# Frames, Fallacies, and the Market for Lemons

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# FRAMES, FALLACIES, AND THE MARKET FOR LEMONS

by
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## Abstract

The purpose of this thesis is to illustrate the impact of an “endowment frame” on risk behavior in games of asymmetric information. Akerlof’s (1970) description of a “market for lemons” led to the creation of a modified screening game into which the endowment frame could be placed. The game was subsequently computerized and administered to 18 test subjects in the Mississippi Experimental Research Laboratory. At the beginning of the experiment, test subjects were randomly assigned to either a control or treatment group. Each participant played 20 rounds of the game and was compensated based on his or her performance. The term “endowment frame” refers to the $0.50 endowment that was granted to treatment group participants at the beginning of each round. Despite the presence of this endowment, the payoff structure was designed so that the expected value of both bid types, high and low, were the same for both experimental conditions. Therefore, in theory, both groups should have produced the same bid selection profiles. However, empirically the treatment group subjects were more likely to select the lower, “riskier” bid. This is consistent with the presence of an endowment effect.

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# Introduction

The game presented in this thesis was derived from Akerlof's (1970) "market for lemons" paper. For the sake of clarity, the game created for and presented in this thesis will be referred to as the "modified lemons game." The original game setup described by Akerlof (1970) will be referred to simply as "the lemons game" or "Akerlof's lemons game." The lemons game describes a hypothetical transaction between a car salesman and a prospective buyer. This relationship was subsequently rendered as an extensive form game in which "nature," the first mover, determines the quality of a car (the car is either of good quality or it is a lemon). The second mover, i.e. the buyer, estimates the probability that the car is of good quality and selects a bid accordingly (his bid is either high or low). Finally, upon considering the magnitude of the buyer's bid, the seller either accepts or rejects the offer.

The lemons game falls into a broader category known as "games of asymmetric information." In these games, one player possesses more information than another player. In the lemons game, the seller knows the quality of the car while the buyer does not. The game's Nash equilibrium is that only lemons get traded, and for the lower bid amount. This outcome results in substantial lost potential gains from trade and, consequently, is sub-optimal for both buyer and seller.

A frame is the deliberate manipulation of the way in which a prospect is presented, while a framing effect is the quantifiable impact of a frame on consumer choice (however, these terms are used somewhat interchangeably). The modified lemons game features what will be referred to as an "endowment frame." Two slightly different versions of the game were administered to the control and treatment groups. The treatment group's version of the game included the endowment frame while the control group's version did not. Just like in Akerlof's lemons game, the buyer, i.e. the test subject, must decide whether to bid high or low on a good. In the modified lemons game, participants bid on a "good" rather than a "used car" in an attempt to avoid introducing any product-specific biases that might skew the results. In addition, for the sake of simplicity, the role of the seller has effectively been omitted. Consequently, the "seller" accepts any bid that is placed. However, there is an implicit benefit or penalty built into each possible payout. If, for example, the buyer selects a low bid but the car is high quality, a rational seller would reject such an offer. In this scenario, the seller's response is reflected in the low payoff that the buyer would receive.

Subjects in the control group were told that they could earn up to $0.50 during each round of the game, while subjects in the treatment group were told that they start each round with $0.50 and could at best retain that amount. This discrepancy in payout presentation is the endowment frame. Given that there is not an endowment frame in the control condition (so control group subjects start each round with $0.00), payouts are framed as a gain. On the other hand, the presence of the endowment frame in the treatment condition results in payouts being framed as loss. Kahneman and Tversky's (1979) value function (see *Figure 1*) hypothesis states that people dislike losses more than they like gains of equal amounts. A value function models how people, generally speaking, have a concave utility function for gains and a convex utility function for losses, relative to a reference point. For the test subject, the reference point is the amount of money that he or she begins each round with.

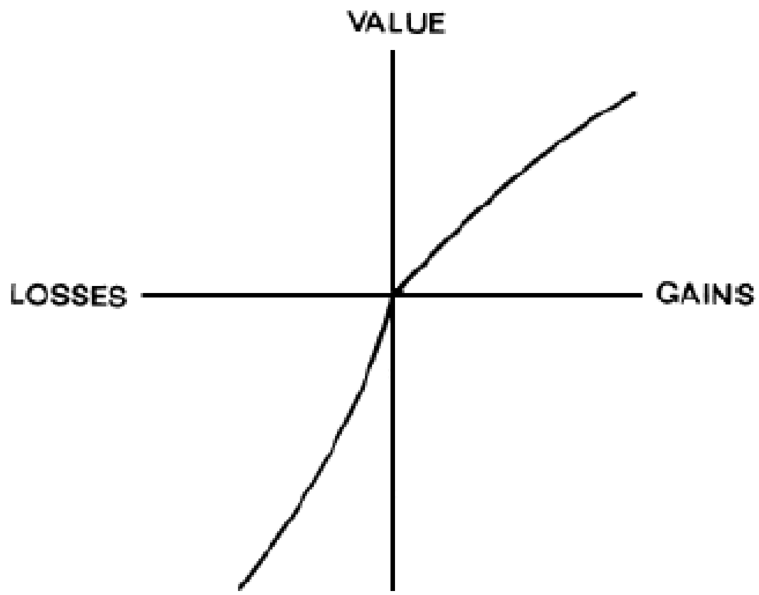


*Figure 1: The Value Function*

*(Kahneman and Tversky (1979))*

In a value function, the left side represents losses and the right side represents gains. Angner (2016) points out that the value function's concavity in the domain of gains indicates risk aversion, while the convexity of the value function in the domain of losses indicates an affinity for risk. Thus, the control group was operating within the domain of gains with a reference point of zero, and the treatment group was operating within the domain of losses with a reference point of $0.50.

In the modified lemons game, the low bid is considered to be riskier because there is a high probability of a low payout and a low probability of a high payout associated with it. The opposite is true for the high bid so it is considered to be the safe bid. If treatment group subjects are in the convex portion of the value function, i.e. the domain of losses, and given that a convex utility function signifies an affinity for risk, then treatment group subjects should select the low bid more than their control group counterparts. Therefore, in accordance with Kahneman and Tversky's (1979) value function, the hypothesis examined here is that relative to the control group, treatment group subjects should be more likely to select the lower, riskier bid. The data from the experiment is consistent with this hypothesis, and led to some unexpected behavioral insights as well.

# Literature Review

## The Market for Lemons

Akerlof's (1970) "market for lemons" paper describes adverse selection, a phenomenon whereby asymmetric information, a form of imperfect information, leads to lost potential gains from trade. Akerlof's lemons game was the first of what are now referred to as "screening games." The amount of utility that the buyer and seller receive is reflected in the magnitude of their monetary payoffs. In the lemons game, the car can be one of two possible qualities: good or bad (i.e. a lemon). The combination of the car's true quality, the buyer's bid selection, and the seller's decision to accept or reject the buyer's bid ultimately leads to the buyer being better off, worse off, or about the same. This goes for the seller as well.

Understanding the intuition behind the buyer's bid selection begins with identifying what the buyer and seller know. First order reasoning reveals that the seller knows the quality of the car but the buyer does not. The buyer only knows the probabilities that the car is good or is bad. Based on second order reasoning, the buyer knows that the seller knows the true quality of the car, and the seller knows that the buyer does not know the true quality of the car. Together, the insights gained from first and second order reasoning can sufficiently explain the Nash equilibrium of the lemons game. Armed with the knowledge of his own strategic disadvantage, the buyer selects the lower bid to avoid potentially getting cheated by the seller. That is, the seller claims the car is of high quality, but it turns out to be a lemon. Since the car salesman would never sell a high-quality vehicle for the low bid price, and because the buyer never places a high bid, as Akerlof puts it, "bad cars drive out the good." According to third order reasoning, the seller knows that the buyer knows that the seller knows the true quality of the car. Consequently, the seller realizes that the buyer does not trust him. This leads the seller to the conclusion that the buyer is making a low bid because of the asymmetric information between them regarding the car's true quality. Ultimately, the market for high quality cars disappears and the game's Nash equilibrium is achieved.

## Prospect Theory

One of the most seminal papers in the development of behavioral economics is Kahneman and Tversky's (1979) original paper on prospect theory. They begin by stating that the limitations of expected utility theory necessitated the creation of a new system to describe the nuances and idiosyncrasies of the decision-making process, one that would be consistent with the empirical evidence that has historically undermined the validity of expected utility theory's positive economic status.

Kahneman and Tversky point out some of the important discrepancies between how people actually behave and the way utility theory says they do. Under utility theory, people are assumed to maximize their expected utility, and for a risk neutral agent, the utility of a prospect equals its expected value. In order to determine a prospect's expected value, the utility of a prospect's outcome is multiplied by the probability of that outcome, and then those probability-weighted utilities are summed. Through some cleverly constructed scenarios and associated survey questions and based on the responses they received, Kahneman and Tversky created some rather compelling evidence in favor of the idea that people often have tremendous difficulty calculating and / or interpreting probabilities. Prospect theory suggests that rather than relying on probabilities alone, people associate each stated probability with a decision weight, denoted $\pi(p)$, that reflects their belief about the impact of a stated probability on the outcome. Therefore, decision weights enable one to quantify inconsistencies between a problem's stated probabilities and test subject responses.

Kahneman and Tversky also provide a series of labels to identify the most common ways in which the axioms of expected utility theory are violated. The first of these fallacies is referred to as the "certainty effect." The certainty effect is the tendency to overweight unlikely outcomes and underweight likely ones. This can result in the early dismissal of likely outcomes and the premature acceptance of unlikely ones.

Another important concept in prospect theory is embodied in what Kahneman and Tversky call the "reflection effect." The same survey problems mentioned previously were administered to different groups of students in Israel and in the United States. Despite any cultural differences that might have influenced the outcome, responses were extremely consistent across groups. Originally, each problem dealt only with selection among positive prospects, meaning the respondents stood only to (hypothetically) receive some type of gain, monetary or non-monetary. By and large, in the "gain only" type scenario, students' responses consistently indicated an aversion to risk. For example, in scenario 3, students were asked to select between two prospects: prospect a or prospect b. The expected values of these prospects were 3,000 and 3,200, respectively. Utility theory's dominance axiom states that, holding probability and risk attitude constant, people will always select the prospect with the highest overall expected value. However, in scenario 3, respondents were 4 times as likely to select prospect a as they were prospect b. This outcome prompted Kahneman and Tversky to pose the same questions again, except this time make all of the prospects negative. When only negative prospects were presented to students, all the preference orders were reversed. This suggests that people are generally risk averse for gains and risk loving for losses.

The reflection effect is an especially meaningful phenomenon because it suggests that the shape of a person's utility function is contingent on the valence of the prospects from which they are choosing. This discovery, among many others, prompted Kahneman and Tversky to transform the utility function into what is referred to as a "value function." One valuable aspect of the value function is that it includes a reference point. The reference point shows a person's current endowment status as well as how perceived gains and losses are valued relative to that point. The reference point determines whether an event is perceived as a gain or a loss, and, consequently, dictates one's attitude toward risk.

Six years before the publication of their original prospect theory paper, Tversky and Kahneman (1971) wrote a paper that discussed the "law of small numbers;" an inferential fallacy in which a small sample size is assumed to be representative of an entire population. As a sample size shrinks, the probability that the sample mean will approach the population mean decreases. Nevertheless, it is not uncommon for people to make wild inferences about remarkably diverse populations based on very limited evidence. The idea that the mean of a sufficiently large sample is indeed representative of the mean of the population is known as the “law of large numbers,” which, unlike the law of small numbers, is a sound statistical inference. As Kahneman and Tversky note, the flawed reasoning behind a belief in the law of small numbers is present in an array of different scenarios. One classic experiment asked participants to imagine that a coin is flipped eight times and to list the hypothetical outcome of each flip. Despite the size of the sample, the majority of participants predicted an equal or nearly equal distribution of heads and tails.

Kahneman and Tversky go on to discuss a fairly ubiquitous and often costly probability error known as the “gambler’s fallacy.” The gambler’s fallacy and the law of small numbers are closely related concepts. The gambler’s fallacy is the erroneous belief that chance outcomes balance each other out. This belief ignores the fact that in, say, a game of roulette, each spin is independent of the last, and any previous sequence of outcomes has no bearing on the current spin. Kahneman and Tversky provide one plausible explanation for why this fallacy plagues the judgement of so many people. They point out that many of the laws that govern the physical universe teach us that things often do return to equilibrium or balance out on their own. An example of this tendency is described by Newton’s third law of motion which states that “[f]or every action, there is an equal and opposite re-action” (Glenn, n.d.). Be that as it may, Kahneman and Tversky continue by saying that there is an important distinction between the physical world and the domain of probabilities: probabilistic outcomes do not cancel one another out. Rather, as a given process is repeated over and over again, the results are simply diluted or washed out.

Knetsch, Thaler, and Kahneman (1991) describe three other fallacies that are committed with regularity: the endowment effect, loss aversion, and status quo bias. The fact that experimental subjects make the same errors today as they did 30 years ago speaks to the ubiquity of these fallacies and their persistent relevance. The endowment effect is best described by a classroom experiment conducted at Simon Fraser University. In the experiment, one group of test subjects was given pens, another was given coffee mugs, and a third group was given some money. The first two groups were then asked how much they would be willing to sell the pens or mugs for, while the third group was asked how much they would be willing to pay for the pens or mugs. The result of the experiment found a major discrepancy in the way that the different groups valued the mugs and pens. Specifically, those endowed with either a pen or a mug attributed a far higher monetary value to the good relative to participants in the money group. This outcome illustrates the willingness to accept (WTA) willingness to pay (WTP) gap (WTA > WTP) and the endowment effect that precedes it.

The next fallacy discussed is status quo bias. This is a phenomenon in which people remain at the status quo due to the potential losses they perceive as a consequence of leaving it. In much the same way that the agoraphobe resides in his home for fear of what might happen if he leaves, someone with status quo bias often forfeits opportunities and experiences for the sake of comfort and security. In their closing remarks, Knetsch, Thaler, and Kahneman conclude by cleverly saying that although they have dedicated roughly a decade researching these fallacies and similar phenomena, they are aware that their work is a part of their endowment, and are open to the notion that they may value it more than others might.

Six years before coauthoring with Knetsch and Kahneman, Thaler (1980) authored a paper on "mental accounting" that appeared in the Journal of Marketing Science. In it, Thaler described the process by which people attach labels to various sums of money, dividing them into separate mental accounts. This tendency can cause people to view quantities of money as a function of the account to which they belong. As a consequence, one who practices mental accounting no longer sees money as an objective measurement of spending power, which can lead to fiscally irresponsible behavior.

Thaler continued by expanding on Kahneman and Tversky's value function. He reached the conclusion that in the pursuit of happiness, it is best to "segregate gains" and "integrate losses." By this Thaler means that in order to maximize the overall utility of two good events, it is best to experience them separately rather than together. On the other hand, if there are two negative events on the horizon, the overall disutility of those experiences will be minimized if they are experienced together.

## Framing Effects

In 1981 Kahneman and Tverksy published a paper specifically on framing effects. Framing effects can have a dramatic impact on consumer choice and are an integral part of the justification behind prospect theory. Kahneman and Tversky (1971 & 1979) often test their hypotheses on human behavior by presenting hypothetical scenarios called "decision problems" to their test subjects. Some of these decision problems have asked test subjects to make decisions concerning vast sums of money and even what course of action they would take in order to minimize a fatal disease's impact on society (Tversky and Kahneman, 1981). The gap between a test subject's behavior in a hypothetical scenario and a real one could be quite large and would indicate a major methodological shortcoming, essential as it may be. Nevertheless, these examples are still quite useful because they draw attention to some of the most common violations of "consistency and coherence" (Tversky and Kahneman, 1981). One example would be the violation of the transitivity of preferences. As Angner (2006) points out, if a is preferred to b, and b is preferred to c, then a is preferred to b regardless of the way these prospects are presented. However, people routinely fall victim to fallacies such as the "decoy effect" and "menu dependence," both of which can lead to a scenario in which the introduction of "c" causes an individual to display intransitive preferences by selecting "b" instead of "a."

Five years after Tverksy and Kahneman's (1981) paper on framing effects and consumer choice, the research duo had a paper published on the topic of rational choice and decision framing. Tversky and Kahneman (1986) begin the paper by noting that the modern theory of choice under risk is a product of the logical and classically consistent (as in pertains to fundamental economic assumptions about rationality) analysis of game theory as opposed to the newest link in the evolution of psychological analyses of risk and value. This approach, in turn, led them to the conclusion that there is in fact a major discrepancy between actual decision making and the collection of axioms that classical economists have long touted as a descriptively accurate and normatively proper theory of consumer choice.

Tversky and Kahneman (1986) begin by laying out the four fundamental axioms upon which utility theory rests. They then demonstrate several ways in which those axioms (cancellation, transitivity, dominance, and invariance) are regularly violated through formal examples and some entertaining anecdotes. The invariance axiom states that the way a prospect is presented has no bearing on whether or not it gets selected. The experiment presented here seeks to illustrate a violation of this axiom. According to Tversky and Kahneman, invariance, in addition to dominance, is essential to the theory of rational decision making.

## Frames in Games

Dufwenberg, Gächter, and Hennig-Schmidt (2011) look at how framing effects impact player decision making in the context of games as opposed to decision problems. In particular, they present two different hypotheses: the first hypothesis looks at guilt aversion and its contribution to second-order beliefs, and the second looks at the concept of reciprocity and its contribution to first-order beliefs. Dufwenberg, Gächter, and Hennig-Schmidt define guilt aversion (not to be confused with regret aversion) as the "dislike of giving others less than they expect." Subsequently, they define reciprocity as a desire to reciprocate any action directed towards you, be it helpful or hurtful. Dufwenberg, Gächter, and Hennig-Schmidt determine that frames affect first and second-order beliefs dramatically. This runs directly counter to the notion of invariance and has major implications for our understanding of how beliefs are formed.

# Experiment

## Game Design

The papers in the literature review suggest that there might be framing effects in games of asymmetric information (like Akerlof's lemons game). However, none of the contemporary literature on this topic provides any empirical evidence on these effects. The lack of research in this area spurred the creation of the modified lemons game. On the following page, *Table 1* maps out the buyer's incentives in the game. The idea here is that just like in Akerlof's lemons game, the "seller" wants to receive as much money for the good as possible, while the buyer wants to pay as little as possible for the good. Technically, based on the structure of the game, the seller has to accept all bids. However, the buyer receives a reduced payout for a low bid on a high-quality good. This reduced payout ($0.20) has the seller's rejection built into it. Similarly, if the buyer places a high bid and the vehicle ends up being high-quality, then the buyer receives a $0.30 payout. This increased payout implies that the seller would have accepted the bid even had he been able to reject the offer.

Since there is a 75% chance that the vehicle is of quality A (i.e. high quality), a high bid will yield the buyer a $0.30 payout 75% of the time. If the buyer selects a low bid, the buyer gets a $0.20 payout 75% of the time. Thus a high bid is considered low risk and a low bid is considered high risk (both bid have an expected value of $0.275). The terms "high-quality" and "low-quality" never appear in either the control or treatment group's instructions. Rather, in order to avoid introducing any potential biases associated with these terms, they were abstracted away from so that now the good is either of "quality A" or "quality B" instead.

*Table 1: Buyer Incentives*

<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="2">B I D   A M O U N T</td></tr>
<tr><td>LOW<br><b = $0.20></td><td>HIGH<br><b = $0.40></td></tr>
<tr><td rowspan="2">Q<br>U<br>A<br>L<br>I<br>T<br>Y</td><td>B (LOW)<br><p = 0.25></td><td>Payout: $0.50<br>(a) Value to buyer increases,<br>(b) Probability of a low payout increases.<br>Effect (a) > Effect (b)</td><td>Payout: $0.20<br>(a) Value to buyer decreases,<br>(b) Probability of a low payout decreases.<br>Effect (a) > Effect (b)</td></tr>
<tr><td>A (HIGH)<br><p = 0.75></td><td>Payout: $0.20<br>(a) Value to buyer increases,<br>(b) Probability of a low payout increases.<br>Effect (a) < Effect (b)</td><td>Payout: $0.30<br>(a) Value to buyer decreases,<br>(b) Probability of a low payout decreases.<br>Effect (a) < Effect (b)</td></tr>
</table>

The game tree in *Figure 2* depicts the underlying framework of the modified lemons game. The payout values are the same for the control and treatment groups. The only difference is that the control group starts each round with $0.00 and gains some amount of money (up to $0.50), while the treatment group starts each round with $0.50 and either keeps that amount or loses a portion of it (up to $0.30). As is customary in screening games, “nature” determines the quality of the good. In this experiment, computer software played the role of nature by randomly generating a number between 0 and 1 (up to 6 decimal places). If the number was between 0 and 0.75, the good would be of quality A. If the number was between 0.75 and 1.0, the good would be of quality B. Thus, there was a 75% chance the good was of quality A and a 25% chance it was of quality B. After nature determines the quality of the good, the buyer, i.e. the test subject, decides whether to place a bid of $0.40 or $0.20. This point in the game is illustrated by the dotted line in *Figure 2*. This line signifies that the buyer is unaware of the good's true quality. On the other hand, the seller does know the good's quality and can also see what bid type the buyer selects.

The total amount of money each participant could earn over the course of the game was based on an estimation of the opportunity cost of their participation ($4.00 to $10.00). From this range, the individual payout values ($0.20, $0.30, and $0.50) were derived. The payouts are large enough to elicit a test subjects' genuine risk inclinations, yet small enough for the experiment to be financially feasible. The Sally McDonnell Barksdale Honors College generously granted the money that made this entire project possible, so to them goes much of the credit.

## Hypothesis

As a consequence of the endowment frame, participants in the treatment condition should select the lower, riskier bid with a higher frequency than participants in the control condition.

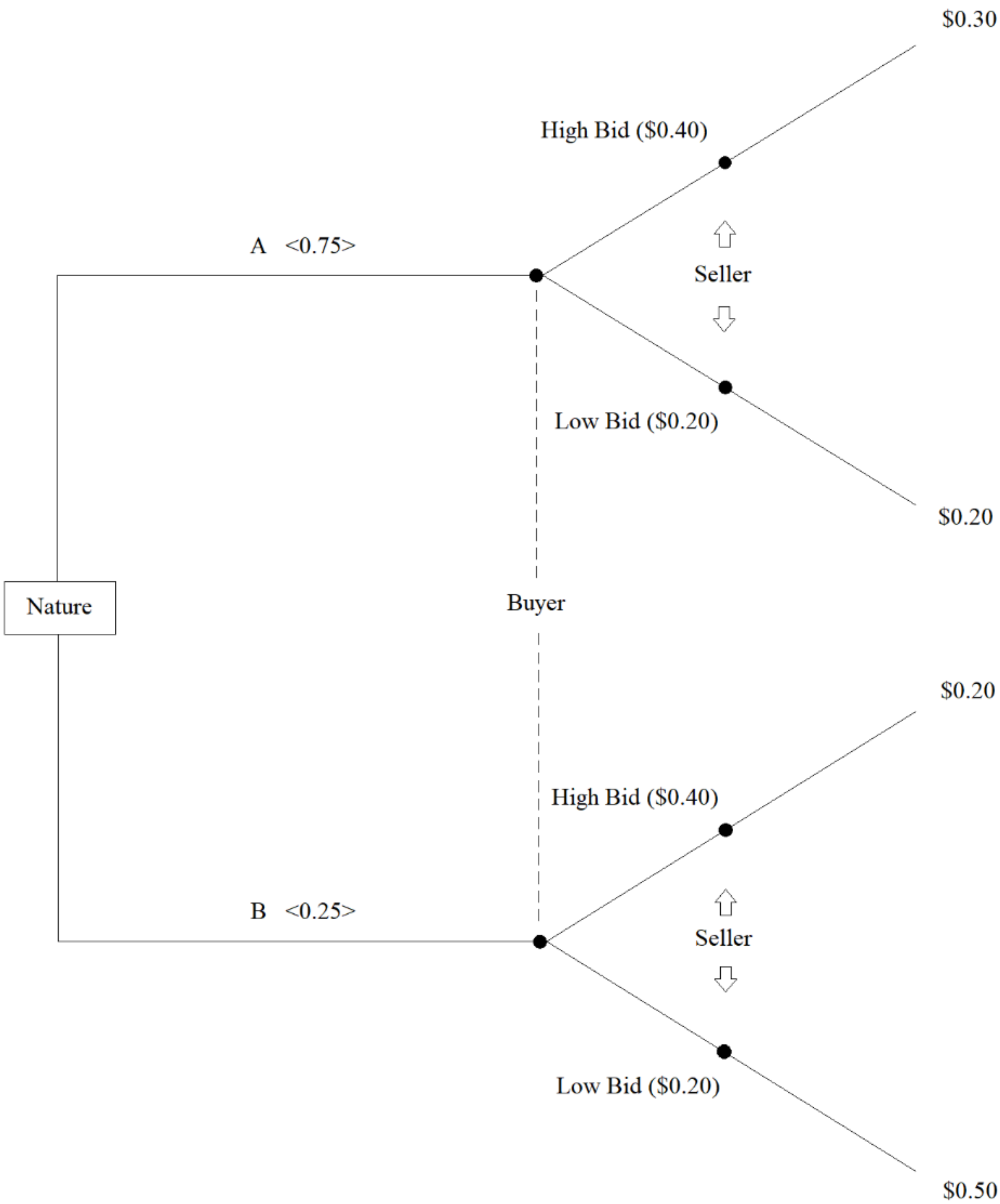


*Figure 2: The Game Tree*

## Experimental Procedure

The participants for this experiment were recruited using flyers. These flyers were distributed physically on campus and virtually through social media. The flyer stated that individuals could earn up to $10 playing an economic decision-making game. The recruitment process yielded 18 test subjects total, each of whom participated in one of three separate experimental sessions. All three sessions were held on Friday, March 29$^{th}$, 2019. The sessions were held at 1:30 PM, 2:00 PM, and 2:30 PM, in which, 4, 1, and 13 test subject(s) participated, respectively. All sessions were conducted at the Mississippi Experimental Laboratory (MERLab), located in Conner Hall Room 5 on the University of Mississippi Oxford campus.

Participants were greeted at the door and told to reach into a black box containing twenty 1-inch by 1-inch squares of paper. On each square there was a number ranging from 1- 20, and each number had a corresponding computer station. Depending on which square the participant selected, they were directed towards the appropriate computer station and told to wait there for further instruction. Once everyone was seated, participants were handed one of two different instruction packets. A packet with the number “22” in the top left corner contained the instructions for the control group, and a packet bearing the number “30” contained the instructions for the treatment group. The following statement was then read aloud to the test subjects:

Good Afternoon,

We are now ready to begin the experiment. Please take the next minute or so to fill in the blanks in the top left corner of the front page of your instruction packet.

(60 seconds transpire)

If you have any questions once the experiment has begun, please consult your instruction packet. It contains all of the information necessary for you to complete the game. On the right side of your work station there is a blue pen. Please take the next 5 minutes or so to carefully read your instruction packet, and feel free to use the pen to underline or take notes on what you have read. The choices you make in the game have a direct impact on how much money you will earn today, so take the time necessary to understand the instructions and formulate a game plan.

The instructions for the **control** group appeared as follows:

**22**

Age: _______

Gender: _______

Major: _______________________

Academic Year: ________________

Computer Station Number: ________

"BEFORE WE BEGIN: You cannot lose money by playing this game. The game consists of 20 identical rounds in which you will select 1 of 2 possible responses. The scenario is entirely hypothetical and is a little abstract, so just try your best to read and understand the information and select a response accordingly. In each round you can earn a minimum of $0.20 and a maximum of $0.50. The questions ask you to bid a certain amount of money, but the money being "bid" isn't real. The payouts however are real and you will leave here today with a maximum of $10 and a minimum of $4. The amount of money that you earn depends on your responses.

Now, let's begin. Please read the paragraph below.

You want to purchase a particular good. The good can be one of two possible qualities: quality A or quality B. You value a quality A good at $0.50 and a quality B good at $0.30. The problem is that only the seller knows the quality of the good, and the only way for you to determine the quality of the good is by buying it. You know that there is a 75%

chance that the good is quality A and a 25% chance that the good is quality B. You have decided to make a high bid ($0.40) or a

low bid ($0.20) for the good. If you bid high, a quality A good will earn you $0.30 and a quality B good will earn you $0.20. If you decide to bid low, a type A good earns you $0.20 and a type B good earns you $0.50. These possible outcomes are the same for each of the 20 rounds. Given this information, would you like to bid high ($0.40) or bid low ($0.20) for the good?

**(Please wait for further instruction. Once everyone has finished reading the instructions the experiment will be loaded onto your computer and you may make your selection.)**

Once you have completed all 20 rounds of the game please remain seated and wait for further instruction.

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The instructions for the **treatment** group appeared as follows:

# 30

Age: _______

Gender: _______

Major: ________________________

Academic Year: ________________

Computer Station Number: ________

"BEFORE WE BEGIN: You cannot lose money by playing this game. The game consists of 20 identical rounds in which you will select 1 of 2 possible responses. The scenario is entirely hypothetical and is a little abstract, so just try your best to read and understand the information and select a response accordingly. In each round you can earn a minimum of $0.20 and a maximum of $0.50. The questions ask you to bid a certain amount of money, but the money being "bid" isn't real. The payouts however are real and you will leave here today with a maximum of $10 and a minimum of $4. The amount of money that you earn depends on your responses.

Now, let's begin. Please read the paragraph below.

You want to purchase a particular good. The good can be one of two possible qualities: quality A or quality B. You value a quality A good at $0.50 and a quality B good at $0.30. The problem is that only the seller knows the quality of the good, and the only way for you to determine the quality of the good is by buying it. You know that there is a 75% chance that the good is quality A and a 25% chance that the good is quality B. You have $0.50 with which to purchase the good, and you have decided to either make a high bid ($0.40) or a low bid ($0.20) for the good. The amount you choose to bid for the good will result in you keeping anywhere from $0.20 up to the entire $0.50 at the end of the round. If you bid high, a quality A good leaves you with $0.30 and quality B good leaves you with $0.20. If you decide to bid low, a quality A leaves you with $0.20 and a quality B good leaves you with $0.50. Therefore, bidding less money doesn't necessarily result in keeping more money. These possible outcomes are the same for each of the 20 rounds. Given this information, would you like to bid high ($0.40) or bid low ($0.20) for the good?

**(Please wait for further instruction. Once everyone has finished reading the instructions the experiment will be loaded onto your computer and you may make your selection.)**

Once you have completed all 20 rounds of the game please remain seated and wait for further instruction.

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While the players were reading the instructions, the computerized version of the modified lemons game was loaded onto the server computer. Once the five minutes had expired, the following paragraph was read aloud:

> Now, please locate the "zleaf" shortcut in the middle of your computer screen and double-click it to launch the program. The experiment will load in a few moments. Once the experiment has loaded, please enter the number that appears in the top left corner of your instructions into the computer and begin playing.

As previously stated, the expected value of both bid types, high and low, were the same for both experimental conditions. The following page contains both the variance and expected value calculations for each bid type.

**E[Payoff to Buyer | Buyer offers $0.40]**

Control group

= 0.75($0.30) + 0.25($0.20)

= $0.225 + $0.05 => $0.275

Treatment group

= $0.50 – (0.75($0.20) + 0.25($0.30))

= $0.50 – ($0.15 + $0.075) = $0.275

$\sigma^2$ = .001875

(9x smaller than the variance of the riskier, $0.20 bid)

**E[Payoff to Buyer | Buyer offers $0.20]**

Control group

= 0.75($0.20) + 0.25($0.50)

= $0.15 + $0.125 => $0.275

Treatment group

= $0.50 – (0.75($0.20) + 0.25($0.30))

= $0.50 – ($0.15 + $0.075) = $0.275

$\sigma^2 = .016875$

(9x as large as the variance of the less risky, $0.40 bid)

Throughout the course of the experiment, the test subjects' progress was monitored from the server computer. Once all the participants were finished, the following passage was read to them:

> The experiment is now finished. Please write your total cash earnings in cents on the front page of your instruction packet. I will now pass out the receipts for your payments. Please fill out all the information requested from you. This information will be used only for reimbursement purposes. PLEASE DO NOT FILL OUT THE BOLD "RECEIVED" LINE.
>
> I will now call you individually by station number. When called, please bring your INSTRUCTION PACKET and your RECEIPT to me and I will pay you in cash. Thank you for your participation in this study.

When a test subject was called to the back of the lab, their materials were collected and they were payed whatever amount they earned over the course of the game. Once they had received their payment, the test subject was thanked again for his or her participation and was dismissed. Alexandros Vasios-Sivvopoulos, a PhD student in the Economics department at Ole Miss, computerized the modified lemons game using “ztree,” a program that enables users to create computerized versions of economics experiments. The test subjects’ only interactions with the computer interface are listed in chronological order below.

1. Double-clicking the “zleaf” icon to begin playing the game. Zleaf was the program on which the modified lemons game was launched.

2. Typing the number that appeared in the top left corner of their instruction packet into the computer when prompted.

3. Selecting between a high or low bid, viewing the payoff result for that round along with that of each previous round, and clicking “okay” to continue playing the game. This process was repeated for all 20 rounds of the game.

4. After the result of the twentieth round was displayed on the screen and the test subjects clicked “okay,” the results of all twenty rounds were listed along with the total amount they earned in cents.

Ztree automatically uploads and categorizes the data recorded during the experiment into a Microsoft Excel file. This includes round number, subject number, group, per round profit, total profit, condition, all possible payouts, bid selection, and the quality of the good.

# Results

*Tables A1-A3* (see appendix) are a series of charts that show whether or not the data are consistent with the research hypothesis based on each test subject's bid selections. The presence of a forward slash indicates that the test subject made a bid selection that was consistent with the hypothesis. For the control group, a forward slash means that the test subject selected the less risky $0.40 bid. For the treatment group, a forward slash indicates that the riskier $0.20 bid was selected. The experimental condition that each test subject participated in can be found in the "Group Type" column.

A preliminary analysis of the data revealed that the frequency with which a control group participant selected the riskier $0.20 bid at least half the time was .333. On the other hand, the frequency with which a treatment group subject selected the risky bid at least half the time was .556. This discrepancy in bid selection profiles was consistent with the hypothesis. After the preliminary analysis was completed, a series of regressions were run using the data in Excel. In order to run the regressions, all qualitative data had to be converted to a numerical value. A key to the regression spreadsheet can be found in *Table A4* (see appendix).

Once the spreadsheet was complete, regression analysis on the data began. All regression analyses were conducted using the regression software "Gretl." The results from each regression can be found in *Table 2*.

*Table 2: Regression Results*

Pooled OLS estimates

| | Dependent Variable | | | | | |
|---|---|---|---|---|---|---|
| | Bid Type | | Payoff Per Round | | Log Payoff Per Round | |
| Constant | 0.506** | 0.408** | 0.274** | 0.180** | -1.346** | -1.653** |
| | (0.081) | (0.110) | (0.008) | (0.018) | (0.028) | (0.057) |
| Treatment | 0.011 | 0.0121 | -0.002 | -0.018* | -0.005 | -0.058* |
| | (0.104) | (0.0810) | (0.013) | (0.010) | (0.042) | (0.031) |
| Age | | -0.108 | | 0.013 | | 0.041 |
| | | (0.064) | | (0.017) | | (0.049) |
| Female | | -0.239* | | 0.036** | | 0.136** |
| | | (0.117) | | (0.009) | | (0.029) |
| Sophomore | | 0.117 | | 0.089** | | 0.305** |
| | | (0.206) | | (0.038) | | (0.120) |
| Junior | | 0.567** | | 0.047 | | 0.137 |
| | | (0.223) | | (0.052) | | (0.151) |
| Senior | | 0.608** | | 0.014 | | 0.039 |
| | | (0.259) | | (0.069) | | (0.206) |
| Business | | 0.0810 | | 0.024** | | 0.069* |
| | | (0.060) | | (0.011) | | (0.033) |
| Science | | 0.012 | | 0.006 | | 0.019 |
| | | (0.086) | | (0.014) | | (0.045) |
| n | 360 | 360 | 360 | 360 | 360 | 360 |
| Adj. $R^2$ | -0.003 | 0.096 | -0.003 | 0.019 | -0.003 | 0.029 |

(Standard errors in parentheses).

* indicates significance at the 10 percent level.

** indicates significance at the 5 percent level.

When the dependent variable was bid type, the coefficient on group type was 0.012. This means that test subjects who were in the treatment group were 1.2% more likely to select the risky bid than were their control group counterparts. However, this result is not statistically significant. When the dependent variable was payoff, the coefficient on group type was -0.018. This indicates that test subjects in the treatment group on average earned $0.18 less than test subjects in the control group. This outcome is significant at the 10% level and demonstrates the negative impact of risky bid selection on total earnings. The third column contains the results of a regression in which the logarithm of the payoff served as the dependent variable. The coefficient on group type for this regression shows that treatment group subjects earned -0.058 or 5.8% less than control group subjects. This outcome is also statistically significant. Two other notable outcomes used "Gender" and "Major" as the regressors. When the dependent variable was bid type, the coefficient on gender is -0.239. This means that females were 23.9% less likely to select the risky bid than males. This outcome was statistically significant at the 10 percent level. On average, business majors earned $0.24 more than social science majors and this outcome is significant at the 5 percent level. On the other hand, science majors only earned $0.06 more than social science majors. This suggests that a business education may actually help students navigate this kind of economic quandary.

# Discussion

The results of this experiment have demonstrated that treatment group participants were, in fact, more inclined to select the lower, riskier bid than their control group counterparts as a result of the endowment frame. An experiment in which the seller is played by an actual test subject might prove to be a fruitful extension of the research presented in this thesis. The extent to which these findings can be extrapolated and applied to the "real-world" is unclear. However, real-world decisions must be based on something, and the results of a carefully conducted research endeavor such as this could, perhaps, be a good place to start.

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# *Appendix*

*Table A1: 1:30 PM Session Results*

| Subject Number | Group Type | Rd. 1 | Rd. 2 | Rd. 3 | Rd. 4 | Rd. 5 | Rd. 6 | Rd. 7 | Rd. 8 | Rd. 9 | Rd. 10 | / in rds. 1-10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Control | / | / | / | | / | / | / | | | | 6/10 |
| 2. | Treatment | / | | | / | | | | / | / | | 4/10 |
| 3. | Treatment | / | | | / | / | / | | | / | | 5/10 |
| 4. | Control | / | | | | | / | / | | | / | 4/10 |

| Subject # | Group Type | Rd. 11 | Rd. 12 | Rd. 13 | Rd. 14 | Rd. 15 | Rd. 16 | Rd. 17 | Rd. 18 | Rd. 19 | Rd. 20 | / in rds. 11-20 | Total / rds. 1-20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Control | | / | / | / | / | | / | / | / | | 7/10 | 13/20 |
| 2. | Treat | | / | | / | | | | | | / | 3/10 | 7/20 |
| 3. | Treat | | | | | | | | | | | 0/10 | 5/20 |
| 4. | Control | / | | / | / | | / | / | | / | / | 7/10 | 11/20 |

*Table A2: 2:00 PM Session Results*

| Subject Number | Group Type | Rd. 1 | Rd. 2 | Rd. 3 | Rd. 4 | Rd. 5 | Rd. 6 | Rd. 7 | Rd. 8 | Rd. 9 | Rd. 10 | / in rds. 1-10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Control | / | / | / | | / | / | / | | / | / | 8/10 |

| Sub. # | Group Type | Rd. 11 | Rd. 12 | Rd. 13 | Rd. 14 | Rd. 15 | Rd. 16 | Rd. 17 | Rd. 18 | Rd. 19 | Rd. 20 | / in rds. 11-20 | Total / rds. 1-20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Control | / | | | / | | / | / | | / | | 5/10 | 13/20 |

*Table A3: 2:30 PM Session Results*

| Subject Number | Group Type | Rd. 1 | Rd. 2 | Rd. 3 | Rd. 4 | Rd. 5 | Rd. 6 | Rd. 7 | Rd. 8 | Rd. 9 | Rd. 10 | / in rds. 1-10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Treatment | | | / | | / | / | | / | / | / | 6/10 |
| 2. | Control | / | / | | / | | / | / | | / | | 6/10 |
| 3. | Treatment | / | | | / | | | | / | | / | 4/10 |
| 4. | Control | | | | | | / | / | | | | 2/10 |
| 5. | Treatment | / | / | / | / | / | / | / | | / | / | 9/10 |
| 6. | Treatment | | / | | | | | / | | / | | 3/10 |
| 7. | Control | / | / | | | | / | / | | | | 4/10 |
| 8. | Control | | | | | | | / | | | | 1/10 |
| 9. | Control | | / | | | | | / | / | / | / | 5/10 |
| 10. | Control | | | / | / | / | | | / | / | / | 6/10 |
| 11. | Treatment | | / | | | / | | / | | | / | 4/10 |
| 12. | Treatment | | / | / | | / | / | / | | / | / | 7/10 |
| 13. | Treatment | / | | | | / | | / | | | | 3/10 |

| Sub. # | Group Type | Rd. 11 | Rd. 12 | Rd. 13 | Rd. 14 | Rd. 15 | Rd. 16 | Rd. 17 | Rd. 18 | Rd. 19 | Rd. 20 | / in rds. 11-20 | Total / rds. 1-20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Treatment | | / | | / | | | / | / | | / | 5/10 | 11/20 |
| 2. | Control | / | | / | / | | / | | / | | / | 6/10 | 12/20 |
| 3. | Treatment | / | / | | / | / | | / | / | | | 6/10 | 10/20 |
| 4. | Control | | | | | | | | | | | 0/10 | 2/20 |
| 5. | Treatment | / | / | / | / | / | | / | | / | / | 8/10 | 17/20 |
| 6. | Treatment | | | / | / | | / | / | / | / | / | 7/10 | 10/20 |
| 7. | Control | / | | | | | | | / | / | | 3/10 | 7/20 |
| 8. | Control | | | / | | | | | | | | 1/10 | 2/20 |
| 9. | Control | / | / | / | / | / | / | / | / | / | / | 10/10 | 15/20 |
| 10. | Control | / | / | / | | / | / | | / | / | | 7/10 | 13/20 |
| 11. | Treatment | / | / | | | | / | | | | | 3/10 | 7/20 |
| 12. | Treatment | / | / | / | / | / | / | / | / | / | / | 10/10 | 17/20 |
| 13. | Treatment | / | | | / | / | | / | / | / | | 6/10 | 9/10 |

*Table A4: Regression Spreadsheet Key*

Column 1: **Session** (1:30 PM, 2:00 PM, 2:30 PM)

0 – 1:30 PM 1 – 2:00 PM 2 – 2:30 PM

Column 2: **Computer Station #**

All Possible Station #s – {1,2,3,4,5, 8, 9, 13, 15, 16,18,19,20}

(Based on the #s randomly drawn by the test subjects)

Computer Station # = Assigned Spreadsheet Value (e.g. Station #3 = 3 in Spreadsheet Column)

Column 3: **Subject #**

All Possible Subject #s – (1-13)

Subject # = Assigned Spreadsheet Value (e.g. Subject #7 = 7 in Spreadsheet Column)

Column 4: **Group Type** (Control or Treatment)

0 – Control Group 1 – Treatment Group

Column 5: **Demographic Column #1** (DC 1) – **Age**

Age 18 – 0 Age 21 – 3

Age 19 – 1 Age 22 – 4

Age 20 – 2

Column 6: **Demographic Column #2** (DC 2) – **Gender**

Male – 0 Female – 1

Column 7: **Demographic Column #3** (DC 3) – **Major**

Accounting – 0 Exercise Science – 3

Biology – 1 Health Management – 4

Computer Science – 2 History – 5

IMC - 6

Managerial Finance – 7

Marketing – 8

Mechanical Engineering – 9

Public Policy Leadership – 10

Sociology – 11

Column 8: **Demographic Column #4** (DC 4) – **Academic Year**

Freshman (Year 1) – 0

Sophomore (Year 2) – 1

Junior (Year 3) – 2

Senior (Year 4) – 3

(Since these were turned into dummy variables that were used in the regression.)

Column 9: Round #

All Possible Round #s – (1-20)

Round # = Assigned Spreadsheet Value (e.g. Round #7 = 7 in Spreadsheet Column

Column 10: **Good Type** (A or B)

Quality A – 0

Quality B – 1

Column 11: **Bid Type** (High or Low)

High ($0.40) – 0

Low ($0.20) – 1

Column 12: **Earnings per Round** ($ / Rnd.)

$0.20 – 0

$0.30 – 1

$0.50 – 2

Column 13: **Total Earnings** (Total $)

$4.60 – 4.60

$4.80 – 4.80

$4.90 – 4.90

$5.20 – 5.20

$5.30 – 5.30

$5.50 – 5.50

$5.60 – 5.60

$5.70 – 5.70

$5.90 – 5.90

$6.20 – 6.20

$6.30 – 6.30

$6.60 – 6.60