$$

When solving for the equilibrium, the informed player spends ¼ of the prize value, similarly as in the symmetrical contests shown in Section 4.1. The uninformed player spends approximately 14.0527 SEK independently of the prize value. The equilibrium bid for the uniformed player is below the lowest prize value ($x_u < v = 20$) which means that there is a unique equilibrium for this prize distribution, where the uninformed player always spends a positive amount. This means that there are more equilibriums to be found, but this is the only one where the uninformed player and the informed player will both spend a positive amount for every value of the prize.

For example, if the value of the prize is $v = 40$, the equilibrium expenditure for the informed player will be ¼ of the prize value $x_I = 10$ and for the uninformed player it will be $x_u = 14{,}0527$.

4.3 Summary

The Nash equilibriums derived are summarized below in Table 4.1:

Table 4.1: Nash equilibrium

Symmetrical contest	
All players	$x_i = \frac{(n-1)}{n^2}v$
Asymmetrical contest	
Uninformed player	$x_u = 14.0527$
Informed player	$x_I = \frac{(n-1)}{n^2}v$

5. Experimental Design and Method

5.1 Choice of Approach and Research Method

As this study takes a deductive approach, we utilize *a priori* established theories and frameworks in relevant areas of research to create a framework for our hypotheses. The research can be characterized as causal as the goal of the experiment is to conclude if there is a cause-and-effect relationship (Bryman, et al., 2015). Therefore, the laboratory experimental study design serves as a good basis for the analysis (Malhotra, 2008). A lottery-contest using this set-up has not been tested before to our knowledge, and will contribute to the research field through its unique design.

5.2 Sampling Procedure

The experiment was conducted through a Qualtrics online-survey that was shared via social media. The survey was distributed mostly to students at the Stockholm School of Economics, but due to the relatively small population of students at the Stockholm School of Economics a small number of participants are students from other universities as well. We collected 74 valid observations, which is in line with the aim of 50-100 participants. The data collection took place from the 7th until the 20th of April 2018. The survey was closed after a satisfactory number of respondents had participated in the experiment.

5.3 Experimental Procedure

The experiment was conducted through an online-survey, which can be found in Appendix A. The survey starts with welcoming the participants to the experiment, which is followed by instructions and rules of the contest. Two control questions conclude the instruction and for clarifying the instruction to the participants, the correct answers are marked. The participants were asked to identify their gender and their phone number as identification and to enable contact. To motivate and attract people to participate in the experiment, a monetary prize is promised to be given to five of the participants. The experimental design allows the players to be completely anonymous from each other since they will never know who they played against. This allows for the players' behavior being investigated without interference from social influence.

After the instructions the participant engages in two independent rounds of a lottery-contest. The rules are similar in both rounds, but the information structure is different between the two: one with symmetrical information ("symmetrical contest") and one with asymmetrical information ("asymmetrical contest"). The participants engage in the two contests in a random order. Furthermore, within the asymmetrical contest the roles of the uninformed and the informed player is randomly assigned. The prize value information given to the informed player varies with an equal distribution of the prize values of 20 SEK, 40 SEK, 60 SEK, 80 SEK and 100 SEK.

The players are asked how much *imaginary* money (SEK) they would like to spend to participate in a lottery where the prize is of uncertain but common value to the players. The players can spend a minimum amount of 1 SEK and a maximum amount of 100 SEK in each round to participate. They submit their own expenditure without knowing what the other player expends. The total payoff after two rounds is: *Total payoff = (100 – expended amount in 1st contest + potential prize) + (100 – expended amount in 2nd contest + potential prize).*

The distribution of the prize value is explained in the instruction and in relation to the contest to ensure that the players are sufficiently informed. In the asymmetrical contest, the uninformed players knows the distribution of the prize value, and is unaware of the actual prize value. The informed player however, will in addition to the common knowledge of the distribution of the prize value, know the actual prize value.

The players do not know the outcome of the contests or who their competitor is. Every participant engages independently and at their time of convenience, meaning that the contests between two players are not performed in real time. Instead, the data collected from one player is paired through randomization with another player's data afterwards, to create contests of two players each. This is described below in Section 5.4.

5.4 Constructing Contests

When the data had been collected, we arranged the data to form virtual contests. In every contest, there is a prize, two players, and one bid from each player for each contest. With regards to the asymmetrical contest, we match one player who was informed with another player who was uninformed. For every asymmetric contest, one of the players have been informed of the prize value and hence the asymmetric prize in the contests formed is given by that information for both players in that couple. For the symmetrical contest the prize for each pair is instead randomized. Due to uneven numbers, some players end up without a competitor. In this case one or both prizes are randomized. The winners of each contest was randomized given every players' probability to win. The total payoff was calculated. Five participants were chosen to receive their total payoff in cash as promised, and was contacted through their phone numbers and paid.

5.5 Exclusions and Attrition

Of the total entries to the survey of 159, 80 entries did not finish the survey and are excluded from the dataset. A number of these unfinished surveys could have been caused by eventual technical errors, causing the survey to be ended or interrupted before completion. The reason for excluding these respondents is to come to terms with the problem of non-response bias. Furthermore, there were two respondents that answered the control question wrong. These were excluded as well since they did not understand the instructions correctly. The reason for this was to come to terms with the response bias that may occur when the player is not provided with enough information to participate correctly in the contest. Furthermore, one player placed a bid of zero SEK in one of the contests, which was not allowed and is therefore excluded. Additionally, two respondents identified as the gender alternative “Other”. To simplify the statistical approach these observations were excluded as well.

5.6 Within- and Between-Group Study Methods

The data is analyzed mostly as a within-group study as the same subjects serves in several treatments. Additionally, some analysis is made by applying the methods of a between-group study, helping us to analyze multiple variables simultaneously (Charness et al, 2012). The advantage of the first approach is that it reduces the error variance that is associated with individual preferences. Hence, we can analyze the difference in behavior without the interference of different risk profiles among the participants. Since the conditions is the same for each group of study the individual variables will be reduced if they are deviant for some reason. As the focus of this thesis is to analyze how individuals’ behavior change under different conditions, this is in line with current methods as well as with the aim of this paper.

5.7 Empirical Strategy

The focus of the study is to investigate how the individual player’s spending behavior change in common-value lottery-contests under different information structures. In order to investigate this question, 5 hypothesizes are formed below. In terms of values we analyze the effort expended (“bids”), the distances between the bids and the theoretical equilibrium (see Section 4) of each contest, and the change of distance between the first contest and second contest. See variable list in Section 5.8 below.

The distance is calculated as the bid placed by the player less the Nash equilibrium expenditure level. The equilibrium in the symmetrical contest is calculated as ¼ of the expected value of the prize value of 60 SEK. For the asymmetrical contest, the uninformed player has a constant equilibrium expenditure of 14,0527 SEK. The informed player has an equilibrium expenditure of ¼ of the prize value, and since these players are informed of the actual prize value this is the number used. The measure of change of distance is thought to show how the behavior of the player changes under different levels of information. Change of distance is calculated as the change between the distances in the first contest compared to the distance in the second contest. Notice that this measure is dependent on the order of the contest and that the first contest could be either the symmetrical or the asymmetrical contest and vice versa.

5.8 Variables

Area	Name	Explanation
Effort expended	$SYMBID_i$	The effort expended ("bid") in the symmetrical contest, value in SEK.
	$ASYBID_i$	The effort expended ("bid") in the asymmetrical contest, value in SEK.
	$SAME\_BID_i$	Describes if the player made the exact same bid in both contests. Dummy variable: SYMBID=ASYBID = 1, SYMBID≠ASYBID = 0.
Gender	$FEMALE_i$	Describes the gender identity of the participant. Dummy variable: Female = 1, Male = 0, Others (two observations) excluded, see Section 5.4.1.
Information level	$INFORMED_i$	Describes the informational role of the participant in the asymmetrical contest. Dummy variable: Informed in asymmetrical contest = 1, Uninformed in symmetrical contest = 0.
Order of contests	$SYMFIRST_i$	Describes in which order the participant conducted the contests. Dummy variable: (symmetrical 1st and asymmetrical 2nd=1), (asymmetrical 1st and symmetrical 2nd=0).
Distance	$DIST\_1_i$	Distance between the Nash equilibrium and the bid placed by player *i* in the first contest, value in SEK.
	$DIST\_2_i$	Distance between the Nash equilibrium and the bid placed by player *i* in the second contest, value in SEK.
Change of distance	$CHNG\_DIST\_12_i$	The change between $DIST\_1_i$ and $DIST\_2_i$, i.e. the change of distance between the distance in the first contests and the distance in the second contest, value in SEK.

5.9 Hypotheses

Hypothesis 1: *The behavior of each individual, with regards to risk behavior, knowledge, understanding and methods of choice are the same through both contests*

We expect the individuals to have the same risk behavior, knowledge, understanding and methods for making a choice of effort expenditure in both contests. We investigate if the distance in the first contest can explain the distance in the second contest, independently on which type of contest was first or second. The idea is that there should be a similar pattern of distances in the first and second contests.

We do a Spearman Rang correlation test to investigate if:

$$H_0\text{: } No\ positive\ association\ in\ the\ population$$

$$H_1\text{: } Positive\ association\ in\ the\ population$$

We do a paired *z-test* to examine if:

$$H_0\text{: } \overline{DIST\_1}_i = \overline{DIST\_2}_i, H_1\text{: } \overline{DIST\_1}_i \neq \overline{DIST\_2}_i$$

We run the regression:

$$DIST2_i = \beta_0 + \beta_1\, DIST1_i + \varepsilon_i$$

Where $DIST2_i$ is the distance between the Nash equilibrium and the bid placed by player *i* in the second contest, $DIST1_i$ is the distance between the Nash equilibrium and the bid placed by player *i* in the first contest, and ε_i is the robust standard errors. We use a *t-test* to see if:

$$H_0\text{: } \beta_1 = 0, H_1\text{: } \beta_1 \neq 0$$

Hypothesis 2: *The average bid of the symmetrical contest is higher than the average bid of the asymmetrical contest*

Theoretical research show that the uninformed player spend less than the informed player. The experimental research confirms this, however the magnitude of the difference between the bids is not consistent between different experiments. To examine if the bids in the symmetrical contest differs from the asymmetrical contest, we do a paired *z-test* to see if:

$$H_0\text{: } \overline{SYMBID}_i = \overline{ASYBID}_i, H_1\text{: } \overline{SYMBID}_i > \overline{ASYBID}_i$$

Hypothesis 3: *Females bid higher than males*

As described in the literature, females tend to bid higher in the first round compared to males. In this study, the participants only play two rounds, hence we expect females to bid higher than males. The previous experimental set-ups differ from ours but we think that the trend will be the same. We use three different two-sample *z-test* to examine if:

$$H_0: \overline{SYMBID_i^{FEMALE=0}} = \overline{SYMBID_i^{FEMALE=1}}, H_1: \overline{SYMBID_i^{FEMALE=0}} < \overline{SYMBID_i^{FEMALE=1}}$$

$$H_0: \overline{ASYBID_i^{FEMALE=0}} = \overline{ASYBID_i^{FEMALE=1}}, H_1: \overline{ASYBID_i^{FEMALE=0}} \neq \overline{ASYBID_i^{FEMALE=1}}$$

$$H_0: \overline{CHNG_{DIST_{12}}{}_i^{FEMALE=0}} = \overline{CHNG_{DIST_{12}}{}_i^{FEMALE=1}}$$

$$H_1: \overline{CHNG\_DIST\_12_i^{FEMALE=0}} < \overline{CHNG\_DIST\_12_i^{FEMALE=1}}$$

Hypothesis 4: *The players who are uninformed in the asymmetrical contest will not change their behavior between the two contests*

The players who are uninformed in the asymmetrical contest have the exact same information regarding the possible value of the prize in both contests. Given this, the behavior should not change unless there is an effect of knowing that you know less than your competitor. However, theoretically the equilibriums of the symmetrical and asymmetrical contests differ as shown in Section 4. Given that this study investigates experimental data, it is unlikely that the participants will act completely rationally.

Using a paired *z-test* we explore if:

$$H_0: \overline{SYMBID_i^{INFORMED=0}} = \overline{ASYBID_i^{INFORMED=0}}$$

$$H_1: \overline{SYMBID_i^{INFORMED=0}} > \overline{ASYBID_i^{INFORMED=0}}$$

We also look into the count of the variable *SAME_BID*$_i$, which describes the number of participants placing the exact same bids in both contests.

We conduct a Sign Test to investigate if the probability that the change of distance (*CHNG_DIST_12*$_i$) is equally likely to be positive or negative:

$$H_0: p = 0{,}5, H_1: p < 0{,}5$$

Using a one-sample *z-test* we investigate if:

$$H_0: \overline{CHNG_{DIST_{12}}{}_i^{INFORMED=0}} = 0$$

$$H_1: \overline{CHNG\_DIST\_12_i^{FEMALE=0}} \neq 0$$

Hypothesis 5: *The change of distance can be explained by the order of contests, the gender, and the information level of the participant*

Given that the participants have the same basic characteristics in both contests, we expect the change of distances to be explained by the order of contests, the gender of the player and the information the participant has received. This is consistent with previous research, but the significance and size of these effects are of interest to investigate.

We run the following regression:

$$CHNG\_DIST\_12_i = \beta_0 + \beta_1\, SYMFIRST_i + \beta_2 FEMALE_i + \beta_3 INFORMED_i + \varepsilon_i$$

We check for any interaction effects within this regression using a three-way Anova analysis. In the regression, $CHNG\_DIST\_12_i$ is the change of distance between distance in the first contests and the distance in the second contest, $SYMFIRST_i$ is a dummy-variable coded 1 if the player participate in an symmetrical contest as their first contest and 0 if not, $FEMALE_i$ is a dummy-variable coded 1 if the players are female and 0 if they are male, $INFORMED_i$ is a dummy-variable describing the informational role of the participant in the asymmetrical contest and is coded 1 if the player is informed in the asymmetrical contest and 0 if not, and ε_i is the robust standard errors. We also split the above regression and investigate the effects for the different information levels, such that the following regression is run separately for $INFORMED_i$=0 and $INFORMED_i=1$:

$$CHNG\_DIST\_12_i = \beta_0 + \beta_1\, SYMFIRST_i + \beta_2\, FEMALE_i + \varepsilon_i$$

5.10 Critical Discussion and Limitations of the Research Design

The experimental design allows us to study the research question in a suitable manner. However, some aspects can influence the observed behavior of the players, originating from the experimental design's shortcomings.

The players who first participates in an asymmetrical contest as the informed player, will have the knowledge of the actual prize value in that specific contest. This means that these players will have a reference point, consciously or not, towards what the prize value might be in the second contest they engage in. In their case it will be the symmetrical incomplete information where they do not know the prize value. To be able to account for this effect, half of the participants engage in an asymmetrical contest first, and half participate in a symmetrical contest first.

Furthermore, the level of understanding amongst the participants cannot be ensured. Complete understanding of the contest and the implications on how to achieve the highest payoff requires the knowledge of what would be the best strategy. The control questions concluding the instructions are aimed at highlighting the differences of the information structures, and enhance the understanding of the participants. However, there is no way for the participants to ask questions whilst doing the survey, and therefore some might misunderstand the information. To solve this issue our contact information could have been available during the survey. This would however yield both a practical issue, and most importantly it would yield the risk of giving indications of the best response in the contest and through that altering the behavior of the participants.

The language used the survey could have effects on the spending behavior. The aim is to be as concise and clear as possible without skewing the behavior in any way. However, completely neutral language is difficult to achieve, and the perception of the words can vary between the players, and affect the players differently. The language is meant to be easily understood by the participants, who are thought of as university students but not necessarily experts on neither statistics nor contests. As an example, wording such as "chance" is used instead of "probability" and "distribution of the prize value". The survey was pre-tested before it was distributed, giving the possibility to adjust the instructions and the language. The test-runs are not included in the data.

The relative homogenous test group could contribute to higher aggregated effort (Stein 2002), but since the competition is performed under anonymity, the homogeneity may not be a disturbance. The assumption is made that the students value money equally. Since the students have the same income due to their studies and also have similar expenses, one could argue that some extra money would be equally useful to all students. However, there is of course variability in any extra income or support, making this assumption weaker.

The motivation of the participants would most probably have been higher, and the experiment would have shown a more accurate behavior, if the prize had instead been higher, for example 2000-10 000 SEK. However, since this study has not received any financial support, the budget for prizes was small and prizes of higher value were not possible to accomplish.

Using the method of collecting data individual by individual, and then construct contests afterwards, could be discussed as the most proper method. However, for the sake of the anonymity this was the most convenient approach. As well, the limited resources of financing and time – ours as well as the participants – a survey was the most preferable format. The randomization of pairs, winners and prize values would most probably have been done in the same way even if the experiments had been carried out by meeting with the participants physically.

This paper aims to investigate the spending behavior with as little impact as possible from engaging in several contests in a row. Therefore, no results of the contests are communicated in any way to the players to avoid learning between the contests. Even though the impact of participating in two contests in a row could have been eliminated completely by just engaging the players in one contest, the participation in the two different contests is crucial for the research question. However, there is only two contests for each player and they are different hence the motivation should not be affected significantly.

The measure of change of distance could be an inadequate technique to measure the change of the behavior between the contests. Other studies have mostly compared the bids placed with the theoretical equilibrium, but that seemed inappropriate for this study, looking at the change of behaviors rather that maximization and outcomes. Measuring a change could have been made through qualitative interviews and analysis rather than the quantitative approach used in this study. A combination of the two would probably have been most rewarding.

6. Results

A summary of the participants is displayed in Table 6.1. The total number of respondents included in the dataset is 74, whereof 33 males and 41 females. Of these, 36 played the symmetric contest first and the other 38 played the asymmetric contest first. In the asymmetric contest 35 were uninformed and 39 were informed. For exclusions see Section 5.5, and for more descriptive statistics see Appendix B. Table 6.2 describes the bids of the symmetrical and asymmetrical contests, the distances between the Nash equilibrium and the bids placed by the players of the first and second contest, and the change of distance between the two contests.

Table 6.1: Participants

Total observations	n = 74
Male	n = 33
Female	n = 41
Symmetrical contest first	n = 36
Asymmetrical contest first	n = 38
Uninformed in asymmetrical contest	n = 35
Informed in asymmetrical contest	n = 39

Table 6.2: Descriptive statistics of the bids

	n	max	Mean	min	Std. Dev	Variance
SYMBID	74	100	47.041	1	25.031	626.533
ASYBID	74	100	38.041	1	27.415	751.601
DIST_1	74	95	28.300	–14	24.542	602.324
DIST_2	74	85	27.296	–14	26.767	716.487
CHNG_DIST_12	74	55	–1.003	–80	25.678	659.399

Hypothesis 1

The Spearman Rang Correlation test in Table 6.3 show that there is positive correlation between the distance in the first contest and the second contest, on a significant level ($p=0.01$). There is a small fraction of tied ranks for each variable, but since the amount is small, the effects is assumed to be negligible in lines with Siegel and Castellan (1956). The paired *z-test* in Table 6.4 show that we cannot reject the null hypothesis that the mean of the distance in the first and second contest are the same. The Regression in Table 6.5 shows that the average distance in the second contest is 11.81 SEK ($p<0.01$), and that this is affected with 54.7% of the distance in the first contest ($p<0.01$).

Table 6.3: Spearmans Rang Correlation test of $DIST\_1_i$ and $DIST\_2_i$

One sided test	
n	74
Same rang	$DIST\_1_i$=12% , $DIST\_2_i$=14%
H_0	No association in the population
H_1	Positive association in the population
$Reject\ H_0\ if\ r_s > r_{s;\alpha}$	
r_s	0.561
$r_{s;0,01}$	0.377
Decision	Reject H_0

Table 6.4: Paired *z-test* of $DIST\_1_i$ and $DIST\_2_i$

n	74
H_0	$H_0: \overline{DIST\_1}_i = \overline{DIST\_2}_i$
H_1	$H_1: \overline{DIST\_1}_i \neq \overline{DIST\_2}_i$
$Reject\ H_0\ if\ p < 0.05$	
p-value	0.7367
Decision	Cannot reject H_0

Table 6.5: Regression of $DIST\_2_i$

VARIABLES	*DIST_2*
DIST_1	0.547***
	(0.113)
Constant	11.81***
	(3.440)
Observations	74
Adj. R^2	0.242

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Hypothesis 2

The descriptive statistics in Table 6.6 show that the mean of the symmetrical bid is approximately 47 SEK, whilst the mean of the asymmetrical bid is approximately 38 SEK. Using a paired *z-test* in Table 6.7, we can reject the null hypothesis that the mean of the symmetrical and asymmetrical bids is the same on a significant level (p=0.0016). There is support for that the mean of the symmetrical bid is larger than the mean of the asymmetrical bids.

Table 6.6: Descriptive statistics *$SYMBID_i$* and *$ASYBID_i$*

Treatment	N	max	Mean	min	Std. Dev	Variance
SYMBID	74	100	47.041	1	25.031	626.533
ASYBID	74	100	38.041	1	27.415	751.601

Table 6.7: Paired *z-test* of *$SYMBID_i$* and *$ASYBID_i$*

n	74
H_0	$H_0: \overline{SYMBID_i} = \overline{ASYBID_i}$
H_1	$H_1: \overline{SYMBID_i} > \overline{ASYBID_i}$
$Reject\ H_0\ if\ p < 0.05$	
p-value	0.0016
Decision	Reject H_0

Hypothesis 3

The descriptive statistics in Table 6.8 show that the symmetrical bid is approximately 52 SEK for females and approximately 40 SEK for males. Table 6.9 shows that the asymmetrical bid is approximately 41 SEK for females and approximately 34 SEK for males. Using a two-sample *z-test* in Table 6.10, we can reject the null hypothesis that the mean of the symmetrical bid is the same for both males and females on a significant level (p=0.0143). There is support for that the mean of the symmetrical bid of the females is larger than that of the males. Using another two-sample *z-test* in Table 6.11, we cannot reject the null hypothesis saying that the asymmetrical bids are the same for both males and females. Using a two-sample *z-test* in Table 6.12, we can reject the null hypothesis that the mean of the change of distance between the first and second contests are the same for males and females (p=0.0255), and there is support for that the mean change of distance of the females are larger than that of the males.

Table 6.8: Descriptive statistics *$SYMBID_i$* by gender

Treatment	n	max	mean	min	Std. Dev	Variance
SYMBID	74	100	47.040	1	25.030	626.533
Male	33	99	40.272	1	21.418	458.767
Female	41	100	52.487	1	26.612	708.206

Table 6.9: Descriptive statistics *$ASYBID_i$* by gender

Treatment	n	max	mean	min	Std. Dev	Variance
ASYBID	74	100	38.040	1	27.415	751.601
Male	33	100	34.303	1	28.303	801.093
Female	41	100	41.048	1	26.645	709.998

Table 6.10: Paired *z-test* of $SYMBID_i$ by gender

Male	33	Std. Dev. 21.419
Female	41	Std. Dev. 26.612
H_0	$H_0: \overline{SYMBID_i^{FEMALE=0}} = \overline{SYMBID_i^{FEMALE=1}}$	
H_1	$H_1: \overline{SYMBID_i^{FEMALE=0}} < \overline{SYMBID_i^{FEMALE=1}}$	
	$Reject\ H_0\ if\ p < 0{,}05$	
p-value	0.0143	
Decision	Reject H_0	

Table 6.11: Two-sample *z-test* of $ASYBID_i$ by gender

Male	33	Std. Dev. 28.304
Female	41	Std. Dev. 26.646
H_0	$H_0: \overline{ASYBID_i^{FEMALE=0}} = \overline{ASYBID_i^{FEMALE=1}},$	
H_1	$H_1: \overline{ASYBID_i^{FEMALE=0}} \neq \overline{ASYBID_i^{FEMALE=1}}$	
	$Reject\ H_0\ if\ p < 0.05$	
p-value	0.2956	
Decision	Cannot reject H_0	

Table 6.12: Two-sample *z-test* of $CHNG\_DIST\_12_i$ by gender

Male	33	Std. Dev. 21.709	Mean –7.220
Female	41	Std. Dev. 27.728	Mean 4
H_0	$H_0: \overline{CHNG\_DIST\_12_i^{FEMALE=0}} = \overline{CHNG\_DIST\_12_i^{FEMALE=1}}$		
H_1	$H_1: \overline{CHNG\_DIST\_12_i^{FEMALE=0}} < \overline{CHNG\_DIST\_12_i^{FEMALE=1}}$		
	$Reject\ H_0\ if\ p < 0.05$		
p-value	0.0255		
Decision	Reject H_0		

Hypothesis 4

The descriptive statistics in Table 6.13 show that the symmetrical bids for uninformed players is approximately 50 SEK, and the asymmetrical bid is approximately 39 SEK. Using a paired *z-test* in Table 6.14, we can reject the null hypothesis that the mean of the symmetrical bid and the asymmetrical bid is the same for the uninformed players (p=0.0099), and there is support for that the symmetrical bid is higher than the asymmetrical bid. Looking at the variable $SAME\_BID_i$ in Table 6.15 we see that 19 of the 35 uninformed players put in the exact same bid in both contests. Investigating the change of distance for the uninformed players, the Sign

Test in Table 6.16 shows that we cannot reject the null hypothesis that the change of distance is equally likely to be positive or negative. Using a one-sample z-test in Table 6.17, we cannot reject the null hypothesis that the mean of the change of distance for uninformed players is equal to zero.

Table 6.13: Descriptive statistics of $SYMBID_i$ and $ASYBID_i$ by information level ($INFORMED_i=0$)

Treatment	N	max	Mean	min	Std. Dev	Variance
SYMBID	35	100	49.571	1	27.401	750.782
ASYBID	35	99	39.2	1	25.909	671.282

Table 6.14: Paired *z-test* of $SYMBID_i$ by information level ($INFORMED_i=0$)

n: SYMBID	35	Std. Dev. 25.031
n: ASYBID	35	Std. Dev. 27.415
H_0	$H_0: \overline{SYMBID_i^{INFORMED=0}} = \overline{ASYBID_i^{INFORMED=0}}$	
H_1	$H_1: \overline{SYMBID_i^{INFORMED=0}} = \overline{ASYBID_i^{INFORMED=0}}$	
$Reject\ H_0\ if\ p < 0.05$		
p-value	0.0099	
Decision	Reject H_0	

Table 6.15: Count of $SAME\_BID_i$

Treatment	Uninformed	Informed	Total
SYMBID ≠ ASYBID	16	32	48
SYMBID=ASYBID	19	7	26
Total	35	39	74

Table 6.16: Sign-rank Test of $CHNG\_DIST\_12_i$

H_0: p=0.5	There is no overall tendency to change bidding behavior between the contests					
H_1: p<0.5	There is a tendency to lower the distance bid between con1 & con2					
Informed						
	Sum (+)	19	*Sum (–)*	15	*Sum (0)*	5
	p-value	0.804				
	Decision		Unable to reject H_0			
Uninformed						
	Sum (+)	20	*Sum (–)*	15	*Sum (0)*	0
	p-value	0.844				
	Decision		Unable to reject H_0			

Table 6.17: One-sample *z-test* of $CHNG\_DIST\_12_i$
by information level ($INFORMED_i=0$)

n: CHNG_DIST_12	35	Std. Dev. 23.963
H_0	$H_0: \overline{CHNG_{DIST_{12}}}_{i}^{INFORMED=0} = 0$	
H_1	$H_1: \overline{CHNG\_DIST\_12_i^{FEMALE=0}} \neq 0$	
	$Reject\ H_0\ if\ p < 0.05$	
p-value		0.5429
Decision		Cannot reject H_0

Hypothesis 5

Using a three-way Anova analysis, we find that there are no significant interaction effects. The output from STATA can be found in Appendix C. In Table 6.18, we find in Regression (1) to (3) that the information level does not affect the change of distance on any significant level. From Regression (1), (3) and (4) we see that gender has a significant effect (p<0,1) on the change of distance of between 10-11 SEK. The largest and most significant effect is the order of the contests (p<0,01) with an effect of about (–16) SEK. Regression (4) has an *adjusted* R^2 of 12.6%, and Regression (1) has an *adjusted* R^2 of 11.4%, implying that Regression (4) has the highest, however low, explanatory value.

Table 6.18: Regression of $CHNG\_DIST\_12_i$

	(1)	(2)	(3)	(4)
VARIABLES	*CHNG_DIST_12*	*CHNG_DIST_12*	*CHNG_DIST_12*	*CHNG_DIST_12*
INFORMED	0.205	0.923	1.937	
	(5.524)	(5.754)	(5.760)	
FEMALE	10.26*		11.07*	10.28*
	(5.412)		(5.693)	(5.475)
SYMFIRST	–16.32***	–16.83***		–16.34***
	(5.670)	(5.800)		(5.550)
Constant	1.582	7.150	–8.159*	1.693
	(5.622)	(5.131)	(4.713)	(4.459)
Observations	74	74	74	74
Adj. R^2	0.114	0.085	0.022	0.126

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

In Table 6.19 we use the model of Regression (4) from Table 6.18 separated on each information level. The Regression (uninformed) shows the uninformed players change of distance and Regression (informed) shows the informed players change of distance. For the (uninformed) Regression, gender and order of contests are significant ($p<0.01$ and $p<0.05$ respectively), and the *adjusted* R^2 of the model is 27.0%. In the (informed) Regression gender is not significant, but the order of contests is significant ($p<0.01$). The model has a low explanatory value of *adjusted* R^2 of 3.0%

Table 6.19: Regression of $CHNG\_DIST\_12_i$ by information level

VARIABLES	(Uninformed) *CHNG_DIST_12*	(Informed) *CHNG_DIST_12*
FEMALE	19.25***	1.997
	(6.755)	(8.174)
SYMFIRST	–15.64**	–15.40*
	(6.626)	(8.736)
Constant	-3.428	6.240
	(5.921)	(6.037)
Observations	35	39
Adj. R^2	0.270	0.030

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

7. Discussion

With regards to the research question of how the individuals' behavior change in the imperfectly discriminating lottery-contest under different information structures, we find several results to be of value in investigating the behaviors.

The results show that the behavior in the second contest can be explained by the behavior in the first contest on a significant level ($p<0.01$). We find that there is a positive association between the distances of each contest ($p=0.01$). This supports Hypothesis (1) showing that the individuals will act quite similarly compared to their own behavior in the two contests. This further implies that the design of the study and the methods chosen are useful. Possibly, this find could be used to predict future behavior, and if this knowledge was communicated to the players they could adjust their own effort accordingly.

Supporting Hypothesis (2), the symmetrical bid is indeed higher than the asymmetrical bid on a significant level ($p=0.0016$). This is in line with what other experiments find (Grosskopf, et al. 2010), as well as the theory on equilibrium expenditure (Wärneryd, 2003). The find implies that incomplete information will increase the expenditure of the players in a lottery-contest. Looking at real-world examples of lotteries where people do spend unrecoverable money for a small probability to win a large prize, this find seems reasonable. The tendency to spend less in the asymmetrical information could have several reasons which are discussed more in relation with the findings of Hypothesis (5) below.

In the symmetrical contests we find that females bid higher than males on a significant level ($p=0.0143$), and we also find that females have a higher positive change of distance than males on a significant level ($p=0.0255$). This supports Hypothesis (3). However, we cannot reject the null hypothesis that the females and males place the same bids in the asymmetrical contest. Since the symmetrical structure gives incomplete information all players are equally uninformed, and females are usually more risk averse than males in economic situations (Croson and Gneezy, 2009). However, in line with our results this deviating behavior of females has been observed before in lottery-contests in the experiment by Grosskopf et. al. (2010), who also find that females bid higher in the first rounds. The effect they observe over the run of 30 rounds is not possible for us to compare with completely since we only do a two-round experiment. We do find that females have an average positive change of distance between the two contests, meaning that they increase the distance from the Nash equilibrium positively between the contests. On the contrary, males increase their distance from the Nash equilibrium negatively between the two contests.

Regarding the uninformed players we can reject that the bids in the symmetrical and asymmetrical contests are the same, supporting that the symmetrical bid is higher (p=0.0099). This does not support Hypothesis (4). Considering the number of same bids, we see that 19 of 35 uninformed players put the same bid into the two contests. Since we can reject that the bids are the same, the uninformed players who did not place the same bids in the two contests must have been changing their behavior considerably. The uninformed players have the same amount of information in both contests, hence the difference of the bids could not be caused by new information regarding the prize value. The only new information the uninformed players receive is that they are uninformed and know less than their competitor. The experimental design creates signaling, since the players are told that some have more information than others, generating signaling effects (Connelly et al., 2011). In this, it might be that the knowledge of being uninformed affects the players, as in line with what Dixit (1987) declares regarding that the pressure on “the favorite” and “the underdog” of a contest is of their own making.

Regarding our last Hypothesis (5), we see that there are some significant effects on the change of distance, which we argue measures the individuals’ change under the different information structures. The gender of the participant ($p<0.1$) and the order of the contests ($p<0.01$) both have significant effects, while the information level has no effect on any significant level. We find no significant interaction effects. An important note is that there is an overall quite low explanatory value even for the best model (4) (*Adj.* R^2=12.6%). The find that information level does not explain the change of distance on any significant level is interesting since this is the main concept investigated. This means that the information level does not explain the change of distance between the two contests. Looking at the other results previously discussed, we do however see that the information level affects other measures.

The order of the contests has the largest effect, implying that the order of the contests affects the outcomes and payoffs to a great extent. The coefficient is approximately (–16), meaning that the players who engage in the symmetrical contest firstly, will have a change of distance between the first and second contest approximately 16 SEK lower than those who did the asymmetrical contest first. Symmetric bids was earlier in the discussion found to be higher than the asymmetrical bid. Given this, players who engage in the symmetrical contest first will place a higher bid in their first contest and a lower bid in their second contests, which is confirmed through the regression. The players who first engage in the asymmetrical contest, will on the other hand place their lower bid first, and their higher bid in their second contest. The prospect theory (Tversky and Kahneman, 1992) could possibly help explain this further. The symmetrical structure has incomplete information, creating equal uncertainty regarding the actual prize value for all players. This might affect the players who engage in the symmetrical contest first to have a reference point for the optimal bid based on equal risk of overbidding in relation to the prize value. On the contrary, the players who engage in the asymmetric contest first know that the risk of overbidding in relation to information of the prize value is different for the informed and uninformed players. This might affect the players to have a more risk averse reference point in their first contest, resulting in a smaller change of distance between the two contests since they have already placed a bid closer to the Nash equilibrium in their first contest.

Running Regression (4) separately for the information levels, we find that the uninformed players' change of distance is significantly affected by the factors of gender and order of contests. The (uninformed) regression also shows an explanatory value of ($Adj.R^2$=27.0%). The (informed) regression shows a significant effect from the order of contests, but no significant effect from gender. Furthermore, the (informed) model has a low explanatory value ($Adj.R^2$=3.0%). The higher variance in the (informed) regression could likely be caused by a reaction to the information given, affecting the behavior of the informed players to change their bids more than they would if no new information had been received. The (uninformed) significant regression mirrors the situation when no exact information regarding the actual prize value is received. Hence, for players who receive no exact information regarding the prize value, we can explain the change of distance, i.e. the change in behavior between the contests, but for players who receive information regarding the actual prize value, we cannot predict the behavior.

7.1 Suggestions for Future Research

For future research, we suggest to further investigate the effects of lottery-contests under anonymity. Many contest situations involves limited transparency, for example with two lobbyists expending effort to influence political decisions or companies competing to discover new innovations. Additionally, we believe it could be valuable to compare contest set-ups which are alike except that one part of the players act under anonymity and one part faces their competitor. This would allow measuring the effects of social influence more carefully, and it could be possible to analyze in which case the most rational choice is made. Furthermore, if possible, more truthful behavior would most probably be observed if larger prizes were used in a set-up similar to the one of this study. More realistic motivation could give even more insight into why the behaviors differ between the different contests. Moreover, gathering more data regarding the participants' educational background and knowledge of contests could be of interest to for similar studies. Qualitative interviews with the participants after they have placed bids could give insight into the process of choice. Lastly, the signaling effects from the information structures as well as the framing effects could be investigated more carefully, which would contribute to the field of behavior economics.

8. Conclusion

This study experimentally investigates how individuals' behavior change in an imperfectly discriminating common-value lottery-contest under two different information structures: a symmetrical structure with incomplete information of the prize value, and an asymmetrical contest where the uninformed player has incomplete information of the prize value and the informed player knows the actual prize value. The Nash equilibriums of each type of contest is mathematically calculated according to the model of Wärneryd (2003). The optimal strategies for the symmetrical contest is found to be ¼ of the prize value. For the asymmetrical contest, the informed player spends ¼ of the prize value of which they are informed of, and the uninformed agent spends a constant amount of 14,0527 SEK.

The experiment was conducted through an online-survey and provided 74 valid observations. The participants engage in the two contests, one symmetrical and one asymmetrical, in a random order. Furthermore, within the asymmetrical contest the roles of the uninformed and the informed player is randomly assigned. The prize value information given to the informed player is exact but varies with an equal distribution of the prize values 20, 40, 60, 80 and 100 SEK. The experimental design allows for anonymity and leaves the players unknowing of the outcome of the contests.

To summarize our findings, the behavior of the first and second contest are connected, implying that the spending behaviors of the individuals are quite similar in both contests. The symmetrical contests yield higher bids than the asymmetrical contests, in line with other research. Females bid higher than males in the symmetrical contest, which is in contrast with economic situations overall, but in line with lottery-contest in particular. The uninformed players does not place the same bids in both contests, implying a possible signaling effect coming from the informational structure. The overall change of distance can be explained by the gender and the order of contest, but not by the information level. When investigating the change of distance for only the uninformed players, the gender and the order of contests is found to have significant effects. However, for the informed players there appears to be no significant effect of the gender and the order of contests. Concluding, we argue that we are able to predict the behavior of a player if they receive no exact information regarding the prize value, but for players who receive information regarding the actual prize value, we cannot predict the behavior.

The experimental set-up of this study reflects real-life contest situations, mirroring the common lack of knowledge regarding the actual prize value, the competitors and the outcome of the contests. The findings that the uninformed players seems to be affected by the awareness of their lacking knowledge, implies that there is an effect of knowing what you don’t know. We hope that future research will investigate this further and give more insight on the subject.

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Appendix

Appendix A

The program used for producing the survey is called Qualtrics. The survey format is shown below in figure 1–5.

Figure 1: Introduction and instruction providing the respondent with basic background information about the reason behind the survey as well as the information needed to participate in the game.

Welcome to our Lottery Contest!

This lottery contest is in form of a survey and will take about 10 minutes to complete.

The survey is structured as follows:
1) Instructions of the lottery contest
2) Participate in two rounds of the lottery contest

If you participate, you have the chance of winning up to 398 SEK in cash!

The data collected will be used in our Bachelor Thesis in Economics.

Thank you in advance for participating!

Best regards,
Sandra & Ludwig

Instruction

The rules of the lottery contest will now be described.

Following the information is two short control-questions.
These questions will have no effect on the outcome in the lottery.

After that, you will participate in two rounds of the lottery.

Let's go!

The Lottery Contest

The Lottery Contest

In this lottery contest, you will compete against one other player to win a prize.

You will pay *imaginary* money for lottery tickets, and we will draw a winner from a bucket.

The winner gets the prize.

We will match your answers randomly with another player's answers afterwards. Hence, you will not know who you are competing against.

So, how does the lottery contest work?

You can think of the lottery contest as if we had a big bucket and blank lottery tickets, and a very valuable prize.

We will ask you how much you would like to pay to participate in the lottery contest.

For each SEK you pay, you will get one lottery ticket with your name on it in the bucket.

You pay x SEK: so x lottery tickets with your name will be put into the bucket.

Your opponent pays z SEK: so z lottery tickets with the opponent's name will also be put into the bucket.

In total there will be (x + z) lottery tickets in the bucket: x with your name on it, z with the opponents name on it.

We will then draw one lottery ticket from the bucket and the player who's name is on that lottery ticket is the winner.

The winner gets the prize.

You will do two independent rounds of the lottery.

What is the prize?

The prize is an envelope of money.

But we *don't know* how much money is actually in the envelope.

The only thing we know is that with:

- 20% chance there is 20 SEK in the envelope
- 20% chance there is 40 SEK in the envelope
- 20% chance there is 60 SEK in the envelope
- 20% chance there is 80 SEK in the envelope
- 20% chance there is 100 SEK in the envelope

How much money could you spend?

For every new round you will have 100 SEK to spend.

You will spend money to participate in the lottery contest.

You may win and get the money in the envelope.

In the end of each round you will have:

Result = (starting money: 100 SEK) - (amount spent to participate) + (prize money if you win)

What is the minimum amount I can pay in each round to participate in the lottery contest?

Minimum: 1 SEK

Maximum: 100 SEK

Will there be any difference between the two rounds of the lottery contest?

Yes!

So far you know that with 20% chance there is 20/40/60/80/100 SEK in the envelope.

You will do one round when you and your opponent know only this information.

You both know the same information so it is a *symmetrical lottery contest*.

You will also do one round where you OR your opponent will know more than the other. In this round you will either be told that you are the *uninformed player* which means you do not get any extra information.
Or you will be told that you are the *informed player* and then we will tell you <u>the actual value of the prize</u>.
Since you will know different information it is an *asymmetrical lottery contest.*

Are the two rounds of the lottery contest connected in any way?
No!
The two rounds are in no way connected.
The value of the prize in one round is not connected to the value of the prize in another round.

What's in it for me?
We will randomly choose 5 participants who will get their total resulting amount paid out in real money! They will get the money via Swish or other convenient method. You can win up to 398 SEK!

Will you know my name?
You and all other participants are anonymous towards each other.

We need your phone number to be able to identify the separate players, and to be able to contact you if you win cash as described above.

That was all :) Don't worry - the most important information will be shown in connection to each round.

May the odds be in your favor!

Figure 2: Control question, in order make the respondents understand the game

Control question number 1

If there is an asymmetrical lottery and you are the UNINFORMED player - what information, do you get?

1. Only that 20% chance there is 20/40/60/80100 SEK in the envalope ----(Hint This is the correct anwser)
2. Only the actuall value of the price
3. Two things: the actual value of the price AND that with 20% chance there is 20/40/60/80100 SEK in the envalope

Control question number 2

If there is an asymmetrical lottery and you are the INFORMED player - what information, do you get?

1. Only that 20% chance there is 20/40/60/80100 SEK in the envalope
2. Only the actuall value of the price
3. Two things: the actual value of the price AND that with 20% chance there is 20/40/60/80100 SEK in the envalope ----(Hint This is the correct anwser)

You will now participate in two independent rounds of the lottery.

Figure 3: Identification based upon phonenumber and gender identification

Please write your phone number as identification and for us to be able to contact you if you win the money as described before.

Write "+46" followed by your specific 9 digits.

Example: +46707123456

Please choose what you identify yourself as:

1. Male
2. Female
3. Other

Figure 4: Survey question assymetric lottery

Asymmetric lottery

You will now take part in an asymmetrical lottery.

You are the *uninformed player*.

The probable value of the prize is:

20% chance: 20 SEK

20% chance: 40 SEK

20% chance: 60 SEK

20% chance: 80 SEK

20% chance: 100 SEK

How much would you like to pay to participate in the lottery of this prize?

To participate: Minimum 1 SEK, maximum 100 SEK

The winner is the player whose lottery ticket is drawn from the bucket.

Figure 5: Survey question symmetric lottery

Symmetric lottery

You will now take part in a symmetrical lottery.

Both players have the *same information*.

The probable value of the prize is:

20% chance: 20 SEK

20% chance: 40 SEK

20% chance: 60 SEK

20% chance: 80 SEK

20% chance: 100 SEK

How much would you like to pay to participate in the lottery of this prize?

To participate: Minimum 1 SEK, maximum 100 SEK

The winner is the player whose lottery ticket is drawn from the bucket.

Appendix B

Table Appendix B: Descriptive Statistics of the bids placed in the contests

Treatment	n	max	Mean	min	Std. Dev	Variance
Symmetrical Bid (SYMBID)	74	100	47.04054	1	25.03063	626.5326
FEMALE						
Male	33	99	40.27273	1	21.41885	458.767
Female	41	100	52.4878	1	26.61214	708.2061
SYMFIRST						
Asymmetric contest first	36	100	50.27778	1	26.99906	728.9492
Symmetric contest first	38	100	43.97368	1	22.95058	526.729
INFORMED						
Uninfomred in asymmetric contest	35	100	49.57143	1	27.40039	750.7815
Infomred in asymmetric contest	39	100	44.76923	1	22.81788	520.6559
Asymmetric Bid (ASYBID)	74	100	38.04054	1	27.41534	751.6011
FEMALE						
Male	33	100	34.30303	1	28.30358	801.0928
Female	41	100	41.04878	1	26.64578	709.9976
SYMFIRST						
Asymmetric contest first	36	100	41.91667	1	28.0707	787.9643
Symmetric contest first	38	99	34.36842	1	26.62799	709.0498
INFORMED						
Uninfomred in asymmetric contest	35	99	39.2	1	25.90912	671.2824
Infomred in asymmetric contest	39	100	37	1	28.99819	840.8947

Appendix C

A three-way Anova Table for interaction effects in connection with Hypothesis 5:

```
anova CHNG_DIST_12 FEMALE##SYMFIRST##INFORMED
```

	Number of obs =	74	R-squared =	0.1987	
	Root MSE =	24.174	Adj R-squared =	0.1138	

Source	Partial SS	df	MS	F	Prob>F
Model	9566.9121	7	1366.7017	2.34	0.0340
FEMALE	2241.7911	1	2241.7911	3.84	0.0544
SYMFIRST	3868.4975	1	3868.4975	6.62	0.0123
FEMALE#SYMFIRST	839.23741	1	839.23741	1.44	0.2351
INFORMED	75.720343	1	75.720343	0.13	0.7200
FEMALE#INFORMED	1623.7723	1	1623.7723	2.78	0.1003
SYMFIRST#INFORMED	.0556891	1	.0556891	0.00	0.9922
FEMALE#SYMFIRST#INFORMED	208.78515	1	208.78515	0.36	0.5521
Residual	38569.228	66	584.38225		
Total	48136.14	73	659.39918		