

Pre-Analysis Plan for Scaling and Equity Auctions: The Types-as-Marginal-Costs Case

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1 Introduction

Infrastructure investment is a cornerstone of economic development but, unlike standard procurement, it entails exceptional complexity and uncertainty. Large-scale projects consist of interdependent tasks that are highly exposed to unforeseen shocks, generating substantial cost volatility for both contractors and public agencies. This systemic risk often leads to public scrutiny and persistent cost overruns, revealing structural deficiencies in project management and procurement design (Flyvbjerg, 2009).

A growing body of research has compared mechanisms that can be used to assign the rights to complete these large projects and to determine the payment for completion. In addition to standard cash auctions, research has considered both security-bid and scaling auctions (De-Marzo et al., 2005; Bolotnyy and Vasserman, 2023; Luo and Takahashi, 2025). Security-bid auctions allow transfers to depend on observable outcomes such as revenue or costs. Scaling auctions allow transfers to depend on the quantity of each input that is used by the firm. These auctions with contingent payments can be attractive to both contractors and public agencies because they incorporate insurance directly into the structure of payments.

In the experiment described in this pre-analysis plan, we study how the properties of cash, equity-bid, and scaling auctions depend on the economic environment when bidders share fixed-costs and input requirements, but have private information about their marginal costs of providing inputs.

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2 Experimental Design

Our experiment is designed to compare how cash, scaling, and equity-bid auctions perform in a procurement setting with input uncertainty. We will perform comparisons in two environments: one in which the requirements of the two inputs are positively correlated, and another in which they are negatively correlated. Participants face a reverse auction for the rights to complete a project. To complete the project, the participant must pay a non-contractible fixed cost and also provide two types of costly inputs that are potentially contractible.

In cash auctions, participants make bids in terms of the number of points they must be paid to complete the project. The winner, who is the lowest bidder, is paid their bid and must pay the costs associated with the project. In scaling auctions, participants must state how much they wish to be paid for each unit of each type of input. The auctioneer then multiplies these prices by fixed weights (which are both equal to one in this experiment) to compute a “score,” and the winner is the bidder with the lowest score. The winner then pays the costs associated with the project and receives payments for each type of input equal to their bid. In equity-bid auctions, participants must make bids in terms of what percentage of their variable costs they request reimbursement of. The lowest bidder wins the auction, pays the costs associated with the project, and receives both an up-front payment of 4400 points and the percentage reimbursement they requested. The experiment will implement a mixed between- and within-subject design: participants will participate in 15 rounds of cash auctions and 15 rounds of either equity-bid or scaling auctions.

Subjects begin the experiment by reviewing instructions that describe the structure of the auctions they will participate in. They first see instructions describing the general economic environment, followed by instructions about cash-bid auctions (which are referred to as “Fixed-Payment Auctions”) and finally either equity (“Cost-Share Auctions”) or scaling (“Unit-Price Auctions”) depending on treatment. They are presented with one example for each type of auction that they will see, showing how payoffs are calculated. After reviewing the examples, subjects complete a quiz and receive feedback about the correct answers for the quiz. Subjects are paid one dollar for each answer they get correct. They then move on to complete 30 rounds of auctions. Screenshots of all parts of the experiment can be found in Appendix A.

In the experiment, the auctions are explicitly framed such that the government is the auctioneer that needs a project to be completed and participants are bidding to determine who will complete the project and how much they will be paid. Participants are informed that payments will be made in terms of points and that in the round that counts for payment, 200 points will be worth \$1. Bidders are informed that in order to complete the project, the winner must pay a fixed cost of 2400 points and provide two types of inputs, referred to as Input 1 and Input 2. The quantity of each input is random in each round and unknown when the subject is making their bid. In the “Positive Correlation” treatments, the required inputs are (2, 2) or (6, 6) with equal probability, while in the “Negative Correlation” treatments, the inputs are (1, 5) or (5, 1) with equal probability. Marginal costs are randomly and independently drawn in each round, unique to each bidder, and private. In the positive correlation environment, the marginal cost of each unit of input 1 is uniformly drawn from $\{320, 324, \dots, 396, 400\}$ and the marginal cost of each unit of input 2 is one half the cost of input 1. In the negative correlation environment, the marginal cost of each unit of input 1 is uniformly drawn from $\{560, 567, \dots, 693, 700\}$ and the marginal cost of each unit of input 2 is one seventh the cost of input 1.

In all treatments, subjects participate in 30 rounds of auctions, with groups rematched each round. Odd rounds are cash auctions, while even rounds are scaling or equity auctions, depending on the treatment. Bids are made using sliders. Bids in the cash treatment are multiples of 20 between 0 and 10,000. The bid represents the payment, in points, that the government will pay if the bidder wins the auction. Bids in the equity treatment are integers between 0 and 50, and represent the percent of variable costs that will be paid by the government if the bidder wins the auction. Bids in the scaling treatment are multiples of 10 between 0 and 1600, and represent the payments per unit of input used if the bidder wins the auction. Subjects are informed that these bids will be added together to form a score, with the bidder with the lowest score winning the auction. This computation is completed for them below the sliders. Examples of the interfaces for making bids in the three types of auctions can be found in Figures 1, 2, and 3.

Round 1: Fixed-Payment Auction

Each participant is assigned **different per-unit costs** for the inputs in each round. You see only your own per-unit costs. Your opponent's are hidden.

In this round, your per-unit costs are **376 for Input 1** and **188 for Input 2**.

Use the slider to choose a **payment** you request if you win the auction. The bidder asking for the **lowest payment** wins.

If you win: $10000 + \text{your requested payment} - \text{your per-unit costs} \times \text{units} - 2400$.

If you lose: you keep 10000.



Click Next when you're ready to submit your bid.

Next

Figure 1: Bidding interface in cash auctions

Round 2: Cost-Share Auction

Each participant is assigned **different per-unit costs** for the inputs in each round. You see only your own per-unit costs. Your opponent's are hidden.

In this round, your per-unit costs are **392 for Input 1** and **196 for Input 2**.

Use the slider to choose the **percent of variable costs you request to be covered**. The bidder asking for the **smallest share** wins.

If you win: $10000 + \text{baseline payment (4400)} - (1 - \text{your bid}) \times \text{your per-unit costs} \times \text{units} - 2400$.

If you lose: you keep 10000.



Click Next when you're ready to submit your bid.

Next

Figure 2: Bidding interface in equity-bid auctions

Round 2: Unit-Price Auction

Each participant is assigned **different per-unit costs** for the inputs in each round. You see only your own per-unit costs. Your opponent's are hidden.

In this round, your per-unit costs are **400 for Input 1** and **200 for Input 2**.

Set your **bid per unit** for Input 1 and Input 2 using the sliders. These bids will be added together to calculate your **score**. The **lowest score wins**.

If you win: $10000 + (\text{your bid} - \text{your per-unit costs}) \times \text{units} - 2400$.

If you lose: you keep 10000.



0		1600
0		1600

Click Next when you're ready to submit your bid.

Next

Figure 3: Bidding interface in scaling auctions

To aid participants with their decision-making in the auctions, bidding pages also included an interactive feature that allowed them to calculate their payoffs conditional on winning and for both possible sets of input requirements. This figure looked the same in both treatments and all rounds, and the activated version can be found in Figure 19.

After a round is completed, participants are informed about the outcome of the auction. They are informed about both bids (in Cash and Equity rounds) and both scores (in Scaling rounds). The participant that did not win is reminded that they will receive their endowment of 10,000 points if it was the round that counted. The participant that did win is reminded of the two possible values their payoffs from the round could take, as well as the payoffs that the other bidder received. Winners are *not* informed which of the two possible payments would be realized for the round.

2.1 Data Collected

In addition to choice data from the auctions, we will collect the decision time for each choice. We will also collect standard demographic data including gender, age, college major, and whether English is the subject's first language. We will supplement these data with a cognitive reflection test and a short survey about the experiment, including a Likert scale question about which type of auction the subject preferred.

3 Empirical Analysis

The focus of our study will be the outcomes of the auctions, both in terms of the expected amount the auctioneer would need to pay the winning bidder (the equivalent of the auctioneer's earnings in a standard auction) and the expected costs that would need to be spent on the project (equivalent to efficiency). Based on previous experience, we expect that decision-making

will be noisy as subjects gain experience in the first few rounds. Thus, in our main analysis, we will focus only on rounds 5 to 30. The full dataset will be analyzed as a robustness check.

The primary estimating equation will be

$$y_{sjt} = \beta_1 S_{st} + \beta_2 E_{st} + \beta_3 (S_{st} \times \text{Neg}_s) + \beta_4 (E_{st} \times \text{Neg}_s) + \gamma_s + \theta' Z_{sjt} + \varepsilon_{sjt}. \quad (1)$$

Index s refers to the session, index j to the group, and index t to the round. The outcome variable y_{sjt} refers to one of two auction outcomes: (1) the ex-interim expected costs of the winning bidder, or (2) the ex-interim expected costs to the government.¹ S_{st} and E_{st} are indicators for session s in round t being either a Scaling or Equity auction, respectively. Neg_s is an indicator for session s being a session in the negative correlation environment. γ_s refers to session fixed effects. Z_{sjt} is a vector containing the highest and lowest cost types in the auction as well as the round number.

3.1 Minimum Detectable Effect

In our statistical analysis, our main focus will be on the difference between β_3 and β_4 , which can be interpreted as how the correlation environment affects the difference in outcomes between the auctions with contingent payments (i.e. scaling and equity auctions) and cash auctions. Theoretical predictions for the relative performance of different auction formats depend crucially on participants' risk preferences, which are not known ex-ante. We therefore report a minimum detectable effect (*MDE*) for $\beta_4 - \beta_3$.

In calculating the *MDE*, we target a two-sided 5% test with 80% power. In our main dataset, each subject participates in 13 rounds of cash auctions and 13 rounds of the auction with contingent payments. The interaction effect aggregates data from four treatment cells. Thus, we calculate the *MDE* as

$$MDE \approx 2.8\hat{\sigma}\sqrt{\frac{4}{13N_A}}$$

where N_A is the number of auctions per round-cell and $\hat{\sigma}$ is the residual variance after controlling for cost types in the auction, round, and session fixed-effects. Without pilot data, we use the data from a similar experiment (described in AEARCTR-0017041) to estimate a residual standard deviation of $\hat{\sigma} \approx 660$.² Our planned design involves two experimental sessions per environment with 18 subjects per session on average (for a total of roughly 144 subjects), implying that $N_A = 18$. Thus, our *MDE* is 240.

¹We write “ex-interim” because we will calculate expected costs conditional on the outcome of the auction, but before the final inputs are realized. In Cash auctions, the cost to the government is simply the winning bid. In Scaling auctions, the cost to the government is calculated based on multiplying the bids of the winner by the winner's expected quantities. In equity auctions, it is the up-front payment plus the product of the winner's bid and variable costs.

²The previous experiment had a worse conversion rate from points to dollars (which likely leads to higher residual variance) but *substantially* less variance in the economic environment (likely leading to lower residual variance). Thus, we expect that this is a conservative estimate.

References

- Bolotnyy, V. and Vasserman, S. (2023). Scaling auctions as insurance: A case study in infrastructure procurement. *Econometrica*, 91(4):1205–1259.
- DeMarzo, P. M., Kremer, I., and Skrzypacz, A. (2005). Bidding with securities: Auctions and security design. *American economic review*, 95(4):936–959.
- Flyvbjerg, B. (2009). Survival of the unfittest: Why the worst infrastructure gets built—and what we can do about it. *Oxford Review of Economic Policy*, 25(3):344–367.
- Luo, Y. and Takahashi, H. (2025). Bidding for contracts under uncertain demand: Skewed bidding and risk sharing. *The RAND Journal of Economics*, 56(3):325–343.

A Screenshots/Instructions

Below, we include screenshots from the experiment.

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 90-120 minutes, 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 2025/HE001937).

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 match are selected independently of who you play with in any other match.

Please pay close attention to the instructions on the next page. After you read these instructions, there will be a short quiz on the instructions. You will receive \$1 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 4: Introduction

Instructions

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

In this study you will participate in 30 rounds of "reverse" auctions: the government needs someone to complete a project, and participants in the auction make bids to determine who will complete the project and how much they will be paid.

You will always see numbers in **points**. At the end, one round is picked at random to pay you at 200 points = \$1. You start each round with an **endowment of 10000 points**.

Every round, you're matched with **one other bidder**, and you will be randomly rematched in the next round. You will participate in two types of auctions, which we describe on the next two pages.

About the Project

The project requires two different **inputs**. You can think of these as two kinds of work or materials. What matters is how many *units* of each input are needed.

- **Input 1:** either 2 units (Set A) or 6 units (Set B).
- **Input 2:** either 2 units (Set A) or 6 units (Set B).

At the start of each round, there is a 50–50 chance the project will require **Set A** quantities or **Set B** quantities. You will not know which set applies when you bid.

If you win the project, you must pay two types of costs: a **fixed cost** (which does not depend on input quantities) and **variable costs** (which do depend on input quantities). The fixed cost is **2400 points**.

In each round, your per-unit input costs are **randomly drawn** and **can differ across participants**.

The per-unit cost of Input 1 is equally likely to take any value between 320 and 400 (in steps of 4). The per-unit cost of Input 2 is equally likely to take any value between 160 and 200 (in steps of 2). **These two costs are perfectly linked: in every round, Input 1's unit cost is exactly two times Input 2's unit cost.**

Your total variable cost is: (unit cost of Input 1 × your quantity of Input 1) + (unit cost of Input 2 × your quantity of Input 2).

Bidding & Interface

- You will place bids using **sliders** on the screen.
- You will see **your own per-unit costs** and the possible net payoffs you would receive for winning the auction.
- You will **not** see your opponent's per-unit costs.

Feedback

After each round:

- The loser sees only their own result.
- The winner sees their own result and a reminder of what the loser's payoff is.

Payment

- At the end of the experiment, one round will be chosen at random to be the round that counts. Your payment will be determined by the number of points you earned in that round.

Next

Figure 5: Positive Correlation Instructions

Instructions

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

In this study you will participate in 30 rounds of "reverse" auctions: the government needs someone to complete a project, and participants in the auction make bids to determine who will complete the project and how much they will be paid.

You will always see numbers in **points**. At the end, one round is picked at random to pay you at 200 points = \$1. You start each round with an **endowment of 10000 points**.

Every round, you're matched with **one other bidder**, and you will be randomly rematched in the next round. You will participate in two types of auctions, which we describe on the next two pages.

About the Project

The project requires two different **inputs**. You can think of these as two kinds of work or materials. What matters is how many *units* of each input are needed.

- **Input 1:** either 1 unit (Set A) or 5 units (Set B).
- **Input 2:** either 5 units (Set A) or 1 unit (Set B).

At the start of each round, there is a 50–50 chance the project will require **Set A** quantities or **Set B** quantities. You will not know which set applies when you bid.

If you win the project, you must pay two types of costs: a **fixed cost** (which does not depend on input quantities) and **variable costs** (which do depend on input quantities). The fixed cost is **2400 points**.

In each round, your per-unit input costs are **randomly drawn** and **can differ across participants**.

The per-unit cost of Input 1 is equally likely to take any value between 560 and 700 (in steps of 7). The per-unit cost of Input 2 is equally likely to take any value between 80 and 100 (in steps of 1). **These two costs are perfectly linked: in every round, Input 1's unit cost is exactly seven times Input 2's unit cost.**

Your total variable cost is: (unit cost of Input 1 × your quantity of Input 1) + (unit cost of Input 2 × your quantity of Input 2).

Bidding & Interface

- You will place bids using **sliders** on the screen.
- You will see **your own per-unit costs** and the possible net payoffs you would receive for winning the auction.
- You will **not** see your opponent's per-unit costs.

Feedback

After each round:

- The loser sees only their own result.
- The winner sees their own result and a reminder of what the loser's payoff is.

Payment

- At the end of the experiment, one round will be chosen at random to be the round that counts. Your payment will be determined by the number of points you earned in that round.

Next

Figure 6: Negative Correlation Instructions

Instructions: Fixed-Payment Auction

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

Auction Rules

In these auctions, you will use a slider to choose a **fixed payment amount**. This is your **bid**.

- **Lower bids** mean the government pays a smaller amount overall (you receive less).
- The bidder with the **lowest bid** wins. If bids are tied, the winner is chosen at random with equal probability.

What happens if you win?

Your final points for the round are:

- **Your endowment** (10000), plus **your bid**,
- minus, for each input: **cost per unit** $\times$ **actual units**,
- minus the **fixed cost** of 2400 points.

What happens if you lose?

You simply keep your endowment (10000) for that round (no gains or losses from the project).

Click Next to see the instructions for the other type of auction.

Next

Figure 7: Instructions for Cash Auctions

Instructions: Cost-Share Auction

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

Auction Rules

In these auctions, you will use a slider to choose the **percent of variable costs you request to be covered**. This is your **bid**.

- **Lower bids** mean the government covers a *smaller* share (you cover more).
- The bidder who asks for the **smallest share** to be covered wins. If bids are tied, the winner is chosen at random with equal probability.

The winner will receive a baseline payment of **4400 points**.

What happens if you win?

Your final points for the round are:

- **Your endowment** (10000), plus the **baseline payment** (4400),
- minus **your share of the project's variable costs** (based on the inputs actually used),
- minus the **fixed cost** of 2400 points.

The project's variable cost depends on how many units of each input are used in that round (which can be from Set A or Set B). "Your share of the cost" depends on your bid. For example, if you bid 40%, then 40% of the variable costs will be paid by the government and you pay the remaining 60%.

What happens if you lose?

You simply keep your endowment (10000) for that round (no gains or losses from the project).

On the next page, you will find a few examples to help you better understand the rules. Please go through them at your own pace. After you have reviewed the examples, click Next again to begin the quiz.

Next

Figure 8: Instructions for Equity-Bid Auctions

Instructions: Unit-Price Auction

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

Auction Rules

In these auctions, you will use a slider to submit two **unit prices** that you want to be paid for the inputs: one price per unit of Input 1 and one price per unit of Input 2. Your **score** for the auction is the sum of your two unit prices.

- **Lower unit prices** mean the government pays a *smaller* amount per unit (you receive less).
- The bidder with the **lowest score** wins. If bids are tied, the winner is chosen at random with equal probability.

What happens if you win?

Your final points for the round are:

- **Your endowment** (10000),
- plus, for each input: **(your unit price – cost per unit) × actual units**,
- minus the **fixed cost** of 2400 points.

If your price is above cost, you gain on that input; if it's below cost, you lose on that input. The actual units can be from Set A or Set B.

What happens if you lose?

You simply keep your endowment (10000) for that round (no gains or losses from the project).

On the next page, you will find a few examples to help you better understand the rules. Please go through them at your own pace. After you have reviewed the examples, click Next again to begin the quiz.

Next

Figure 9: Instructions for Scaling Auctions

Examples

Please read both examples carefully.

Example 1: Fixed-Payment Auction

- Ann bids **4000** points. Bob bids **4300** points. Ann wins (lowest bid).
- Ann's per-unit costs this round are:
 - Input 1 cost = 360
 - Input 2 cost = 180
- If Set A (2,2) is realized:
 - Variable cost = $2 \times 360 + 2 \times 180 = 1080$
 - Final points = $10000 + 4000 - 1080 - 2400 = \mathbf{10520}$
- If Set B (6,6) is realized:
 - Variable cost = $6 \times 360 + 6 \times 180 = 3240$
 - Final points = $10000 + 4000 - 3240 - 2400 = \mathbf{8360}$
- Bob loses and receives **10000** points.

Example 2: Cost-Share Auction

- Ann bids **30%**. Bob bids **42%**. Ann wins (lowest requested share).
- Ann's per-unit costs: Input 1 = 360, Input 2 = 180.
- Baseline payment in this auction is **4400** points.
- Because Ann bid 30%, she pays 70% of variable cost.
- If Set A (2,2):
 - Variable cost = 1080
 - Final points = $10000 + 4400 - 0.70 \times 1080 - 2400 = \mathbf{11244}$
- If Set B (6,6):
 - Variable cost = 3240
 - Final points = $10000 + 4400 - 0.70 \times 3240 - 2400 = \mathbf{9732}$
- Bob loses and receives **10000** points.

When you are ready, click Next to continue to the quiz.

Next

Figure 10: Examples (Positive Correlation, Equity-Bid Treatment)

Examples

Please read both examples carefully.

Example 1: Fixed-Payment Auction

- Ann bids **3500** points. Bob bids **3800** points. Ann wins (lowest bid).
- Ann's per-unit costs this round are:
 - Input 1 cost = 630
 - Input 2 cost = 90
- If Set A (1,5) is realized:
 - Variable cost = $1 \times 630 + 5 \times 90 = 1080$
 - Final points = $10000 + 3500 - 1080 - 2400 = \mathbf{10020}$
- If Set B (5,1) is realized:
 - Variable cost = $5 \times 630 + 1 \times 90 = 3240$
 - Final points = $10000 + 3500 - 3240 - 2400 = \mathbf{7860}$
- Bob loses and receives **10000** points.

Example 2: Cost-Share Auction

- Ann bids **40%**. Bob bids **46%**. Ann wins (lowest requested share).
- Ann's per-unit costs: Input 1 = 630, Input 2 = 90.
- Baseline payment in this auction is **4400** points.
- Because Ann bid 40%, she pays 60% of variable cost.
- If Set A (1,5):
 - Variable cost = 1080
 - Final points = $10000 + 4400 - 0.60 \times 1080 - 2400 = \mathbf{11352}$
- If Set B (5,1):
 - Variable cost = 3240
 - Final points = $10000 + 4400 - 0.60 \times 3240 - 2400 = \mathbf{10056}$
- Bob loses and receives **10000** points.

When you are ready, click Next to continue to the quiz.

Next

Figure 11: Examples (Negative Correlation, Equity-Bid Treatment)

Examples

Please read both examples carefully.

Example 1: Fixed-Payment Auction

- Ann bids **4000** points. Bob bids **4300** points. Ann wins (lowest bid).
- Ann's per-unit costs this round are:
 - Input 1 cost = 360
 - Input 2 cost = 180
- If Set A (2,2) is realized:
 - Variable cost = $2 \times 360 + 2 \times 180 = 1080$
 - Final points = $10000 + 4000 - 1080 - 2400 = \mathbf{10520}$
- If Set B (6,6) is realized:
 - Variable cost = $6 \times 360 + 6 \times 180 = 3240$
 - Final points = $10000 + 4000 - 3240 - 2400 = \mathbf{8360}$
- Bob loses and receives **10000** points.

Example 2: Unit-Price Auction

- Ann submits unit prices: Input 1 = **760**, Input 2 = **380**.
- Ann's score is $760 + 380 = \mathbf{1140}$. Bob's score is 1160, so Ann wins.
- Ann's per-unit costs: Input 1 = 360, Input 2 = 180.
- If Set A (2,2):
 - Final points = $10000 + [2 \times (760 - 360) + 2 \times (380 - 180)] - 2400 = \mathbf{8800}$
- If Set B (6,6):
 - Final points = $10000 + [6 \times (760 - 360) + 6 \times (380 - 180)] - 2400 = \mathbf{11200}$
- Bob loses and receives **10000** points.

When you are ready, click Next to continue to the quiz.

Next

Figure 12: Examples (Positive Correlation, Scaling Treatment)

Examples

Please read both examples carefully.

Example 1: Fixed-Payment Auction

- Ann bids **3500** points. Bob bids **3800** points. Ann wins (lowest bid).
- Ann's per-unit costs this round are:
 - Input 1 cost = 630
 - Input 2 cost = 90
- If Set A (1,5) is realized:
 - Variable cost = $1 \times 630 + 5 \times 90 = 1080$
 - Final points = $10000 + 3500 - 1080 - 2400 = \mathbf{10020}$
- If Set B (5,1) is realized:
 - Variable cost = $5 \times 630 + 1 \times 90 = 3240$
 - Final points = $10000 + 3500 - 3240 - 2400 = \mathbf{7860}$
- Bob loses and receives **10000** points.

Example 2: Unit-Price Auction

- Ann submits unit prices: Input 1 = **1200**, Input 2 = **171**.
- Ann's score is $1200 + 171 = \mathbf{1371}$. Bob's score is 1400, so Ann wins.
- Ann's per-unit costs: Input 1 = 630, Input 2 = 90.
- If Set A (1,5):
 - Final points = $10000 + [1 \times (1200 - 630) + 5 \times (171 - 90)] - 2400 = \mathbf{8575}$
- If Set B (5,1):
 - Final points = $10000 + [5 \times (1200 - 630) + 1 \times (171 - 90)] - 2400 = \mathbf{10531}$
- Bob loses and receives **10000** points.

When you are ready, click Next to continue to the quiz.

Next

Figure 13: Examples (Negative Correlation, Scaling Treatment)

Quiz

You will now be given a series of questions to check your understanding of the instructions and examples. You will be paid \$1 for each answer you get correct.

At the end of the experiment, how is your final payment determined?

- ☐ By summing your total points across all rounds
- ☐ By averaging your points across all rounds
- ☐ By selecting one round at random and paying based on its points
- ☐ By paying based on a round you won the auction

Which of the following is true about the project's input requirements?

- ☐ You know whether Set A or Set B will be realized before bidding
- ☐ Set A and Set B are equally likely, and the realized set is unknown when bidding
- ☐ Set A occurs with 75% probability and Set B with 25%
- ☐ The realized set is chosen by the winner

What happens if you lose an auction round?

- ☐ You pay only the fixed cost
- ☐ You get your endowment only
- ☐ You receive an extra payment
- ☐ You must skip the next round

In the Cost-Share auction, what do you submit?

- ☐ Two unit prices, one per input
- ☐ A fixed cost level
- ☐ A lump-sum payment request
- ☐ A percent of variable costs you request to be covered

In the Cost-Share auction, how is the winner determined?

- ☐ Smallest requested share to be covered
- ☐ Bid closest to 50%
- ☐ Highest requested share to be covered
- ☐ Highest baseline payment

When you believe you have answered all questions correctly, press Next to check your answers.

Next

Figure 14: Quiz (Equity-Bid Treatment)

Quiz

You will now be given a series of questions to check your understanding of the instructions and examples. You will be paid \$1 for each answer you get correct.

At the end of the experiment, how is your final payment determined?

- ☐ By summing your total points across all rounds
- ☐ By averaging your points across all rounds
- ☐ By selecting one round at random and paying based on its points
- ☐ By paying based on a round you won the auction

Which of the following is true about the project's input requirements?

- ☐ You know whether Set A or Set B will be realized before bidding
- ☐ Set A and Set B are equally likely, and the realized set is unknown when bidding
- ☐ Set A occurs with 75% probability and Set B with 25%
- ☐ The realized set is chosen by the winner

What happens if you lose an auction round?

- ☐ You pay only the fixed cost
- ☐ You get your endowment only
- ☐ You receive an extra payment
- ☐ You must skip the next round

In the Unit-Price auction, what do you submit?

- ☐ A single lump-sum payment request
- ☐ Only a price for Input 1
- ☐ A percent of variable costs to be covered
- ☐ Two unit prices: one for Input 1 and one for Input 2

In the Unit-Price auction, how is the winner determined?

- ☐ Lowest score (price for Input 1 + price for Input 2)
- ☐ Lowest price for Input 1 only
- ☐ Lowest fixed cost
- ☐ Highest total unit-price sum

When you believe you have answered all questions correctly, press Next to check your answers.

Next

Figure 15: Quiz (Scaling Treatment)

Quiz Answers

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

Question 1: At the end of the experiment, how is your final payment determined?

Correct Answer: By selecting one round at random and paying based on its points

Your Answer: By averaging your points across all rounds

Question 2: Which of the following is true about the project's input requirements?

Correct Answer: Set A and Set B are equally likely, and the realized set is unknown when bidding

Your Answer: Set A occurs with 75% probability and Set B with 25%

Question 3: What happens if you lose an auction round?

Correct Answer: You get your endowment only

Your Answer: You receive an extra payment

Question 4: In the Cost-Share auction, what do you submit?

Correct Answer: A percent of variable costs you request to be covered

Your Answer: A percent of variable costs you request to be covered

Question 5: In the Cost-Share auction, how is the winner determined?

Correct Answer: Smallest requested share to be covered

Your Answer: Highest requested share to be covered

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 16: Quiz Answers (Equity-Bid Treatment)

Quiz Answers

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

Question 1: At the end of the experiment, how is your final payment determined?

Correct Answer: By selecting one round at random and paying based on its points

Your Answer: By selecting one round at random and paying based on its points

Question 2: Which of the following is true about the project's input requirements?

Correct Answer: Set A and Set B are equally likely, and the realized set is unknown when bidding

Your Answer: Set A and Set B are equally likely, and the realized set is unknown when bidding

Question 3: What happens if you lose an auction round?

Correct Answer: You get your endowment only

Your Answer: You pay only the fixed cost

Question 4: In the Unit-Price auction, what do you submit?

Correct Answer: Two unit prices: one for Input 1 and one for Input 2

Your Answer: Two unit prices: one for Input 1 and one for Input 2

Question 5: In the Unit-Price auction, how is the winner determined?

Correct Answer: Lowest score (price for Input 1 + price for Input 2)

Your Answer: Lowest score (price for Input 1 + price for Input 2)

You earned \$4.0 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 17: Quiz Answers (Scaling Treatment)

Round 1: Fixed-Payment Auction

Each participant is assigned **different per-unit costs** for the inputs in each round. You see only your own per-unit costs. Your opponent's are hidden.

In this round, your per-unit costs are **376 for Input 1** and **188 for Input 2**.

Use the slider to choose a **payment** you request if you win the auction. The bidder asking for the **lowest payment** wins.

If you win: $10000 + \text{your requested payment} - \text{your per-unit costs} \times \text{units} - 2400$.

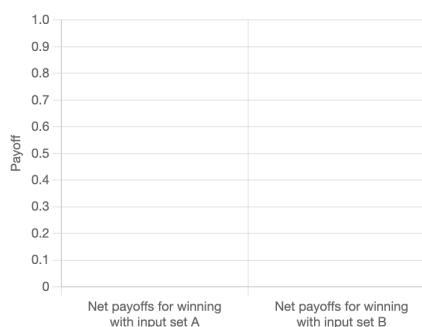
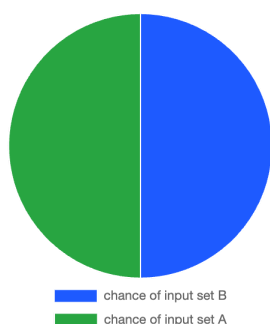
If you lose: you keep 10000.

0

10000

Click Next when you're ready to submit your bid.

Next



Key Reminders

- Only **one randomly selected round** will be paid in cash.
- Your endowment is **10000 points**.
- Conversion rate: **200 points = \$1**.
- Fixed cost if you win: **2400 points**.
- Input requirements: Input 1 **Set A = 2, Set B = 6**; Input 2 **Set A = 2, Set B = 6**.
- Personal per-unit costs: Your input prices are **private** and **different for each bidder**; each round, Input 1 is randomly drawn from 320 to 400 and Input 2 from 160 to 200, with all values in each range equally likely, and Input 1 is always exactly double Input 2.

Figure 18: Cash Auction Bidding Page

Round 1: Fixed-Payment Auction

Each participant is assigned **different per-unit costs** for the inputs in each round. You see only your own per-unit costs. Your opponent's are hidden.

In this round, your per-unit costs are **376 for Input 1** and **188 for Input 2**.

Use the slider to choose a **payment** you request if you win the auction. The bidder asking for the **lowest payment** wins.

If you win: $10000 + \text{your requested payment} - \text{your per-unit costs} \times \text{units} - 2400$.

If you lose: you keep 10000.

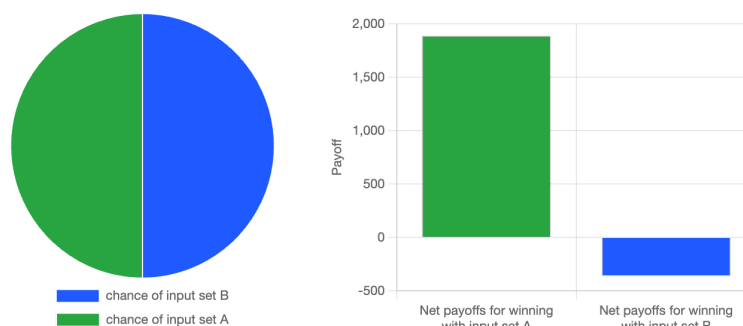
0

10000

Bid: 5420

Click Next when you're ready to submit your bid.

Next



Key Reminders

- Only **one randomly selected round** will be paid in cash.
- Your endowment is **10000 points**.
- Conversion rate: **200 points = \$1**.
- Fixed cost if you win: **2400 points**.
- Input requirements: Input 1 **Set A = 2, Set B = 6**; Input 2 **Set A = 2, Set B = 6**.
- Personal per-unit costs: Your input prices are **private** and **different for each bidder**; each round, Input 1 is randomly drawn from 320 to 400 and Input 2 from 160 to 200, with all values in each range equally likely, and Input 1 is always exactly double Input 2.

Figure 19: Cash Auction Bidding Page (tool active)

Round 1 Results

You did not win this round.

Your bid was 7080 and the other bid was 5420.

Thus, your payoff for this round will be 10000.

Next

Figure 20: Results Page (Loss)

Round 1 Results

Congratulations! You won the auction.

Your bid was 5420 and the other bid was 7080.

Your payoff for this round will be $10000 + 5420 - (376 \times 6 + 188 \times 6) - 2400 = 9636$ with one-half chance and $10000 + 5420 - (376 \times 2 + 188 \times 2) - 2400 = 11892$ with one-half chance.

The payoff of the bidder that did not win will be 10000 with certainty.

Next

Figure 21: Cash Auction Results Page

Round 2: Cost-Share Auction

Each participant is assigned **different per-unit costs** for the inputs in each round. You see only your own per-unit costs. Your opponent's are hidden.

In this round, your per-unit costs are **392 for Input 1** and **196 for Input 2**.

Use the slider to choose the **percent of variable costs you request to be covered**. The bidder asking for the **smallest share** wins.

If you win: $10000 + \text{baseline payment } (4400) - (1 - \text{your bid}) \times \text{your per-unit costs} \times \text{units} - 2400$.

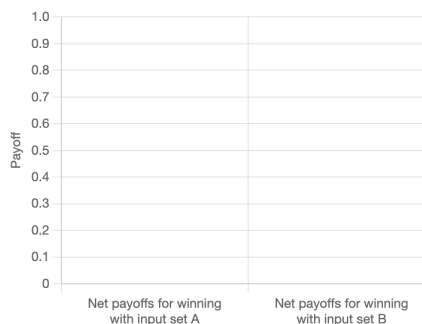
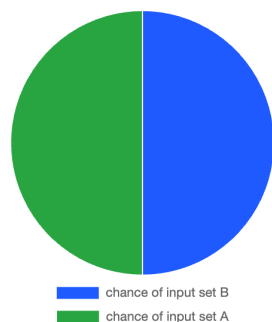
If you lose: you keep 10000.

0

50

Click Next when you're ready to submit your bid.

Next



Key Reminders

- Only **one randomly selected round** will be paid in cash.
- Your endowment is **10000 points**.
- Conversion rate: **200 points = \$1**.
- Fixed cost if you win: **2400 points**.
- Input requirements: Input 1 **Set A = 2, Set B = 6**; Input 2 **Set A = 2, Set B = 6**.
- Personal per-unit costs: Your input prices are **private** and **different for each bidder**; each round, Input 1 is randomly drawn from 320 to 400 and Input 2 from 160 to 200, with all values in each range equally likely, and Input 1 is always exactly double Input 2.

Figure 22: Equity-Bid Auction Bidding Page

Round 2: Unit-Price Auction

Each participant is assigned **different per-unit costs** for the inputs in each round. You see only your own per-unit costs. Your opponent's are hidden.

In this round, your per-unit costs are **400 for Input 1** and **200 for Input 2**.

Set your **bid per unit** for Input 1 and Input 2 using the sliders. These bids will be added together to calculate your **score**. The **lowest score wins**.

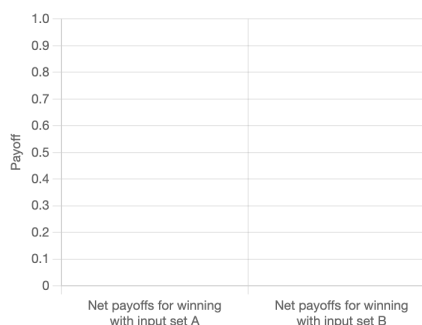
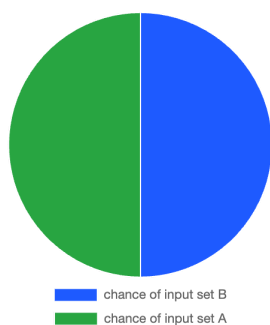
If you win: $10000 + (\text{your bid} - \text{your per-unit costs}) \times \text{units} - 2400$.

If you lose: you keep 10000.

0		1600
0		1600

Click Next when you're ready to submit your bid.

Next



Key Reminders

- Only **one randomly selected round** will be paid in cash.
- Your endowment is **10000 points**.
- Conversion rate: **200 points = \$1**.
- Fixed cost if you win: **2400 points**.
- Input requirements: Input 1 **Set A = 2, Set B = 6**; Input 2 **Set A = 2, Set B = 6**.
- Personal per-unit costs: Your input prices are **private** and **different for each bidder**; each round, Input 1 is randomly drawn from 320 to 400 and Input 2 from 160 to 200, with all values in each range equally likely, and Input 1 is always exactly double Input 2.

Figure 23: Scaling Auction Bidding Page

Round 2 Results

Congratulations! You won the auction.

Your bid was 12% and the other bid was 34%.

Your payoff for this round will be $10000 + 4400 - (1 - (12/100)) \times ((332 \times 6) + (166 \times 6)) - 2400 = \mathbf{9371}$ with **one-half chance** and $10000 + 4400 - (1 - (12/100)) \times ((332 \times 2) + (166 \times 2)) - 2400 = \mathbf{11124}$ with **one-half chance**.

The payoff of the bidder that did not win will be 10000 with certainty.

Next

Figure 24: Equity-Bid Auction Results Page

Round 2 Results

Congratulations! You won the auction.

Your score was 1680.0 and the other bidder's score was 2720.0.

Your payoff for this round will be $10000 + (1060 - 400) \times 6 + (620 - 200) \times 6 - 2400 = \mathbf{14080}$ with one-half chance and $10000 + (1060 - 400) \times 2 + (620 - 200) \times 2 - 2400 = \mathbf{9760}$ with one-half chance.

The payoff of the bidder that did not win will be 10000 with certainty.

Next

Figure 25: Scaling Auction Results Page

Payoffs

That was the last match of the experiment. The computer has randomly selected match 1 to be the match that counts for your payment.

In that round, you won the auction. You ended up needing the Set B inputs for the project, so your payoff in points for that match was 9636. This corresponds to \$48.18.

With your quiz payment of \$0.0, this gives a total of \$48.18.

The next few pages consist of survey questions. Please complete the survey while we prepare your payment.

Next

Figure 26: Final Payoffs

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 27: Demographic 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 28: Cognitive Reflection Test

Survey

Please answer the following questions:

The instructions of this study were easy to understand.

☐ Strongly disagree ☐ Disagree ☐ Neither agree nor disagree ☐ Agree ☐ Strongly agree

What, if anything, were you confused about in the study?

I knew how to make the decisions that were best for me in the experiment.

☐ Strongly disagree ☐ Disagree ☐ Neither agree nor disagree ☐ Agree ☐ Strongly agree

How did you make decisions in the study?

Of the two types of auctions today, I preferred to participate in the Cost-Share auction.

☐ Strongly disagree ☐ Disagree ☐ Neither agree nor disagree ☐ Agree ☐ Strongly agree

Please briefly explain that response.

What do you think this study was about?

Next

Figure 29: Experiment Feedback