Pre-Analysis Plan for Insurance Sophistication and the Threat of Attack

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1 Introduction

Key infrastructure institutions worldwide are increasingly targeted in ransomware attacks, particularly those in the healthcare, financial services, higher education, telecommunication, and energy sectors. Ransomware is a form of malware that infects computers using security flaws in order to gather, encrypt, or erase original data files before the attacker demands a ransom from the victim. Ransomware attacks could cause temporary or permanent loss of sensitive or proprietary information, disruption to regular operations, financial losses to restore systems and files, and damage to an organization's reputation. There, however, has been little systematic theoretical, experimental, and behavioral research on ransomware. Policymakers disagree on the most effective approach to mitigating the impact of ransomware attacks. While many companies use cybersecurity insurance as a risk management tool, it is not clear whether cybersecurity insurance encourages attacks, whether it should be outlawed, and whether paying ransoms should be made illegal. Those who advocate for insurance bans or for making ransom payments illegal argue that such actions will reduce the profitability of ransomware attacks and deter new players from entering the ransomware market.

The focus of this experiment will be the effect that the structure of the insurance market has on the outcomes of ransomware attacks. In a simple model, we can show that ransomware insurance affects the distribution of attackers' ransom requests and the likelihood that the data is returned. In the experiment, we will empirically evaluate the effects of two types of insurance: "naive" (insurance that is predicted to lead to lower overall efficiency) and "sophisticated" (insurance that is predicted to lead to higher overall efficiency).

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2 Experimental Design

Our laboratory experiment is a mixed between and within design. The "within" randomization includes whether insurance is available in a particular round, the subject's role, and the victims' initial budgets (discussed below). The "between" treatment (naive vs. sophisticated) is completed at the session level and changes the form of the insurance that is available to subjects.

At the beginning of each round, subjects are randomly assigned to groups of three. Each subject is randomized into a role, with one subject acting as the "attacker" and the other two subjects acting as "targets". The subjects then participate in a game with three stages. In the first stage, targets are informed of their initial budget, which is randomly drawn and equally likely to take all integer values between \$1 and \$24. If insurance is available in the round and their budget is sufficient, targets can choose to purchase it at this point. In the second stage of the round, the attacker makes a ransom request to one randomly selected target. The interface for this decision can be seen in figure 1.[1] The attacker is aware of whether insurance was available in the round, but is not aware of the target's budget or whether they purchased insurance. In the third stage, the targets' final budgets are updated depending on whether they bought insurance (and the type of that insurance) as well as whether they were randomly selected to receive the ransom request. If the selected target's final budget is higher than the request, then they can choose whether or not to pay the ransom. If their final budget is lower than the request, the request is automatically rejected. After each round, subjects are informed of their payoffs and how they were calculated.

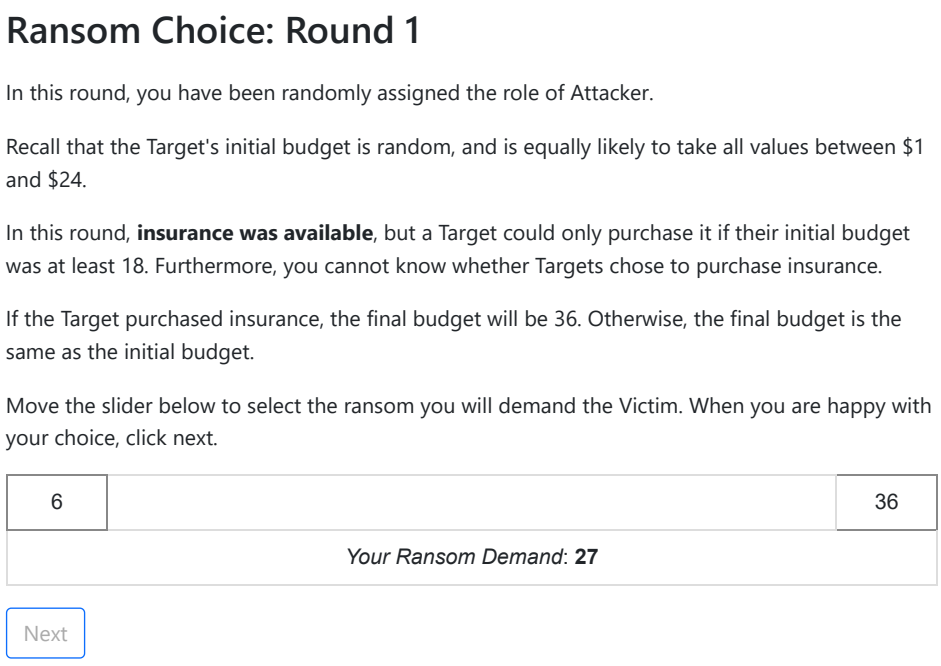

Figure 1: Attacker ransom decision in the naive insurance treatment

[1] Screenshots of the experiment can be found in Appendix A.

Payoffs are as follows. The target that was not chosen to receive a ransom request receives their initial budget minus any amount spent on insurance plus a bonus of \$36. The target that received the ransom request receives her final budget. If she accepts the ransom request, she pays that amount but receives a bonus of \$36. The attacker receives their ransom request if it was accepted and otherwise receives \$6. Additionally, all subjects receive a baseline payment of \$25.

Regardless of the treatment, insurance is available to 50% of the groups within a session in each round. The price of insurance depends on the subject's initial budget and the form of insurance available. If a target purchases insurance and is chosen to receive the ransom request, their final budget is \$36 if the insurance is naive and \$18 if it is sophisticated. If they did not purchase insurance, their final budget is equal to their initial budget. Given budget w, the price of naive insurance is $36 - w$ (so only targets with $w \geq 18$ can purchase it) while the price of sophisticated insurance is $18 - w$ (so only targets with $9 \leq w < 18$ can purchase it). Payments will be made based on one randomly selected round.

Each subject will participate in 25 rounds. After completing all rounds of the experiment, subjects complete a short demographic survey and a cognitive reflection test as payments are prepared.

2.1 Data Collected

In addition to choice data from the games, we collect the decision time for each choice. We also collect standard demographic data including gender, age, college major, etc. We supplement these data with a short cognitive reflection test.

3 Empirical Analysis

3.1 Ransom Requests and Surplus

The primary focus of the study is the effect of different insurance regimes on three outcomes: 1) ransom requests, 2) total surplus, and 3) target surplus. Ransom requests are simply the ransom requests that attackers made. Notice that while budgets affect surplus within a given round, they are randomly determined in a way that is independent of any treatment effect, so they are not included in the surplus variables. Furthermore, insurance coverage is on average a net zero transfer between targets, so it will not be included in target surplus. Thus, the total surplus is 30 if the ransom request is accepted and zero otherwise. Target surplus is 36 minus the ransom request if the request is accepted and zero otherwise. Based on pilot data, we expect that decision-making will be noisy as subjects gain experience in the first few rounds. Thus, in our main analyses, we will focus only on rounds 6 to 25. The full data set will be analyzed as a robustness check.

In evaluating the average treatment effects of the different types of insurance on ransom requests, our primary specification will be the following random effects regression:

$$r_{it} = \beta_0 + \beta_1 \text{Soph}_i + \beta_2 \text{Ins}_{it} + \beta_3 \text{Ins}_{it} \times \text{Soph}_i + \alpha_i + \gamma_t + \varepsilon_{it}. \tag{1}$$

The index i refers to the subject acting as the attacker in a given round t. Soph_i and Ins_{it} are indicators that capture whether, respectively, the group was in the sophisticated treatment and whether the victims had access to insurance in round t. α_i and γ_t are attacker and round fixed effects. Standard errors will be clustered at the attacker level. The main coefficients of interest will be β_2 and β_3, which give the effects of different types of insurance on ransom requests. Standard errors will be clustered at the attacker level.

To evaluate treatment effects of different types of insurance on total and target surplus, our primary specification will be the following random effects regression:

$$S_{it} = \beta_0 + \beta_1 \text{Soph}_i + \beta_2 \text{Ins}_{it} + \beta_3 \text{Ins}_{it} \times \text{Soph}_i + \sum_{w=1}^{24} \delta_w \mathbf{1}\{w_{it} = w\} + \alpha_i + \gamma_t + \varepsilon_{it}. \quad (2)$$

The dependent variable S_{it} will refer to either the total surplus of the group in round t or the payoffs of the target matched with attacker i in round t. The variable w_{it} refers to the initial budget of this target. Otherwise, all variables in Equation 2 are the same as those in Equation 1. Again, the main coefficients of interest will be β_2 and β_3, which give the effects of different types of insurance on ransom requests. Standard errors will be clustered at the attacker level.

3.2 Power Analysis

We ran a pilot of the naive insurance treatment with 12 subjects in May 2023.[2] We estimate Equations 1 and 2 using the pilot data. We compute power under the assumption that the true coefficients are equal to their theoretical counterparts, and focus on the coefficients that are expected to be the smallest (we predict that $\beta_2 + \beta_3 = 3$ in Equation 1, $\beta_2 = -3.75$ in the total surplus version of Equation 2, and $\beta_2 + \beta_3 = 3.25$ in the victim surplus version of Equation 2). For a sample size of N, we expect that the standard error will be equal to the corresponding estimated standard error multiplied by $\sqrt{\frac{12}{N}}$. We plot the calculated power in Figure 2.

Based on this analysis, we expect that a sample size of 70 for each treatment would be sufficient to have at least 80% chance of rejecting the null hypotheses that the effects of different insurance regimes are zero. However, we will take a conservative approach and expect to recruit a sample of 80-90 for each treatment, leading to a total sample of 160-180.

[2]We do not have pilot data using the sophisticated treatment so β_1 and β_3 are not identified. Below, we implicitly assume that the standard error of the estimated effect of sophisticated insurance will be roughly equal to that of naive insurance. Due to the limited data, we also omit the round fixed effects from this estimation procedure.

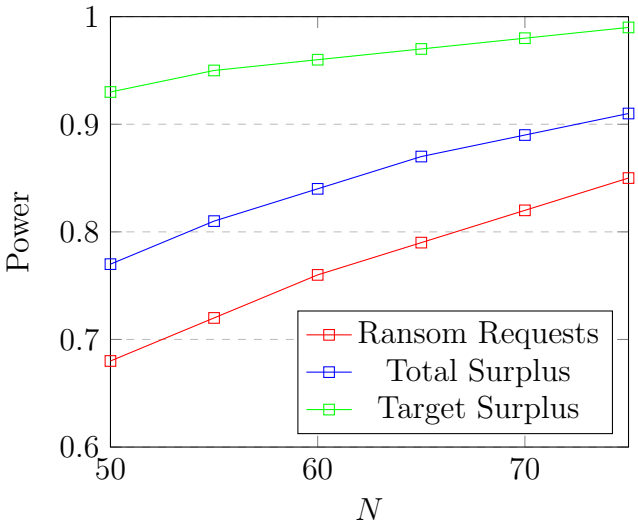

Figure 2: Computed power based on pilot results.

A Screen-shots/Instructions

Below, we include screenshots of the Naive treatment of the experiment. The sophisticated treatment included only minor differences in the explanations and displays.

Introduction

PLEASE READ CAREFULLY AND DO NOT PRESS NEXT UNTIL INSTRUCTED TO DO SO.

Thank you for participating in this study. This study is about decision-making. It should take about 2 hours, and you will be paid based on your earnings from the experiment. The money you earn will be paid either in cash at the end of the study or electronically within a few days of the end of the study.

Please do not use any electronic devices or talk with other participants during this study.

There will be no deception in this study. Every decision you make will be carried out exactly as it is described in the instructions. Anything else would violate the human ethics protocol under which we run the study (UQ Human Research Ethics Approval 2023/HE000101).

In the study you will make decisions that will affect the amount of money you earn. The study will consist of games that you will play with other randomly selected players. The players that you are paired with in a round are selected independently of whom you play with in any other match.

Please pay close attention to the instructions on the next page and the examples on the page after that. After you read the examples, there will be a short quiz on the instructions. You will receive $0.5 (i.e., 50 cents) for each question you answer correctly.

If you have questions at any point, please raise your hand and we will answer your questions privately.

Next

Figure 3: Introduction

Instructions

PLEASE READ CAREFULLY AND DO NOT PRESS NEXT UNTIL INSTRUCTED TO DO SO.

In this study, you will play 25 rounds of a game with monetary payoffs. In each round, there will be two other players; they will be selected independently of who you play with in any other round.

Before playing the game, you will be asked to answer a quiz with multiple choice questions about your understanding of the game. Each correct answer in the quiz is worth 50 cents. Your payment for participating in this study will be based on the outcomes of the game. At the end of the study, a round of play will be chosen randomly, and your payoffs from that round will be the ones that determine your payment. In addition to the payoff from the randomly chosen round and the payoff from the quiz, you will receive a baseline payment of $25.

In each round, each player will be assigned a role, which determines the player's available choices and payoffs. One player will be the ransomware "Attacker" and the other two players will be the potential "Targets" of a ransomware attack. Each Target owns valuable data that might be stolen by the Attacker. One of the two Targets becomes the Victim of a successful attack and the other does not. The Attacker may give the stolen data back to the Victim after payment of a ransom. Without insurance, the Victim may or may not have a sufficient budget to cover the ransom requested by the Attacker. Before knowing if they are attacked, Targets may be able to purchase insurance that will supplement their available budget in case of an attack.

In each round, each Target may have the opportunity to buy insurance, while the Attacker will choose what ransom (price) to demand to return the data. In each round, each Target has an initial budget that they control. The initial budget may take any value between $1 and $24; each value is equally likely. The budget can be used to purchase insurance and to pay the ransom.

Each round has two stages:

Target Stage 1: Insurance Choice With a roughly 50-50 chance, insurance will be available to the Targets. If their initial budget is at least $18, Targets can buy full insurance. If they buy insurance and they are attacked, then their final budget is $36. If they buy insurance and they are not attacked, then their final budget is twice their initial budget minus $36. If they don't buy insurance, then their final budget is the same as their initial budget, regardless of whether they are attacked.

Attacker Stage 1: Ransom Choice The Attacker chooses a ransom to return the stolen data. The ransom must be between $6 and $36. Before choosing the ransom, the Attacker is told whether full insurance is available to the Targets. The Attacker does not know the Targets' budgets or whether they purchased insurance.

Figure 4: Instructions

Targets Stage 2: Purchase Choice One of the two Targets becomes the Victim of a successful attack, and the other does not. If the final budget of the Victim of an attack is at least as high as the ransom demanded by the Attacker, then the Victim chooses whether to pay the ransom to have the data returned. Otherwise, the Victim cannot pay the ransom. The Target who has not been attacked has no choice to make.

Target Payoffs: Targets receive their final budget, minus the ransom if they pay it. They also receive a value for the use of the data of $36 if either they are not the Victim (their data is not stolen), or if they paid the ransom and the data was returned to them.

Attacker Payoffs: If the Victim pays the ransom, then the Attacker receives the ransom. Otherwise, the Attacker receives the value of owning the stolen data, which is $6.

Below is a demonstration of the payoffs achievable by the players in a game. By moving the two sliders below you can select different levels of the Target's initial budget and the ransom chosen by the Attacker. The table below the sliders gives the players' payoffs. The first row gives the Attacker's payoff, the second row gives the Victim's payoff and the third row gives the payoff of the Target that was not attacked. The columns specify the Target's choices of whether to buy the insurance and to pay the ransom. For example, the cell in the second row and the third column contains the Victim's payoff if the Victim bought insurance, but did not pay the ransom. Note that a cell's payoff could be "Not Possible". This occurs if the initial budget and the ransom are incompatible with the players' choices associated with the cell.

1		24
Example Budget: **21**		
6		36
Example Ransom Demand: **17**		

	Did not buy insurance, did not pay the ransom	**Did not buy insurance, paid the ransom**	**Bought insurance, did not pay the ransom**	**Bought insurance, paid the ransom**
Attacker	$6	$17	$6	$17
Victim	$21	$40	$36	$55
Target, not attacked	$57	Not Possible	$42	Not Possible

The next page contains a few examples to help you understand the game better. Read through the examples at your own pace, then continue to complete the quiz.

Figure 5: Instructions

Examples

Example 1: Allan is assigned the role of the Attacker; Betty and Carol are assigned the roles of Targets. Betty draws an initial budget of $10, and Carol draws an initial budget of $20.

In stage 1, Full insurance is available. Betty cannot buy insurance as her budget is below $18. Carol chooses to buy insurance. Allan knows that insurance is available and demands a ransom of $26 to return the stolen data.

In stage 2, Betty is not attacked. Carol is the Victim of an attack. Carol decides to pay the ransom.

The payoffs are as follows: Betty's final budget is $10 because she could not buy insurance. Since she was not attacked, her payoff is $10 + $36. Carol's final budget is $36 because she bought insurance and she was the Victim of an attack. Since she pays the ransom, her payoff is $36 - $26 + $36. Allan's received the ransom payment and thus his payoff is $26.

Example 2: Danielle is assigned the role of the Attacker. Ephraim and Francisco are assigned the role of Targets. Ephraim draws an initial budget of $16, and Francisco draws an initial budget of $12.

In stage 1, Ephraim and Francisco find out that there is no option to buy insurance in this match. Their final budgets are the same as their initial budgets and there is no insurance choice for them to make. Danielle knows that insurance is not available and chooses a ransom demand of $14 to return the stolen data.

In stage 2, Ephraim is not attacked. Francisco is the Victim of an attack. Francisco cannot pay the ransom and have the stolen data returned because the ransom demand chosen by Danielle is higher than his budget.

The payoffs are as follows: Because he was the Victim of an attack but he could not pay the ransom, Francisco receives only his budget of $12. Because he was not attacked, Ephraim receives his budget plus the value of the data $16 + $36. Because Danielle's ransom demand was (automatically) rejected, she receives the value of owning the stolen data, which is $6.

Quiz: When you are ready, you may click next and begin the quiz.

Next

Figure 6: Examples

Quiz

Please answer the following questions. You will earn 50 cents for each question you answer correctly.

Suppose: (i) Insurance is NOT available; (ii) The Attacker demands a ransom of $26 to return the stolen data; (iii) The Victim has an initial budget of $18. What are the payoffs of the Attacker and of the Victim?

- ○ The Attacker's payoff is $26; The Victim's payoff is $10.
- ○ The Attacker's payoff is $6; The Victim's payoff is $18.
- ○ The Attacker's payoff is $26; The Victim's payoff is $18.
- ◉ Cannot tell. It depends on whether the Victim pays the ransom.

Suppose: (i) Insurance is NOT available; (ii) The Attacker demands a ransom of $16 to return the stolen data; (iii) The Victim has an initial budget of $18; (iv) The Victim pays the ransom. What are the payoffs of the Attacker and the Victim?

- ○ The Attacker's payoff is $6; The Victim's payoff is $18.
- ○ The Attacker's payoff is $16; The Victim's payoff is $38.
- ○ The Attacker's payoff is $16; The Victim's payoff is $2.
- ◉ The Attacker's payoff is $6; The Victim's payoff is $20.

Suppose: (i) Insurance is available; (ii) The Attacker demands a ransom of $30 to return the stolen data; (iii) The Victim bought insurance. How do the payoffs of the Attacker depend on whether the Victim pays the ransom?

- ○ If the Victim pays the ransom, the Attacker's payoff is $6; If the Victim doesn't pay the ransom, the Attacker's payoff is $30.
- ○ If the Victim pays the ransom, the Attacker's payoff is $6; If the Victim doesn't pay the ransom, the Attacker's payoff is $20.
- ○ If the Victim pays the ransom, the Attacker's payoff is $20; If the Victim doesn't pay the ransom, the Attacker's payoff is $6.
- ◉ If the Victim pays the ransom, the Attacker's payoff is $30; If the Victim doesn't pay the ransom, the Attacker's payoff is $6.

Suppose: (i) Insurance is available; (ii) The Attacker demands a ransom of $32 to return the stolen data; (iii) The Victim bought insurance. How does the payoff of the Victim depend on whether or not the Victim pays the ransom?

- ○ If the Victim pays the ransom, the Victim receives $4; If the Victim doesn't pay the ransom, the Victim receives $0.

Figure 7: Quiz

- ○ If the Victim pays the ransom, the Victim receives $6; If the Victim doesn't pay the ransom, the Victim receives $6.
- ○ If the Victim pays the ransom, the Victim receives $40; If the Victim doesn't pay the ransom, the Victim receives $36.
- ◉ Cannot tell. It depends on the Victim's initial budget.

Suppose: (i) Insurance is NOT available; (ii) The Attacker demands a ransom of $16 to return the stolen data. What is the chance that the Victim has a final budget that is at least as high as the demanded ransom?

- ○ The chance that the final budget is at least as high as the ransom is 2 out of 24.
- ○ The chance that the final budget is at least as high as the ransom is 6 out of 24.
- ○ The chance that the final budget is at least as high as the ransom is 9 out of 24.
- ◉ The chance that the final budget is at least as high as the ransom is 14 out of 24.

Suppose: (i) Insurance is available; (ii) The Attacker has demanded a ransom of $30; (iii) The Victim buys insurance whenever they can. What is the chance that the Victim has a final budget that is at least as high as the demanded ransom?

- ○ The chance that the final budget is at least as high as the ransom is 0 out of 24.
- ○ The chance that the final budget is at least as high as the ransom is 3 out of 24.
- ○ The chance that the final budget is at least as high as the ransom is 5 out of 24.
- ◉ The chance that the final budget is at least as high as the ransom is 7 out of 24.

Next

Figure 8: Quiz

Quiz Answers

The answers for the quiz are given below. Please review the answers and note any mistakes you have made.

Question 1: Suppose: (i) Insurance is NOT available; (ii) The Attacker demands a ransom of $26 to return the stolen data; (iii) The Victim has an initial budget of $18. What are the payoffs of the Attacker and of the Victim?
Correct Answer: The Attacker's payoff is $6; The Victim's payoff is $18.
Your Answer: Cannot tell. It depends on whether the Victim pays the ransom.

Question 2: Suppose: (i) Insurance is NOT available; (ii) The Attacker demands a ransom of $16 to return the stolen data; (iii) The Victim has an initial budget of $18; (iv) The Victim pays the ransom. What are the payoffs of the Attacker and the Victim?
Correct Answer: The Attacker's payoff is $16; The Victim's payoff is $38.
Your Answer: The Attacker's payoff is $6; The Victim's payoff is $20.

Question 3: Suppose: (i) Insurance is available; (ii) The Attacker demands a ransom of $30 to return the stolen data; (iii) The Victim bought insurance. How do the payoffs of the Attacker depend on whether the Victim pays the ransom?
Correct Answer: If the Victim pays the ransom, the Attacker's payoff is $30; If the Victim doesn't pay the ransom, the Attacker's payoff is $6.
Your Answer: If the Victim pays the ransom, the Attacker's payoff is $30; If the Victim doesn't pay the ransom, the Attacker's payoff is $6.

Question 4: Suppose: (i) Insurance is available; (ii) The Attacker demands a ransom of $32 to return the stolen data; (iii) The Victim bought insurance. How does the payoff of the Victim depend on whether or not the Victim pays the ransom?
Correct Answer: If the Victim pays the ransom, the Victim receives $40; If the Victim doesn't pay the ransom, the Victim receives $36.
Your Answer: Cannot tell. It depends on the Victim's initial budget.

Question 5: Suppose: (i) Insurance is NOT available; (ii) The Attacker demands a ransom of $16 to return the stolen data. What is the chance that the Victim has a final budget that is at least as high as the demanded ransom?
Correct Answer: The chance that the final budget is at least as high as the ransom is 9 out of 24.
Your Answer: The chance that the final budget is at least as high as the ransom is 14 out of 24.

Question 6: Suppose: (i) Insurance is available; (ii) The Attacker has demanded a ransom of $30; (iii) The Victim buys insurance whenever they can. What is the chance that the Victim has a final budget that is at least as high as the demanded ransom?

Figure 9: Quiz Answers

Correct Answer: The chance that the final budget is at least as high as the ransom is 7 out of 24.
Your Answer: The chance that the final budget is at least as high as the ransom is 7 out of 24.

You earned $1.0 from your correct answers. Please review any questions you answered incorrectly. When you are ready to begin the first round, click the next button.

Next

Figure 10: Quiz Answers

Insurance Choice: Round 1

In this round, you have been randomly assigned the role of Target. Your budget is $21.

Insurance is available this round for a price of $15. If you choose to purchase, your budget will be $36 if you are the victim of an attack and $6 if you are not the victim of an attack.

Do you want to buy insurance?

- (•) Yes
- ( ) No

Next

Below, you will find an interactive feature to help you make decisions. Targets have access to this feature when they are purchasing insurance, and Attackers have access when they are choosing the ransom to demand. Move both of the sliders to activate the feature to see what the payoffs to each player are of various choices. Remember that Attackers will not know the budget or insurance decision when choosing their ransom demand.

1		24
Example Budget: **8**		
6		36
Example Ransom Demand: **20**		

	Did not buy insurance, did not pay the ransom	**Did not buy insurance, paid the ransom**	**Bought insurance, did not pay the ransom**	**Bought insurance, paid the ransom**
Attacker	$6	Not Possible	Not Possible	Not Possible
Victim	$8	Not Possible	Not Possible	Not Possible
Target, not attacked	$44	Not Possible	Not Possible	Not Possible

Figure 11: Insurance Choice (sufficient budget)

Insurance Choice: Round 5

In this round, you have been randomly assigned the role of Target. Your budget is $16.

Insurance is available this round, but its price is $20 so your budget is not large enough to purchase it. Please click next.

Next

Below, you will find an interactive feature to help you make decisions. Targets have access to this feature when they are purchasing insurance, and Attackers have access when they are choosing the ransom to demand. Move both of the sliders to activate the feature to see what the payoffs to each player are of various choices. Remember that Attackers will not know the budget or insurance decision when choosing their ransom demand.

1		24
Example Budget: **16**		
6		36
Example Ransom Demand: **10**		

	Did not buy insurance, did not pay the ransom	**Did not buy insurance, paid the ransom**	**Bought insurance, did not pay the ransom**	**Bought insurance, paid the ransom**
Attacker	$6	$10	Not Possible	Not Possible
Victim	$16	$42	Not Possible	Not Possible
Target, not attacked	$52	Not Possible	Not Possible	Not Possible

Figure 12: Insurance Choice (insufficient budget)

Insurance Choice: Round 2

In this round, you have been randomly assigned the role of Target. Your budget is $19.

Insurance is not available in this round. Please click next.

Next

Below, you will find an interactive feature to help you make decisions. Targets have access to this feature when they are purchasing insurance, and Attackers have access when they are choosing the ransom to demand. Move both of the sliders to activate the feature to see what the payoffs to each player are of various choices. Remember that Attackers will not know the budget or insurance decision when choosing their ransom demand.

1		24
6		36

MOVE BOTH SLIDERS TWICE TO ACTIVATE PAYOFF TABLE

	Did not buy insurance, did not pay the ransom	**Did not buy insurance, paid the ransom**	**Bought insurance, did not pay the ransom**	**Bought insurance, paid the ransom**
Attacker				
Victim				
Target, not attacked				

Figure 13: Insurance Choice (no insurance available)

Ransom Choice: Round 1

In this round, you have been randomly assigned the role of Attacker.

Recall that the Target's initial budget is random, and is equally likely to take all values between $1 and $24.

In this round, **insurance was available**, but a Target could only purchase it if their initial budget was at least 18. Furthermore, you cannot know whether Targets chose to purchase insurance.

If the Target purchased insurance, the final budget will be 36. Otherwise, the final budget is the same as the initial budget.

Move the slider below to select the ransom you will demand the Victim. When you are happy with your choice, click next.

6		36
	Your Ransom Demand: **27**	

Next

Below, you will find an interactive feature to help you make decisions. Targets have access to this feature when they are purchasing insurance, and Attackers have access when they are choosing their ransom. Move both of the sliders to activate the feature to see what the payoffs to each player are of various choices. Remember that Attackers will not know the budget or insurance decision when choosing their ransom demand.

1		24
	Example Budget: **24**	
6		36
	Example Ransom Demand: **36**	

	Did not buy insurance, did not pay the ransom	**Did not buy insurance, paid the ransom**	**Bought insurance, did not pay the ransom**	**Bought insurance, paid the ransom**
Attacker	$6	Not Possible	$6	$36

Figure 14: Ransom choice (insurance round)

Victim	$24	Not Possible	$36	$36
Target, not attacked	$60	Not Possible	$48	Not Possible

Figure 15: Ransom choice (insurance round)

Ransom Choice: Round 2

In this round, you have been randomly assigned the role of Attacker.

Recall that the Target's initial budget is random, and is equally likely to take all values between $1 and $24.

In this round, **insurance was not available**, so the final budget is the same as the initial budget.

Move the slider below to select the ransom you will demand the Victim. When you are happy with your choice, click next.

6		36

Next

Below, you will find an interactive feature to help you make decisions. Targets have access to this feature when they are purchasing insurance, and Attackers have access when they are choosing their ransom. Move both of the sliders to activate the feature to see what the payoffs to each player are of various choices. Remember that Attackers will not know the budget or insurance decision when choosing their ransom demand.

1		24
6		36

MOVE BOTH SLIDERS TWICE TO ACTIVATE PAYOFF TABLE

	Did not buy insurance, did not pay the ransom	**Did not buy insurance, paid the ransom**	**Bought insurance, did not pay the ransom**	**Bought insurance, paid the ransom**
Attacker				
Victim				

Figure 16: Ransom choice (no insurance available)

Target, not attacked				

Figure 17: Ransom choice (no insurance available)

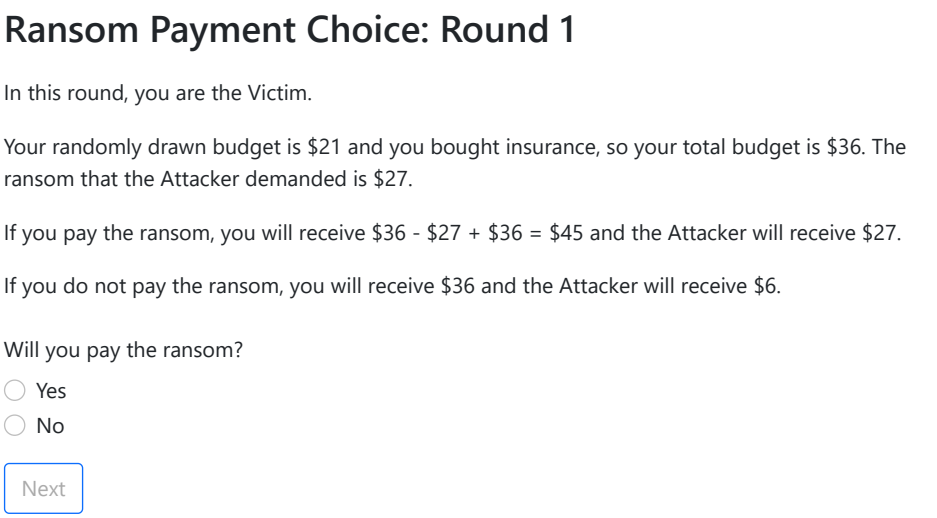

Figure 18: Ransom payment choice

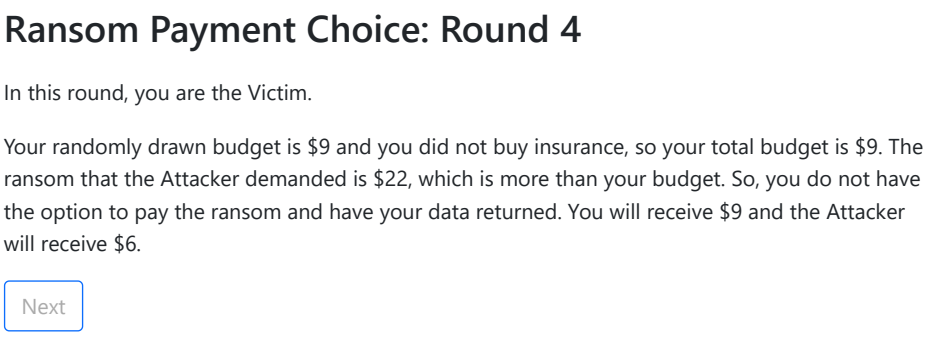

Figure 19: Ransom payment choice (insufficient budget)

Results: Round 1

In this round, you were the Victim.

Your randomly drawn initial budget was $21, and you bought insurance for a price of $15. So, your final budget was $36.

You paid the ransom demand of $27, so you paid the Attacker that amount and received the value of using the data of $36. So if this round is selected to be the one that counts, your final payoff will be $36 - $27 + $36 = $45.

Next

Figure 20: Victim Results

Results: Round 1

In this round, you were the Target who was not attacked.

Your randomly drawn initial budget was $19, and you bought insurance for a price of $17. So, your final budget was $2.

Because you were not attacked, you automatically receive the value of using the data of $36. So if this round is selected to be the one that counts, your final payoff will be $2 + $36 = $38.

Next

Figure 21: Target Results

Results: Round 1

In this round, you were the Attacker.

The Victim had a randomly drawn initial budget of $21 and chose to buy insurance. So, their final budget was $36.

The Victim paid your ransom demand of $27. So if this round is selected to be the one that counts, your final payoff will be $27.

Next

Figure 22: Attacker Results

Final Results

The computer has randomized over all rounds, and the round that will determine payoffs for all participants is Round 22. In that round, you received a payoff of $56. Combined with your quiz payment of $1.0 and the base payment of $25, your total payoff from the study will be $82.00.

Please click next and complete a short survey while we prepare your payments. After the survey is completed, stay in your seat. We will deliver your payments to you.

Next

Figure 23: Final Results

Survey

Please answer the following questions.

What is your age?

What gender do you identify with the most?

- Female
- Male
- Other/Prefer Not to Say

Is English your first language?

- Yes
- No

Are you completing or have you completed an economics degree?

- Yes
- No

Next

Figure 24: Survey

Survey

Please answer the following questions.

A bat and a ball cost 22 dollars in total. The bat costs 20 dollars more than the ball. How many dollars does the ball cost?

If it takes 5 machines 5 minutes to make 5 widgets, how many minutes would it take 100 machines to make 100 widgets?

In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how many days would it take for the patch to cover half of the lake?

Next

Figure 25: CRT

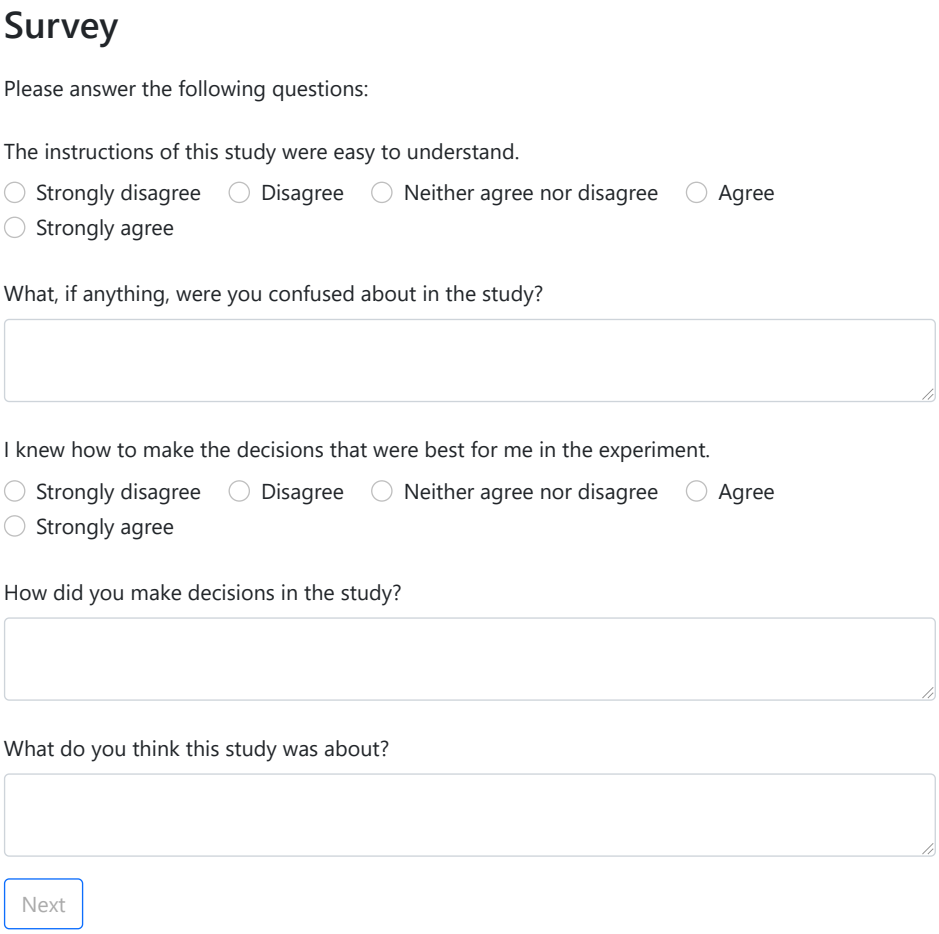

Figure 26: Feedback