An Analysis of Contracting and Breach Decisions
Under Various Damage Remedies.

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Matthew C. McGill

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Matthew C. McGill, Ohio University.

Faculty Advisor: E. Glenn Dutcher, Ohio University.

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Abstract

This goal of this thesis was to investigate the foundational assumptions underlying the expectation damages remedy, which remain largely untested despite the remedy’s widespread use. Its popularity among courts is largely predicated on theoretical conjectures which claim that expectation damages reflect the damages that parties would have set for themselves, and that inefficient breach will not occur under this remedy. To test these conjectures, laboratory experiments were conducted where participants -assigned the role of buyer or seller- negotiated the terms of a contract, before one participant was given a chance to breach. To distinguish between the various breach remedies, and to test competing hypotheses, participants were assigned to one of three treatments which varied the damage remedy. The Liquidated Damages remedy had the lowest rate of inefficient breach, and the highest rate of efficient breach decisions, out of the three remedies applied.
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Part I

Introduction

Contracts have been a central part of how individuals trade with each other for much of recorded human history (Eigen 2012). These agreements, when enforced, have allowed people to exchange goods and services over long distances and periods of time with the knowledge that the other party would fulfill their end of the bargain. As such, the security that contracts provide has helped facilitate a great deal of economic activity around the globe. Of course the existence of a contract between two parties does not necessarily mean that both will adhere to performance. Extenuating circumstances may prevent one party from providing the good, service, or payment that they promised. For example, if a seller finds that the cost of fulfilling the contract is greater than the cost of nonperformance, they will likely choose to breach the contract. Alternatively, if after agreeing to a contract with a buyer the seller finds someone who would be willing to pay more for the good or service, they will likely breach in order to make a larger profit. While these two scenarios may appear to differ from each other significantly, both amount to a breach of contract.

When contracts between two parties are breached, damages to the breached-against party are generally a) stipulated in the contract or b) determined by the courts. When the damages for breach are stipulated in the contract the role of the court is to enforce the contract, but as Shavell (1980) points out, contracts are unlikely to account for every way in which breach may occur. Either because the costs of negotiating that contingency were too high relative to how likely it was to occur, or simply because neither party considered that it may occur. When the contingency of the breach is not fully addressed by the original contract, the courts must make use of the variety of damage remedies they have at their disposal to resolve the dispute.
In making their decision, the courts generally favor whichever damage remedy will maximize social welfare. This goal usually compels the courts to apply the expectation damages remedy (Wilkinson-Ryan and Hoffman, 2010). Under the expectation damages remedy the breaching party must pay the breached against party an amount that makes them monetarily indifferent between breach and performance.

Support for the use of expectation damages in the law and economics literature is generally based on the concept of efficient breach. From an economic perspective, a breach of a contract is socially efficient if it increases the net welfare of the parties of a contract. It is important to note that this does not mean that both parties must benefit from breach in order for it to be efficient. In fact, breach can still be efficient even if it makes the breached against party worse off, so long as the breaching party gains more than the breached against loses. A stricter, and perhaps more satisfactory definition of efficient breach, sometimes called Pareto efficient breach, requires that at least one party be made better off, and no party be made worse off to meet the standard of efficiency. Shavell (2006) argues that by forcing the breaching party to compensate the breached against party for the full benefit they would have received from completion of the contract the expectation damages remedy encourages parties to breach when doing so would be efficient, and discourages them from breaching when breach would be economically inefficient.

Shavell also contends that another benefit of the expectation damages remedy is that the court awarded damages may mimic damages the parties would have agreed to had they stipulated damages when they originally formed the contract. Assuming that this is true, the expectation damages remedy may also allow parties to forego some negotiating costs, since expectation damages would serve as a mutually acceptable default remedy for breaches that are not covered in the original contract. Since parties would be expected to negotiate damages such that they are not made worse off in the event that they are breached against, the expectation damages remedy is Pareto
optimal. This is because it allows both parties to breach the contract for their own gain when it is efficient, and protects them from losses if they are breached against, since they receive compensation equal to the benefit they would have received from completing the contract.

While the case for expectation damages is strong, there are a number of significant criticisms concerning how well the theoretical arguments supporting the remedy hold up in the real world. One issue is that the parties to a contract do not know, with certainty, the amount of damages the court will impose when they are faced with a breach decision. This uncertainty makes the costs and benefits of breach unclear to a potential breaching party, which may lead to inefficient non-breach if the party is ambiguity averse. Additionally, survey results presented in Wilkinson-Ryan and Hoffman (2010) show that, for a variety of reasons, many people claim that they would require payment above that of expectation damages in order to make breach acceptable. Some proposed explanations for this are that people dislike risk, have preferences for fairness, or feel guilty for breaking what they see as a promise. Whatever the reason for the observed difference between theory and the results of the survey, Wilkinson-Ryan’s study clearly conflicts with Shavell’s assessment that parties would have agreed to expectation damages when forming the original contract.

One possible weakness of Wilkinson-Ryan’s study is that participants were paid for participating in the surveys rather than according to results. As a result participants did not have to consider the monetary consequences of their choices and therefore may not have acted in the same way they would have if a financial reward was on the line. Wilkinson-Ryan also changed more than one aspect of the experiment between her treatments, making causal arguments difficult to justify.

The expectation damages remedy plays a significant role in many legal systems, and this role is largely predicated on the idea that it, unlike other court imposed remedies, encourages breach only when efficient and discourages it otherwise (Goetz
and Scott 1977). While a number of studies have attempted to determine whether or not this prediction holds, most have focused on the damages participants say they would require as compensation for breach, rather than on how the efficiency of breach decisions are affected by the use of different damage remedies, and the role that uncertainty may play. Additionally, prior research in this vein, such as Feldman and Teichman (2011), and Wilkinson-Ryan (2010), has typically had unresolved design issues. The lack of incentives based on behavior may be a critical flaw in these experiments, because as Holt and Laury (2002) shows, subjects appear to be unable to predict how they would actually behave when presented with a hypothetical scenario.

This project aimed to add to the existing literature by examining the rates of efficient breach outcomes and inefficient breach under expectation damages relative to other remedies. Critically, this paper sought to determine how the efficiency of the expectation damages remedy is affected by uncertainty regarding the actual amount of damages. To do so, I began by establishing model of a two-stage game with two players, a buyer and a seller. Predictions about the relative rates of inefficient breach and efficient breach decisions in each treatment were derived from this model, and tested in a laboratory setting. Participants were placed in one of three treatments: one in which a no damages remedy was applied, one in which expectation damages were applied, and a liquidated damages condition where parties negotiated damages for themselves. Participants were either assigned to the role of buyer or seller and paired with a participant of the opposite role. They then negotiated the terms of a contract through one party making a one-time take-it-or-leave-it offer which the other party could either accept or reject. If this offer was accepted, the game proceeded to the second stage. In the second stage, the seller received a randomly generated outside offer, which they could either accept or reject. If they rejected the outside offer, then the original contract agreed to in the first stage was fulfilled. If they accepted the outside offer, then each parties payoff was determined according to the value of the
outside offer and the damage remedy in place in that treatment. While contracting scenarios in a real world setting are likely to be higher stakes than they are in this experiment, Andersen et. al (2011) suggests that behavior in bargaining games is largely unaffected by the scale of the payoffs. As a result, the relatively small stakes of a laboratory experiment do not seem particularly damaging to the external validity of this experiment.

The results of this study suggest that, in the setting examined, the expectation damages remedy is less effective at preventing inefficient breach, and less effective at ensuring an efficient breach decision, than requiring parties negotiate damages for themselves in their original contract. Additionally, while the expectation damages remedy was better at ensuring an efficient breach decision than a no damages remedy, it was not significantly better at preventing inefficient breach. This may have significant implications for the way that contract breach is handled by the legal system. If these results can be shown to hold in other settings, then the widespread use of the expectation damages remedy is largely misguided. If it can be shown that the expectation damages remedy also fails to prevent inefficient breach and ensure efficient breach decisions in other settings, then courts wishing to maximize social welfare would be better served by encouraging parties to negotiate damages for themselves rather than applying expectation damages as a default.

Part II

Literature Review

A significant portion of the existing literature focuses on reasons why the expectation damages remedy may not facilitate efficient breach decisions. The results of the experiment presented in Bigoni et al (2014) for example, indicate that breached
against parties demand more compensation when the other party breaches to capture a gain relative to when they breach to avoid a loss. Numerous studies conducted by Wilkinson-Ryan tend to attribute deviations from the predictions of breach decisions in Shavell (1980) to moral qualms with breaching contracts. Wilkinson-Ryan (2012) shows that people may have a “psychological contract” in mind that impose different conditions and expectations than the actual contract. She suggests that a number of social and moral norms may also play a role in the formation of the psychological contract. Results from survey experiments presented in (Wilkinson-Ryan and Hoffman, 2010), and (Wilkinson-Ryan, 2010) suggest that people may view contracts as more than just an instrument of economic interaction, and that their willingness to breach or view breach as acceptable may depend largely on the context in which breach occurs. In this sense it could be said that there may be some sort of moral cost to breach that may not be accounted for in most economic analyses of breach. Shiffrin (2007) takes a similar view of contracts as promises, and suggests that by allowing parties to breach a contract rather than forcing them to perform, the legal system may encourage promise-breaking and lead to an erosion of trust between parties. This is interesting because it suggests that allowing breach, even when it is efficient, may lead to a decline in mutually beneficial interaction later on. Shavell (2009) contests the assertion that breach of contract is immoral, with his argument primarily resting on the idea that in some cases all parties to a contract would agree to allow non-performance, even when it is not explicitly stated in the written contract. Shavell contends that contract breach can be moral given that all contracts are essentially incomplete, since they do not explicitly cover every scenario that may arise. In particular, he asserts that when the cost of performance exceeds the value of performance, or when a buyer with a higher value of performance materializes, both parties would have agreed to non-performance ex ante. Given this, one would expect that had the parties to a contract negotiated a complete contract they would have
allowed for breach in the specified scenarios, so allowing breach in these scenarios is not immoral.

The body of empirical and experimental economic literature on social interaction and bargaining behavior also helps to inform my research. Gneezy and Rustichini (2000) presents experimental findings regarding the use of fines to deter undesirable behaviors. The authors examine the rates at which parents arrived late to pick their children up from daycare under two conditions. Daycares in the first condition instituted a small fine for parents who picked their children up more than ten minutes late, while those in the second condition did not impose any punishment for late arrivals. The authors found that the daycares that implemented the fine actually saw the rate of late arrivals rise, while those that did not impose a fine saw no such increase. Additionally, when the daycares removed the fine, late arrival rates did fall back to their previous level. The authors suggest that the increase in late arrivals may be the result of how parents viewed the fine. They argue that the fine essentially put a price on being late, and so parents might have chosen to purchase the right to arrive late, whereas before a fine was implemented it might have seemed socially unacceptable to do so. In terms of contract behavior, this result suggests that people might be more willing to breach a contract when the context of breach is addressed in the original contract, or if the damage remedy was widely known. A somewhat different result is found by Feldman and Teichman (2011). In their study, they found that subjects were less willing to breach when there was uncertainty as to whether or not a damage remedy would actually be enforced than they were when there was uncertainty regarding what damage remedy would be imposed. However, their results still suggested that people may be more reluctant to breach when damages are uncertain than a traditional economic analysis would predict. Alternatively, Charness and Dufwenberg (2006) suggests that people may be guilt averse, in the sense that they have some dislike for decreasing the payoffs of others even when doing so increases
their own. The results of this study are significant because if people are guilt averse, then we may expect lower rates of both efficient and inefficient breach under damage remedies that undercompensate the breached against party. If, as some of the law literature suggests, parties view contracts as promises rather than just a tool for economic interaction, guilt aversion may also lead parties to avoid breach even when it is efficient under damage remedies that fully compensate, or overcompensate the breached against party.

Sloof et. al (2007) examines the role that the default damage remedy plays in the drafting of contract terms. Participants were randomly assigned to the role of buyer or seller, and kept this role for the duration of the experiment. They were then anonymously paired with a member of the matching group in their session. The role of proposer was split evenly between the buyer and the seller within each session. The proposer proposed one of four contracts; expectation damages, a specific performance property rule, a specific performance liability rule, and a restitution/reliance damage remedy. The first result generated by this experiment is that the choice of default contract has little effect on which contract the proposer offers. The only exceptions to this are that sellers are more likely to propose the specific performance property rule when it is the default, and that buyers are less likely to propose the specific performance liability rule when it is the default. The second result produced by this experiment is that roughly half of the contract proposals differ from the efficient expectation damages contract. Additionally, sellers are more likely to propose an inefficient contract than buyers. The authors suggest that this finding fits better with a theory of regret-avoidance than it does with risk attitudes. The experimenters also found that the default contract was as likely to be implemented as the expectation damages contract. Participants tended to stick towards the default, likely as the result of regret-avoidance, as well as disagreements between the two parties over contract preference. Other results suggest that the default contract does not have a substantial
impact on proposal acceptance, and that breach decisions are almost always made in a way that maximizes seller payoffs.

**Part III**

**Research Questions**

The goal of this research project was to use rigorous experimental economic methodology to determine a) whether breach decisions are as efficient under the expectation damages remedy as they are under the liquidated damages remedy, and b) whether the rate of inefficient breach under the expectation damages remedy is the same as the rate of inefficient breach under the expectation damages remedy.

**Part IV**

**Approach**

In order to begin to answer these questions, it was important to first establish a model from which predictions of behavior will be derived. Here the model was designed as a two-stage game that begins with two players, a buyer and a seller, who are both assumed to behave in a way that maximizes expected payoffs. In the first stage of the model, the buyer and seller negotiate a selling price. In the second stage, the seller receives an outside offer from a second buyer, which they can either accept or reject. Taking after the ultimatum game (Guth et al. 1982), this game was modeled as a one time take-it-or-leave-it offer. While in reality contract negotiations can involve many offers going back and forth between parties, there will eventually be a final offer before one of the parties is willing to end the negotiations. This model is therefore
best viewed as the last stage of a potentially long negotiation process. The model was applied to both the case where the seller makes the final offer, and the case where the buyer makes the final offer. Both cases were examined under three different damage rules: no damages, expectation damages, and liquidated damages.

Unlike the model presented in Shavell (1980), which forms much of the basis of the economic understanding of contract breach, this model includes an element of uncertainty regarding the damage payments. In Shavell’s model, the breaching party knows ex ante the amount of damages that they will have to pay to the breached against party, regardless of the damage remedy that is in place. While this remains true for the no damages condition in our model, uncertainty regarding damages does affect the behavior of the breaching party under the expectation damages remedy. Since the seller does not know ex ante the amount of damages they will be required to pay should they choose to breach, they must act based off of an expectation of the buyer’s value. Uncertainty has a similar effect in the liquidated damages condition under our model. While the seller knows ex ante the amount of damages they will be required to pay should they choose to breach, uncertainty regarding the amount of the outside offer forces the parties to negotiate the damage payment in Part 1 based off of the expected value of the outside offer.

Additionally, the breach scenario that sellers face in our model can be seen as one where they have the opportunity to breach in order to capture a gain, rather than to avoid a loss. This allows us to get at the more interesting result of Bigoni et al (2014), which suggests that buyers may demand more compensation for breach when breaching captures additional gains.
1 No Damages

Under the no damages remedy, if the seller chooses to breach their contract with the first buyer in order to accept the outside offer they will incur no penalty, and the buyer will not be compensated for the breach. The case where the buyer makes the final take it or leave it offer will be presented first, followed by the seller’s.

1.1 Buyer:

In this setting, the first buyer must maximize their expected payoff by choosing a final price, \( p_b \in [0, \overline{p}_b] \). When making their choice, they know that there will be an eventual outside offer, \( \theta \in [0, \overline{\theta}] \). For simplicity, we will assume that if \( \theta > p_b \), the outside offer is accepted which gives us the expected payoff of buyer 1 equal to:

\[
E(\pi_{B1}) = [(v_b - p_b)Pr(\theta)](1 - Pr(r))
\]

Where \( v_b \) is the value of the purchased good to the buyer, \( Pr(r) \) is the probability the offer is rejected by the seller and \( Pr(\theta) \) is the probability that the final price, \( p_b \), is higher than the outside option, or the probability that the seller does not breach. This can be expressed as \( Pr(\theta) = \frac{v_b}{\theta} \). For simplicity, we will assume \( v_b \) is uniformly distributed between 1 and 10, while \( \theta \) is uniformly distributed between 0 and 10. Since the seller is assumed to be an expected payoff maximizer, they will accept any offer because it would result in a higher expected payoff than rejecting a payoff of 0. As a result, it will always be true that \( Pr(r) = 0 \) and \( 1 - Pr(r) = 1 \) in all of the buyer’s cases in this model. The buyer’s maximization problem is:

\[
max_{p_b \in [0, \overline{p}_b]} \frac{v_b p_b - \overline{p}_b^2}{\overline{\theta}}
\]

---

1 In our experiment \( \overline{p}_b = \overline{\theta} = 10 \).
From this we can derive the optimal price for the buyer$^2$:

\[ p^*_b = \frac{v_b}{2} \]

Recall that $v_b$ follows a uniform distribution between 1 and 10. This means that, on average, $v_b = 5.5$. So, the model predicts that the average price when the buyer makes the offer is,

\[ E(p^*_b) = \frac{5.5}{2} = 2.75 \]

### 1.2 Seller:

In the case where the seller makes the final take it or leave it offer, the expected payoff to the seller can be expressed as:

\[ E(\pi_s) = [p_s Pr(\theta) + E(\theta)(1 - Pr(\theta))](1 - Pr(r)) \]

where $E(w_o)$ is the expected value of the outside offer and all else is the same as above. We will again assume a uniform distribution of $\theta$. Now however, we must specify $Pr(r)$ since some values in the possible distribution can result in negative profits for the buyer. Specifically, we will assume a buyer will accept any price which generates a positive profit and reject all else. The probability that a price generates a negative profit for the buyer is the probability that the buyer’s value is less than the price, or $Pr(p_s > v_b) = Pr(r)$. Recall that $v_b$ is uniformly distributed over $v_b \epsilon [v_b, \bar{v}_b]$, where $v_b = 1$ and $\bar{v}_b = 10$, so the probability that the buyer rejects the seller’s offer can be expressed as $Pr(r) = \frac{(p_s - v_b)}{(\bar{v}_b - v_b)}$. Therefore, the seller’s maximization problem is:

\[ \max_{p_s \epsilon [0, \bar{v}_b]} \frac{\bar{v}_b p^2_s - p^3_s}{\overline{\theta}(\bar{v}_b - v_b)} + \frac{\bar{v}_b E(\theta) - p_s E(\theta)}{(\bar{v}_b - v_b)} - \frac{\bar{v}_b p_s E(\theta) - p^2_s E(\theta)}{\overline{\theta}(\bar{v}_b - v_b)} \]

$^2$See section 8.1 of the appendix to see the derivation of this result.
Checking the critical points and the corners gives us an optimal price for the seller of $p_s^* = 1$.\footnote{See section 8.2 of the appendix to see the derivation of this result.} This makes intuitive sense because any price greater than one would mean that there is some probability that the buyer would reject the offer. In our model, this would mean that the seller would not be able to see the outside offer at all. As a result, the seller’s optimal strategy under the no damages condition is to offer a price, 

$$p_s^* = 1$$

and then breach if the outside offer is greater than one.

1.3 The Likelihood of Breach

After the buyer and seller agree on a price $p_{b,s}$ the seller receives the outside offer $\theta$, which they can either accept, thereby breaching their original contract with the first buyer; or reject, and receive the original price. If we assume that the seller will make the decision that yields them the highest payoff, we can say that the seller will breach whenever the following inequality holds:

$$\theta > p_{b,s}$$

This makes intuitive sense, because the seller does not pay any damages to the buyer if they choose to breach, so we should expect them to choose the higher price (either $\theta$ or $p_{b,s}$) every time. Given this breach condition, we can determine when the no damages remedy allows for inefficient breach. Before doing so, it may be appropriate to reiterate a few points. First, because we have assumed that the buyer will never accept a price that will give them a negative payoff, we can say that a contract will only be made when $p_{b,s} \leq v_b$ regardless of which agent makes the final offer. Second, because the seller will only breach if $\theta > p_{b,s}$, we only need to examine
scenarios where this inequality holds. Additionally, because $\theta$ and $v_b$ are uniformly distributed over $[0, 10]$, and $[1, 10]$ respectively, $v_b > \theta$, $v_b < \theta$, and $v_b = \theta$, are all possible scenarios. However, we only need to consider the first two cases, since total surplus will be the same regardless of whether or not the seller chooses to breach when $v_b = \theta$ meaning that breach cannot be inefficient. Finally, because breaching when $\theta > v_b$ maximizes the combined payoff to the buyer and the seller, it is efficient. Taken together, these statements tell us that the only scenarios that may result in inefficient breach are those that satisfy the inequality:

$$v_b > \theta > p_{b,s}$$

In this case the seller would still choose to breach to obtain the higher individual payoff, but doing so would result in a lower combined payoff than choosing not to breach. Therefore we can say that inefficient breach will occur under the no damages remedy whenever $v_b > \theta > p_{b,s}$. Since we have already used the model to derive predicted prices for when the buyer makes the final offer and when the seller makes the final offer, we can also state when inefficient breach and inefficient non-breach will occur in each case.

### 1.3.1 Buyer Offers

When the buyer makes the final offer, due to the above inequality and the derived optimal price, inefficient breach will take place when:

$$v_b > \theta > \frac{v_b}{2}$$

Which occurs with a probability of $Pr(iBr_B) = Pr(v_b > \theta > \frac{v_b}{2}) = 0.275$, when the parameters used in this experiment are substituted into the above inequality.\(^4\)

\(^4\)See section 8.3.1 of the appendix to see the derivation of this result.
Inefficient non-breach will occur when the buyer makes the offer when:

\[ \frac{v_b}{2} > \theta > v_b \]

Which occurs with a probability of \( Pr(iBr_B) = Pr(\frac{v_b}{2} > \theta > v_b) = 0 \) because \( \frac{v_b}{2} \not> v_b \).

Taken together, these probabilities imply that the probability of an efficient breach decision when the buyer makes the offer under the No Damages remedy is,

\[ Pr(E_{outB1}) = 1 - (0.275 + 0) = 0.725 \]

**1.3.2 Seller Offers**

Inefficient breach will occur when the seller makes the final offer whenever,

\[ v_b > \theta > 1 \]

Which occurs with a probability of \( Pr(iBr_s) = Pr(v_b > \theta > 1) = 0.45 \) with the parameter values used in this experiment.\(^5\)

And inefficient non-breach will occur whenever,

\[ 1 > \theta > v_b \]

However, since \( v_b \geq 1 \), the probability of inefficient non-breach is zero because \( 1 > v_b \) cannot hold.

From these two probabilities it can be shown that the probability of an efficient breach decision is 0.725 when the buyer makes the offer under the No Damages remedy.

\(^5\)See section 8.3.2 of the appendix to see the derivation of this result.
outcome when the seller makes the offer under the No Damages remedy is,

\[
Pr(E_{out, S}) = 1 - [Pr(v_b > \theta > 1) + Pr(1 > \theta > v_b)]
\]

\[
= 1 - (0.45 + 0) = 0.55
\]

### 1.3.3 Overall Efficiency

Considering the fact that the buyer and seller are equally likely to make the offer, the overall probability of inefficient breach can be calculated as a weighted average of the probabilities of inefficient breach.\(^6\) Doing so yields,

\[
Pr(iBr_{ND}) = \frac{0.275}{2} + \frac{0.45}{2} = \frac{0.725}{2} = 0.3625
\]

Similarly, the overall probability of an efficient outcome can be calculated as a weighted average of the probabilities of an efficient outcome.\(^7\)

\[
Pr(E_{out_{ND}}) = \frac{0.725}{2} + \frac{0.55}{2} = \frac{1.275}{2} = 0.6375
\]

### 2 Expectation Damages

Under the expectation damages remedy, if breach occurs, the breached against party receives compensation equal to their expected profit had the original contract been fulfilled. In this scenario, this means that the seller must pay the first buyer \(v_b - p_{b,s}\) should they choose to breach by accepting the outside offer. Additionally, since the seller must act based off of an expectation of the buyer's value, in their equation, \(v_b\) becomes \(E(v_b) = 5.5\). This also means that under the expectation damages remedy, 

\[
Pr(\theta) = \frac{E(v_b)}{\theta}.
\]

\(^6\)See section 8.3.3 of the appendix to see the derivation of this result.

\(^7\)See section 8.3.3 of the appendix to see the derivation of this result.
2.1 Buyer:

Under the expectation damages remedy the first buyer must maximize their expected payoff by choosing a final price, $p_b \in [0, \overline{p}_b]$, just as they would if there were no damage remedy. Once again, the first buyer is aware that there is an eventual outside offer, and that if this offer is greater than the price $p_b$, then the outside offer will be accepted. However, in this case the buyer also knows that if breach occurs, they will be compensated by the seller with a sum equal to what they would have received from performance. Since we expect the seller to accept any positive offer from the buyer, we will once again set $Pr(r) = 0$, and $1 - Pr(r) = 1$. This means that the expected payoff to the first buyer can be expressed as:

$$E(\pi_{B1}) = [(v_b - p_b)Pr(\theta) + (v_b - p_b)(1 - Pr(\theta))](1 - Pr(r))$$

Which can be simplified to,

$$E(\pi_{B1}) = v_b - p_b$$

Meaning that the buyer’s maximization problem can be written as,

$$\max_{p_b \in [0, \overline{p}_b]} v_b - p_b$$

Which means that the first buyer's optimal price is the lowest possible value of $p_b$, which in our case is $p_b = 0$.\footnote{See section 9.1 of the appendix to see the derivation of this result.}
2.2 Seller:

Under the expectation damages remedy the expected payoff to the seller can be expressed as:

\[
E(\pi_s) = [p_s Pr(\theta) + (E(\theta) - (E(v_b) - p_s))(1 - Pr(\theta))](1 - Pr(r))
\]

Once again we will assume a uniform distribution of \(v_b\). We will also assume that \(Pr(p_s > v_b) = Pr(r) = \frac{(p_s - v_b)}{(\bar{v}_b - v_b)}\). The resulting maximization problem can then be expressed as:

\[
\max_{p_s \in [0,p_b]} \frac{\bar{v}_b E(\theta) - p_s E(\theta)}{(\bar{v}_b - v_b)} - \frac{\bar{v}_b E(v_b) - p_s E(v_b)}{(\bar{v}_b - v_b)} + \frac{p_s \bar{v}_b - p_s^2}{(\bar{v}_b - v_b)} \frac{\bar{v}_b E(\theta) E(v_b) - p_s E(\theta) E(v_b)}{(\bar{v}_b - v_b)}
\]

\[
+ \frac{v_b [E(v_b)]^2 - p_s [E(v_b)]^2}{(\bar{v}_b - v_b)^2}
\]

Which yields the seller’s optimal price:9

\[
p^*_s = \frac{1}{2} [E(v_b)(1 + \frac{E(\theta) - E(v_b)}{\bar{\theta}}) - E(\theta) + \bar{v}_b] \approx 5.1
\]

2.3 The Likelihood of Breach

Once again, after the buyer and the seller come to an agreement on the price the seller will receive an outside offer that they can choose to either accept or reject. Under expectation damages the seller will receive a payoff of \(\pi_s = \theta - v_b + p_{b,s}\) should they choose to breach, and \(\pi_s = p_{b,s}\) if they fulfill the original contract. However, because the seller only knows the expectation of \(v_b\), which is affected by what the agreed to price is, \(E(v_b)\) will differ depending on which party makes the offer. This is because the buyer and the seller are predicted to make different price offers. If the buyer offers a price of \(p_b = 0\), then the seller only knows that the buyer’s value is between 1 and

---

9See section 9.2 of the appendix to see the derivation of this result.
10, with all values on that range being equal likely. On the other hand, if the seller offers a price of \( p_s = 5.1 \), and the buyer accepts that offer, then the seller knows that \( v_b \) is between 5.1 and 10 (with all values being equally likely), because the buyer will not accept a price that gives them a negative payoff.

### 2.3.1 Buyer Offers

When the buyer makes the offer, the predicted price is \( p_b = 0 \), and since this is below the possible range of \( v_b \), the seller receives no new information about the buyer’s value from this offer. Therefore, when the buyer makes the offer, the seller will choose to breach whenever,

\[
\theta - E(v_b) + p_b > p_b
\]

Where the left-hand side of the inequality is the expected payoff the seller receives if they choose to breach, and the right-hand side is the payoff they receive if they choose not to breach. Simply put, this inequality tells us that a seller will choose to breach when they expect that doing so will yield a larger payoff.

The above inequality can be rearranged to get:

\[
\theta > E(v_b)
\]

This implies that, when the buyer makes the offer, inefficient breach will only occur when,

\[
v_b > \theta > E(v_b)
\]

Which occurs with probability \( Pr(v_b > \theta > E(v_b)) = 0.1125 \) with the parameter values used in this experiment.\(^{10}\)

Additionally, inefficient non-breach when the buyer makes the offer will occur

\(^{10}\text{See section 9.3.1 of the appendix to see the derivation of this result.}\)
whenever,

\[ E(v_b) > \theta > v_b \]

Which can also be shown to occur with \( Pr(E(v_b) > \theta > v_b) = 0.1125 \). \(^{11}\)

Taken together, these probabilities imply that the probability of an efficient breach decision when the buyer makes the offer under the Expectation Damages remedy is,

\[
Pr(\text{Out}_{B}) = 1 - [Pr(v_b > \theta > E(v_b)) + Pr(E(v_b) > \theta > v_b)] \\
= 1 - (0.1125 + 0.1125) = 0.775
\]

### 2.3.2 Seller Offers

When the seller makes the offer, the predicted price is \( p_s = 5.1 \), and the seller gains additional information about the buyer’s value based on the buyer’s decision to accept. If the buyer accepts an offer of \( p_s = 5.1 \), the seller will learn that \( v_b \epsilon [5.1, 10] \). Additionally, since the seller also knows that each value on this range is equally likely because \( v_b \) is uniformly distributed the seller is able to form an updated expectation of the buyer’s value, which we will call \( E(v_b)_2 \). It can be shown that the seller’s updated expectation of the buyer’s value is, \(^{12}\)

\[ E(v_b)_2 = 7.505 \]

From this we can say that, when the seller makes the offer, they will choose to breach whenever the outside offer is greater than the seller’s updated expectation of the buyer’s value. Or,

\[ \theta > E(v_b)_2 \]

This implies that, when the seller makes the offer, inefficient breach will occur

\(^{11}\)See section 9.3.1 of the appendix to see the derivation of this result.

\(^{12}\)See section 9.3.2 of the appendix to see the derivation of this result.
when,
\[ v_b > \theta > E(v_b)_2 \]

So inefficient breach occurs with probability \( Pr(v_b > \theta > E(v_b)_2) = 0.0333 \) with the parameter values used in this experiment.\(^{13}\)

Inefficient non-breach will occur when the seller makes the offer whenever,

\[ E(v_b)_2 > \theta > v_b \]

Which, given that \( E(v_b)_2 = 7.505 \), occurs with probability \( Pr(E(v_b)_2 > \theta > v_b) = 0.2351 \).\(^ {14}\)

The probability of an efficient breach outcome when the seller makes the offer under the Expectation Damages remedy is,

\[
Pr(E_{out_S}) = 1 - [Pr(v_b > \theta > E(v_b)_2) + Pr(E(v_b)_2 > \theta > v_b)]
\]

\[= 1 - (0.0333 + 0.2351) = 0.7316\]

\subsection*{2.3.3 Overall Efficiency}

Since the buyer’s offer is predicted to be \( p_b = 0 \), which the seller will always accept, while seller’s offer is predicted to be \( p_s = 5.1 \), which the buyer will sometimes reject, given that \( v_b \sim U[1, 10] \). This means that there should be fewer excepted offers when the seller makes the offer, and as such, fewer breach opportunities. This means that the overall probability of inefficient breach is,

\[
Pr(iBr_{ED}) = Pr(B)Pr(iBr_B) + (1 - Pr(B))Pr(iBr_S)
\]

Where \( Pr(B) \) is the probability that the buyer made the accepted offer, and

\(^{13}\)See section 9.3.2 of the appendix to see the derivation of this result.

\(^{14}\)See section 9.3.2 of the appendix to see the derivation of this result.
1 − Pr(B) as the probability that the seller made the accepted offer.

Similarly, the overall probability of an efficient outcome can be expressed as,

\[
Pr(E_{out_{ED}}) = Pr(B)Pr(E_{out_{B}}) + (1 − Pr(B))Pr(E_{out_{S}})
\]

By solving for \(Pr(B)\), we find that,\(^{15}\)

\[
Pr(iBr_{ED}) = 0.0846
\]

and that,\(^{16}\)

\[
Pr(E_{out_{ED}}) = 0.7597
\]

### 3 Liquidated Damages

Under the liquidated damages remedy, the first buyer and the seller must come to an agreement on both the price and the amount in damages, \(d\), that the seller must pay the first buyer in the event of a breach. Under this damage remedy, \(Pr(\theta) = \frac{d + p_{b,s}}{\theta}\).

Additionally, we will restrict the values of \(d\) and \(p_{b,s}\) such that \(d + p_{b,s} \leq \bar{\theta}\).

#### 3.1 Buyer:

Under the liquidated damages remedy the first buyer must maximize their expected payoff by choosing a final price, \(p_b \in [0, \bar{p}_b]\), and damages, \(d \in [0, \bar{d}]\). The first buyer knows there will be an outside offer, and that the seller must pay damages equal to \(d\) in the event of breach. Since we expect the seller to accept any positive offer from the buyer, we will once again set \(Pr(r) = 0\), and \(1 − Pr(r) = 1\). Hence the first buyer’s

---

\(^{15}\)See section 9.3.3 of the appendix to see the derivation of this result.

\(^{16}\)See section 9.3.3 of the appendix to see the derivation of this result.
expected payoff is:

\[E(\pi_{B1}) = [(v_b - p_b)Pr(\theta) + d(1 - Pr(\theta))] (1 - Pr(r))\]

In this case there is a boundary solution to the buyer’s maximization problem. Instead, given our parameters, expected profit to the buyer is maximized at\(^\text{17}\):

\[p^*_b = 0\]
\[d^* = \frac{v_b + \theta}{2}\]

### 3.2 Seller:

Under a liquidated damages remedy the expected payoff to the seller can be expressed as:

\[E(\pi_s) = [p_s Pr(\theta) + (E(\theta) - d)(1 - Pr(\theta))] (1 - Pr(r))\]

Once again, we will assume that \(Pr(p_s > v_b) = Pr(r) = \frac{(p_s - v_b)}{(v_b - v_b)}\). The seller’s maximization problem does not have an interior solution given our parameters. Instead, the seller’s expected profit is maximized at\(^\text{18}\):

\[p^*_s = 1\]
\[d^* = 0\]

These values make intuitive sense for the seller to offer. Clearly the seller would prefer not to pay damages in the event they choose to breach, and, as in the No Damages condition; a price of one makes sense because any price greater than one would mean that there is some probability that the buyer would reject the offer. In

\(^\text{17}\)See section 10.1 of the appendix to see the derivation of this result.

\(^\text{18}\)See section 10.2 of the appendix the derivation of this result.
our model, this would mean that the seller would not be able to see the outside offer at all. As a result, the seller’s optimal strategy under the no damages condition is to offer a price of one, and then breach if the outside offer is greater than one.

3.3 The Likelihood of Breach

Under the liquidated damages remedy the seller will receive a payoff of $\pi_s = \theta - d$ if they choose to breach, and $\pi_s = p_{b,s}$ if they fulfill the original contract. Consequently, we can say that the seller will choose to breach whenever:

$$\theta - d > p_{b,s}$$

Which can be rearranged to get:

$$\theta > p_{b,s} + d$$

As is the case under the two previous damage remedies, efficient breach will occur whenever $\theta > v_b$, since both the seller’s payoff and the combined payoff of the two agents are greater under breach. Accordingly, the only possibilities for inefficient breach occur when $v_b > \theta$. By assumption, the seller will choose to fulfill the original contract when $v_b \geq p_{b,s} + d > \theta$ because choosing to breach would lower their payoff, so inefficient breach will not occur. However, if $v_b > \theta > p_{b,s} + d$, the seller can increase their own payoff by breaching, even though doing so would lower the agents’ combined payoff. Since we expect the seller to act in a way that maximizes their payoff, inefficient breach is predicted to occur whenever $\theta > p_{b,s} + d$. 
3.3.1 Buyer Offers

This means that inefficient breach when the buyer makes the final offer under this remedy will occur when,

\[ v_b \theta > \frac{v_b + \theta}{2} \]

Which can be shown to be occur with probability \( Pr(iBr_B) = Pr(v_b > \theta > \frac{v_b + \theta}{2}) = 0.19 \). We can also say that inefficient non-breach will occur whenever,

\[ \frac{v_b + \theta}{2} \theta > v_b \]

Which can be shown to occur with probability \( Pr(iNBr_B) = 0.225 \) when we substitute in the parameter values used in this experiment.²⁰

From these two probabilities it can be shown that the probability of an efficient outcome when the buyer makes the offer under the Liquidated Damages remedy is,

\[
Pr(E_{out}S) = 1 - \left[ v_b > \theta > \frac{v_b + \theta}{2} \right] + Pr\left( \frac{v_b + \theta}{2} > \theta > v_b \right) \\
= 1 - (0 + .225) = 0.775
\]

3.3.2 Seller Offers

Inefficient breach will occur when the seller makes the final offer whenever,

\[ v_b \theta > 1 \]

Which occurs with a probability of \( Pr(iBr_S) = Pr(v_b > \theta > 1) = 0.45 \).²¹

---

²⁰See section 10.3.1 of the appendix to see the derivation of this result.
²¹See section 10.3.2 of the appendix to see the derivation of this result.
And inefficient non-breach will occur whenever,

\[ 1 > \theta > v_b \]

However, since \( v_b \geq 1 \), the probability of inefficient non-breach is zero because \( 1 > v_b \) cannot hold.

From these two probabilities it can be shown that the probability of an efficient outcome when the seller makes the offer under the No Damages remedy is,\(^{22}\)

\[
Pr(E_{outS}) = 1 - [Pr(v_b > \theta > 1) + Pr(1 > \theta > v_b)]
\]

\[= 1 - (0.45 + 0) = 0.55\]

### 3.3.3 Overall Efficiency

Considering the fact that the buyer and seller are equally likely to make the offer, and that both offers should always be accepted, the overall probability of inefficient breach is,\(^{23}\)

\[
Pr(iBr_{LD}) = \frac{0.225 + 0.45}{2} = \frac{0.675}{2} = 0.3375
\]

and the probability of an efficient outcome is,

\[
Pr(E_{outLD}) = \frac{0.775 + 0.55}{2} = \frac{1.325}{2} = 0.6625
\]

\(^{22}\)See section 10.3.2 of the appendix to see the derivation of this result.  
\(^{23}\)See section 10.3.3 of the appendix to see the derivation of this result.
4 Derived Hypotheses

While the model explored above does give us specific values about how often inefficient breach and efficient breach decisions will occur under each damage remedy, the focus of this analysis will be on the relative rates at which they occur. This is because the point predictions made by the model are largely a product of the assumptions made in the model. The assumption that the buyer’s value and the outside offer are uniformly distributed, as well as the bargaining process in the outlined in the model, and the allowable ranges set for buyer’s value, the outside offer, price, and damages all likely affect the exact values that the model predicts. As a result, it seems more prudent to focus on a comparative static results rather than a quantitative analysis.

The first relevant hypothesis derived from the above model concerns the relative rates of inefficient breach in the No Damages and Expectation Damages conditions. Given that the model predicts that the probability of inefficient breach under the No Damages remedy is $Pr(iBr_{ND}) = 0.3625$ and that the probability of inefficient breach under the Expectation Damages remedy is $Pr(iBr_{ED}) = 0.0846$, we can state;

Hypothesis 1: The rate of inefficient breach will be higher under the No Damages remedy than under the Expectation Damages remedy.

The model also predicts that the probability of an efficient breach decision is $Pr(Out_{ND}) = 0.6375$ under the No Damages remedy, and $Pr(Out_{ED}) = 0.7597$ under the Expectation Damages remedy. As a result, we can state that;

Hypothesis 2: Efficient breach decisions will be made more often under the Expectation Damages remedy than they will under the No Damages remedy.

The predicted probability of inefficient breach under the Liquidated Damages remedy, $Pr(iBr_{LD}) = 0.33750$, is lower than the predicted probability of inefficient breach under the No Damages remedy, $Pr(iBr_{ND}) = 0.3625$, so we state,
Hypothesis 3: The rate of inefficient breach will be higher under the No Damages remedy than under the Liquidated Damages remedy.

Because the model predicts a higher probability of efficient breach outcomes under the Liquidated Damages remedy relative to the No Damages remedy we can state,

Hypothesis 4: Efficient breach decisions will be made more often under the Liquidated Damages remedy than they will under the No Damages remedy.

Given that the probability of inefficient breach under the Expectation Damages remedy is $Pr(iBr_{ED}) = 0.0846$, and that this is lower than the probability that inefficient breach will occur under the Liquidated Damages remedy, $Pr(iBr_{LD}) = 0.33750$, the model predicts that,

Hypothesis 5: The rate of inefficient breach will be higher under the Liquidated Damages remedy than under the Expectation Damages remedy.

Finally, the model predicts that $Pr(Eout_{ED}) = 0.7597$, and $Pr(Eout_{LD}) = 0.6625$, which gives us the last hypothesis.

Hypothesis 6: Efficient breach decisions will be made more often under the Expectation Damages remedy than they will under the No Damages remedy.

All together, these hypotheses imply that the rate of inefficient breach will be lowest under the Expectation Damages remedy, second lowest under the Liquidated Damages remedy, and highest under the No Damages remedy. They also imply that efficient breach decisions will occur most often under the Expectation Damages remedy, second most often under the Liquidated Damages remedy, and least often under the No Damages remedy.
Part V

Experimental Design

In order to test the hypotheses laid out in the previous section, 78 students from the standard Ohio University Economics subject pool were recruited to one of six sessions. In each section, participants were randomly assigned to one of three treatments where there were two sessions of each treatment. Each participant played the contracting game a total of ten rounds, and was paid based on their choices in six of these rounds, which were randomly determined. Each round consisted of two parts that were played sequentially. At the beginning of each round, each participant was randomly assigned to the role of the buyer or the seller (referred to as Player B and Player S during the experiment), and paired with a player in the opposite role who was randomly selected. Roles remained fixed for the duration of the session, and participants were paired using random rematching. The entire experiment took place on the computer, which allowed data to be collected easily, and ensured that participants could not communicate with their counterparts. In addition to the payments that participants earned from the experimental game, they were also paid a $5.00 show up fee, as well as what they won in the risk assessment lottery described at the end of this section. Participants earned an average of $21.31 for their participation in the experiment. Since the participants did not know which rounds they were paid for until the end the session, we can assume that they treated each round as if they were being paid based on the outcome (Bardsley et al. 2010).

The first part of the experiment mimicked the experimental design presented in Guth et al (1982). In Part 1, the buyer and the seller attempted to reach an agreement on how many dollars the seller would receive. One player from each pair was randomly chosen to make a take-it-or-leave-it offer for how many dollars the seller
would receive. This offer had to be between $0 and $10 in $0.10 increments. In the liquidated damages treatment, they also proposed a transfer amount that the seller was required to pay the buyer if the seller chose to breach in Part 2. This offer also had to be between $0 and $10 in $0.10 increments. The player who did not make the proposal then had to decide whether to accept or reject their counterpart’s proposal.

The player in the role of the seller received a payoff equal to the accepted offer, if they decide not to breach in Part 2. The buyer received a payoff equal to a randomly determined number between $1 and $10 minus the amount that the seller received. This random number, which represents the buyer’s value, was known to the buyer, but was not be known to the seller. The buyer observed the random number when they made a proposal or when they decided whether to accept or reject the proposal, depending on which party made the offer. If the party that received the proposal chose to reject it, then the round ended, and both players received a payoff of zero for that round. If they accepted the proposal, then Part 2 of the experiment was played.

In Part 2, the seller received an alternative offer between $0 and $10, with each amount in the range being equally likely to occur. The seller was required to choose whether to accept or reject this offer. If they decided to reject this offer then the players received their payoffs according to the amount agreed to in Part 1 (i.e. the seller received the offered amount, and buyer received the random number minus the seller’s payoff). If the seller decided to accept the alternative offer, then the seller received that amount of money minus whatever damages they were required to transfer to the buyer, and the buyer only received that transfer amount. The way in which this transfer amount was determined differed between the three treatments. In the no damages treatment, the buyer and the seller did not negotiate a transfer amount, so the seller was not required to transfer any money to the buyer if they chose to breach by accepting the alternative offer. This also meant that the buyer received a payoff of zero in the event of breach. In the expectation damages treatment, if
the seller chose to breach by accepting the alternative offer, they were then required to transfer to the buyer the amount of money that the buyer would have received had the seller not breached the agreement. In this scenario, the seller’s payoff was the alternative offer, minus the amount they were required to transfer to the buyer. Finally, in the liquidated damages treatment, the seller was required to send to the buyer the transfer payment that both parties agreed to in Part 1. Once the seller decided whether or not to accept the alternative offer, both players saw their own payoff and the round concluded. Participants were then randomly paired with another player, and the process described above was repeated for a total of ten rounds.24

At the end of the ten rounds, participants were asked to play a lottery game. In the lottery game, subjects were asked to select one out of a list of available lotteries with payoffs determined by the outcome of a coin flip. This lottery game was used to elicit a 1 to 5 measure of the subjects’ risk preferences. After subjects made their choices and observed the outcome of the coin flip, they were asked to complete a short demographic questionnaire, which collected their age, gender, and year in school. This information was collected in order to control for any effect that these factors may have had on breach decisions.

Part VI

The Data

Since this experiment was conducted entirely on computers, collecting the necessary data was fairly straightforward. The program zTree was used to run the experimental sessions and record relevant variable values (Fischbacher 2007). Summary statistics for each treatment are given in the tables below. In all tables the No Damages

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24Example screens are given in section 11 of the appendix, as are sample instructions.
treatment, Expectation Damages treatment, and Liquidated Damages treatment, are referred to as ND, ED, and LD respectively.

The first table provides basic information about the general characteristics of subjects in each treatment. The notation for the first table is defined as follows: \( n \) is the number of subjects, \( Female \) is the proportion of the subjects in each treatment that were female, \( Age \) is the average age of the subjects, and \( Risk \) is the average risk preference of subjects on a 1 (lowest) to 5 (highest) scale. Standard errors are given in parentheses, and the subscripts \( B \) and \( S \) denote that the variable was calculated using only buyers or sellers respectively. The age differences between subjects in different roles and treatments were small, as were the differences in risk preferences (with the obvious exception being sellers in the No Damages treatment, which necessitated controlling for risk preferences econometrically). The proportion of subjects that were female was substantially larger in the No Damages treatment than in the other two treatments, with a particularly noticeable disparity between ND sellers and ED sellers. The large differences in female proportion between treatments necessitated controlling for gender econometrically, because there may have been some unobserved difference between men and women in the bargaining setting that could have affected the efficiency of breach decisions (Croson and Gneezy 2009). A potential unobserved difference between men and women was controlled for in the regression models, but the differences in female proportion are still less than ideal.

The second table includes information about the profits that subjects earned in each treatment, as well as the payout that they received for the six rounds they were paid. \( \pi \) is the average profit earned across all ten rounds of the experiment, while \( payout \) is the average payout earned for the six rounds that were randomly selected for payment plus the payment earned in the risk preference assessment and the show up fee. Once again, standard errors are given in parentheses, and the subscripts \( B \) and \( S \)
Table 1: General Subject Characteristics.

<table>
<thead>
<tr>
<th>Variable</th>
<th>ND</th>
<th>ED</th>
<th>LD</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>24</td>
<td>30</td>
<td>24</td>
</tr>
<tr>
<td>Female</td>
<td>0.625 (0.101)</td>
<td>0.400 (0.091)</td>
<td>0.417 (0.103)</td>
</tr>
<tr>
<td>Female&lt;sub&gt;B&lt;/sub&gt;</td>
<td>0.500 (0.151)</td>
<td>0.467 (0.133)</td>
<td>0.417 (0.149)</td>
</tr>
<tr>
<td>Female&lt;sub&gt;S&lt;/sub&gt;</td>
<td>0.750 (0.131)</td>
<td>0.333 (0.126)</td>
<td>0.417 (0.149)</td>
</tr>
<tr>
<td>Age</td>
<td>22.208 (0.843)</td>
<td>20.633 (0.509)</td>
<td>21.792 (0.853)</td>
</tr>
<tr>
<td>Age&lt;sub&gt;B&lt;/sub&gt;</td>
<td>22.167 (1.403)</td>
<td>20.533 (0.798)</td>
<td>22.083 (1.401)</td>
</tr>
<tr>
<td>Age&lt;sub&gt;S&lt;/sub&gt;</td>
<td>22.250 (1.001)</td>
<td>20.733 (0.658)</td>
<td>21.500 (1.034)</td>
</tr>
<tr>
<td>Risk</td>
<td>4.167 (0.231)</td>
<td>3.600 (0.290)</td>
<td>3.375 (0.268)</td>
</tr>
<tr>
<td>Risk&lt;sub&gt;B&lt;/sub&gt;</td>
<td>3.917 (0.379)</td>
<td>3.733 (0.441)</td>
<td>3.667 (0.355)</td>
</tr>
<tr>
<td>Risk&lt;sub&gt;S&lt;/sub&gt;</td>
<td>4.417 (0.260)</td>
<td>3.467 (0.389)</td>
<td>3.08 (0.398)</td>
</tr>
</tbody>
</table>

Table 2: Profits and Payouts.

<table>
<thead>
<tr>
<th>Variable</th>
<th>ND</th>
<th>ED</th>
<th>LD</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\pi$</td>
<td>24.54 (4.53)</td>
<td>25.97 (2.60)</td>
<td>26.96 (1.86)</td>
</tr>
<tr>
<td>$\pi_B$</td>
<td>3.79 (1.48)</td>
<td>18.37 (3.36)</td>
<td>21.04 (1.82)</td>
</tr>
<tr>
<td>$\pi_S$</td>
<td>45.29 (2.30)</td>
<td>33.56 (2.91)</td>
<td>32.88 (2.19)</td>
</tr>
<tr>
<td>payout</td>
<td>21.34 (3.03)</td>
<td>21.11 (1.90)</td>
<td>21.10 (1.19)</td>
</tr>
<tr>
<td>payout&lt;sub&gt;B&lt;/sub&gt;</td>
<td>8.47 (1.60)</td>
<td>16.28 (2.41)</td>
<td>18.21 (1.53)</td>
</tr>
<tr>
<td>payout&lt;sub&gt;S&lt;/sub&gt;</td>
<td>34.22 (2.41)</td>
<td>25.95 (2.41)</td>
<td>24.00 (1.43)</td>
</tr>
</tbody>
</table>

denote that the variable was calculated using only buyers or sellers respectively. The No Damages treatment had the most unequal distribution of profits between buyers and sellers, which was expected since the seller faced a breach opportunity with no pecuniary repercussion for accepting the outside offer. On the other end, the most equal distribution of profits occurred in the Liquidated Damages treatment, with the distribution of profits in the Expectation Damages treatment being only slightly less equitable.

The third table includes the random variables used in the first part of the experiment. The variable $obs$ is the number of observations for each treatment in the data. $V_B$ represents the average buyer’s value, and Seller is the proportion of ob-
Table 3: Stage 1 Random Variables.

<table>
<thead>
<tr>
<th>Variable</th>
<th>ND</th>
<th>ED</th>
<th>LD</th>
</tr>
</thead>
<tbody>
<tr>
<td>obs</td>
<td>120</td>
<td>150</td>
<td>120</td>
</tr>
<tr>
<td>$V_B$</td>
<td>6.283 (0.230)</td>
<td>6.173 (0.213)</td>
<td>5.983 (0.242)</td>
</tr>
<tr>
<td>$V_{B,B}$</td>
<td>6.078 (0.363)</td>
<td>6.700 (0.314)</td>
<td>5.707 (0.335)</td>
</tr>
<tr>
<td>$V_{B,S}$</td>
<td>6.435 (0.299)</td>
<td>5.713 (0.281)</td>
<td>6.242 (0.348)</td>
</tr>
<tr>
<td>Seller</td>
<td>0.575 (0.045)</td>
<td>0.533 (0.041)</td>
<td>0.517 (0.046)</td>
</tr>
</tbody>
</table>

Observations in which the seller made the offer in Part 1. Standard errors are given in parentheses, and the subscript $B$ denotes that the variable was calculated using only observations where a buyer made the offer in Part 1, while $S$ denotes that the variable was calculated using only observations where a seller made the offer in Part 1.

The fourth table includes data on the bargaining decisions of subjects in each treatment. $P$ and $d$ are the average proposed price and damage payment respectively, while $Price$ and $damages$ are the average accepted price and damage payment. The variable $accept$ gives the proportion of offers that were accepted in each treatment. Standard errors are given in parentheses, and the subscript $B$ denotes that the variable was calculated using only observations where a buyer made the offer in Part 1, while $S$ denotes that the variable was calculated using only observations where a seller made the offer in Part 1. For the most part, prices were set higher than what was predicted by the model, and damages were mostly off of their predicted amounts as well. This is in line with the findings of other bargaining experiments, like Guth et al. (1982) and Andersen et al. (2011), where more equitable offers were made than would be predicted by traditional game theory. The proportion of buyers’ offers that were accepted was substantially higher than the proportion of sellers’ offers that were accepted, but both of these proportions were nearly equivalent across the three treatments.
<table>
<thead>
<tr>
<th>Variable</th>
<th>ND</th>
<th>ED</th>
<th>LD</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P$</td>
<td>5.055 (0.279)</td>
<td>4.756 (0.243)</td>
<td>4.413 (0.261)</td>
</tr>
<tr>
<td>Price</td>
<td>4.352 (0.298)</td>
<td>4.235 (0.266)</td>
<td>3.624 (0.252)</td>
</tr>
<tr>
<td>$P_B$</td>
<td>3.120 (0.328)</td>
<td>3.177 (0.323)</td>
<td>2.310 (0.244)</td>
</tr>
<tr>
<td>Price$_B$</td>
<td>3.252 (0.357)</td>
<td>3.413 (0.337)</td>
<td>2.396 (0.262)</td>
</tr>
<tr>
<td>$P_S$</td>
<td>6.486 (0.328)</td>
<td>6.138 (0.277)</td>
<td>6.379 (0.274)</td>
</tr>
<tr>
<td>Price$_S$</td>
<td>5.585 (0.415)</td>
<td>5.432 (0.365)</td>
<td>5.431 (0.299)</td>
</tr>
<tr>
<td>$d$</td>
<td>0</td>
<td>1.417 (0.331)</td>
<td>5.046 (0.256)</td>
</tr>
<tr>
<td>damages</td>
<td>0</td>
<td>2.552 (0.366)</td>
<td>4.646 (0.287)</td>
</tr>
<tr>
<td>$d_B$</td>
<td>0</td>
<td>3.523 (0.433)</td>
<td>4.629 (0.371)</td>
</tr>
<tr>
<td>damages$_B$</td>
<td>0</td>
<td>3.509 (0.465)</td>
<td>4.368 (0.382)</td>
</tr>
<tr>
<td>$d_S$</td>
<td>0</td>
<td>-0.425 (0.390)</td>
<td>5.435 (0.350)</td>
</tr>
<tr>
<td>damages$_S$</td>
<td>0</td>
<td>1.159 (0.530)</td>
<td>5.056 (0.427)</td>
</tr>
<tr>
<td>accept</td>
<td>0.725 (0.041)</td>
<td>0.720 (0.037)</td>
<td>0.742 (0.040)</td>
</tr>
<tr>
<td>accept$_B$</td>
<td>0.902 (0.042)</td>
<td>0.914 (0.034)</td>
<td>0.914 (0.037)</td>
</tr>
<tr>
<td>accept$_S$</td>
<td>0.594 (0.060)</td>
<td>0.550 (0.056)</td>
<td>0.581 (0.063)</td>
</tr>
</tbody>
</table>

The fifth table includes information about the outside offers received by sellers in Part 2, as well as the breach decisions made. The variable $\theta$ represents the average outside offer when the offer in Part 1 was accepted. $\text{BreachOpp}$ gives the number of times that a seller was presented with an opportunity to breach (i.e. how often the offer in Part 1 was accepted). $\#breaches$ gives the number of times that a seller chose to breach the original agreement, and $\text{breach}$ gives the proportion of times a seller chose to breach when presented with the opportunity. Again, standard errors are given in parentheses, and the subscript $B$ denotes that the variable was calculated using only observations where a buyer made the offer in Part 1, while $S$ denotes that the variable was calculated using only observations where a seller made the offer in Part 1. Breaches occurred at a much higher rate under the No Damages condition than under the Expectation Damages condition or Liquidated Damages condition. This seems to conflict with the idea that people have some moral opposition to breaching contracts, since subjects were, on average, very willing to breach when there was no
Table 5: Outside Offers and Breach Opportunities/Decisions.

<table>
<thead>
<tr>
<th>Variable</th>
<th>ND</th>
<th>ED</th>
<th>ED</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\theta$</td>
<td>5.172  (0.325)</td>
<td>5.833  (0.301)</td>
<td>5.697  (0.289)</td>
</tr>
<tr>
<td>$\theta_B$</td>
<td>4.826  (0.427)</td>
<td>5.750  (0.367)</td>
<td>5.528  (0.371)</td>
</tr>
<tr>
<td>$\theta_S$</td>
<td>5.561  (0.494)</td>
<td>5.955  (0.516)</td>
<td>5.944  (0.463)</td>
</tr>
<tr>
<td>BreachOpp</td>
<td>87</td>
<td>108</td>
<td>89</td>
</tr>
<tr>
<td>BreachOpp$_B$</td>
<td>46</td>
<td>64</td>
<td>53</td>
</tr>
<tr>
<td>BreachOpp$_S$</td>
<td>41</td>
<td>44</td>
<td>36</td>
</tr>
<tr>
<td>#breaches</td>
<td>56</td>
<td>48</td>
<td>30</td>
</tr>
<tr>
<td>#breaches$_B$</td>
<td>31</td>
<td>32</td>
<td>24</td>
</tr>
<tr>
<td>#breaches$_S$</td>
<td>25</td>
<td>16</td>
<td>6</td>
</tr>
<tr>
<td>breach</td>
<td>0.644  (0.052)</td>
<td>0.444  (0.048)</td>
<td>0.337  (0.050)</td>
</tr>
<tr>
<td>breach$_B$</td>
<td>0.674  (0.070)</td>
<td>0.500  (0.063)</td>
<td>0.453  (0.069)</td>
</tr>
<tr>
<td>breach$_S$</td>
<td>0.610  (0.077)</td>
<td>0.364  (0.073)</td>
<td>0.167  (0.063)</td>
</tr>
</tbody>
</table>

punishment imposed for doing so.

The sixth table presents information regarding inefficient breach. $iBrOpp$ gives the number of times that a seller faced a breach decision where breaching would be inefficient. The variable $iBr$ gives the proportion of times that a seller chose to breach when faced with an inefficient breach opportunity. Standard errors are given in parentheses, and the subscripts $B$ denotes that the variable was calculated using only observations where a buyer made the offer in Part 1, and $S$ denotes that the variable was calculated using only observations where a seller made the offer in Part 1. Inefficient breach was most common under the No Damages remedy, followed by the Expectation Damages remedy. Inefficient breach was rare in the Liquidated Damages treatment, and never occurred in that treatment when the seller made the offer.

The seventh table presents information regarding the efficiency of breach decisions. The variable $EoutOpp$ tells us the number of times a seller faces a breach opportunity where there is an efficient decision (i.e. any time the seller faces a breach decision where $v_b \neq \theta$). The rows with the $Eout$ variables give the proportion of breach
opportunities where the seller made the efficient breach decision (breached when \(v_b < \theta\) and did not breach when \(v_b > \theta\)). Again, standard errors are given in parentheses, and the subscripts \(B\) denotes that the variable was calculated using only observations where a buyer made the offer in Part 1, and \(S\) denotes that the variable was calculated using only observations where a seller made the offer in Part 1. The proportion of breach decisions that were efficient was about equivalent between the No Damages and Expectation Damages treatments. However the efficient decision was made at a noticeably higher rate under the Liquidated Damages remedy.
Part VII

Testing Hypotheses

The hypotheses put forward in Section 4.4 were tested using random effects logistic (logit) regression models. This model was selected because both outcome variables, accept2 and Eout are binary. The seller either chose to breach when it was inefficient or they didn’t. In the same way, a seller’s breach decision was either efficient or inefficient. Since each observation of these variables will equal either 1 or 0, the model had to be selected with this in mind. Additionally, because multiple observations were drawn from each subject in the experiment, observations are not independent. Because of this, it is likely that the data is autocorrelated and heteroskedastic, meaning that error terms are correlated and the variance is not constant. To try to correct for this, all models used the clustered standard errors suggested by Rogers (1993). It is possible, as Frechette (2011) suggests, that there were some different characteristics between the six sessions of this experiment that affected the outcome of interest, and were not controlled for. Despite the potential for session-effects, no fixed effects dummy variables were included in this analysis. This decision was made for three primary reasons also addressed by Frechette (2011): 1) Most common methods for session-effects seem unable to fully correct for the error. 2) Session-effects, whether they are static or dynamic, generally appear to be small, and are therefore unlikely to significantly affect the outcome of the analysis. 3) Including variables for the round in which an observation took place and using robust standard errors should help account for the fact that there are multiple observations from each subject. All variables used in this analysis are defined in the table below. The variables female, age, Significance levels for regression coefficients are denoted as follows: \(* = p = 0.10\), \(\star\star = p = 0.05\), and \(\star\star\star = p = 0.01\).
<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>accept2</td>
<td>Equals 1 if inefficient breach occurred, and 0 otherwise.</td>
</tr>
<tr>
<td>efout</td>
<td>Equals 1 if the breach decision was efficient, and 0 otherwise.</td>
</tr>
<tr>
<td>ed</td>
<td>Equals 1 if the observation is from ED, and 0 otherwise.</td>
</tr>
<tr>
<td>ld</td>
<td>Equals 1 if the observation is from LD, and 0 otherwise.</td>
</tr>
<tr>
<td>nd</td>
<td>Equals 1 if the observation is from ND, and 0 otherwise.</td>
</tr>
<tr>
<td>vb</td>
<td>The buyer’s value</td>
</tr>
<tr>
<td>price</td>
<td>The agreed to price</td>
</tr>
<tr>
<td>damages</td>
<td>The damages, whether set by rule or negotiated</td>
</tr>
<tr>
<td>θ</td>
<td>The value of the outside offer</td>
</tr>
<tr>
<td>female</td>
<td>Equals 1 if subject is female, and 0 otherwise</td>
</tr>
<tr>
<td>age</td>
<td>Equals the subject’s age</td>
</tr>
<tr>
<td>risk</td>
<td>Subject’s 1-5 risk score from preference assessment</td>
</tr>
<tr>
<td>period</td>
<td>The round of the experiment the observation is from</td>
</tr>
</tbody>
</table>

The coefficients on the variables female, age, risk, and period are not included in the regression tables below, but their inclusion in the regression models is denoted by Controls = Yes. Significance levels for regression coefficients are denoted as follows: ∗ = p = 0.10, ∗∗ = p = 0.05, and ∗∗∗ = p = 0.01.

The first logit model allowed for the evaluation of Hypotheses 1 and 3, and took the following form.

accept2\_i = β_0 + β_1ed\_i + β_2ld + β_3vb\_i + β_4price\_i + β_5damages\_i + β_6θ_i + β_7Female\_i + \beta_8Age\_i + \beta_9Risk_i + \beta_10Period_i + e_i

Running this model yielded,
<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Robust Standard Error</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(ed)</td>
<td>-2.516551</td>
<td>2.078085</td>
<td>0.226</td>
</tr>
<tr>
<td>(ld)</td>
<td>-5.149774*</td>
<td>2.953093</td>
<td>0.081</td>
</tr>
<tr>
<td>(v_b)</td>
<td>0.0963254</td>
<td>0.1871641</td>
<td>0.607</td>
</tr>
<tr>
<td>(price)</td>
<td>-1.191855***</td>
<td>0.3267594</td>
<td>0.000</td>
</tr>
<tr>
<td>(damages)</td>
<td>-0.1263886</td>
<td>0.251796</td>
<td>0.616</td>
</tr>
<tr>
<td>(\theta)</td>
<td>0.9693718**</td>
<td>0.4731187</td>
<td>0.040</td>
</tr>
<tr>
<td>Controls</td>
<td>Yes</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

The coefficients on the regressors are given in log odds, which makes the estimates difficult to interpret. While the coefficients could be transformed into odds ratios to provide a better understanding of the effect of each variable, this analysis is not concerned with point predictions, as they are largely dependent on the model’s parameters. Instead, this analysis is solely concerned with the comparative effects of the regressors, so the log odds coefficients are sufficient for the purpose of this thesis.

Of primary concern are the coefficients on the treatment variables, \(ed\) and \(ld\), because these are the only ones in this regression that are relevant to the hypotheses derived from the model. Since the variable \(nd\) was omitted from this regression, the No Damages treatment served as the baseline that the other two treatment variables were compared to.

Result 1: The rate of inefficient breach under the Expectation Damages remedy is not significantly less than the rate of inefficient breach under the No Damages remedy.

The coefficient on the \(ed\) variable is negative, suggesting that the rate of inefficient breach was lower under the Expectation Damages remedy than it was under the
No Damages remedy, but this coefficient is not significant at any standard level, so we cannot say that the rate of inefficient breach was lower under the Expectation Damages remedy. This result does not lend support to Hypothesis 1, but because the two treatments are not statistically different, we also cannot reject this hypothesis.

Result 2: The rate of inefficient breach was lower under the Liquidated Damages remedy than under the No Damages remedy.

The negative coefficient on the $ld$ variable is statistically significant at $p = 0.081$. While many analyses require a p-value of $p = 0.05$ or lower for a coefficient to be considered statistically significant, this is a somewhat arbitrary cutoff point (Wasserstein and Lazar 2016). With this, and the small size of the experimental sample, in mind, we will accept p-values below $p = 0.1$ as statistically significant. Under this rule we accept that the rate of inefficient breach was significantly lower under the Liquidated Damages remedy than it was under the No Damages remedy, and confirm Hypothesis 3.

The second random effects logit model allowed for the evaluation of Hypothesis 5, and took the following form.

$$
accept_{2i} = \beta_0 + \beta_1 ed_i + \beta_2 nd + \beta_3 v_{ki} + \beta_4 price_i + \beta_5 damages_i + \beta_6 \theta_i + \beta_7 Female_i + \beta_8 Age_i + \beta_9 Risk_i + \beta_{10} Period_i + e_i
$$

Note that in this regression the variable $ld$ was omitted from the model, and $nd$ was included. This means that the No Damages treatment served as the baseline that the other two treatment variables were compared to.

Running the second model gave the following estimates.
Since the first regression model already compared the rates of inefficient breach under the No Damages and Liquidated Damages remedies, the coefficient on the variable \( nd \) is not of interest. This means that the only variable relevant to a hypothesis of the model is \( ed \).

Result 3: The rate of inefficient breach under the Expectation Damages remedy was higher than the rate of inefficient breach under the Liquidated Damages remedy.

The coefficient on \( ed \) is positive and statistically significant at the \( p = 0.057 \) level, so we can say that the rate of inefficient breach was significantly higher under the Expectation Damages remedy than it was under the Liquidated Damages remedy. Given that Hypothesis 5 predicted the opposite, we reject that hypothesis.

The third random effects logit model,

\[
E_{out_i} = \beta_0 + \beta_1 ed_i + \beta_2 ld + \beta_3 v_{b,i} + \beta_4 price_i + \beta_5 damages_i + \beta_6 \theta_i + \beta_7 Female_i \\
+ \beta_8 Age_i + \beta_9 Risk_i + \beta_{10} Period_i + e_i
\]

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Robust Standard Error</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( ed )</td>
<td>2.633223*</td>
<td>1.381866</td>
<td>0.057</td>
</tr>
<tr>
<td>( nd )</td>
<td>5.149774*</td>
<td>2.953093</td>
<td>0.081</td>
</tr>
<tr>
<td>( v_b )</td>
<td>0.0963254</td>
<td>0.1871641</td>
<td>0.607</td>
</tr>
<tr>
<td>( price )</td>
<td>-1.191855***</td>
<td>0.3267594</td>
<td>0.000</td>
</tr>
<tr>
<td>( damages )</td>
<td>-0.1263886</td>
<td>0.251796</td>
<td>0.616</td>
</tr>
<tr>
<td>( \theta )</td>
<td>0.9693718**</td>
<td>0.4731187</td>
<td>0.040</td>
</tr>
<tr>
<td>Controls</td>
<td>Yes</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
allowed for the evaluation of Hypotheses 2 and 4. Running this model gave the estimates,

\[
\begin{array}{|c|c|c|c|}
\hline
\text{Variable} & \text{Coefficient} & \text{Robust Standard Error} & \text{P-value} \\
\hline
ed & 0.648828^* & 0.3820392 & 0.089 \\
ld & 1.468017^{**} & 0.6573501 & 0.026 \\
v_b & 0.0134494 & 0.0947517 & 0.887 \\
price & 0.0113358 & 0.0753406 & 0.880 \\
damages & -0.086405 & 0.0867025 & 0.319 \\
\theta & -0.1029413^{**} & 0.0497853 & 0.039 \\
\hline
\end{array}
\]

Since we wanted to compare the efficiency of breach decisions under the No Damages treatment to the efficiency of breach decisions under the Expectation Damages treatment, and the Liquidated Damages treatment, we are concerned with both \(ed\) and \(ld\).

Result 4: Efficient breach decisions were more likely to occur under the Expectation Damages remedy than they were under the No Damages remedy.

The coefficient on \(ed\) is positive and statistically significant at \(p = 0.089\). This means that breach decisions were significantly more efficient under the Expectation Damages remedy than they were under the No Damages remedy, confirming Hypothesis 2.

Result 5: Efficient breach decisions were more likely under the Liquidated Damages remedy than under the No Damages remedy.

The coefficient on \(ld\) is also positive, and is statistically significant at \(p = 0.026\),
so Hypothesis 4 is also confirmed.

Finally, the last random effects logit model allowed for the evaluation of Hypothesis 6, and took the following form.

\[
E_{out_i} = \beta_0 + \beta_1 ed_i + \beta_2 nd + \beta_3 v_{b,i} + \beta_4 price_i + \beta_5 damages_i + \beta_6 \theta_i + \beta_7 Female_i + \beta_8 Age_i + \beta_9 Risk_i + \beta_{10} Period_i + e_i
\]

Note that, once again, the variable \( ld \) was omitted from the model and \( nd \) was included, meaning that the No Damages treatment served as the baseline that the other two treatment variables were compared to.

The estimates of this model are displayed below.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Robust Standard Error</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( ed )</td>
<td>-0.819189*</td>
<td>0.4702691</td>
<td>0.082</td>
</tr>
<tr>
<td>( nd )</td>
<td>-1.468017**</td>
<td>0.6573501</td>
<td>0.026</td>
</tr>
<tr>
<td>( v_{b} )</td>
<td>0.0134494</td>
<td>0.0947517</td>
<td>0.887</td>
</tr>
<tr>
<td>( price )</td>
<td>0.0113358</td>
<td>0.0753406</td>
<td>0.880</td>
</tr>
<tr>
<td>( damages )</td>
<td>-0.086405</td>
<td>0.0867025</td>
<td>0.319</td>
</tr>
<tr>
<td>( \theta )</td>
<td>-0.1029413**</td>
<td>0.0497853</td>
<td>0.039</td>
</tr>
<tr>
<td>( Controls )</td>
<td>Yes</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

As in the second regression model, we are only concerned with the variable \( ed \), because the previous regression model already compared the rates of inefficient breach under the No Damages and Liquidated Damages remedies.

Result 6: Efficient breach decisions were less likely under the Expectation Damages remedy than they were under the Liquidated Damages remedy.
Here the coefficient on \( cd \) is negative and statistically significant at \( p = 0.082 \). As a result, we say that breach decisions were significantly less efficient under the Expectation Damages remedy than they were under the Liquidated Damages remedy, meaning that we reject Hypothesis 6.

**Part VIII**

**Conclusion**

5 **Brief Review**

Before discussing the implications of this analysis’ results, it may be helpful to briefly review exactly what each hypothesis predicted would occur, and what actually occurred according to the data. This information is presented in the table below.

<table>
<thead>
<tr>
<th>Hypothesis #</th>
<th>Hypothesized Outcome</th>
<th>Actual Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>( Pr(iBr_{ED}) &lt; Pr(iBr_{ND}) )</td>
<td>( Pr(iBr_{ED}) - ? - Pr(iBr_{ND}) )</td>
</tr>
<tr>
<td>2</td>
<td>( Pr(Eout_{ED}) &gt; Pr(Eout_{ND}) )</td>
<td>( Pr(Eout_{ED}) &gt; Pr(Eout_{ND}) )</td>
</tr>
<tr>
<td>3</td>
<td>( Pr(iBr_{LD}) &lt; Pr(iBr_{ND}) )</td>
<td>( Pr(iBr_{LD}) &lt; Pr(iBr_{ND}) )</td>
</tr>
<tr>
<td>4</td>
<td>( Pr(Eout_{LD}) &gt; Pr(Eout_{ND}) )</td>
<td>( Pr(Eout_{LD}) &gt; Pr(Eout_{ND}) )</td>
</tr>
<tr>
<td>5</td>
<td>( Pr(iBr_{ED}) &lt; Pr(iBr_{LD}) )</td>
<td>( Pr(iBr_{ED}) &gt; Pr(iBr_{LD}) )</td>
</tr>
<tr>
<td>6</td>
<td>( Pr(Eout_{ED}) &gt; Pr(Eout)_{LD} )</td>
<td>( Pr(Eout_{ED}) &lt; Pr(Eout)_{LD} )</td>
</tr>
</tbody>
</table>

While the Expectation Damages remedy was more efficient overall than the No Damages remedy overall, it failed to prevent inefficient breach significantly more often than the No Damages remedy. Additionally, Expectation Damages was worse at preventing inefficient breach and ensuring efficient outcomes than the Liquidated Damages remedy was, despite the model’s predictions to the contrary. Meanwhile,
the Liquidated Damages remedy proved more effective at preventing inefficient breach and ensuring efficient outcomes than either of the other damage remedies analyzed.

6 Interpretation

The results of the experiment presented in this thesis provide evidence against the widespread application of the Expectation Damages remedy by courts in settling contract breach cases. The assertion made by Shavell (2006), that, like liquidated damages, the expectation damages remedy encourages parties to breach when doing so would be efficient, and discourages them from breaching when breach would be economically inefficient, did not hold in the setting examined in this experiment. The exact reason for this difference between the two remedies is outside the scope of this thesis, but may have been due to the fact that the party facing the breach decision (in this case the seller) did not know with certainty the amount of damages that they would be required to pay under the expectation damages remedy.

Regardless of the exact reason for the difference in efficiency between the two damage remedies, it is clear that, in this setting, expectation damages did not maximize social welfare, since the “good” was moved to a lower valued use less often than when parties set damages for themselves. While the widespread application of the expectation damages remedy likely allows parties to forego some negotiating costs, these cost savings could be outweighed by the costs implied by the lower rate of efficient breach decisions, if the results of this experiment can be shown to generalize to a wider range of contracting scenarios. If this is the case, then the way that courts typically handle contract breach may be significantly flawed. If the goal of the courts is to facilitate efficient economic interaction, then it may better to encourage parties to negotiate more complete damage clauses in their contracts than to apply expectation damages as a standard default rule.
7 Future Research

Although the results of the experiment presented in this thesis may have significant implications for contract law, there are still a couple of questions that need to be answered. The first of these questions is,

What causes the expectation damages remedy to be less efficient than liquidated damages in this setting?

In this thesis I have proposed that the difference in efficiency between the two remedies is due to the fact that a potential breaching party does not know the amount of damages they would have to pay with certainty. However, the design of the experiment does not allow us to confirm or reject this hypothesis. The comparison of breach under expectation damages and liquidated damages tells us that there is some difference between the two remedies that causes expectation damages to be less efficient, but not what that cause is. The two remedies differ in more than one way. Primarily, the certainty of the damage payment and how those damages are determined, so the exact cause cannot be isolated. To determine if the lack of certainty regarding damages is what drives the efficiency difference, an additional treatment of an experiment like the one in this thesis where the potential breaching party knows what the damage payment would be when they make their breach decision could be included. Comparing efficiency between this treatment and an expectation damages treatment with uncertain damages would allow us to pin down the effect of uncertainty.

The second question that future research could address is,

Do these results hold in a more realistic bargaining setting?

In this experiment, bargaining took place via one party making a take-it-or-leave-it offer which the other party could either accept or reject. If that offer was rejected, then no agreement was reached, and no further bargaining took place. In a real world environment, parties typically negotiate back and forth over the terms of a contract,
rather than make a single take-it-or-leave-it offer. From a game theoretic standpoint, any bargaining experiment with a limited number of back and forth offers or a limited amount of time to make offers back and forth offers will reduce down to a single take-it-or-leave-it offer, but actual behavior may differ from what game theory predicts. If future research in this vein sought to address this, an experiment could allow for each party to make an offer or multiple offers, however time is a constraint in laboratory experiments. Alternatively, if future research sought to study breach decisions, it may be prudent to ensure that the breaching party does not make the final offer, since in this experiment acceptance rates were substantially lower when the seller made the offer.

In building off of the findings of this thesis, future research that addresses the concerns above would significantly further our understanding of contract and breach, potentially having major implications for contract law.

Part IX

References


Part X

Appendix

8 No Damages

8.1 Buyer

To find the optimal price for the buyer under the no damages condition, we need to take the first derivative of the expected profit function with respect to $p_b$ and set it equal to zero.

$$E(\pi_{B1}) = [(v_b - p_b)Pr(\theta)](1 - Pr(r)) = \frac{v_b p_b - p_b^2}{\theta}$$

$$\frac{\delta E(\pi_{B1})}{\delta p_b} = \frac{v_b - 2p_b}{\theta} = 0$$

Solving for $p_b$ yields,

$$p_b = \frac{v_b}{2}$$

Since both corners $p_b = 0, 10$ clearly give the buyer an expected payoff of zero or less for all values of $v_b$, $p_b^* = \frac{v_b}{2}$ is the buyer’s optimal price under the no damages condition.

8.2 Seller

To solve the seller’s maximization problem under the no damages condition, we rearrange the expected profit function and take the first derivative of the expected profit function with respect to $p_s$ and set it equal to zero.

$$E(\pi_s) = [p_s Pr(\theta) + E(\theta)(1 - Pr(\theta)))(1 - Pr(r))$$
\[
\frac{p_s^2}{\overline{\theta}}(1 - Pr(r)) + E(\theta)(1 - Pr(r)) - \frac{p_s E(\theta)}{\overline{\theta}}(1 - Pr(r))
\]

Given that \( Pr(r) = \frac{p_s - \theta}{r - \theta} \), we can say that \((1 - Pr(r)) = \frac{\theta - \theta}{r - \theta} - \frac{p_s - \theta}{r - \theta} = \frac{\theta - p_s}{r - \theta} \), which implies that the above equation can be rewritten as;

\[
\frac{p_s^2(\nu_b - p_s)}{\overline{\theta}(\nu_b - \nu_b)} + \frac{E(\theta)(\nu_b - p_s)}{(\nu_b - \nu_b)} - \frac{(\nu_b - p_s)p_s E(\theta)}{\overline{\theta}(\nu_b - \nu_b)}
\]

Taking the derivative with respect to \( p_s \) and setting it equal to zero yields,

\[
\frac{\delta E(\pi_s)}{\delta p_s} = \frac{2\overline{\nu}_b p_s - 3p_s^2}{\overline{\theta}(\nu_b - \nu_b)} - \frac{E(\theta)}{(\nu_b - \nu_b)} - \frac{\overline{\nu}_b E(\theta) - 2p_s E(\theta)}{\overline{\theta}(\nu_b - \nu_b)} = 0
\]

Multiplying by \( \overline{\theta}(\nu_b - \nu_b) \) gives us,

\[
2\overline{\nu}_b p_s - 3p_s^2 - \overline{\theta}E(\theta) - \overline{\nu}_b E(\theta) + 2p_s E(\theta) = 0
\]

\[
-3p_s^2 + p_s(2\overline{\nu}_b + E(\theta)) - E(\theta)(\overline{\theta} + \nu_b) = 0
\]

Using the quadratic formula, we find that;

\[
p_s = \frac{-2(\overline{\nu}_b + 2E(\theta)) \pm \sqrt{(2\overline{\nu}_b + 2E(\theta))^2 - 4(-3)(-\overline{\theta}E(\theta) - \overline{\nu}_b E(\theta))}}{2(-3)}
\]

\[
= \frac{-2(\overline{\nu}_b + E(\theta)) \pm \sqrt{4\overline{\nu}_b^2 + 8\overline{\nu}_b E(\theta) + 4E(\theta)^2 - 12\overline{\theta}E(\theta) - 12\overline{\nu}_b E(\theta)}}{-6}
\]

\[
= \frac{-2(\overline{\nu}_b + E(\theta)) \pm 2\sqrt{\overline{\nu}_b^2 + 2\overline{\nu}_b E(\theta) + (E(\theta))^2 - 3\overline{\theta}E(\theta) - 3\overline{\nu}_b E(\theta)}}{-6}
\]

\[
p_s = \frac{\overline{\nu}_b + E(\theta) \pm \sqrt{\overline{\nu}_b^2 + E(\theta)(2\overline{\nu}_b + E(\theta) - 3\overline{\theta} - 3\overline{\nu}_b)}}{3}
\]
Plugging in our parameter values: \( \nu_b = \bar{\theta} = 10 \), and \( E(\theta) = 5 \) gives us,

\[
ps = \frac{10 + 5 \pm \sqrt{10^2 + 5[2(10) + 5 - 3(10) - 3(10)]}}{3}
\]

\[
= \frac{15 \pm \sqrt{100 + 5(20 + 5 - 60)}}{3}
= \frac{15 \pm \sqrt{100 + 5(-35)}}{3}
\]

\[
ps = \frac{15 \pm \sqrt{100 - 175}}{3} = \frac{15 \pm \sqrt{-75}}{3} = \frac{15 \pm \sqrt{-1}(25)(3)}{3}
\]

\[
ps = \frac{15 \pm 5i\sqrt{3}}{3}
\]

Since this will always give us an imaginary term, the seller’s optimal price must be at the corner.

At \( ps = 1 \),

\[
E(\pi_s) = \frac{1}{\theta(\nu_b - \nu_b)} + E(\theta)(\nu_b - 1) - \frac{(\nu_b - 1)(1) E(\theta)}{\theta(\nu_b - \nu_b)}
\]

\[
E(\pi_s) = \frac{(\nu_b - 1)}{\theta(\nu_b - \nu_b)} + E(\theta)(\nu_b - 1) - \frac{(\nu_b - 1) E(\theta)}{\theta(\nu_b - \nu_b)}
\]

Since our parameters are set such that \( \nu_b \in [1, 10], \nu_b = 1 \), and \( \bar{\nu}_b = 10 \). Plugging in our parameter values gives us,

\[
E(\pi_s) = \frac{(10 - 1)}{10(10 - 1)} + \frac{5(10 - 1)}{(10 - 1)} - \frac{(10 - 1)5}{10(10 - 1)}
\]

\[
= \frac{1}{10} + 5 - \frac{5}{10} = 4.6
\]

At \( ps = 10 \),

\[
E(\pi_s) = \frac{10^2(\nu_b - 10)}{\theta(\nu_b - \nu_b)} + E(\theta)(\nu_b - 10) - \frac{(\nu_b - 10)(10) E(\theta)}{\theta(\nu_b - \nu_b)}
\]
Plug in parameter values;

\[
E(\pi_s) = \frac{10^2(10 - 10)}{10(10 - 1)} + \frac{5(10 - 10)}{(10 - 1)} - \frac{(10 - 10)(10)(5)}{10(10 - 1)}
\]

\[
= \frac{100(0)}{90} + \frac{5(0)}{9} - \frac{50(0)}{90} = 0
\]

So the seller’s optimal price under the no damages condition is \( p_s^* = 1 \).

8.3 Likelihood of Breach

8.3.1 Buyer Offers

From these inequalities it is possible to determine the probability of inefficient breach or non-breach in each case. When the buyer makes the final offer, the probability of an inefficient breach is:

\[
Pr(iBr_B) = Pr(v_b > \theta > \frac{v_b}{2})
\]

If we assume that a seller facing a breach decision based on a cutoff rule this can be expressed as;

\[
= \frac{\int_1^{10} (v_b - \frac{v_b}{2})dv_b}{\int_1^{10} 10dv_b} = \frac{\int_1^{10} \frac{v_b}{2}dv_b}{10x|_{10}^{10}} = \frac{\frac{v_b^2}{4}|_{10}^{10}}{100 - 10}
\]

\[
= \frac{1}{4}(v_b^2|_{10})^{10} = \frac{(100 - 1)}{4 \times 90} = \frac{99}{360} = 0.275
\]

Similarly, the probability of inefficient non-breach can be expressed as;

\[
Pr(iNBr_B) = (\frac{v_b}{2} > \theta > v_b)
\]

Since \( \frac{v_b}{2} > v_b \) is not possible, the probability of inefficient non-breach is zero.

Therefore the probability of an efficient outcome when the buyer makes the offer
under the No Damages remedy can be expressed as;

\[ Pr(E_{out_B}) = 1 - [Pr(v_b > \theta > \frac{v_b}{2}) + (\frac{v_b}{2} > \theta > v_b)] \]

\[ = 1 - (0.275 + 0) = 0.725 \]

### 8.3.2 Seller Offers

When the seller makes the final offer, the probability of inefficient breach is:

\[ Pr(iBr_S) = Pr(v_b > \theta > 1) \]

\[ = \frac{\int_1^{10} (v_b - 1)dv_b}{\int_1^{10} 10 dv_b} = \frac{\int_1^{10} v_b dv_b - \int_1^{10} dv_b}{90} = \frac{v_b^{10}|_1^{10} - v_b|_1^{10}}{90} \]

\[ = \frac{\frac{1}{2}(100 - 1) - (10 - 1)}{90} = \frac{40.5}{90} = 0.45 \]

And the probability of inefficient non-breach is;

\[ Pr(iNBr_S) = Pr(1 > \theta > v_b) \]

Since \( v_b \geq 1 \), the probability of inefficient non-breach is zero because \( 1 > v_b \) cannot hold.

Therefore the probability of an efficient outcome when the seller makes the of under the No Damages remedy can be expressed as;

\[ Pr(E_{out_S}) = 1 - [Pr(v_b > \theta > 1) + Pr(1 > \theta > v_b)] \]

\[ = 1 - (0.45 + 0) = 0.55 \]
8.3.3 Interpretation

Considering the fact that the buyer and seller are equally likely to make the offer, and that both offers should always be accepted, the overall probability of an inefficient breach is,

\[
Pr(iBr_{ND}) = \frac{Pr(iBr_B)}{2} + \frac{Pr(iBr_S)}{2} = \frac{0.275}{2} + \frac{0.45}{2} = \frac{0.725}{2} = 0.3625
\]

and the overall probability of an efficient outcome is;

\[
Pr(E_{out}_{ND}) = \frac{Pr(E_{out}_B)}{2} + \frac{Pr(E_{out}_S)}{2} = \frac{0.725}{2} + \frac{0.55}{2} = \frac{1.275}{2} = 0.6375
\]

9 Expectation Damages

9.1 Buyer

Under the expectation damages remedy, the buyer’s expected profit function simplifies to,

\[
E(\pi_{B1}) = v_b - p_b
\]

To maximize the buyer’s expected payoff, we need to take the first derivative of the expected profit function with respect to \( p_b \) and set it equal to zero.

\[
\frac{\delta E(\pi_{B1})}{\delta p_b} = -1
\]

Since the price cannot be negative, the buyer’s optimal price must be one of the corners.
If \( p_b = 0 \) then,
\[
E(\pi_{B1}) = v_b - 0 = v_b
\]

If \( p_b = 10 \) then,
\[
E(\pi_{B1}) = v_b - 10
\]

So clearly the buyer’s optimal price under the expectation damages remedy is \( p_b^* = 0 \).

9.2 Seller

To maximize the seller’s expected profit under the expectation damages remedy, we rearrange the function and take the first derivative of the expected profit function with respect to \( p_s \).

\[
E(\pi_s) = [p_s Pr(\theta) + (E(\theta) - (E(v_b) - p_s))(1 - Pr(\theta))](1 - Pr(r))
\]

\[
= [p_s Pr(\theta) + E(\theta) - E(v_b) - p_s - E(\theta)Pr(\theta) + E(v_b)Pr(\theta) - p_s Pr(\theta)](1 - Pr(r))
\]

\[
= (E(\theta) - E(v_b) - p_s - \frac{E(\theta)E(v_b)}{\theta} + \frac{[E(v_b)]^2}{\theta})(1 - Pr(r))
\]

As in the No Damages: Seller case, \( (1 - Pr(r)) = \frac{\bar{v}_b - v_b}{\bar{v}_b - v_b} = \frac{\bar{v}_b - p_s}{\bar{v}_b - v_b} \). This means that the above equation can be rewritten as,

\[
E(\pi_s) = \frac{(\bar{v}_b - p_s)E(\theta)}{(\bar{v}_b - v_b)} - \frac{(\bar{v}_b - p_s)E(v_b)}{(\bar{v}_b - v_b)} + \frac{p_s(\bar{v}_b - p_s)}{(\bar{v}_b - v_b)} - \frac{(\bar{v}_b - p_s)E(\theta)E(v_b)}{(\bar{v}_b - v_b)\theta} + \frac{(\bar{v}_b - p_s)[E(v_b)]^2}{(\bar{v}_b - v_b)\theta}
\]

\[
= \frac{\bar{v}_bE(\theta) - p_sE(\theta)}{(\bar{v}_b - v_b)} - \frac{\bar{v}_bE(v_b) - p_sE(v_b)}{(\bar{v}_b - v_b)} + \frac{p_s\bar{v}_b - p_s^2}{(\bar{v}_b - v_b)} - \frac{\bar{v}_bE(\theta)E(v_b) - p_sE(\theta)E(v_b)}{(\bar{v}_b - v_b)\theta}
\]

\[
+ \frac{\bar{v}_b[E(v_b)]^2 - p_s[E(v_b)]^2}{(\bar{v}_b - v_b)\theta}
\]

Taking the derivative with respect to \( p_s \), and setting it equal to zero yields,
\[
\frac{\delta E(\pi_s)}{\delta p_s} = \frac{-E(\theta)}{(\bar{v}_b - v_b)} + \frac{E(v_b)}{(\bar{v}_b - v_b)} + \frac{\bar{v}_b - 2p_s}{(\bar{v}_b - v_b)} + \frac{E(\theta)E(v_b)}{(\bar{v}_b - v_b)\bar{\theta}} - \frac{[E(v_b)]^2}{(\bar{v}_b - v_b)\bar{\theta}} = 0
\]

Multiplying by \((\bar{v}_b - v_b)\) gives us,

\[
E(v_b) - E(\theta) + \bar{v}_b - 2p_s + \frac{E(\theta)E(v_b)}{\bar{\theta}} - \frac{[E(v_b)]^2}{\bar{\theta}} = 0
\]

Which implies that,

\[
2p_s = E(v_b) - E(\theta) + \frac{E(\theta)E(v_b) - [E(v_b)]^2}{\bar{\theta}}
\]

\[
2p_s = E(v_b)(1 - \frac{E(\theta) - E(v_b)}{\bar{\theta}}) - E(\theta) + \bar{v}_b
\]

\[
p_s = \frac{E(v_b)}{2} \left(1 - \frac{E(\theta) - E(v_b)}{\bar{\theta}}\right) - \frac{E(\theta) + \bar{v}_b}{2}
\]

\[
p_s = \frac{1}{2} \left[E(v_b)(1 + \frac{E(\theta) - E(v_b)}{\bar{\theta}}) - E(\theta) + \bar{v}_b\right]
\]

Plugging in our parameter values: \(E(v_b) = 5.5\), \(E(\theta) = 5\), \(\bar{v}_b = \bar{\theta} = 10\) this becomes,

\[
p_s = \frac{1}{2} \left[5.5\left(\frac{5 - 5.5}{10}\right) - 5 + 10\right]
\]

\[
= \frac{1}{2} \left[5.5\left(-\frac{1}{20}\right) + 5\right] = 5.1125 \approx 5.1
\]

In order to determine if this value of \(p_s\) maximizes the seller’s expected profit, we need to plug our parameters into the original expected profit function, and then check it against the potential corner solutions.

\[
E(\pi_s) = [p_s Pr(\theta) + (E(\theta) - (E(v_b) - p_s))(1 - Pr(\theta))](1 - Pr(r))
\]

\[
= [p_s(\frac{E(v_b)}{\bar{\theta}}) + (E(\theta) - E(v_b) + p_s)(1 - \frac{E(v_b)}{\bar{\theta}})](\frac{\bar{v}_b - p_s}{\bar{v}_b - v_b})
\]
\[ E(\pi_s) = (5.1 - .225)(\frac{10 - 5.1}{9}) = 4.875(\frac{4.9}{9}) \approx 2.654 \]

At \( p_s = 1 \),
\[ E(\pi_s) = (1 - .225)(\frac{10 - 1}{9}) = .775 \]

And at \( p_s = 10 \),
\[ E(\pi_s) = (10 - .225)(\frac{10 - 10}{9}) = 9.775(0) = 0 \]

So the seller’s expected profit is maximized at \( p_s^* = \frac{1}{2}[E(v_b)(1 + \frac{E(\theta) - E(v_b)}{\theta}) - E(\theta) + v_b] \approx 5.1 \) under the expectation damages remedy.

### 9.3 Likelihood of Breach

#### 9.3.1 Buyer Offers

The probability of inefficient breach when the buyer makes the final offer can be expressed as:
\[ Pr(iBr_B) = Pr(v_b > \theta > E(v_b)) \]

If continue to assume that the seller uses a cutoff rule,
\[ Pr(iBr_B) = \frac{\int_{5.5}^{10} (10 - v_b)dv_b}{\int_{1}^{10} 10dv_b} - \frac{\int_{5.5}^{10} 10dv_b - \int_{5.5}^{10} v_bdv_b}{90} = \frac{10v_b|_{5.5}^{10} - \frac{v_b^2}{2}|_{5.5}^{10}}{90} \]
\[ = \frac{10(10 - 5.5) - \frac{1}{2}(10^2 - 5.5^2)}{90} = \frac{10.125}{90} = 0.1125 \]

And the probability of inefficient non-breach can be expressed as:

\[ Pr(iNBr_B) = Pr(E(v_b) > \theta > v_b) \]
\[ = \frac{\int_{1}^{10} (v_b - 1)dv_b}{\int_{1}^{10} 10dv_b} = \frac{\int_{1}^{5.5} v_bdv_b - \int_{5.5}^{10} v_bdv_b}{90} = \frac{\frac{v_b^2}{2}|_{1}^{5.5} - v_b|_{1}^{5.5}}{90} \]
\[ = \frac{\frac{1}{2}(5.5^2 - 1^2) - (5.5 - 1)}{90} = \frac{10.125}{90} = 0.1125 \]

From this we can say that the probability of an efficient outcome when the buyer makes the offer under the Expectation Damages remedy is:

\[ Pr(E_{out_B}) = 1 - [Pr(v_b > \theta > E(v_b)) + Pr(E(v_b) > \theta > v_b)] \]
\[ = 1 - (0.1125 + 0.1125) = 0.775 \]

### 9.3.2 Seller

The probability of inefficient breach when the seller makes the offer is:

\[ Pr(iBr_S) = Pr(v_b > \theta > E(v_b)_2) \]

Where \( E(v_b)_2 \) is the seller’s updated expectation of the buyer’s value given that they buyer accepted an offer of \( p_s \). This can be calculated as \( E(v_b)_2 = \frac{p_s + \bar{\theta}}{2} \). Since the model predicts that \( p_s = 5.1 \), and our parameters set \( \bar{\theta} = 10 \), this becomes
This means that,

\[
Pr(iBr_S) = \frac{\int_{7.505}^{10} (10 - v_b)dv_b}{\int_{10}^{10} 10dv_b} = \frac{\int_{7.505}^{10} 10dv_b - \int_{7.505}^{10} v_bdv_b}{90}
\]

\[
= \frac{10v_b|_{7.505}^{10} - \frac{v_b^2}{2}|_{7.505}^{10}}{90} = \frac{10(10 - 7.505) - \frac{1}{2}(7.505^2 - 1^2)}{90} = 0.0333
\]

And the probability of inefficient non-breach is;

\[
Pr(iNBr_S) = Pr(E(v_b)_2 > \theta > v_b)
\]

\[
= \frac{\int_{1}^{7.505} (v_b - 1)dv_b}{\int_{10}^{10} 10dv_b} = \frac{\int_{1}^{7.505} v_bdv_b - \int_{1}^{7.505} 1dv_b}{90} = \frac{\frac{v_b^2}{2}|_{1}^{7.505} - v_b|_{1}^{7.505}}{90}
\]

\[
= \frac{\frac{1}{2}(7.505^2 - 1^2) - (7.505 - 1)}{90} = 0.2351
\]

From this we can say that the probability of an efficient outcome when the seller makes the offer under the Expectation Damages remedy is:

\[
Pr(E_{out}S) = 1 - [Pr(v_b > \theta > E(v_b)_2) + Pr(E(v_b)_2 > \theta > v_b)]
\]

\[
= 1 - (0.0333 + 0.2351) = 0.7316
\]

9.3.3 Interpretation

While the buyer and seller are equally likely to make the original offer, the probabilities of acceptance are different. The buyer’s offer should always be accepted, since assuming that the seller receiving this offer is expected profit maximizing implies that they prefer a price of zero and a chance of receiving an outside offer greater than the buyer’s expected value to rejecting an receiving a guaranteed payoff of zero. However, because there is some probability that the buyer’s value is lower than the seller’s
predicted offer, there should be fewer excepted offers when the seller makes the offer, and as such there should be fewer breach opportunities. To deal with this we can set $Pr(B)$ as the probability that the buyer made the accepted offer, and $1 - Pr(b)$ as the probability that the seller made the accepted offer. Therefore,

$$Pr(iBr_{ED}) = Pr(B)Pr(iBr_{B1}) + (1 - Pr(B))Pr(iBr_S)$$

and,

$$Pr(E_{out_{ED}}) = Pr(B)Pr(E_{out_{B1}}) + (1 - Pr(B))Pr(E_{out_S})$$

We can determine the value $Pr(b)$ by first figuring out how often the seller’s predicted offer should be accepted. That is,

$$1 - Pr(r_S) = 1 - \frac{(p^* - v_b)}{(\bar{v}_b - v_b)}$$

$$= 1 - \frac{5.1 - 1}{10 - 1} = 1 - \frac{4.1}{9} = 0.5444$$

Since the buyer’s predicted offer should always be accepted, we can say that $1 - Pr(r_B) = 1$. Therefore $Pr(B)$ can be calculated as,

$$Pr(B) = \frac{1 - Pr(B)}{(1 - Pr(B)) * (1 - Pr(B))}$$

$$= \frac{1}{1 + 0.5444} = 0.6475$$

So the $Pr(iBr_{ED})$ equation becomes,

$$Pr(iBr_{ED}) = (0.6475)Pr(iBr_{B1}) + (1 - 0.6475)Pr(iBr_S)$$

$$= (0.6475)(0.1125) + (0.3525)(0.0333)$$
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\[ Pr(iBr_{ED}) = 0.0846 \]

and the \( Pr(E_{out_{ED}}) \) equation becomes,

\[ Pr(E_{out_{ED}}) = (0.6475)Pr(E_{out_B}) + (1 - 0.6475)Pr(E_{out_S}) \]

\[ = (0.6475)(0.775) + (0.3525)(0.7316) \]

\[ Pr(E_{out_{ED}}) = 0.7597 \]

10 Liquidated Damages

10.1 Buyer

To solve the buyer’s maximization problem under the liquidated damages remedy, we should first check for interior solutions. To do so, we first rearrange the buyer’s expected profit function, and then take its first derivative with respect to \( p_b \) and \( d \).

\[ E(\pi_{B1}) = [(v_b - p_b)Pr(\theta) + d(1 - Pr(\theta))] (1 - Pr(r)) \]

\[ = v_bPr(\theta) - p_bPr(\theta) - dPr(\theta) + d \]

\[ = \frac{v_b(d + p_b)}{\theta} - \frac{p_b(d + p_b)}{\theta} + \frac{d(d + p_b)}{\theta} \]

\[ = \frac{v_b d + v_b p_b}{\theta} - \frac{p_b d + p_b^2}{\theta} - \frac{d^2 + p_b d}{\theta} + d \]

Taking the first derivative with respect to \( p_b \) yields,

\[ \frac{\delta E(\pi_{B1})}{\delta p_b} = v_b - \frac{d + 2p_b}{\theta} - \frac{d}{\theta} = 0 \]
Which implies that,
\[ v_b - 2d - 2p_b = 0 \]
\[ p_b = \frac{v_b - 2d}{2} \]

Taking the first derivative with respect to \( d \) yields,
\[
\frac{\delta E(\pi_{B1})}{\delta d} = \frac{v_b}{\bar{\theta}} - \frac{p_b}{\bar{\theta}} + 1 - \frac{2d + p_b}{\bar{\theta}} = 0
\]
\[ v_b - 2p_b + \bar{\theta} - 2d = 0 \]
\[ d = \frac{v_b - 2p_b + \bar{\theta}}{2} \]

Which implies that,
\[ p_b = \frac{v_b - 2d + \bar{\theta}}{2} \]

Since no values of \( p_b \) and \( d \) can satisfy both equations given that \( \bar{\theta} \neq 0 \), the solution to the buyer’s maximization problem will either be found at a corner or somewhere on the boundary. Simplifying the buyer’s expected profit function and plugging in our parameter values,
\[
E(\pi_{B1}) = v_bPr(\theta) - p_bPr(\theta) + d - dPr(\theta)
\]
\[ = (v_b - p_b - d)Pr(\theta) + d \]
\[ = (v_b - p_b - d)(\frac{d + p_b}{\bar{\theta}}) + d \]

At the corner \( p_b = 0, d = 0; \)
\[
E(\pi_{B1}) = (v_b - 0 - 0)(\frac{0 + 0}{\bar{\theta}}) + 0 = 0
\]
At the corner \( p_b = 0, d = \bar{d} \);

\[
E(\pi_{B1}) = (v_b - 0 - \bar{d})(\frac{\bar{d} + 0}{\theta}) + \bar{d} = (v_b - \bar{d})(\frac{\bar{d}}{\theta}) + \bar{d}
\]

\[
= (v_b - 10)(\frac{10}{10}) + 10 = v_b - 10 + 10 = v_b
\]

At the corner \( p_b = \bar{p}_b, d = 0 \);

\[
E(\pi_{B1}) = (v_b - \bar{p}_b - 0)(\frac{0 + \bar{p}_b}{\theta}) + 0 = (v_b - \bar{p}_b)(\bar{p}_b)
\]

\[
= (v_b - 10)(\frac{10}{10}) = v_b - 10
\]

Given our parameter values, the corner \( p_b = \bar{p}_b, d = \bar{d} \) violates the restriction that \( p_b + d \leq \bar{d} \), so we do not need to check this corner.

At the boundary \( p_b = 0 \);

\[
E(\pi_{B1}) = (v_b - 0 - d)(\frac{d + 0}{\theta}) + d
\]

\[
= (v_b - d)(\frac{d}{\theta}) + d = \frac{v_b d - d^2}{\theta} + d
\]

Taking the derivative with respect to \( d \) yields,

\[
\frac{\delta E(\pi_{B1})}{\delta d} = \frac{v_b - 2d}{\theta} + 1 = 0
\]

\[
v_b - 2d + \bar{d} = 0
\]

\[
d = \frac{v_b + \bar{d}}{2}
\]

Plugging this back into the expected profit function,

\[
E(\pi_{B1}) = (v_b - \frac{v_b + \bar{d}}{2})(\frac{v_b + \bar{d}}{2\bar{d}}) + (\frac{v_b + \bar{d}}{2})
\]
\[= \left(\frac{v_b - \overline{\theta}}{2}\right)\left(\frac{v_b + \overline{\theta}}{2}\right) + \left(\frac{v_b + \overline{\theta}}{2}\right) = \frac{v_b^2 - \overline{\theta}^2}{4\overline{\theta}} + \frac{v_b + \overline{\theta}}{2}\]

\[= \frac{v_b^2 - 100}{40} + \frac{v_b + 10}{2} = \frac{v_b^2 - 100}{40} + \frac{20v_b + 200}{40}\]

\[= \frac{v_b^2 + 20v_b + 100}{40} = \left(\frac{v_b + 10}{40}\right)^2\]

At the boundary \(p_b = \overline{p}_b\):

\[E(\pi_{B1}) = (v_b - \overline{p}_b - d)\left(\frac{d + \overline{p}_b}{\overline{\theta}}\right) + d\]

\[= \frac{v_b(d + \overline{p}_b) - \overline{p}_b(d + \overline{p}_b) - d(d + \overline{p}_b)}{\overline{\theta}} + d\]

\[= \frac{v_b(d + v_b\overline{p}_b) - \overline{p}_bd + \overline{p}_b^2 - d^2 + \overline{p}_bd}{\overline{\theta}} + d\]

Taking the derivative with respect to \(d\) yields,

\[\frac{\delta E(\pi_{B1})}{\delta d} = \frac{v_b - 2\overline{p}_b - 2d}{\overline{\theta}} + 1 = 0\]

\[= v_b - 2\overline{p}_b - 2d + \overline{\theta} = 0\]

\[d = \frac{v_b + \overline{\theta} - 2\overline{p}_b}{2} = \frac{v_b + 10 - 20}{2} = \frac{v_b - 10}{2}\]

However this value is less than zero for all allowable cases except \(v_b = 10\), in which case \(d = 0\). Since the buyer is not allowed to set \(d < 0\), and the case where \(p_b = \overline{p}_b\) and \(d = 0\) is a corner that has already been examined, we do not need to check this boundary.

At the boundary \(d = 0\):

\[E(\pi_{B1}) = (v_b - p_b - 0)\left(\frac{0 + p_b}{\overline{\theta}}\right) + 0\]
\[ (v_b - p_b) p_b = \frac{v_b p_b - p_b^2}{\theta} \]

Taking the derivative of this function with respect to \( p_b \) yields,

\[ \frac{\delta E(\pi_{B1})}{\delta p_b} = \frac{v_b - 2p_b}{\theta} = 0 \]

\[ p_b = \frac{v_b}{2} \]

Plugging this back into the buyer’s expected profit function,

\[ E(\pi_{B1}) = (v_b - \frac{v_b}{2}) \left( \frac{v_b}{2} \right) = \left( \frac{2v_b - v_b}{2} \right) \left( \frac{v_b}{2\theta} \right) = \left( \frac{v_b}{2} \right) \left( \frac{v_b}{2\theta} \right) \]

\[ = \left( \frac{v_b}{2} \right) \left( \frac{v_b^2}{2\theta} \right) = \frac{v_b^2}{4\theta} = \frac{v_b^2}{40} \]

At the boundary \( d = \bar{d} \);

\[ E(\pi_{B1}) = (v_b - p_b - \bar{d}) \left( \frac{\bar{d} + p_b}{\theta} \right) + \bar{d} \]

\[ = \frac{v_b(\bar{d} + p_b)}{\theta} - \frac{p_b(\bar{d} + p_b)}{\theta} - \bar{d}(\bar{d} + p_b) + \bar{d} \]

\[ = \frac{v_b(\bar{d} + p_b) - p_b(\bar{d} + p_b) - \bar{d}(\bar{d} + p_b) + \bar{d}}{\theta} \]

\[ = \frac{v_b \bar{d} + v_b p_b - p_b \bar{d} - p_b^2 - \bar{d}^2 - p_b \bar{d} + \bar{d}}{\theta} \]

\[ = \frac{v_b \bar{d} + v_b p_b - 2p_b \bar{d} - p_b^2 - \bar{d}^2 + \bar{d}}{\theta} \]

Taking the derivative of this function with respect to \( p_b \) yields,

\[ \frac{\delta E(\pi_{B1})}{\delta p_b} = \frac{v_b - 2\bar{d} - 2p_b}{\theta} = 0 \]

\[ p_b = \frac{v_b - 2\bar{d}}{2} = \frac{v_b - 20}{2} = \frac{v_b}{2} - 10 \]
However this value is negative for all allowable $v_b$, and since the price cannot be negative, this solution will not work.

Clearly the expected profit to the buyer is maximized at the boundary point $p_b = 0, d = \frac{v_b + \theta}{2}$. This can be confirmed with a grid search with all possible values of $v_b$.

### 10.2 Seller

To solve the seller’s maximization problem under the liquidated damages remedy, we should first check for interior solutions.

\[
E(\pi_S) = [p_s Pr(\theta) + (E(\theta) - d)(1 - Pr(\theta))](1 - Pr(r))
\]

\[
E(\pi_S) = [p_s(\frac{p_s + d}{\theta}) + (E(\theta) - d)(1 - \frac{p_s + d}{\theta})](\frac{v_b - p_s}{v_b - v_b})
\]

\[
= (\frac{p_s^2 + p_sd}{\theta} + E(\theta) - d - \frac{p_sE(\theta) + dE(\theta)}{\theta} + \frac{p_s d + d^2}{\theta})(\frac{v_b - p_s}{v_b - v_b})
\]

\[
= (\frac{p_s^2 + 2p_sd - p_sE(\theta) - dE(\theta) + d^2}{\theta} + E(\theta) - d)(\frac{v_b - p_s}{v_b - v_b})
\]

\[
= \frac{p_s^2(v_b - p_s)}{\theta(v_b - v_b)} + \frac{2p_s d (v_b - p_s) - p_s E(\theta)(v_b - p_s)}{(v_b - v_b)} - \frac{E(\theta) d(v_b - p_s)}{(v_b - v_b)}
\]

\[
+ \frac{d^2(v_b - p_s)}{\theta(v_b - v_b)} + \frac{E(\theta)(v_b - p_s)}{(v_b - v_b)} - \frac{d(v_b - p_s)}{(v_b - v_b)}
\]

\[
= \frac{p_s^2 v_b - p_s^3 + 2p_s d v_b - 2p_s^2 d - p_s E(\theta) v_b + p_s^2 E(\theta) - d E(\theta) v_b + d E(\theta) p_s}{\theta(v_b - v_b)}
\]

\[
+ \frac{d^2 v_b - d^2 p_s}{\theta(v_b - v_b)} + \frac{E(\theta) v_b - E(\theta) p_s}{(v_b - v_b)} + \frac{d p_s - d v_b}{(v_b - v_b)}
\]

Taking the first derivative of the seller’s expected profit function with respect to
\[ \frac{\delta E(\pi_s)}{\delta p_s} = \frac{2p_s\bar{v}_b - 3p_s^2 + 2d\bar{v}_b - 4p_s d - E(\theta)\bar{v}_b + 2p_s E(\theta)}{\bar{\theta}(\bar{v}_b - v_b)} \]

\[ + \frac{dE(\theta) - d^2}{\bar{\theta}(\bar{v}_b - v_b)} + \frac{d - E(\theta)}{(\bar{v}_b - v_b)} = 0 \]

\[ 2p_s\bar{v}_b - 3p_s^2 + 2d\bar{v}_b - 4p_s d - E(\theta)\bar{v}_b + 2p_s E(\theta) \]

\[ + dE(\theta) - d^2 - \bar{\theta}E(\theta) + \bar{\theta}d = 0 \]

\[ -3p_s^2 + p_s(2\bar{v}_b - 4d + 2E(\theta)) \]

\[ + (2d\bar{v}_b - E(\theta)\bar{v}_b + dE(\theta) - d^2 - \bar{\theta}E(\theta) + \bar{\theta}d) = 0 \]

Using the quadratic formula, we find that

\[ p_s = \frac{-(2\bar{v}_b - 4d + 2E(\theta))}{2(-3)} \]

\[ \pm \sqrt{(2\bar{v}_b - 4d + 2E(\theta))^2 - 4(-3)(2d\bar{v}_b - E(\theta)\bar{v}_b + dE(\theta) - d^2 - \bar{\theta}E(\theta) + \bar{\theta}d)} \]

\[ p_s = \frac{(2\bar{v}_b - 4d + 2E(\theta))}{6} \]

\[ \pm \sqrt{(2\bar{v}_b - 4d + 2E(\theta))^2 + 12(2d\bar{v}_b - E(\theta)\bar{v}_b + dE(\theta) - d^2 - \bar{\theta}E(\theta) + \bar{\theta}d)} \]

Plugging in our parameter values, this becomes

\[ p_s = \frac{(2(10) - 4d + 2(5))}{6} \]

\[ \pm \sqrt{(2(10) - 4d + 2(5))^2 + 12[2(10)d - (5)(10) + 5d - d^2 - (10)(5) + 10d]} \]
\[
p_s = \frac{(20 - 4d + 10)}{6}
\]

\[
\pm \frac{\sqrt{(20 - 4d + 10)^2 + 12(20d - 50 + 5d - d^2 - 50 + 10d)}}{6}
\]

\[
p_s = \frac{(30 - 4d) \pm \sqrt{(30 - 4d)^2 + 12(35d - d^2 - 100)}}{6}
\]

\[
p_s = \frac{(30 - 4d) \pm \sqrt{16d^2 - 240d + 900 + 420d - 12d^2 - 1200}}{6}
\]

\[
p_s = \frac{2(15 - 2d) \pm \sqrt{4(d^2 + 45d - 75)}}{6}
\]

\[
p_s = \frac{15 - 2d \pm \sqrt{d^2 + 45d - 75}}{6}
\]

The first derivative of the seller’s expected profit function with respect to \(d\) yields,

\[
\frac{\delta E(\pi_S)}{\delta d} = \frac{2p_s \overline{v}_b - 2p_s^2 - \overline{v}_b E(\theta) + p_s E(\theta) + 2d \overline{v}_b - 2dp_s}{\overline{\theta}(\overline{v}_b - \overline{v}_b)}
\]

\[
\quad + \frac{p_s - \overline{v}_b}{(\overline{v}_b - \overline{v}_b)} = 0
\]

Which can be rearranged to get,

\[
2p_s \overline{v}_b - 2p_s^2 - \overline{v}_b E(\theta) + p_s E(\theta) + 2d \overline{v}_b - 2dp_s + p_s \overline{\theta} - \overline{v}_b \overline{\theta} = 0
\]

\[
2(\overline{v}_b - p_s)d = 2p_s^2 - 2p_s \overline{v}_b - p_s \overline{\theta} - p_s E(\theta) + \overline{v}_b E(\theta) + \overline{v}_b \overline{\theta}
\]

\[
d = \frac{2p_s^2 - 2p_s \overline{v}_b - p_s \overline{\theta} - p_s E(\theta) + \overline{v}_b E(\theta) + \overline{v}_b \overline{\theta}}{2(\overline{v}_b - p_s)}
\]

\[
d = \frac{2p_s^2 - 20p_s - 10p_s - 5p_s + 50 + 100}{2(10 - p_s)}
\]
\[ d = \frac{2p_s^2 - 35p_s + 150}{20 - 2p_s} = \frac{(p_s - 30)(p_s - 5)}{20 - 2p_s} \]

There is no solution that satisfies both equations such that both choice variables are within the allowable range, so this solution does not maximize the seller’s expected profit.

At the corner \( p_s = 1, \ d = 0 \):

\[ E(\pi_S) = [1(\frac{1 + 0}{10}) + (5 - 0)(1 - \frac{1 + 0}{10})](10 - \frac{1}{10 - 1}) \]

\[ = (\frac{1}{10} + 5 - \frac{5}{10}) = 4.6 \]

The corner \( p_s = 1, \ d = \overline{d} \) does not need to be examined because \( 1 + \overline{d} = 1 + 10 = 11 > \overline{\theta} = 10 \).

At the corner \( p_s = \overline{p}_s, \ d = 0 \):

\[ E(\pi_S) = [\overline{p}_s(\frac{\overline{p}_s + 0}{\overline{\theta}}) + (E(\theta) - 0)(1 - \frac{\overline{p}_s + 0}{\overline{\theta}})](1 - \frac{\overline{p}_s - \overline{v}_b}{\overline{v}_b - \overline{v}_b}) \]

\[ = [\overline{p}_s(\frac{\overline{p}_s}{\overline{\theta}}) + E(\theta)(1 - \frac{\overline{p}_s}{\overline{\theta}})](1 - \frac{\overline{p}_s - \overline{v}_b}{\overline{v}_b - \overline{v}_b}) = 0 \]

\[ = [\overline{p}_s(\frac{\overline{p}_s}{10}) + 5(1 - \frac{\overline{p}_s}{10})](1 - \frac{\overline{p}_s - 1}{10 - 1}) = 0 \]

\[ = [10(\frac{10}{10}) + 5(1 - \frac{10}{10})](1 - \frac{10 - 1}{10 - 1}) \]

\[ = 0 \]

The corner \( p_s = \overline{p}_s, \ d = \overline{d} \) does not need to be examined because \( \overline{p}_s + \overline{d} = 10 + 10 = 20 > \overline{\theta} = 10 \).

At the boundary \( p_s = 1 \),

\[ E(\pi_S) = [1(\frac{1 + d}{\overline{\theta}}) + (E(\theta) - d)(1 - \frac{1 + d}{\overline{\theta}})](1 - \frac{1 - \overline{v}_b}{\overline{v}_b - \overline{v}_b}) \]
\[\left[\left(\frac{1 + d}{\theta} \right) + (E(\theta) - d)(1 - \frac{1 + d}{\theta})\right](1 - \frac{1 - \nu_b}{\nu_b - \nu_b}) \]

\[\left[\left(\frac{1 + d}{\theta} \right) + (E(\theta) - d)(1 - \frac{1 + d}{\theta})\right]\left(\frac{\nu_b - 1}{\nu_b - \nu_b}\right) \]

Since \(\nu_b = 1\), this is equivalent to,

\[\left(\frac{1 + d}{\theta} \right) + (E(\theta) - d)(1 - \frac{1 + d}{\theta}) \]

\[= \frac{1 + d}{\theta} + E(\theta) - d - \frac{E(\theta)(1 + d)}{\theta} + \frac{d(1 + d)}{\theta} \]

\[= \frac{1 + d}{\theta} + E(\theta) - d - \frac{E(\theta) + E(\theta)d}{\theta} + \frac{d + d^2}{\theta} \]

Taking the derivative of this function with respect to \(d\) yields,

\[\frac{\delta E(\pi_S)}{\delta d} = \frac{1}{\theta} - \bar{\theta} - \frac{E(\theta)}{\theta} + \frac{1 + 2d}{\theta} = 0 \]

Which can be rewritten as,

\[1 - \bar{\theta} - E(\theta) + 1 + 2d = 0 \]

\[2d - \bar{\theta} - E(\theta) + 2 = 0 \]

\[d = \frac{\bar{\theta} + E(\theta) - 2}{2} \]

Plugging this value back into the expected profit function gives us,

\[E(\pi_S) = \left(\frac{1 + d}{\theta}\right) + (E(\theta) - d)(1 - \frac{1 + d}{\theta}) \]

\[= \left(\frac{1 + \bar{\theta} + E(\theta) - 2}{\theta^2}\right) + (E(\theta) - \frac{\bar{\theta} + E(\theta) - 2}{2})(1 - \frac{1 + \bar{\theta} + E(\theta) - 2}{\theta^2}) \]

\[= \frac{2 + \bar{\theta} + E(\theta) - 2}{2\theta} + \left(\frac{2E(\theta)}{2} - \frac{\bar{\theta} + E(\theta) - 2}{2}\right)(1 - \frac{2 + \bar{\theta} + E(\theta) - 2}{2\theta}) \]
\[
\begin{align*}
\frac{\bar{\theta} + E(\theta)}{2\bar{\theta}} + \frac{(2E(\theta) - \bar{\theta} + E(\theta) - 2)(2\bar{\theta} - \bar{\theta} + E(\theta))}{2} \\
= \frac{\bar{\theta} + E(\theta)}{2\bar{\theta}} + \frac{(2E(\theta) - \bar{\theta} - E(\theta) + 2)(2\bar{\theta} - \bar{\theta} - E(\theta))}{2} \\
= \frac{\bar{\theta} + E(\theta)}{2\bar{\theta}} + \frac{(E(\theta) - \bar{\theta} + 2)(\bar{\theta} - E(\theta))}{2}
\end{align*}
\]

So plugging in the parameter values yields,
\[
\begin{align*}
\frac{10 + 5}{2(10)} + \frac{(5 - 10 + 2)(10 - 5)}{2(10)} \\
= \frac{15}{20} + \frac{-3}{2} \left( \frac{5}{20} \right) \\
= \frac{30}{40} - \frac{15}{40} = \frac{15}{40} = \frac{3}{8}
\end{align*}
\]

At the boundary \( p_s = \bar{p}_s \);
\[
E(\pi_S) = [p_s(\frac{p_s + d}{\bar{\theta}}) + (E(\theta) - d)(1 - \frac{p_s + d}{\bar{\theta}})](\frac{\bar{\nu}_b - p_s}{\bar{\nu}_b - \bar{\nu}_b})
\]

Since \( \bar{p}_s = 10 = \bar{\nu}_b \), this becomes,
\[
E(\pi_S) = [p_s(\frac{p_s + 0}{\bar{\theta}}) + (E(\theta) - 0)(1 - \frac{p_s + 0}{\bar{\theta}})](\frac{0}{\bar{\nu}_b - \bar{\nu}_b})
\]

meaning that, at this boundary, \( E(\pi_S) = 0 \).

At the boundary \( d = 0 \);
\[
E(\pi_S) = [p_s(\frac{p_s + 0}{\bar{\theta}}) + (E(\theta) - 0)(1 - \frac{p_s + 0}{\bar{\theta}})](\frac{\bar{\nu}_b - p_s}{\bar{\nu}_b - \bar{\nu}_b})
\]

\[
= [p_s(\frac{p_s}{\bar{\theta}}) + (E(\theta))(1 - \frac{p_s}{\bar{\theta}})](\frac{\bar{\nu}_b - p_s}{\bar{\nu}_b - \bar{\nu}_b})
\]

\[
= (\frac{p_s^2}{\bar{\theta}} + E(\theta)p_s)(\frac{\bar{\nu}_b - p_s}{\bar{\nu}_b - \bar{\nu}_b})
\]
\[
\frac{p_s^2(v_b - p_s)}{\theta(v_b - v_b)} + \frac{E(\theta)(v_b - p_s)}{(v_b - v_b)} - \frac{E(\theta)p_s(v_b - p_s)}{\theta(v_b - v_b)} = \frac{p_s^2v_b - p_s^3}{\theta(v_b - v_b)} + \frac{E(\theta)v_b - E(\theta)p_s}{(v_b - v_b)} - \frac{E(\theta)p_s v_b - E(\theta)p_s^2}{\theta(v_b - v_b)}
\]

Taking the derivative of this function with respect to \(w_s\) gives us,

\[
\frac{\delta E(\pi_s)}{\delta p_s} = \frac{2p_s v_b - 3p_s^2}{\theta(v_b - v_b)} - \frac{E(\theta)}{(v_b - v_b)} - \frac{E(\theta)v_b - 2E(\theta)p_s}{\theta(v_b - v_b)} = 0
\]

Which can be rewritten as,

\[
2p_s v_b - 3p_s^2 - \theta E(\theta) - E(\theta)v_b + 2E(\theta)p_s = 0
\]

\[
-3p_s^2 + 2p_s v_b + 2E(\theta)p_s - \theta E(\theta) - E(\theta)v_b = 0
\]

\[
-3p_s^2 + p_s(2v_b + 2E(\theta)) - E(\theta)(\theta + v_b) = 0
\]

Using the quadratic formula, we find that

\[
p_s = \frac{-2(v_b + E(\theta)) \pm \sqrt{(2v_b + 2E(\theta))^2 - 4(-3)(-E(\theta)(\theta + v_b))}}{2(-3)}
\]

\[
p_s = \frac{-2(v_b + E(\theta)) \pm \sqrt{(2v_b + 2E(\theta))^2 - 12E(\theta)(\theta + v_b)}}{-6}
\]

Plugging in our parameters, this becomes;

\[
p_s = \frac{-2(10 + 5) \pm \sqrt{(2(10) + 2(5))^2 - 12(5)(10 + 10)}}{-6}
\]

\[
p_s = \frac{-30 \pm \sqrt{(30)^2 - 1200}}{-6} = \frac{-30 \pm \sqrt{900 - 1200}}{-6}
\]

Both solutions result in an imaginary value of \(p_s\), and since price must be a real number neither of these solutions maximize expected profit to the seller.
At the boundary $d = \bar{d}$;

\[
E(\pi_S) = E(\pi_S) = [p_s\left(\frac{p_s + \bar{d}}{\bar{\theta}}\right) + (E(\theta) - \bar{d})(1 - \frac{p_s + \bar{d}}{\bar{\theta}})]\left(\frac{\bar{v}_b - p_s}{\bar{v}_b - v_b}\right)
\]

\[
= \left(\frac{p_s^2}{\bar{\theta}} + p_s\bar{d} + E(\theta) - \bar{d} - \frac{E(\theta)p_s + E(\theta)\bar{d}}{\bar{\theta}} + \frac{\bar{d}p_s + \bar{d}^2}{\bar{\theta}}\right)\left(\frac{\bar{v}_b - p_s}{\bar{v}_b - v_b}\right)
\]

\[
= \frac{p_s^2(\bar{v}_b - p_s)}{\bar{\theta}(\bar{v}_b - v_b)} + \frac{p_s\bar{d}(\bar{v}_b - p_s)}{(\bar{v}_b - v_b)} + \frac{E(\theta)(\bar{v}_b - p_s) + \bar{d}(\bar{v}_b - p_s)}{(\bar{v}_b - v_b)}
\]

\[
- \frac{E(\theta)p_s(\bar{v}_b - p_s)}{\bar{\theta}(\bar{v}_b - v_b)} + \frac{E(\theta)\bar{d}(\bar{v}_b - p_s)}{(\bar{v}_b - v_b)} + \frac{\bar{d}p_s(\bar{v}_b - p_s) + \bar{d}^2(\bar{v}_b - p_s)}{(\bar{v}_b - v_b)}
\]

\[
= \frac{p_s^2\bar{v}_b - p_s^3 + p_s\bar{d}\bar{v}_b - p_s^2\bar{d}}{\bar{\theta}(\bar{v}_b - v_b)} + \frac{E(\theta)\bar{v}_b - E(\theta)p_s - \bar{d}\bar{v}_b - \bar{d}p_s}{(\bar{v}_b - v_b)}
\]

\[
- \frac{E(\theta)p_s\bar{v}_b - E(\theta)p_s^2 + E(\theta)\bar{d}\bar{v}_b - E(\theta)\bar{d}p_s}{\bar{\theta}(\bar{v}_b - v_b)}
\]

\[
+ \frac{\bar{d}p_s\bar{v}_b - \bar{d}p_s^2 + \bar{d}^2\bar{v}_b - \bar{d}^2p_s}{\bar{\theta}(\bar{v}_b - v_b)}
\]

Taking the first derivative with respect to $p_s$ yields,

\[
\frac{\delta E(\pi_S)}{\delta p_s} = 2p_s\bar{v}_b - 3p_s^2 + \bar{d}\bar{v}_b - 2p_s\bar{d} - \frac{E(\theta) + \bar{d}}{(\bar{v}_b - v_b)}
\]

\[
- \frac{E(\theta)\bar{v}_b - 2E(\theta)p_s - E(\theta)\bar{d}}{\bar{\theta}(\bar{v}_b - v_b)} + \frac{\bar{d} - 2\bar{d}p_s - \bar{d}^2}{\bar{\theta}(\bar{v}_b - v_b)} = 0
\]

\[
= 2p_s\bar{v}_b - 3p_s^2 + \bar{d}\bar{v}_b - 2p_s\bar{d} - \bar{\theta}E(\theta) - \bar{\theta}\bar{d}
\]

\[
- E(\theta)\bar{v}_b + 2E(\theta)p_s + E(\theta)\bar{d} + \bar{d} - 2\bar{d}p_s - \bar{d}^2 = 0
\]
Plug in parameter values in order to simplify,

\[ = 2(10)p_s - 3p_s^2 + (10)(10) - 2(10)p_s - (10)(5) - (10)(10) \]

\[ - (5)(10) + 2(10)p_s + (5)(10) + 10 - 2(10)p_s - 10^2 = 0 \]

\[ = 20p_s - 3p_s^2 + 100 - 20p_s - 50 - 100 - 50 + 20p_s \]

\[ + 50 + 10 - 20p_s - 100 = 0 \]

\[ = -3p_s^2 - 140 = 0 \]

So,

\[ 3p_s^2 = -140 \]

\[ p_s = i\sqrt{\frac{140}{3}} \]

Which is not a possible price given our parameters because this value is imaginary.

Through this examination it is clear that the seller’s expected profit is maximized at the corner \( p_s = 1, d = 0 \), which can be confirmed using a grid search with all of the potential values of \( v_b \).

### 10.3 Likelihood of Breach

#### 10.3.1 Buyer

The probability of inefficient breach when the buyer makes the final offer can be expressed as:

\[ Pr(iBr_B) = Pr(v_b > \theta > \frac{v_b + \bar{\theta}}{2}) \]
Because $v_b = \bar{\theta}$ we can that $v_b \neq \frac{v_b + \bar{\theta}}{2}$ occurs with a probability of zero. Therefore, $Pr(iBr_B) = 0$.

The probability of inefficient non-breach when the buyer makes the offer under the liquidated damages remedy is,

$$Pr(iNBr_B) = Pr\left(\frac{v_b + \bar{\theta}}{2} > \theta > v_b\right)$$

$$= Pr\left(\frac{v_b + 10}{2} > \theta > v_b\right)$$

$$= \int_1^{10} \frac{(v_b + 10 - v_b)}{10} dv_b = \frac{\int_1^{10} v_b + 10 - 2v_b dv_b}{90}$$

$$= \frac{\int_1^{10} 10 - v_b dv_b}{90} = \frac{\frac{1}{2} \int_1^{10} (10 - v_b) dv_b}{90}$$

$$= \frac{\frac{1}{2} \left[10x\right]_1^{10} - \frac{x^2}{2}\left[10\right]}{90} = \frac{(100 - 10) - (50 - 0.5)}{180}$$

$$= \frac{20.25}{90} = 0.225$$

So the probability of an efficient outcome when the buyer makes the offer under this condition can be expressed as,

$$Pr(Eout_B) = 1 - [Pr(v_b > \theta > \frac{v_b + \bar{\theta}}{2}) + Pr(\frac{v_b + \bar{\theta}}{2} > \theta > v_b)]$$

$$= 1 - (0 + 0.225) = 0.775$$

### 10.3.2 Seller

The probability of inefficient breach when the seller makes the final offer can be expressed as:

$$Pr(iBr_S) = Pr(v_b > \theta > 1)$$
\[ \frac{\int_1^{10} (v_b - 1)dv_b}{\int_1^{10} 10dv_b} = \frac{\int_1^{10} v_bdv_b - \int_1^{10} dv_b}{90} = \frac{\frac{v_b^2}{2}|_{1}^{10} - v_b|_{1}^{10}}{90} \]

\[ = \frac{\frac{1}{2}(100 - 1) - (10 - 1)}{90} = \frac{40.5}{90} = 0.45 \]

And the probability of inefficient non-breach is;

\[ Pr(iNBr_S) = Pr(1 > \theta > v_b) \]

But, because \( v_b \geq 1 \), the probability of inefficient non-breach is zero because \( 1 > v_b \) cannot hold.

Therefore the probability of an efficient outcome when the seller makes the of under the Liquidated Damages remedy can be expressed as;

\[ Pr(E_{OutS}) = 1 - [Pr(v_b > \theta > 1) + Pr(1 > \theta > v_b)] \]

\[ = 1 - (0.45 + 0) = 0.55 \]

### 10.3.3 Interpretation

Considering the fact that the buyer and seller are equally likely to make the offer, and that both offers should always be accepted, the overall probability of an inefficient breach is,

\[ Pr(iBr_{LD}) = \frac{Pr(iBr_B) + Pr(iBr_S)}{2} \]

\[ = \frac{0.225 + 0.45}{2} = \frac{0.675}{2} = 0.3375 \]

and the overall probability of an efficient outcome is,

\[ Pr(E_{Out_{LD}}) = \frac{Pr(E_{Out_B}) + Pr(E_{Out_S})}{2} \]
$= \frac{0.775 + 0.55}{2} = \frac{1.325}{2} = 0.6625$

11 Supplemental Materials

Included below are the subject instructions for all three of the experiment’s treatments, a copy of the consent form used for this experiment, the receipt form used, and sample screenshots from the experiment.
Welcome to an experiment on decision making. We thank you for your participation!

The experiment will be conducted on the computer. All decisions and answers will remain confidential and anonymous. Please do not talk to each other or attempt to look at each other’s computer screens during the experiment. Please turn off your cell phones now, and put them away for the duration of the experiment.

During the experiment, you and the other participants will be asked to make a series of decisions. Your payment will be determined by your decisions as well as the decisions of the individual you are paired with according to the following rules. If you have any questions about the experiment, please raise your hand and one of us will come to you and answer it privately.

You will be paid the dollar amount that you earn in the experiment plus a participation payment of $5.

Rounds and Roles:

The experiment will take place over ten rounds. Following the conclusion of the final round, six random numbers will be drawn by the computer to determine which six rounds will be paid. For example, if the random numbers are 1, 2, 4, 5, 7, 9 then you will be paid for rounds 1, 2, 4, 5, 7 and 9. Because all rounds are equally likely to be used to determine your payment, you should make decisions in each round as if it were the round to be paid. At the beginning of the experiment, you will be randomly assigned to the role of Player B or Player S. Your assigned role will appear on your computer screen. This role will remain fixed for the duration of the experiment.

At the start of every round you will be randomly paired with someone in the opposite role. For instance, if you are a Player B you will be paired with a Player S, and vice versa. You will never be told the identities of those you are paired with, and they will never be told your identity.

Parts:

Each round consists of two parts that will be played sequentially (Part 1 is followed by Part 2). Your payoffs may be determined by Part 1 or Part 2. We will first describe Part 1.

Part 1:

In Part 1, either you or your counterpart will be chosen at random to make an offer. Both of you are equally likely to be chosen to make the offer. If you are chosen to make the offer, you must decide how much Player S receives. The proposed offer must be between $0 and $10 in $0.10 increments. Your counterpart will observe this offer and will decide to either accept or reject the offer. If an offer is rejected, both you and your counterpart receive $0 for this round (if it is randomly chosen for payment) and the round ends without advancing to Part 2. If an offer is accepted, you may receive positive, negative or zero payment for this round (if it is randomly chosen for payment).

If you are in the role of Player S, your payoff in Part 1 is equal to the offer if it is accepted. If you are in the role of Player B, your payoff in Part 1 is equal to a random number minus the proposed offer if it is accepted. The random number is determined at the start of the round and is between $1 and $10 in $0.10 increments. This random number is only known to Player B and Player B observes this random number when they make their decision.

For example, if Player B were randomly chosen to make the offer and proposed Player S receive $8 and Player S accepts this offer, Player S would receive $8. The payoff to Player B is determined by this offer and the random number. If the random number is, for instance, $4, Player B would lose $4 ($4-$8 = -$4). If, on the other hand, the proposed offer accepted by Player S was $3, Player S would receive $3 and
Player B would receive $1 ($4 - $3 = $1). The payoff works in the same manner if Player S were randomly chosen to make the offer.

**Part 2:**

In Part 2, Player S will be presented with an alternative offer between $0 and $10 (in $0.10 increments) that is randomly drawn by the computer. All outcomes between $0 and $10 are equally likely. If Player S decides to reject the alternative offer, then both players’ payoffs are determined as explained in Part 1. If Player S decides to accept the alternative offer, then the offer from Part 1 will be canceled and will not be used to determine either player’s payoff. Instead, payoffs will be determined using the alternative offer. Player S will receive the alternative offer, while Player B will receive $0.

For example, if Player S accepted an alternative offer of $1, then Player S would receive $1, and Player B would receive $0. On the other hand, if Player S accepted an alternative offer of $6, then Player S would receive $6, and Player B would receive $0.

If Player S does not accept the alternative offer, the agreed upon offer from Part 1 is used as previously described.

At the end of the round, you will be shown the results of the round on your computer screen.

If you turn to your computer now, we will go through an example of how the computer interface works.

**Summary:**

At the beginning of the experiment, the computer will randomly assign you to the role of Player B or Player S. Each round will begin with you being randomly paired with a person of the opposite role (if you are a Player B you will be paired with a Player S and vice versa). In Part 1, either you or your counterpart will make an offer for how much money Player S will receive. If you make the offer, your counterpart will then decide whether to accept or reject the offer. If they choose to reject the offer, then the round will end, and both of you will receive a payoff of $0 for that round. If they choose to accept the offer, then you will proceed to Part 2. In Part 2, Player S must decide whether to accept or reject an alternative offer. If Player S rejects the alternative offer, then they will receive the amount agreed to in Part 1, and Player B will receive the random number minus the amount Player S receives. If Player S accepts the alternative offer in Part 2, then they will receive the alternative offer, and Player B will receive no payment. You will play 10 rounds where you will be randomly rematched with a potentially different counterpart each round. The computer will select 6 of these rounds at random, and you will be paid based off of your results in those rounds.

Are there any questions?
Welcome to an experiment on decision making. We thank you for your participation!

The experiment will be conducted on the computer. All decisions and answers will remain confidential and anonymous. Please do not talk to each other or attempt to look at each other’s computer screens during the experiment. Please turn off your cell phones now, and put them away for the duration of the experiment.

During the experiment, you and the other participants will be asked to make a series of decisions. Your payment will be determined by your decisions as well as the decisions of the individual you are paired with according to the following rules. If you have any questions about the experiment, please raise your hand and one of us will come to you and answer it privately.

You will be paid the dollar amount that you earn in the experiment plus a participation payment of $5.

Rounds and Roles:

The experiment will take place over ten rounds. Following the conclusion of the final round, six random numbers will be drawn by the computer to determine which six rounds will be paid. For example, if the random numbers are 1, 2, 4, 5, 7, 9 then you will be paid for rounds 1, 2, 4, 5, 7 and 9. Because all rounds are equally likely to be used to determine your payment, you should make decisions in each round as if it were the round to be paid. At the beginning of the experiment, you will be randomly assigned to the role of Player B or Player S. Your assigned role will appear on your computer screen. This role will remain fixed for the duration of the experiment.

At the start of every round you will be randomly paired with someone in the opposite role. For instance, if you are a Player B you will be paired with a Player S, and vice versa. You will never be told the identities of those you are paired with, and they will never be told your identity.

Parts:

Each round consists of two parts that will be played sequentially (Part 1 is followed by Part 2). Your payoffs may be determined by Part 1 or Part 2. We will first describe Part 1.

Part 1:

In Part 1, either you or your counterpart will be chosen at random to make an offer. Both of you are equally likely to be chosen to make the offer. If you are chosen to make the offer, you must decide how much Player S receives. The proposed offer must be between $0 and $10 in $0.10 increments. Your counterpart will observe this offer and will decide to either accept or reject the offer. If an offer is rejected, both you and your counterpart receive $0 for this round (if it is randomly chosen for payment) and the round ends without advancing to Part 2. If an offer is accepted, you may receive positive, negative or zero payment for this round (if it is randomly chosen for payment).

If you are in the role of Player S, your payoff in Part 1 is equal to the offer if it is accepted. If you are in the role of Player B, your payoff in Part 1 is equal to a random number minus the proposed offer if it is accepted. The random number is determined at the start of the round and is between $1 and $10 in $0.10 increments. This random number is only known to Player B and Player B observes this random number when they make their decision.

For example, if Player B were randomly chosen to make the offer and proposed Player S receive $8 and Player S accepts this offer, Player S would receive $8. The payoff to Player B is determined by this offer and the random number. If the random number is, for instance, $4, Player B would lose $4 ($4-$8 = -$4). If, on the other hand, the proposed offer accepted by Player S was $3, Player S would receive $3 and
Player B would receive $1 ($4-$3 = $1). The payoff works in the same manner if Player S were randomly chosen to make the offer.

Part 2:
In Part 2, Player S will be presented with an alternative offer between $0 and $10 (in $0.10 increments) that is randomly drawn by the computer. All outcomes between $0 and $10 are equally likely. If Player S decides to reject the alternative offer, then both players’ payoffs are determined as explained in Part 1. If Player S decides to accept the alternative offer, then the offer from Part 1 will be canceled. Instead, Player S will receive the amount of the offer minus a transfer payment to Player B. The amount of the transfer payment to Player B is equal to the random number minus the offer from Part 1. Notice that this payment to Player B is what they would have received had Part 1 been used for payment. Because Player S does not know the random number, the total profit received by Player S for accepting an outside offer will not be known when Player S makes their accept/reject decision on the outside offer. The profit for Player S will only be known after all decisions are made in the round.

For example, suppose Player B observed a random number of $6 (not observed by Player S) and agreed to the Player S’s offer that Player S will receive $1. If Player S accepts an alternative offer of $7 in Part 2, then Player B would receive $5 ($6-$1=$5), and Player S would receive $1 ($7-$6=$1). On the other hand, if Player B and Player S had agreed to an offer of $5, and Player S accepted an alternative offer of $7, then Player B would receive $1 ($6-$5=$1), and Player S would receive $6 ($7-$1=$6).

If Player S does not accept the alternative offer, the agreed upon offer from Part 1 is used as previously described.

At the end of the round, you will be shown the results of the round on your computer screen.

If you turn to your computer now, we will go through an example of how the computer interface works.

Summary:
At the beginning of the experiment, the computer will randomly assign you to the role of Player B or Player S. Each round will begin with you being randomly paired with a person of the opposite role (if you are a Player B you will be paired with a Player S and vice versa). In Part 1, either you or your counterpart will make an offer for how much money Player S will receive. If you make the offer, your counterpart will then decide whether to accept or reject the offer. If they choose to reject the offer, then the round will end, and both of you will receive a payoff of $0. If they choose to accept the offer, then you will proceed to Part 2. In Part 2, Player S must decide whether to accept or reject an alternative offer. If Player S rejects the alternative offer, then they will receive the amount offered in Part 1, and Player B will receive the random number minus the amount Player S receives. If Player S accepts the alternative offer in Part 2, then Player B will receive the same payment as they would have if Player S rejected the alternative offer, and Player S will receive the alternative offer minus the payment to Player B. You will play 10 rounds where you will be randomly rematched with a potentially different counterpart each round. The computer will select 6 of these rounds at random, and you will be paid based off of your results in those rounds.

Are there any questions?
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At the start of every round you will be randomly paired with someone in the opposite role. For instance, if you are a Player B you will be paired with a Player S, and vice versa. You will never be told the identities of those you are paired with, and they will never be told your identity.

Parts:

Each round consists of two parts that will be played sequentially (Part 1 is followed by Part 2). Your payoffs may be determined by Part 1 or Part 2. We will first describe Part 1.

Part 1:

In Part 1, either you or your counterpart will be chosen at random to make an offer. Both of you are equally likely to be chosen to make the offer. If you are chosen to make the offer, you must decide how much Player S receives. The proposed offer must be between $0 and $10 in $0.10 increments.

In addition to the proposed amount Player S receives, you will also be asked to decide on an amount Player S will pay Player B should Player S choose to accept an alternative offer in Part 2 (more on this in a moment). This means that the payment is not used to calculate your profit for Part 1. If you are randomly chosen to make the offer, you will propose this payment at the same time. Your counterpart will observe this offer and will decide to either accept or reject the offer. If an offer is rejected, both you and your counterpart receive $0 for this round (if it is randomly chosen for payment) and the round ends without advancing to Part 2. If an offer is accepted, you may receive positive, negative or zero payment for this round (if it is randomly chosen for payment).

If you are in the role of Player S, your payoff in Part 1 is equal to the offer if it is accepted. If you are in the role of Player B, your payoff in Part 1 is equal to a random number minus the proposed offer if it is accepted. The random number is determined at the start of the round and is between $1 and $10 in in $0.10 increments. This random number is only known to Player B and Player B observes this random number when they make their decision.
For example, if Player B were randomly chosen to make the offer and proposed Player S receive $8 and Player S accepts this offer, Player S would receive $8. The payoff to Player B is determined by this offer and the random number. If the random number is, for instance, $4, Player B would lose $4 ($4-$8 = -$4). If, on the other hand, the proposed offer accepted by Player S was $3, Player S would receive $3 and Player B would receive $1 ($4-$3 = $1). The payoff works in the same manner if Player S were randomly chosen to make the offer.

Part 2:

In Part 2, Player S will be presented with an alternative offer between $0 and $10 (in $0.10 increments) that is randomly drawn by the computer. All outcomes between $0 and $10 are equally likely. If Player S decides to reject the alternative offer, then both players’ payoffs are determined as explained in Part 1. If Player S decides to accept the alternative offer, then the offer from Part 1 will be canceled and will not be used to determine either player’s payoff. Instead, payoffs will be determined using the alternative offer and the payment to Player B agreed to in Part 1. Player S will receive the alternative offer minus the payment to Player B, while Player B will receive the payment from Player S.

For example, if Player B and Player S agreed that Player S would pay Player B $6 if Player S accepted the alternative offer in Part 2, and Player S accepted an alternative offer of $7, then Player S would receive $1 ($7-$6 = $1), and Player B would receive $6. On the other hand, if Player B and Player S agreed that Player S would pay the Player B $1, then Player S would receive $6 ($7-$1 = $6), and Player B would receive $1.

If Player S does not accept the alternative offer, the agreed upon offer from Part 1 is used as previously described.

At the end of the round, you will be shown the results of the round on your computer screen.

If you turn to your computer now, we will go through an example of how the computer interface works.

Summary:

At the beginning of the experiment, the computer will randomly assign you to the role of Player B or Player S. Each round will begin with you being randomly paired with a person of the opposite role (if you are a Player B you will be paired with a Player S and vice versa). In Part 1, either you or your counterpart will make an offer for how much money Player S will receive, as well as an amount that Player S will pay to Player B, should Player S decide to accept the alternative offer in Part 2. If you make the offer, your counterpart will then decide whether to accept or reject the offer. If they choose to reject the offer, then the round will end, and both of you will receive a payoff of $0. If they choose to accept the offer, then you will proceed to Part 2. In Part 2, Player S must decide whether to accept or reject an alternative offer. If Player S rejects the alternative offer, then they will receive the amount offered in Part 1, and Player B will receive the random number minus the amount Player S receives. If Player S accepts the alternative offer in Part 2, then they will receive the alternative offer minus the amount they agreed to pay Player B, and Player B will receive that payment. You will play 10 rounds where you will be randomly rematched with a potentially different counterpart each round. The computer will select 6 of these rounds at random, and you will be paid based off of your results in those rounds.

Are there any questions?
Ohio University Adult Consent Form with Signature

Title of Research: Economics Experiment

Researchers: This research is being done by Matt McGill, undergraduate economics student at Ohio University, and his faculty advisor, Glenn Dutcher, PhD, economics professor at Ohio University.

You are being asked to participate in research. For you to be able to decide whether you want to participate in this project, you should understand what the project is about, as well as the possible risks and benefits in order to make an informed decision. This process is known as informed consent. This form describes the purpose, procedures, possible benefits, and risks. It also explains how your personal information will be used and protected. Once you have read this form and your questions about the study are answered, you will be asked to sign it. This will allow your participation in this study. You should receive a copy of this document to take with you.

Explanation of Study
You are being invited to participate voluntarily in this research experiment to study the economics of decision-making. This experiment will last up to 2 hours. You will be assigned to a computer terminal by chance, “like the flip of a coin” or “random arrival.” You will be playing a series of computerized games with other experimental participants. You should not participate in this study if you are under the age of 18.

Risks and Discomforts
The risks associated with participating in this study are similar to the risks of everyday life. There are no known health risks or health benefits for this experiment beyond those from any other typical activity in an Ohio University classroom or computer lab. We do not employ deception. If we make a representation to you about the experiment, to the best of our knowledge it is true.

Benefits
This study seeks to understand how human actors behave in economic environments of interest to advance science and society. Through your participation, you will gain an understanding of how economic experiments are conducted and you are encouraged to contact me with any questions about the final write-up of the results.

Confidentiality and Records
The confidentiality of any personal information will be protected to the extent allowed by law. On a separate receipt, you will be required to fill in your earnings, your name, address, student ID, date and signature. This information will be shared with the agency providing funds for the study but they will not be made aware of the nature of the experiment, or of any other information collected during the experiment. To the extent allowed by the university, our rule is that only the researcher(s), research assistants conducting this experiment and the granting agency may know what your earnings are (subject to tax reporting requirements below), and only researchers affiliated with the project may have access to the data with your name. Your name will not be reported with any results related to this research, other than your earnings being reported to the granting agency. To provide protection, you will be assigned a subject number and this identifier will be used instead of your name in the data. Demographic information such as your age, and gender will be collected and linked to your subject number.

Additionally, while every effort will be made to keep your study-related information confidential, there may be circumstances where this information must be shared with
* Federal agencies, for example the Office of Human Research Protections, whose responsibility is to protect human subjects in research;
* Representatives of Ohio University (OU), including the Institutional Review Board, a committee that oversees the research at OU;

**Compensation**

In addition to the $5 for showing up on time and participating, you will have the opportunity to earn additional compensation, which will be based upon your decisions, the decisions of others who are in the experiment, and the rules within which those decisions are made. You are free to ask any questions about the rules as to how compensation will be determined. Any compensation you receive as a result of your participation in this experiment may be reported for taxation purposes to appropriate federal and state agencies, but the results of the study will remain confidential and will not be forwarded to tax authorities. You are free to withdraw from the experiment without additional compensation and without incurring the ill will of the experimenters at any time. If you do so, you may keep the $5 show-up fee.

**Contact Information**

If you have any questions regarding this study, please contact the primary investigator Matt McGill at mm109512@ohio.edu or his faculty advisor Glenn Dutcher at dutcher@ohio.edu or 740-597-1261.

If you have any questions regarding your rights as a research participant, please contact Dr. Chris Hayhow, Director of Research Compliance, Ohio University, (740)593-0664 or hayhow@ohio.edu.

By signing below, you are agreeing that:

- you have read this consent form (or it has been read to you) and have been given the opportunity to ask questions and have them answered;
- you have been informed of potential risks and they have been explained to your satisfaction;
- you understand Ohio University has no funds set aside for any injuries you might receive as a result of participating in this study;
- you are 18 years of age or older;
- your participation in this research is completely voluntary;
- you may leave the study at any time; if you decide to stop participating in the study, there will be no penalty to you and you will not lose any benefits to which you are otherwise entitled.

Signature________________________________________________________ Date________________

Printed Name__________________________________________________ Version Date: 02/07/17
Receipt for Participating in Economics Experiment

Name: ___________________________        Address: _______________________________

Student #: ___________________________

I received $___________ from Professor Glenn Dutcher as payment in full for participation in an experiment in the economics of decision making.

Signature  ___________________________

Date  ________________

Receipt for Participating in Economics Experiment

Name: ___________________________        Address: _______________________________

Student #: ___________________________

I received $___________ from Professor Glenn Dutcher as payment in full for participation in an experiment in the economics of decision making.

Signature  ___________________________

Date  ________________
Seller screen if they make the first offer
Buyer screen if they make the first offer.
Seller screen if they make the accept/reject decision.
Buyer screen if they make the accept/reject decision
Profit screen