Competition between sellers in security-bid auctions: An experimental study*

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Abstract

We study how competition impacts formal security-bid auctions. Sellers choose their security designs between debt and equity, and buyers select auctions based on sellers' choices. We focus on the comparison between Monopolistic and Competitive auctions. We find that an auction's security design has limited influence on revenue in the Monopolistic treatment, whereas equity substantially increases revenue in the Competitive treatment. This is mainly due to equity's effectiveness in attracting more bidders. Despite this fact, sellers' rate of choosing equity does not differ between the Monopolistic and Competitive treatments. While securities' extraction and insurance effects theoretically lead to security choice when acting as a buyer to be negatively correlated to one's choice as a seller, we find the empirical correlation to be positive.

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1 Introduction

The markets to sell the rights to implement and control projects that generate future cash-flow streams are often organized as security-bid auctions, allowing payments to depend on the revenue generated by the project. These auctions are used both by governments and individuals in a myriad of contexts. For example, governments often use them to sell oil, gas, timber, and spectrum leases, and individuals use them to sell the rights for publishing books and to select lead plaintiffs in class-action suits. Notably, in all cases, payments to the seller depend on the performance of the underlying asset.

Sellers in these markets often compete aggressively for potential buyers. This is because these auctions sell the rights to implement large-scale projects, which require due diligence, have high entry costs, and attract few bidders. For instance, in the US, departments of natural resources of many states (e.g., Alaska, Arizona, New Mexico, Colorado, and Texas) compete for a limited number of drilling firms to exploit their oil fields. In designing these auctions, sellers must determine not only the auction format but also how payments depend on the revenue that is generated, i.e., the *security design.* For instance, a seller could run their auction in equity, so that each bid corresponds to a "share" or "royalty" over the future project's revenue. Alternatively, sellers can organize their auctions using debt, where a typical bid corresponds to a "default amount" that acts as a threshold, and the buyer pays either their revenue or the given threshold, whichever is lower. In determining which security to use, sellers must consider not only the effect of the security on the outcome of an auction given a set of buyers but also how the security design affects entry into the auction. While there is some theoretical work on the topic, it is an open question as to how buyers and sellers actually interact in these markets.

In this paper, we use an experimental approach to analyze how competition among sellers affects both the design of auctions and the outcomes of those auctions. Subjects act as both sellers (determining the security that will be used) and buyers (making bids and, under competition, choosing which auction to enter). We compare monopolistic settings—with one seller and two buyers—to competitive settings— with two sellers and four buyers. Because the level of competition is experimentally induced and the economic fundamentals are directly observed, we can measure the effects of competition and how it interacts with the choices of auction participants.

Contrary to the theoretical predictions, we find that when given the option between entering an auction using debt or an auction using equity, buyers show a strong preference for equity. This induces stronger incentives for sellers to use equity bids under competition than when they are monopolists because the value of recruiting additional buyers to an auction overwhelms the value of using a particular security. Despite these strong incentives, we find that sellers are not more likely to use equities under competition.

Background In our economic setting, each member of a set of sellers controls the rights to implement a project that generates stochastic revenue. Sellers are interested in allocating the rights to their projects among a set of buyers. The project yields either low revenue or high revenue, and each buyer independently finds out their personal likelihood of receiving the high revenue (i.e., we assume the independent-private-values framework) after entering an auction. Sellers act either (i) in isolation, or (ii) under competition, and use a second-price security-bid auction as a selling mechanism. When acting in isolation, the seller is a monopolist and interacts with a set of two buyers. Under competition, two sellers compete for a group of four buyers.

In monopolistic auctions, there are clear theoretical predictions regarding revenue and efficiency that can be tested in the laboratory. Equity auctions yield greater expected revenue than debt auctions because equity is steeper than debt (see DeMarzo et al., 2005).[1] Intuitively, the former ties the bidder's payment "more tightly" to her underlying true valuation. Thus, monopolistic sellers should choose to run their auctions using equity. All auctions are predicted to be efficient since equilibrium bids are monotone in bidders' signals.

In the competitive environment, the seller's choice of security is more complex because it has offsetting effects. As in monopolistic auctions, equity generates higher revenue conditional on the set of buyers that enter the auction. However, this increase in revenue extraction weakens the incentives of buyers to enter the auction, leading to less competition among buyers. This weakens the incentive for sellers to run their auctions using equity. Furthermore, competition can have deleterious effects on efficiency if buyers are not allocated evenly across auctions.

The incentives of sellers to use equity instead of debt increase when bidders are risk-averse, since, as shown by Fioriti and Hernandez-Chanto (2021), equity also provides greater insurance to risk-averse buyers. This is because equity requires lower payments when revenue is low and

[1] Equity is *steeper* than debt because the slope of the function mapping revenue to payments is higher for equity than debt at the point where the two securities yield the same expected payment

higher payments when revenue is high. This insurance is relatively more valuable to more risk-averse buyers, making them more prone to participate (and bid more aggressively) in auctions under equity, which are, precisely, the type that extracts greater bidders' surplus (Carrasco and Hernandez-Chanto, 2022).

Experimental design We construct the simplest environment in which we can investigate the implications of different market structures on auction design, revenue, and efficiency. In the monopolistic setting, three subjects participate in each auction. One subject acts as the seller, choosing either debt or equity as their security design, and two subjects act as buyers, bidding for the rights to implement a risky project. Meanwhile, in the competitive setting, six subjects participate in each market. Two subjects act as sellers, whereas the other four subjects take on the role of buyers. Sellers compete for buyers using their choice of security design, while buyers need to decide which of the two auctions to join after observing sellers' choices of equity or debt. Once they join an auction, they must submit a bid using the family of securities chosen by the seller (i.e., debt or equity). Subjects' roles as sellers or buyers are chosen randomly at the beginning of each round.

In all auctions, buyers receive their private signals (drawn from a uniform distribution on the unit interval) and make bids using the family of securities chosen for their auction. Buyers are given an endowment, but the winner of the auction must invest that endowment in the project.[2] The project then generates either high or low revenue. Buyers' signals indicate the likelihood that the project generates high revenue. The endowment, the project's revenue, and all payments are made with experimental points.

Subjects participate in 30 rounds of auctions. All subjects act as buyers in rounds 1-10, where half of the auctions are run using equity and the other half are run using debt. These auctions, which are incentivized, allow subjects to gain experience with the structure of security-bid auctions and the two securities we use. We refer to these rounds as the Automated treatment, because a computer acts as the seller (similar to the formal auction treatments found in Breig et al. (2022)). In rounds 11-30, subjects alternate between the Monopolistic and Competitive treatments, which affect the market structure as described above. At the end of

[2]Fundamentally, the winning buyer relinquishes their initial endowment and receives a lottery in return, where the outcomes of the lottery are contingent upon the "price" paid. This price is determined by the second-highest security bid.

each round, all subjects involved in the auction are informed of who won and all bids that were made in their auction. Subjects complete the experiment with a short survey. The ordering of the securities used in the first 10 rounds and the market structure used in rounds 11-30 were varied at the session level to balance any order effects.

Findings We obtained a mixture of supportive and contradictory empirical evidence for the main predictions for monopolistic and competitive auctions found in the theoretical literature.

Contrary to the theory, we find that the security design has a negligible effect on sellers' revenue in the Automated and Monopolistic auctions. Conversely, in Competitive auctions, using equity increases revenue by over 50%, mainly because equity attracts more buyers to the seller's auction. This resembles the classic theoretical result in Bulow and Klemperer (1996) about the importance of competition in auctions. It is *partially* consistent with the results of Gorbenko and Malenko (2011) and Carrasco and Hernandez-Chanto (2022), which stress the importance of security design for encouraging entry into auctions under competition. However, the results in Gorbenko and Malenko (2011) unambiguously imply that *debt* should be the security that attracts more bidders, while empirically it is the opposite. Despite the much stronger empirical incentive to use equities under competition, sellers' rate of running their auctions using equities does not differ across the Monopolistic and Competitive treatments.

Although an auction's security design does not seem to affect revenue when buyers cannot choose between auctions, it does affect buyers' bidding behavior. Here, we find that buyers overbid relative to the risk-neutral Nash equilibrium (RNNE) for all signals under debt and for extreme signals under equity. However, there is no evidence that the way buyers bid is affected by the number of opponents in the auction. This is consistent with the theoretical prediction for second-price auctions and excludes the possibility that buyers experience a cognitive bias of aggressiveness coming from higher competition.

Finally, as subjects act both as buyers and as sellers in the experiment, we can inspect how their choice of security designs as sellers correlates with their entry strategies as buyers. Contrary to the theory, we find that for some subjects there is a correlation between both choices. That is, those who more often choose to run their auctions using equity as sellers tend to enter equity auctions when given the choice. This is counter-intuitive because a subject that expects a particular security to increase payoffs or decrease risk for sellers should expect it to decrease payoffs or increase risk for buyers.

Organization of the paper Section 2 discusses the related literature. Section 3 introduces the theoretical model and gives experimental hypotheses. Section 4 describes the experimental design. Section 5 presents the main results regarding buyers' and sellers' behavior and auctions' revenue and efficiency under all treatments. Finally, Section 6 presents some concluding remarks.

2 Related literature

There is an increasing body of literature devoted to the analysis of security-bid auctions due to their growing importance in the allocation of many complex projects and assets across various markets. This analysis has built on the early observation in Hansen (1985) about the fact that equity auctions yield higher revenue than cash auctions due to the greater linkage they create. This observation was later developed in Riley (1988) and Rhodes-Kropf and Viswanathan (2000) to include auctions that combine cash and equity payments. Later on, DeMarzo et al. (2005) generalized this finding to a large class of securities, showing that steeper securities generate higher revenue. The revenue superiority of security-bid auctions over their cash counterparts hinges on several assumptions that later endeavors relaxed in order to inspect more closely the relationship between steepness and revenue in richer environments. For instance, this relationship does not necessarily hold with particular types of adverse selection, moral hazard, or negative externalities (Che and Kim, 2010; Kogan and Morgan, 2010; Hernandez-Chanto and Fioriti, 2019). Conversely, other features of the economic environment reinforce the beneficial role of steepness, such as endogenous entry or risk-averse buyers (Sogo et al., 2016; Fioriti and Hernandez-Chanto, 2021).

Interestingly, most of the literature has focused on the analysis of monopolistic auctions, yet the most natural applications involve the competition of sellers for a limited number of buyers, as shown in the examples in the introduction. To incorporate this feature, Gorbenko and Malenko (2011) extended the framework in DeMarzo et al. (2005) to include the possibility of having multiple sellers competing for a set of buyers. It focused on symmetric equilibria and showed that any security can be part of an equilibrium by inducing adequate levels of participation. Moreover, it showed that, in large markets, the unique equilibrium is in pure cash, and that binding reserve prices can never constitute part of an equilibrium as long as the security design is not a call option.

Carrasco and Hernandez-Chanto (2022) extended the study of security-bid auctions under competition to include risk-averse bidders. It showed that when there are only two competing sellers (as in our setting) any equilibrium must be symmetric if bidders are homogeneously risk-averse. Furthermore, it showed that when bidders are heterogeneously risk-averse, sellers separate in their security design, in the sense that one seller chooses the steeper security to attract the most-risk-averse bidders and the other chooses the flatter one to attract the least-risk-averse bidders. This behavior is based on the fact that steeper securities provide greater insurance, which is more valuable for more risk-averse bidders (Fioriti and Hernandez-Chanto, 2021). The current paper uses an experimental approach based on the economic environments proposed in Gorbenko and Malenko (2011) and Carrasco and Hernandez-Chanto (2022) to empirically study the effects of competition.

It is difficult to empirically test many of the theoretical results shown in the literature due to a lack of data.[3] Buyers must usually complete due diligence to simply make bids, and these bids are normally not publicly available because they can reveal crucial information about bidding firms. For these reasons, it is natural to use an experimental approach: the researcher controls selling mechanisms and market structures and directly observes choices and private information. Additionally, concerns about complementarities between projects, common values, repeated-game incentives, or other omitted variables are ruled out by construction.

Following this methodology, Kogan and Morgan (2010) considered a situation where two entrepreneurs compete for the funds of an investor by bidding in an English auction conducted under either equity or debt. The entrepreneur who obtains the funds can exercise costly effort to increase the value of her project. The returns to effort are fixed and are only realized if the project is successful. As such, the setting is one with competition in formal auctions under *moral hazard*. Kogan and Morgan (2010) analyzes the *extraction-incentives* trade-off implicitly entailed in the equity-debt choice: equity is more extractive but induces entrepreneurs to exert less effort, whereas debt does the opposite. In contrast, we abstract from moral hazard considerations but consider sellers who compete by means of their security designs. Then, in our model, sellers are concerned primarily with buyers' pre-auction entry decisions rather than

[3] Bhattacharya et al. (2022) and Kong (2021), both of which examine auctions for oil and gas leases in the Permian Basin, are notable exceptions.

post-auction effort decisions.

Breig et al. (2022) experimentally tested buyers' and sellers' behavior in both formal and informal security-bid auctions. In formal auctions, the format is predetermined, given by a combination of either a first- or a second-price rule and either an equity or a debt security design. In informal auctions, buyers are free to choose to bid using either debt or equity (but not combinations thereof) and the seller is not bound by any rule to choose the winning bidder. Here, buyers use bids as signaling devices, so the seller must form beliefs about the value of each bid to choose the most attractive bid ex-post. The results showed that contrary to what the theory predicts, debt auctions generate more revenue than equity auctions. The superiority of debt in revenue is mainly driven by buyers' strong overbidding behavior under this security. In addition, second-price equity auctions generated slightly more surplus than other treatments and noisy bidding had differential effects depending on the format. In informal auctions, buyers used equity more often than theory predicts, and sellers successfully chose dominant bids, despite facing a complex decision problem that involves signaling incentives.

Contemporaneously to Breig et al. (2022), Bajoori et al. (2022) studied experimental first- and second-price auctions using cash and equity. In its setting, first-price equity auctions raise the highest revenue but both cash auction formats raise more revenue than second-price equity auctions. Unlike Breig et al. (2022), it showed that auctions using steeper securities (equity-bid auctions) outperform the auctions using flatter securities (cash auctions) in terms of revenue, although the relationship is only significant for first-price auctions and the difference is smaller than theory predicts.

We build on the framework of Breig et al. (2022) to study second-price auctions in both monopolistic and competitive environments. In contrast to Breig et al. (2022), sellers participating in our experiment need to choose a security design for their auction. In our Monopolistic treatment, this affects only the way bids and payments are made, whereas in competitive auctions it can affect both the entry of bidders to the auction and how they bid conditional on bidders' participation. Hence, we can test how buyers and sellers behave in a more complex environment when sellers play a simultaneous game against each other and where buyers' entry is endogenous.

Our results can be compared to other experimental work in which subjects act as sellers in auctions. Greenleaf (2004) and Davis et al. (2011) study how subjects choose reserve prices when acting as auctioneers. In Shachat and Tan (2015), buyers in reverse auctions make take-it-or-leave-it offers after the auction's conclusion. Breig et al. (2022) has a treatment in which subjects act as sellers in informal auctions, in which they choose between bids that are potentially made using different securities. Thus, the decision problem our sellers face, while common among actual auction designers, is novel to the experimental literature.

More broadly, we also contribute to the experimental literature in which several principals compete for agents by offering differentiated menus. For instance, Cabrales et al. (2010) analyzed a multi-stage game in which four teams of two principals compete by offering agents a contract from a fixed menu. Each agent must select one of the available contracts, meaning she chooses to "work" for a principal. After the "entry" stage is played, production is determined by the outcome of an effort game induced by the corresponding contract. Similarly, Cabrales et al. (2011) explored the effect that different degrees of bargaining power have on the selection of contracts when multiple principals compete for agents that have hidden information. In contrast to these works, we do not consider moral hazard and use auctions instead of bargaining protocols; additionally, we allow buyers to contract with securities instead of cash.

3 Theoretical framework and hypotheses

In this section, we discuss the theoretical results that are relevant to our experimental design. We present the simplest possible environment that captures the main features of sellers' competition for bidders through their security-design choices.

A set of sellers $\mathcal{S} = \{1, \ldots, n_s\}$ have one indivisible project each and seek to individually allocate the n_s *ex-ante identical* projects among a set of interested buyers $\mathcal{B} = \{1, \ldots, n_b\}$. Each seller uses a second-price auction to allocate his project. Although the format is predetermined, sellers have the flexibility to choose the security design between the equity and debt families to run their auctions.

Conditional on winning the auction, any buyer $i \in \mathcal{B}$ must make a non-contractible investment of $\kappa = 2000$ to implement any project. This investment can be interpreted as the cost of forgoing other investment opportunities due to the allocation of funds from buyers' portfolios and is common knowledge to all buyers. If buyer i acquires a project and makes the required investment, the project yields a stochastic and contractible revenue of $Z_i \in \mathcal{Z} \triangleq \{z_L, z_H\}$, where $z_L = 2000$ refers to the revenue that the project yields in the low state of the world and $z_H = 6000$ refers to the revenue in the high state. A project has no value if it is retained by any seller.

Buyers observe sellers' choices of security designs before deciding which auction to join. After selecting an auction, each buyer i receives a private signal $p_i \in [0,1]$ that corresponds to the probability of being in the high state. Hence, the distribution of Z_i conditional on the buyer's signal is Bernoulli with parameter p_i. Bidders learn their signals after entering their chosen auction since due diligence is costly. Signals are drawn independently from a uniform distribution on the unit interval. All probability mass (density) functions are commonly known by all sellers and buyers.

Securities Bids are expressed by derivative securities in which the underlying asset is the project's revenue Z. A security is a function that maps $\mathcal{Z}$ to payments to the seller. We focus on two types of securities, presented below.

- Debt: When A buyer wins the auction at a "price" of d, she retains all revenue above d. That is, the payment to the seller for any revenue z is $\min\{z, d\}$.
- Equity: When a buyer wins the auction at a "price" of e, she retains a proportion $1 - e$ of the revenue. That is, the payment to the seller for any revenue z is $e \times z$.

A graphical representation of these securities and how they map revenue to payments can be found in Figure 1.

Market structure We consider two market structures that vary in the competition faced by sellers. The first one corresponds to monopolistic auctions, in which one seller seeks to sell one project among the set of buyers $\mathcal{B} = \{1,2\}$. The second one corresponds to competitive auctions. Here, two sellers $\mathcal{S} = \{1,2\}$ compete to allocate their ex-ante identical indivisible project among $\mathcal{B} = \{1,2,3,4\}$ buyers by means of their choices of security designs.

The competitive structure introduces a tension in the seller's choice of design. The reason is that when bidders are risk-neutral, flatter securities (e.g., debt) ex-ante attract more bidders but generate lower revenue conditional on entry; whereas stepper securities (e.g., equity) ex-ante attract less bidders but yields a higher revenue conditional on entry. Furthermore, Fioriti and Hernandez-Chanto (2021) demonstrates that in the presence of risk-averse bidders, the

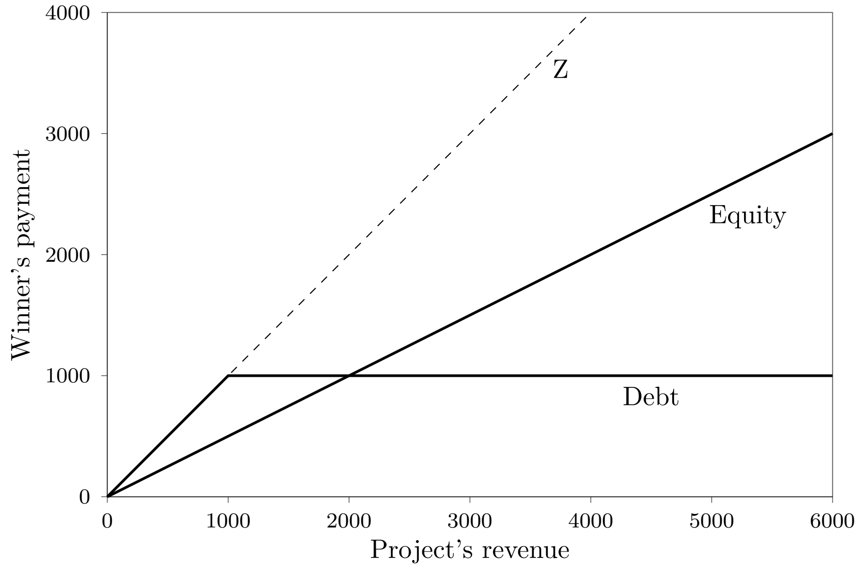


Figure 1: Example mapping of project revenue to payments from the winner to the seller for debt and equity.

entry strategies of these bidders and the revenue of sellers are influenced by the insurance effect embedded in each security design. This adds complexity to sellers' decision-making process regarding their choice of security design.

Auction format We focus on second-price auctions, in which the winner is the buyer who submits the highest bid, and the final price paid corresponds to the second-highest bid.

Equilibrium In a competitive scenario, the model entails analyzing a sequential game whose solution is determined through a subgame perfect Nash equilibrium (SPNE). The supergame has three subgames corresponding to: (i) the choice of seller's security design; (ii) the buyers' entry decision; and (iii) buyers submission of security bids. We solve for the SPNE using backward induction.

Timing Figure 2 depicts the timeline of the sequential game under seller's competition. First, each seller chooses a security design from equity and debt to run their corresponding second-price auction. Then, bidders observe the sellers' choices and make auction-entry decisions. Once bidders enter an auction, they learn their signal about the future revenue of the project, observe the number of competitors in their chosen auction, and submit their bids. Then, a winner is determined in each auction. Finally, projects' revenues are realized and payments are made.

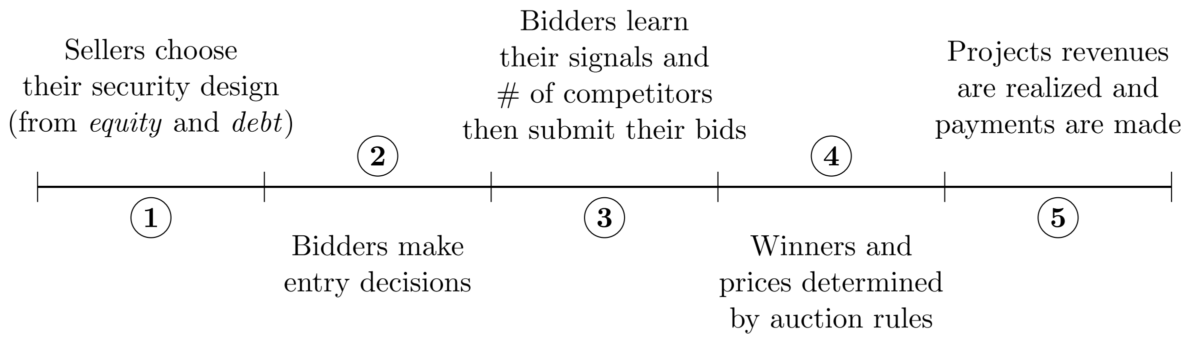


Figure 2: Timing of the two competing auctions.

3.1 Buyer Behavior

3.1.1 Bidding Strategies

DeMarzo et al. (2005) and Fioriti and Hernandez-Chanto (2021) show that, as in second-price auctions using cash, the unique symmetric equilibrium is for buyers to submit a bid that makes them indifferent between losing the auction and winning at a price equal to their bid. In fact, this strategy is weakly dominant, so buyers' beliefs about other players should not affect their choices. A risk-neutral buyer making a bid using equity should use a bidding function $e^*(p)$ that satisfies

$$0 = (1 - e^*(p))[pz_H + (1-p)z_L] - \kappa. \tag{1}$$

The left-hand side of equation (1) reflects that any buyer receives a payoff of zero conditional on losing the auction, whereas the right-hand side gives the expected payoff for the buyer if they win the project at a price of $e^*(p)$. The equilibrium bidding function for second-price debt auctions can be computed in a similar manner. These computations lead to our prediction for bidding behavior in the experiment.

Hypothesis 1. *In second-price auctions using debt, buyers will bid according to*

$$d^*(p) = \begin{cases} 4000p \ \textit{if } p \leqslant \frac{1}{2} \\ 6000 - \frac{2000}{p} \ \textit{otherwise,} \end{cases} \tag{2}$$

while in second-price auctions using equity, buyers will bid according to

$$e^*(p) = \frac{2p}{2p+1}. \tag{3}$$

Importantly, submitting a bid that induces an expected payoff equal to the buyer's outside option is a dominant strategy regardless of the number of opponents in the auction.

The theoretical results from the security-bid auction literature also provide strong predictions about the relative efficiency of the auction formats. In the equilibria described above, bidding strategies are increasing in the buyers' private signals so the project is always assigned to the participant buyer with the highest chance of generating high revenue.

Hypothesis 2. *Conditional on the set of buyers in the auction, all auctions are efficient. That is, the buyer with the highest signal in the auction wins.*

3.1.2 Auction Entry

Toward determining the ex-ante entry probabilities for each auction, we first need to compute buyers' interim and ex-ante utilities of joining each particular auction for each possible number of participants in the auction. It is worth highlighting that bidders' interim utilities can be computed at two stages conditional on their entry decision to an auction run under $S \in \{D, E\}$: (i) when bidders know both the number of opponents in the auction and their signal, $U(k, p_i|S)$; and (ii) when bidders only know the number of opponents in the auction, $U(k|S)$.

Because the auction format is a second-price, if there is only one entrant, the winning buyer obtains the rights to the project at a price of zero. That is, if there is only buyer in an auction then their expected payoffs are the revenue generated from the project, so $U(1, p_i|D) = U(1, p_i|E) = 6000p_i + 2000(1 - p_i) - 2000 = 4000p_i$. Conversely, when there is competition within the auction, the price paid in the auction depends on the second-order statistic of the signal, whose density is denoted as $f(y; k) = (y - 1)^{k-2}$. Hence, when the number of buyers in an auction is $k \geqslant 2$, a bidder's interim utility in a debt auction corresponds to:

$$U(k, p_i|D) = \int_0^{p_i} \left[p_i(6000 - d^*(y)) + (1 - p_i)\max\{2000 - d^*(y), 0\} - 2000\right] f(y; k)dy.$$

Similarly, for equity we have

$$U(k, p_i|E) = \int_0^{p_i} [(1 - e^*(y))[6000p_i + 2000(1 - p_i)] - 2000]\, f(y;k)dy.$$

We then compute the expected utility conditional on the number of entrants as

$$U(k|S) = \int_0^1 U(k, p_i|S) f(p_i)$$

for any $S \in \{D, E\}$.

As the number of participants in an auction increases, buyers' expected payoff decreases due to the increase in competition. Additionally, Gorbenko and Malenko (2011) shows that expected payoffs take a particular shape, regardless of the family of securities and distribution of signals.

Hypothesis 3. *Expected payoffs for buyers are decreasing and convex in the number of entrants for both debt and equity.*

Given the security choices made by the sellers, S_1, $S_2 \in \{D, E\}$, we label the probability that the buyer enters the S_1-auction as $q(S_1, S_2)$. In equilibrium, buyers will enter whichever auction offers them weakly higher payoffs in expectation. These payoffs depend on the security that is chosen for the auction and the probability that other buyers will enter the auction. Since we focus on symmetric equilibria, the payoffs from entering the S_1-auction are

$$\mathcal{U}(S_1) = \sum_{k=1}^{4} \binom{3}{k-1} q(S_1, S_2)^{k-1}[1 - q(S_1, S_2)]^{4-k} U(k|S_1)$$

It follows immediately that the unique equilibrium entry strategy when both sellers choose the same family of securities is for the buyers to randomize equally between entering the two auctions. When the same family is being used in both auctions, every buyer would strictly prefer to enter the auction other buyers are choosing with a probability of less than one-half. Thus, the only equilibrium strategy is $q(D, D) = q(E, E) = 0.5$. When the sellers choose different securities, there is a unique value for $q(E, D)$ that equates the payoffs of entering both auctions.[4]

[4]The explicit numeric calculations can be found in Appendix A.

Hypothesis 4. *In any symmetric equilibrium, the buyers' entry strategy q^* is such that:*

i) If buyers are risk-neutral or homogeneously risk-averse then $q^*(D, D) = q^*(E, E) = 0.5$.

ii) If buyers are risk-neutral $q^*(E, D) = 1 - q^*(D, E) \approx 0.463$.

3.2 Seller Behavior and Payoffs

The vast majority of the literature on security-bid auctions has focused on the study of monopolistic auctions. Seminal work by Hansen (1985), Riley (1988), and Rhodes-Kropf and Viswanathan (2000) shows the revenue-dominance of equity auctions over cash auctions. This result was later generalized by DeMarzo et al. (2005) to a large class of securities that satisfy two-sided limited liability and which include all standard securities (e.g., debt, equity, and call options). DeMarzo et al. (2005) shows that if two securities can be ordered using the notion of steepness, then the steeper security yields the seller a greater expected revenue than the flatter one.

Hypothesis 5. *Conditional on the number of buyers, a second-price equity auction generates a higher expected revenue than a second-price debt auction.*

It is important to note that while the parametric nature of our model allows us to give point predictions for revenue, the *ranking* implied by these predictions is much more general. This ranking follows the results of DeMarzo et al. (2005), which characterizes securities in terms of what they call steepness. A security is steeper than another if the seller's expected payment has a "greater slope" under the steeper security, starting at the signal level at which both securities yield the same expected payment. From Figure 1, it can be seen that equity is steeper than debt. DeMarzo et al. (2005) shows that for a fixed number of participants in the auction, steeper securities generate higher revenue under fairly general conditions.

When both sellers and bidders are risk neutral, the seller's expected revenue, conditional on the number of buyers, can be expressed as

$$V(k|S) = \int_0^1 [4000p](kp^{k-1})dp - kU(k|S).$$

That is, the seller's expected revenue can be expressed as the total surplus generated by the project when k bidders participate minus the corresponding buyers' expected surplus. Gorbenko and Malenko (2011) shows that the seller's expected revenue depends on the number of buyers in a consistent way regardless of security choice.

Hypothesis 6. *For any security design $S \in \{D, E\}$ and number of participant buyers $k > 0$, the seller's interim expected revenue is an increasing and concave function of k.*

We are now able to make predictions about the choices of sellers. The first hypothesis about seller behavior is for the monopolistic case and follows directly from Hypothesis 5.

Hypothesis 7. *Monopolistic sellers will choose to run their auction using equity.*

Hypothesis 7 follows from the fact that equity-bid auctions generate more revenue than debt-bid auctions under risk neutrality. This hypothesis is robust to risk aversion among buyers: For a given signal, a bid made in equities will provide the buyer with more insurance, leading risk-averse buyers to bid more aggressively, maintaining the dominance of equities over debt for the seller (Fioriti and Hernandez-Chanto, 2021). However, this result is not necessarily robust to risk aversion among sellers. In the same way that equity bids provide insurance for buyers, debt bids provide insurance for sellers. Thus, a sufficiently risk-averse seller may prefer to run their auction using debt.

While determining the seller's optimal choice is straightforward in the monopoly case, this reasoning cannot be straightforwardly applied in the case of competition. The reason is that competition introduces another force to the seller's decision problem: the problem of attracting buyers to the auction. The higher revenue of auctions using steeper securities is driven by higher levels of surplus extraction from buyers. This, in turn, leads to buyers being less willing to select these auctions to enter, holding fixed their other alternatives. Because sellers earn more from auctions with more buyers, in equilibrium, they must trade off the incentives for buyers' attraction and surplus extraction given the choices of other sellers.

To determine the equilibrium security choice for sellers, we take the equilibrium behavior of buyers (including bidding behavior and auction entry decisions specified in Hypotheses 1 and 4) as a given. The payoff for Seller i of choosing security S_i while seller j chooses S_j can be written as

$$\mathcal{V}(S_i|S_j) = \sum_{k=0}^{4} \binom{4}{k} q(S_i, S_j)^k [1 - q(S_i, S_j)]^{4-k} V(k|S_i). \tag{4}$$

		Seller 2	
		Debt	Equity
Seller 1	Debt	(1182.48, 1182.48)	(1282.05, 1304.11)
	Equity	(1304.11, 1282.05)	(1424.02, 1424.02)

Figure 3: Theoretically predicted security choice game for sellers

Equation 4 makes the seller's tradeoff clear. Running the auction using equity bids increases the profits for a given number of sellers, i.e., $V(k|E) \geqslant V(k|D)$ for all k, but lowers the likelihood that buyers enter the auction, i.e., $q(E, S_j) < q(D, S_j)$ for any S_j. We compute $\mathcal{V}(S_i|S_j)$ for $S_i, S_j \in \{D, E\}$ and use it to create the normal form of the security choice game shown in Figure 3.

Examining the game in Figure 3, it is immediately apparent that there is a unique dominant-strategy equilibrium for sellers to run their auctions using equity bids. That is, regardless of the other seller's choice of security, it is always a dominant strategy with these parameters to choose to run the auction using equity. Thus, we should expect sellers in the experiment to run their auctions using equities. This provides us with our next hypothesis.

Hypothesis 8. *Under competition, sellers will choose to run their auction using equity.*

While the prediction under subgame perfect Nash equilibrium is that sellers will always choose equity, this expectation is tempered by a comparison of the payoff calculations under competition versus those under monopoly. In the unique equilibrium under competition, switching from debt to equity increases expected payoffs by 100-120, or less than 10%. On the other hand, switching from debt to equity as a monopolist increases expected payoffs by over 350, which is more than 25%. Thus, we may expect that sellers would be more likely to select debt under competition. This is consistent with the intuition presented in Gorbenko and Malenko (2011), which argues that larger markets (holding the ratio of buyers to sellers constant) should be associated with sellers using flatter securities.

Finally, we discuss the ex-ante expected distribution of payoffs under competition and relate them to the ex-ante expected distribution of payoffs under monopoly. Because each competitive setting has two projects that can be implemented, in making comparisons we divide the total surplus of the competitive setting by two.[5] Hypothesis 2, which states that auctions are efficient

[5] We note that even when dividing the total surplus it is possible for a fixed set of four signals to lead to higher surplus under competition than they do under monopoly. This could be true if the two highest signals

conditional on entrants, is expected to hold regardless of whether sellers are competitive or monopolistic. Thus, any differences in efficiency are due to the allocation of buyers across auctions.

Hypothesis 9. *As compared to Monopolistic auctions, Competitive auctions will generate less revenue, more buyer surplus, and less total surplus.*

The change in surplus distribution between Monopolistic and Competitive auctions is primarily a result of random buyer selection of auctions. The theoretical prediction under both settings is that sellers should run their auctions using equity. Thus, the change in surplus distribution is not due to differential surplus extraction as a result of different securities. Instead, this is a result of the concavity (convexity) of seller (buyer) payoffs with respect to the number of entrants. Introducing even a small amount of competition between buyers (moving from one to two buyers in an auction) increases seller payoffs and decreases buyer payoffs much more than adding a third or fourth buyer. Thus, the chance of having only a single buyer within an auction substantially reduces seller payoffs and increases buyer payoffs.

The reasoning for why total surplus is lower under Competitive auctions is similar. The expectation of the highest signal is a concave function of the number of entrants (David, 1997). Hence, in any symmetric equilibrium, the expectation of the average winning signal must be lower under competition than under monopoly, in which each auction is guaranteed to have the same number of entrants.

4 Experimental Design

The experiment consisted of four sessions conducted at the University of Queensland Behavioural and Economic Sciences Cluster (BESC) during the months of September and October of 2022. Subjects were recruited using Sona Systems, and a total of 126 individuals took part in the study. Demographic summary statistics are available in Appendix Table 9. Each subject appeared in only one session, which was completed in person via computer terminals. The experiments were coded using oTree (Chen et al., 2016). Screenshots of the experiment are provided in Appendix C.

split between the two auctions under competition but were allocated to the same auction under monopoly. However, this is not possible for the game that we described, because auction selection occurs prior to buyers observing their signals.

We designed the experiment to allow for within-subject analyses of how market structure and the security used for bidding affect behavior.[6] Each auction was carried out within one of three market structures: Automated, Monopolistic, and Competitive. Below, we refer to the variation of this market structure as the "Seller Treatment". The first ten auctions that each subject participated in were Automated, while auctions 11-30 alternated between Monopolistic and Competitive. In Automated auctions, a computer took the role of the seller and two subjects acted as buyers. In Monopolistic auctions (which we referred to as "3-player auctions"), one subject acted as a seller while two subjects acted as buyers. Finally, in Competitive auctions (which we referred to as "6-player auctions"), each group consisted of two subjects acting as sellers and four subjects acting as buyers. Groups and roles were randomized between each round of auctions.

All sessions followed the same procedure. Subjects were invited to the laboratory and directed to their assigned computer terminals. They were given a participant information sheet and a consent form to review and sign. Once the consent forms were collected, one of the experimenters read out loud the instructions for the first ten rounds. Subjects were then provided time to read through the instructions and practice with examples at their own pace before completing a quiz assessing their understanding of the rules of each type of auction. After completing the quiz, subjects participated in the 10 rounds of Automated auctions. Once these ten rounds were completed, the experimenter read out loud the instructions for the following twenty rounds and subjects completed another quiz to test their comprehension of two new auction formats, i.e., Monopolistic and Competitive auctions. They then completed rounds 11-30. Following the completion of all auction rounds, subjects filled out a brief survey and received payment for a randomly selected auction.

Aside from the treatments noted above, the economic fundamentals of each auction were the same and matched those described in Section 3. Payoffs were in points, with 100 points corresponding to one Australian dollar. At the beginning of each auction, both buyers and

[6] We also instituted a between-subjects ordering treatment at the session level using a 2×2 design. Specifically, in two sessions subjects used equity bids in the odd rounds of the Automated auctions, while they used debt bids in the even rounds. For the other two sessions, the order was reversed. Similarly, in two sessions Competitive auctions were completed in odd rounds, while in the other two sessions, they were completed in even rounds. This variation allows us to control for any order effects, and we do so by using either subject- or session-level fixed effects in all of our regressions. Three sessions had 30 subjects and one session had 36 subjects. We do not show these results because they are not the focus of our analysis, but they are available upon request.

sellers were endowed with 2000 points.

Automated auctions In Automated auctions, subjects are told the likelihood of obtaining high revenue if they win the auction. They are then reminded of the security design under which the auction was conducted (with equity-bid auctions being referred to as "percentage-bid" and debt-bid auctions being referred to as "point-bid"). The bidding page also includes an interactive feature to help them understand the potential outcomes of their bids. Examples of the bidding page for an equity-bid auction in this treatment can be found in Figure 4.

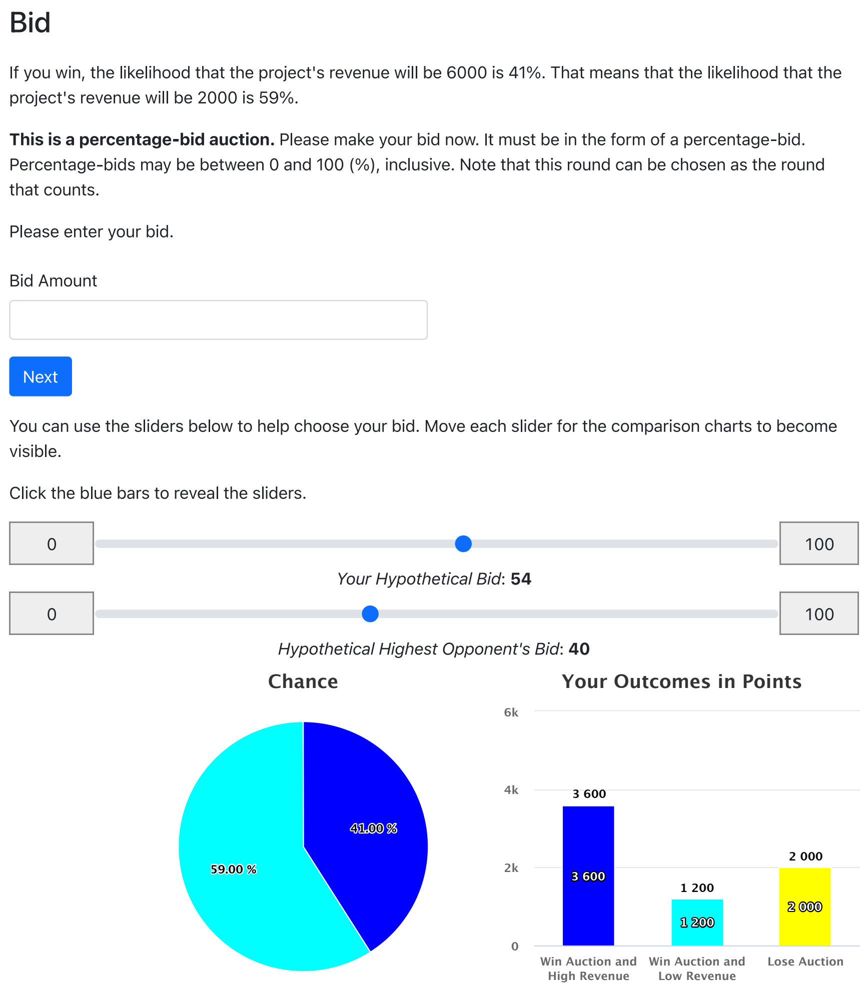


Figure 4: Bid page for an equity-bid auction in the Automated treatment.

After placing their bid (an integer between 0 and 6000 points in debt-bid auctions or an integer between 0 and 100 percent in equity-bid auctions), subjects were displayed with the auction's result. The winner of the auction was informed of her potential high and low payoffs and the probabilities of receiving them. She was also informed about the losing bid. Meanwhile, the loser was informed of their payoffs and their opponent's bid. Neither buyer was informed of the revenue realization or their opponent's signal. An example of a winning buyer's results page can be found in Figure 5.

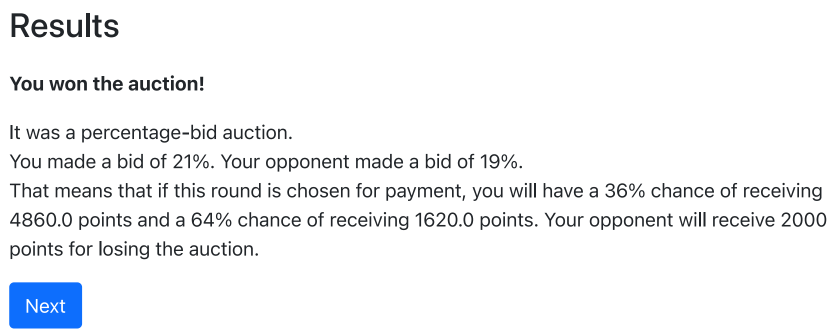


Figure 5: Results page for winner of a percentage-bid auction.

Monopolistic auctions In Monopolistic auctions, the subject assigned the role of the seller moved first, determining whether their auction would be run using either debt bids or equity bids. The security choice page provided the sellers with an interactive feature that displayed their payments for each security conditional on the realized price and revenue level. An example of the security choice page for a seller can be found in Figure 6.

Once the seller made their choice, the subjects assigned the role of buyers were given a bidding page that was similar to those from the Automated auctions. Buyers were informed of the security design that the seller selected. After both buyers submitted their bids, the auction results were displayed to all parties. The buyers were presented with the same information they received in the Automated treatment. The seller was reminded of the auction design they chose, informed of the winner and loser's bid, and given information on their potential payoff in both states of the world. However, they were not informed about the realization of the revenue, the winner's signal, or the loser's signal.

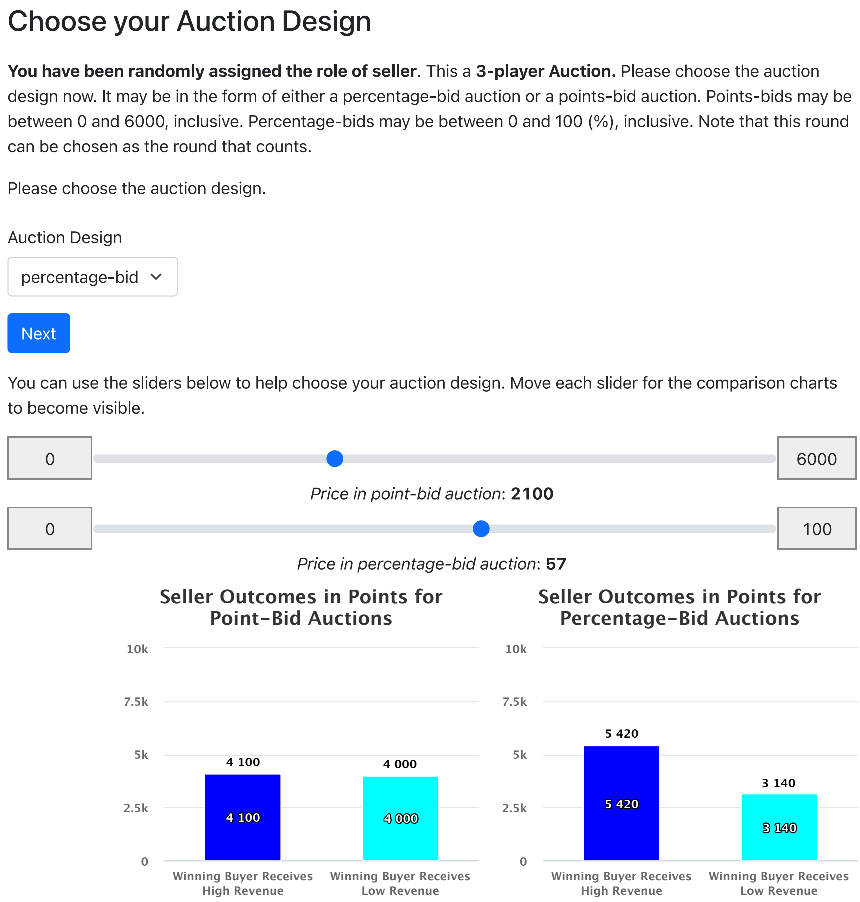


Figure 6: Seller's security design page for a Monopolistic auction.

Competitive auctions In Competitive auctions, subjects assigned the role of the seller were given the option to choose between debt and equity for their auction. They were provided with the same interactive feature as was provided in Monopolistic auctions, showing payments to the seller conditional on security, realized price, and realized revenue.

After both of the sellers had chosen their security design, the four buyers were informed of the sellers' choices and given the option to choose which auction to enter. When making this decision, buyers had access to an interactive feature that allowed them to compute their payoffs conditional on the security used and the realized price. Consistent with the theoretical model, buyers made their choice simultaneously and did not know the number of other buyers entering either auction. Figure 32 in the Appendix shows an example of the auction choice page for a

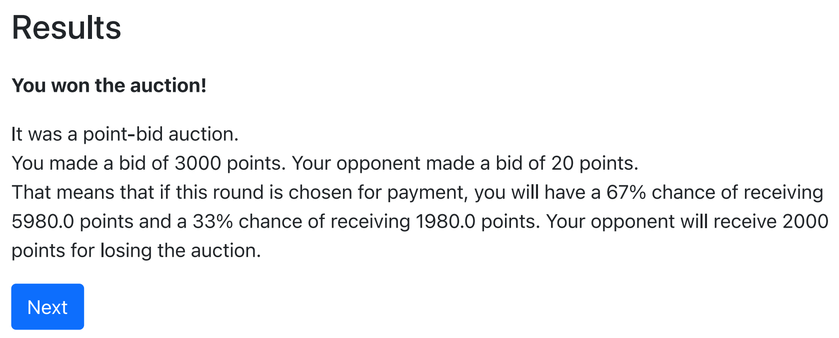


Figure 7: Results page for the winner of a Monopolistic point-bid auction.

buyer.

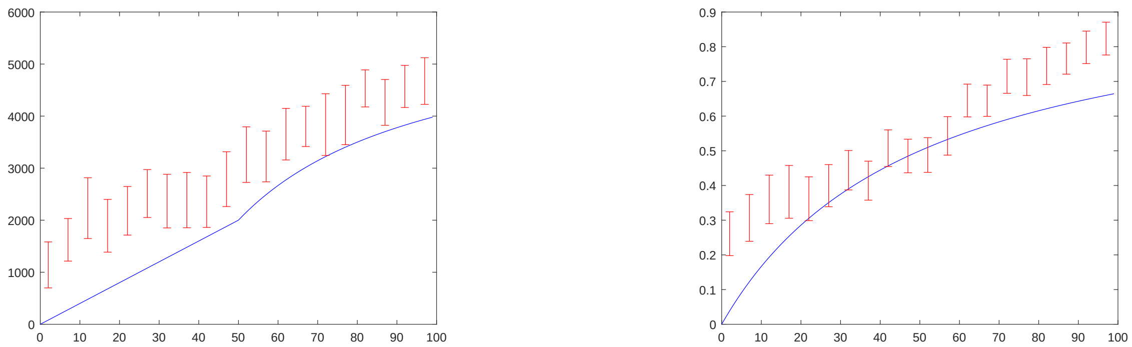
After selecting which auction to enter, buyers moved to the bidding page.[7] Each buyer is informed about the number of opponents in the auction and makes a bid. Otherwise, the bidding page was similar to those in the Automated and Monopolistic auctions.

Once all bids in both auctions were made, the results were presented to each subject in the group. All participants are informed of the number of buyers in their auction, the winning and the second-highest bids in their auction, and the potential payoffs they could receive. Only the winning bidder is informed of the chances of receiving those payoffs. If a subject was the only participant to enter an auction, they were informed that they won the auction by default.

Payoffs and Survey After finishing all thirty auction rounds, the computer randomly chose one round to determine payments. The subjects were informed of the chosen round and the potential outcomes with their respective probabilities. They were also informed of any randomizations that occurred and their total payments. Subsequently, they completed a demographic survey and a cognitive reflection rest (Frederick, 2005). Subjects were asked to provide feedback on the experiment as well as their level of understanding of the experiment and their level of confidence in their strategy.

In addition to any earnings from the round selected for payment, all subjects were paid $20 for completing the experiment and $1 for each quiz question they answered correctly. Sessions

[7]If only one buyer entered an auction, that buyer did not make a bid. This is because they would automatically win the auction at a price of zero, so the bid was effectively unincentivized. In both this case and the case in which no buyers entered an auction, the bidding page was skipped entirely.



(a) Second-price debt

(b) Second-price equity

Figure 8: Average bids with 95% confidence interval conditional on signals falling within windows of 5

lasted two hours. Payments ranged from \$24 to \$99 with an average total payment of \$56.42.

5 Results

5.1 Buyer behavior and payoffs

Average bidding behavior as a function of the buyer's signal can be found in Figure 8, with debt-bid auctions summarized in panel (a) and equity-bid auctions summarized in panel (b). The Nash equilibrium bids provided in Hypothesis 1 are shown in blue. Bids from the experiment are pooled in windows of 5 signals (0-4, 5-9, etc. until 95-100) for comparison purposes. We then compute 95% confidence intervals for the average bid conditional on the signal being within the window and plot them in red.[8] The figure indicates that subjects overbid for all signals in debt-bid auctions and for extreme signals in equity-bid auctions. Thus, we can reject Hypothesis 1.

Result 1. *Subjects overbid on average for all signals in debt auctions and for all but intermediate signals in equity auctions.*

The effect of changes in competition can be found in Table 1. The table presents coefficients from a fixed-effects regression of the level of overbidding (the subject's bid minus the RNNE

[8]These results are very similar to those that were found in Breig et al. (2022). A direct comparison of average bidding functions can be found in Appendix Figure 11.

bid) on the treatment variables and round, which is a proxy for experience.[9,10] Columns (1) and (3) restrict attention to debt-bid auctions while columns (2) and (4) restrict attention to equity-bid auctions. In all regressions, the constant is positive and statistically significant, reflecting the overbidding already identified in Result 1. The results show that there are no statistically significant differences in overbidding between auctions held under monopoly and competitive settings.[11]

Table 1: Overbidding levels by treatment

	(1) Overbid	(2) Overbid	(3) Overbid	(4) Overbid
Monopolistic	-20.5	-2.77	93.7	-4.84**
	(123.9)	(1.76)	(159.7)	(1.92)
Competitive	-193.7	-1.13	-70.6	-3.09*
	(136.8)	(1.67)	(196.7)	(1.77)
Round			-8.01	0.13
			(10.2)	(0.11)
Constant	1013.4***	10.3***	1057.4***	9.61***
	(49.4)	(0.98)	(83.7)	(1.38)
Security	Debt	Equity	Debt	Equity
Observations	1130	1696	1130	1696

Notes: Linear regression with subject-level fixed-effects and standard errors clustered at the subject level. Significance indicated by: *** p<0.01, ** p<0.05, * p<0.1.

We now turn to the question of whether the *number* of bidders affects bidding in an auction. Because these are second-price auctions, it is a dominant strategy to bid at the level where the buyer is indifferent between losing the auction and winning the auction at their bid. Thus, the number of buyers in an auction *should* not affect bids. Table 2 presents the results of fixed-effect regressions in which the dependent variable is the level of overbidding and we control for

[9]The total number of buyer-participations in auctions was 2940: all 126 subjects completed 10 rounds of Automated auctions for 1260 bids, while $(2/3) \times 126 = 84$ subjects participated in each of the 20 rounds of Monopolistic or Competitive auctions. The total number of observed bids is only 2826 because 114 competitive auctions had only one buyer enter. That buyer would always win the auction at a price of zero, so any bid would be unincentivized and we did not ask the buyer to make one.

[10]Appendix Table 10 completes the same analysis but with a focus on overbidding *rates* rather than levels. The signs of coefficients are largely the same, with consistent overbidding on average but no significant differences between the Monopolistic and Competitive treatments.

[11]Overbidding with equities seems to be lower in the Monopoly and Competitive treatments, but this result should be interpreted with caution. Rounds $1-10$ were all Automated auctions, while the Monopolistic and Competitive treatments were applied in rounds $11-30$. If experience affects overbidding non-linearly, which is likely, then the effects of experience and treatment will be conflated.

the number of bidders. Columns 1 and 2 include all auctions, whereas columns 3 and 4 only include competitive auctions. In line with the theoretical prediction, the results show that bids are not substantially higher when there are more bidders in the auction.

Result 2. *Bidding behavior is not affected by the number of buyers in an auction.*

Table 2: Overbidding levels by number of bidders

	(1) Overbid	(2) Overbid	(3) Overbid	(4) Overbid
Monopolistic	100.7	-4.83**		
	(163.4)	(1.95)		
Competitive	-90.9	-2.99		
	(251.0)	(2.16)		
Round	-8.55	0.13	20.4	0.30*
	(10.5)	(0.11)	(20.5)	(0.16)
Num. Bidders=3	85.6	-0.13	169.8	0.017
	(232.4)	(1.78)	(255.3)	(1.94)
Num. Bidders=4	-124.4	-0.14	-252.2	0.091
	(346.3)	(2.85)	(391.0)	(2.70)
Constant	1060.6***	9.61***	221.4	3.57
	(84.8)	(1.38)	(414.7)	(3.72)
Security	Debt	Equity	Debt	Equity
Competitive Only	No	No	Yes	Yes
Observations	1130	1696	200	526

Notes: Linear regression with subject-level fixed-effects and standard errors clustered at the subject level. Significance indicated by: *** p<0.01, ** p<0.05, * p<0.1.

Table 3 conducts a regression analysis on how the number of bidders in the auction affects surplus.[12] In columns (1) and (2), the dependent variable is the auction's Misallocation, which is defined as the potential ex-interim surplus (defined as the expected surplus conditional on the buyer with the highest signal winning the auction) minus the realized ex-interim surplus (the expected surplus conditional on the signal of the auction's actual winner). Auctions with only one buyer are omitted because there is no Misallocation in these auctions by construction. The results show that there is Misallocation and that this Misallocation is increasing in the number of buyers (although the latter relationship is only significant for equity-bid auctions). Thus, we reject Hypothesis 2 that all auctions are efficient conditional on the set of buyers.

[12]These regressions are computed with data from all auctions. The results are reproduced with data from only Competitive auctions in Appendix Table 11. Patterns are broadly similar, although average buyer surplus is no longer convex in the number of entrants in equity-bid auctions.

Table 3: Misallocation & buyer surplus

	(1) Misallocation	(2) Misallocation	(3) Avg. Buyer Surplus	(4) Avg. Buyer Surplus
# Buyers=2			-1554.4***	-1837.3***
			(172.3)	(150.7)
# Buyers=3	85.8	173.8**	-1936.4***	-2127.1***
	(144.7)	(77.1)	(185.0)	(153.0)
# Buyers=4	200.8	368.4**	-2067.0***	-2342.2***
	(249.7)	(158.2)	(276.7)	(155.1)
Constant	309.7***	273.4***	1872.4***	2161.9***
	(28.8)	(21.3)	(165.9)	(148.3)
Security	Debt	Equity	Debt	Equity
Observations	544	784	601	841

Notes: Linear regression with session- and round-level fixed-effects and robust standard errors. Significance indicated by: *** p<0.01, ** p<0.05, * p<0.1.

Result 3. *The buyer with the highest signal does not always win, and surplus lost to Misallocation is increasing in the number of bidders.*

Columns (3) and (4) of Table 3 show how the number of buyers in an auction affects Average Buyer Surplus in debt-bid and equity-bid auctions respectively. Average Buyer Surplus is calculated as the project's expected revenue minus the expected payment to the seller, *divided by the number of bidders.* The omitted category corresponds to the case where there is only one bidder, so the constant represents what the bidder gets if she is the only participant in the auction.[13] The results show that empirically, Average Buyer Surplus is decreasing and convex in the number of bidders, which is consistent with Hypothesis 3.

Result 4. *Average Buyer surplus is decreasing and convex in the number of entrants for both debt and equity.*

We now evaluate how buyers make choices in competitive auctions. The theoretical prediction is that buyers will balance the likelihood of being in an auction with fewer bidders with the properties of the security used in those auctions. Table 4 reports the rate of selecting to enter the equity-bid auction when the buyer faces both types of security. In column (1), the independent variable ED controls for the labeling of auctions, and is equal to one when equity bids were chosen by the "first" seller and debt bids were chosen by the "second" seller. The

[13] Because the allocation of buyers to auctions occurs in a way that is unrelated to buyers' signals, this constant should be 2000, which is the expected surplus of a project with a single randomly allocated buyer.

regression shows that the rate of choosing to enter equities is roughly 60%, which is significantly higher than the predicted value of 46.3%. Thus, we reject Hypothesis 4 part *ii*.[14] In column (2), we control for Round (which, for competitive auctions, spans the range from 11 to 30) to proxy for experience. While there is some evidence that subjects are less likely to choose to enter equity-bid auctions as they become more experienced, the relationship is not significant and not large enough to approach the equilibrium prediction.

Table 4: Buyer security choice

	(1) Equity Chosen	(2) Equity Chosen
ED	-0.029	-0.025
	(0.052)	(0.052)
Round		-0.0037
		(0.0043)
Constant	0.61***	0.68***
	(0.026)	(0.089)
Observations	424	424

Notes: Linear regression with subject-level fixed-effects and standard errors clustered at the subject level. Significance indicated by: *** p<0.01, ** p<0.05, * p<0.1.

Result 5. *When presented with two auctions using different securities, buyers choose to enter equity auctions with a probability of roughly 60%. Entry into equity-bid auctions is positively correlated with quiz scores, negatively correlated with subjects' self-reported understanding of rules, and uncorrelated with other demographics.*

Result 5 also discusses the subject-level correlates of choosing to make bids with equities. The evidence for these results can be found in Appendix Table 12. The results show that none of the demographic measures we collected were significantly correlated with choosing to enter equity-bid auctions. The regressions also show that rates of overbidding in the Automated auctions are unrelated to the choice of security as a buyer, but that choice of security as a seller is highly correlated with choice as a buyer. This final point will be explored further in Section 5.2.

[14] For buyers choosing between two auctions using the same security, the only feature that differentiated the two auctions was their label (1 or 2). Thus, the only way that Hypothesis 4 part *i* could be rejected would be for buyers to favor one of these labels. While we do not find order effects when buyers face two different securities, we do find that subjects are slightly more likely to choose auction one than auction two when both securities are the same. These results can be found in Appendix Table 13.

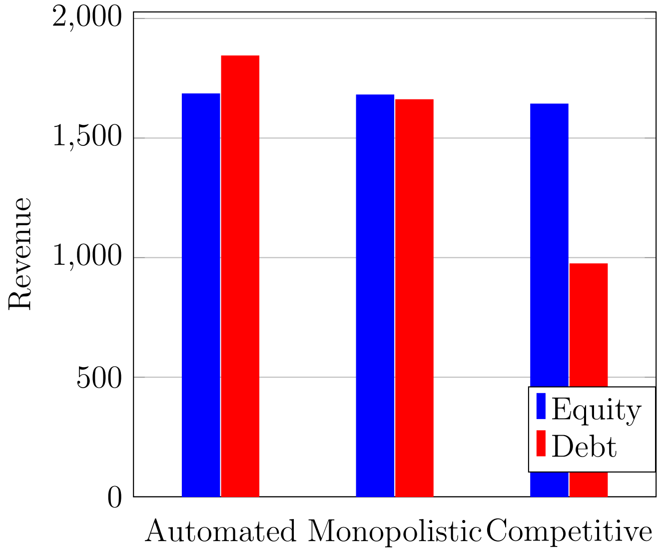


Figure 9: Average revenue by treatment and security

5.2 Seller behavior and payoffs

We now turn to the payoffs that the seller receives across treatments and as a function of security choice. Figure 9 presents the average revenue generated by auctions according to the security used and the seller treatment. Corresponding regression results can be found in Appendix Table 14, and distribution of payoffs for sellers across monopolistic and competitive auctions can be found in Appendix Figure 12.

Result 6. *The security used for bidding does not have a statistically significant effect on revenue in Automated or Monopolistic auctions.*

The figure shows that the security used has only a minor effect on seller payoffs for Automated and Monopolistic auctions, and these differences are not statistically significant. We can reject the null hypothesis that equities generate revenue that is 359 points higher on average (two-sided tests generate p-values of less than 0.01 for Automated auctions and equal to 0.02 for Monopolistic auctions). Thus, this is evidence against Hypothesis 5.

The revenue conditional on the security and number of buyers in the auctions is shown in Table 5. The regressions include only auctions with at least two buyers because the revenue when there is a single seller is always zero by construction. Thus, the omitted category is when the number of buyers is equal to two. The results are consistent with Hypothesis 6 that interim expected revenue is an increasing and concave function of the number of buyers.[15] Furthermore, given that revenue increases dramatically when shifting from one to two buyers, it stresses the importance to sellers of inducing buyers to enter their auction.

Table 5: Revenue by security and number of bidders

	(1) Revenue	(2) Revenue
# Buyers=3	949.8***	830.8***
	(296.5)	(154.6)
# Buyers=4	1301.8	1487.7***
	(820.5)	(305.2)
Constant	1722.0***	1694.3***
	(66.8)	(51.1)
Security	Debt	Equity
Observations	544	784

Notes: Linear regression with session- and round-level fixed-effects and robust standard errors. Significance indicated by: *** p<0.01, ** p<0.05, * p<0.1.

Result 7. *Regardless of security choice, revenue is increasing and concave in the number of bidders for* $n \geqslant 1$*.*

We now turn to the effect of security choice on revenue in Competitive auctions. Figure 9 already shows that debt-bid auctions earn much lower revenue than equity-bid auctions under competition. This result is explored further in Table 6. Column (2) shows that not only does a seller's choice of security affect their revenue, but the security choice of the other seller also affects it substantially: choosing to run an auction using equity bids increases one's revenue, while the other seller choosing to run their auction using equity bids decreases one's revenue. In column (3), we demonstrate that the effect of security choice on payoffs primarily acts by encouraging entry into the auction. Controlling for the number of buyers that enter an auction, the estimated effects of both security choice and the other seller's security choice are more than halved and are no longer statistically significant.

[15]The results using only data from Competitive auctions can be found in Appendix Table 15. The results for equity-bid auctions are essentially the same, but for debt-bid auctions, the relationship between Revenue and the number of buyers is no longer concave. However, the results are very noisy and are only based on 79 auctions in total, with only 5 debt-bid auctions involving four buyers.

Table 6: Revenue by opponent security (competitive auctions only)

	(1) Revenue	(2) Revenue	(3) Revenue
Equity	670.7***	607.3**	301.6
	(162.1)	(236.4)	(340.0)
Opponent Equity		-472.6**	-154.4
		(225.9)	(368.8)
Equity × Opponent Equity		-7.06	-12.3
		(251.3)	(416.8)
# Buyers=3			871.9***
			(174.0)
# Buyers=4			1409.1***
			(316.8)
Constant	972.0***	1321.9***	1507.1***
	(115.9)	(179.8)	(312.1)
Only # Buyers ⩾ 2	No	No	Yes
Observations	420	420	278

Notes: Linear regression with session- and round-level fixed-effects. Standard errors are clustered at the market level, so each pair of competitive auctions belongs to its own cluster. Significance indicated by: *** p<0.01, ** p<0.05, * p<0.1.

		Seller 2: Debt	Seller 2: Equity
Seller 1	Debt	(1322, 1322)	(852, 1929)
	Equity	(1929, 852)	(1450, 1450)

Figure 10: Empirically realized (average) security choice game for sellers

We use the calculated payoffs from column (2) of Table 6 as payoffs to generate the normal-form game in Figure 10, which can be compared to its theoretically predicted counterpart in Figure 3. In both the theoretical prediction and the empirical realization, choosing equity is a dominant strategy for the sellers.[16] However, this relationship appears more strongly empirically than it does theoretically. The RNNE predicts that switching from debt to equity increases revenues by a *maximum* of 142, but empirically the *minimum* increase is 604.

Result 8. *Under competition, equity is the dominant strategy empirically. This is primarily the result of buyers being more likely to select equity auctions.*

We now turn to analyze the security choice by the seller in the auctions. Table 7 presents

[16] Indeed, as can be seen in Appendix Figure 12, the revenue generated by choosing to run the auction using equity first-order stochastically dominates the revenue generated by choosing debt.

the results of a fixed effects regression in which the dependent variable is sellers' security choices. Column (1) shows that there is no statistically significant difference between the Monopolistic and Competitive treatments in the rate of choosing Equity. Column (2) explores this relationship further by including round (which proxies for experience) and the interaction of round and the treatment variable. We find that experience is positively correlated with choosing to run Monpolistic auctions using equities, but that the relationship is not significant for Competitive auctions. However, when controlling for experience, there is a large and positive (albeit insignificant) effect of the Competitive treatment on the rate of choosing to use equities, so the predicted rates of choosing Equity at the end of the experiment are similar across treatments. Overall, we can reject Hypotheses 7 and 8. We also note that the theoretical prediction is that the gains from switching from Debt to Equity are higher in monopolistic auctions than in competitive auctions, while the empirical result is the reverse. Despite these facts, there is virtually no difference in the rates at which sellers choose to use equity-bid auctions across Monopolistic and Competitive Auctions.

Result 9. *Sellers choose equity roughly two-thirds of the time, regardless of competition levels.*

Table 7: Security choice by seller

	(1) Equity	(2) Equity
Competitive	-0.0052	0.16
	(0.034)	(0.12)
Round		0.011***
		(0.0037)
Competitive × Round		-0.0080
		(0.0053)
Constant	0.65***	0.42***
	(0.017)	(0.078)
Observations	840	840

Notes: Linear regression with seller-level fixed-effects and standard errors clustered at the seller level. Significance indicated by: *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Figure 9 shows that while security choice has a negligible effect on revenue generation in Monopolistic auctions, using equities in an auction substantially increases revenue in Competitive auctions. Despite this, sellers only choose to run their auctions using equities about two-thirds of the time regardless of the treatment. This suggests the question: why don't sellers use equities for their auctions more often?

Result 10. *Demographic characteristics are only weakly correlated with the choice of security as a seller. Subjects that prefer to enter equity-bid auctions as a buyer are more likely to choose to use equities as a seller.*

The evidence for Result 10 can be found in Appendix Table 16. We find that the score on the cognitive reflection test is negatively correlated with choosing equity ($p < 0.05$) and reporting to have understood the rules is positively correlated with choosing equity ($p < 0.10$), but no other collected demographics are significantly correlated with security choice. We also find that overbidding rates from the Automated auctions are not significantly correlated with security choices.

One variable that has a strong relationship with choosing to use equity bids as a seller is the rate of choosing to enter equity-bid auctions over debt-bid auctions as a buyer. We find this result surprising because if sellers view one security as being better at extracting surplus from buyers (and thus likely to increase their payoffs as a seller), they should be *less* likely to choose that security when they are buyers. This is especially true for Monopolistic auctions, where the seller has no incentive to induce more participation by using the security preferred by buyers. Furthermore, subjects' risk aversion should also contribute to a negative correlation between security choices as a buyer and as a seller. Equity-bid auctions provide more insurance to buyers, decreasing the variance of payoffs relative to debt-bid auctions (Fioriti and Hernandez-Chanto, 2021). But this feature *increases* the risk to sellers, so subjects that choose equity-bid auctions to reduce risk as a buyer would be more likely to choose debt-bid auctions to reduce risk as a seller. The opposing extraction and insurance effect between buyers and sellers is more pronounced when the security chosen is debt, i.e., the flattest security. The reason is that debt for a buyer operates like call options for the seller. Call options are the steepest security, extracting the highest surplus from buyers and providing the lowest (highest) insurance to buyers (sellers).

Finally, in Table 8, we consider the effect of the three seller treatments on the distribution of surplus. As compared to the Automated treatment, the Monopolistic treatment has slightly lower revenue, slightly higher buyer surplus, and slightly higher overall surplus. However, none

Table 8: Effect of seller treatment on surplus distribution

	(1) Revenue	(2) Buyer Surplus	(3) Surplus
Monopolistic	-90.9	102.9	11.9
	(88.3)	(85.0)	(69.5)
Competitive	-357.4***	214.5**	-142.9*
	(78.1)	(85.1)	(73.2)
Constant	1763.7***	578.0***	2341.7***
	(56.0)	(54.7)	(44.9)
Observations	1470	1470	1470

Notes: Linear regression with session-level fixed-effects. Standard errors are clustered at the market level, so each pair of competitive auctions belongs to its own cluster. Significance indicated by: *** p<0.01, ** p<0.05, * p<0.1.

of these differences are significant even at the 10% level.[17] On the other hand, Competitive auctions have a substantially and significantly different distribution of surplus than Automated auctions. The differences between Monopolistic and Competitive auctions are significant for revenue and total surplus ($p < 0.01$ and $p < 0.05$ respectively) while the differences in buyer surplus are not significant ($p \approx 0.23$). The empirically estimated differences between Monopolistic and Competitive auctions in terms of revenue, buyer surplus, and total surplus (266.5, -111.6, an 154.8, respectively) are close to and not statistically distinguishable from their theoretical counterparts (298.9, -82.2, and 216.7, respectively). Thus, Consistent with Hypothesis 9, competition decreases overall efficiency and shifts surplus towards buyers.

Result 11. *On average, Competitive auctions have lower total surplus, lower total revenue, and higher buyer surplus than Monopolistic Auctions.*

6 Concluding remarks

This paper provides a unified experimental framework to study formal security-bid auctions with and without competition. Security-bid auctions are extensively used in financial markets to allocate complex projects in which sellers can verify their ex-post revenue, allowing them to use it as an underlying asset to securitize the winning buyer's payment. In a myriad of

[17]Theoretically, Monopolistic auctions should have higher revenue, lower buyer surplus, and the same total surplus as Automated auctions. However, since the treatment effect is conflated with experience, we do not focus on the empirical differences.

applications in which these auctions are used, several sellers compete for a small number of bidders by means of their security design. These buyers must complete costly due diligence to simply make bids. We are able to empirically disentangle the effects that the security designs and market structures have on (i) the revenue and efficiency of the auction; (ii) sellers' choices of security designs; (iii) buyers' entry decisions and bidding behavior; and (iv) decision correlations across subjects in their roles of buyers and sellers.

We differentiate three "seller treatments" that are related to the market structure under which the project is auctioned. In the first treatment, sellers are mechanical and bidders submit their bids in the corresponding security designs, allowing subjects to gain experience using different securities. In the second treatment, a subject plays the role of a seller and must choose whether the two buyers in their auction will make bids using debt or equity. Finally, in the last treatment, two subjects play the role of sellers who must compete for four buyers by means of their security designs. Buyers choose which auctions to enter after observing sellers' choices but before learning their signals about the potential revenue of the project.

We find that the security designs have negligible effects in Automated and Monopolistic auctions, but have a clear effect in Competitive auctions: sellers that choose equity to run their auctions obtain greater revenue. This result stems from the fact that equity attracts more bidders and also extracts greater surplus. The coexistence of these two effects contradicts the theoretical predictions because a security that extracts more surplus from buyers must entice fewer of them into the auction. Moreover, the overall effect produced by equity makes the empirical subgame perfect Nash equilibrium stronger than its theoretical counterpart.

While all auctions feature inefficiencies due to the project not always being allocated to the highest-signal bidder, security designs do not have a differential effect on these inefficiencies. Nonetheless, we validate the theoretical predictions regarding how the surplus distribution varies with the number of bidders within auctions. In particular, we find that buyers' surplus is decreasing and convex in the number of participant bidders, whereas sellers' revenue is increasing and concave.

Regarding buyers' behavior, we find that buyers overbid in debt auctions for all signals, whereas they only overbid in equity auctions for extreme signals. The greater overbidding in debt is, nonetheless, not sufficient to generate an impact on sellers' revenue in all treatments. Additionally, we find that buyers' bids are not sensitive to the number of opponents they face in the auction, which is consistent with the fact that they are bidding in second-price auctions. This rules out the presence of any biases related to bidding becoming more aggressive with more competition.

Finally, we tested how well subjects understand the role played by the security designs for sellers and buyers, which is novel in the auction literature. We find there is a moderate correlation in sellers' choice of security design and buyers' entry strategies, which clearly contradicts theoretical predictions since a security that extracts greater surplus is beneficial for a seller but detrimental for a buyer. This result seems to suggest that the simplicity of equity implied by its linearity overcomes the benefit that can come from non-linear securities like debt.

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Appendices

A Theoretical equilibrium outcomes

A.1 Computation of entry strategies

Equity The symmetric equilibrium strategy for any buyer $i \in \mathcal{B}$ with signal p_i is given by

$$e^*(p_i) = \frac{2p_i}{2p_i + 1}.$$

The interim expected utility for a bidder with signal p_i when $1 \leqslant k \leqslant 4$ bidders participate in an equity auction, corresponds to

$$\begin{aligned}
U(p_i, 1|E) &= 6000p_i + 2000(1 - p_i) - 2000 \\
&= 4000p_i \\
U(p_i, 2|E) &= \int_0^{p_i} \left[\left(\frac{1}{2y+1} \right) (2000 + 4000p_i) - 2000 \right] dy \\
&= 1000((2p_i + 1)\ln(2p_i + 1) - 2p_i) \\
U(p_i, 3|E) &= \int_0^{p_i} \left[\left(\frac{1}{2y+1} \right) (2000 + 4000p_i) - 2000 \right] (2y) dy \\
&= 1000\left(2p_i(p_i + 1) - (2p_i + 1)\ln(2p_i + 1)\right) \\
U(p_i, 4|E) &= \int_0^{p_i} \left[\left(\frac{1}{2y+1} \right) (2000 + 4000p_i) - 2000 \right] (3y^2) dy \\
&= 1000p_i^3 - 1500p_i^2 - 1500p_i + 1500p_i \ln(2p_i + 1) + 750\ln(2p_i + 1)
\end{aligned}$$

To obtain the ex-ante utility for $1 \leqslant k \leqslant 4$ bidders, we integrate the interim utilities, $U(p_i, k|E)$, over the unit interval because p_i is uniformly distributed in such support. This yields

$$\begin{aligned}
U(1|E) &= 2000\\
U(2|E) &= 2250\ln(3) - 2000\\
U(3|E) &= \frac{8000}{3} - 2250\ln(3)\\
U(4|E) &= \frac{3375}{2}\ln(3) - 1750.
\end{aligned}$$

Debt auctions The symmetric equilibrium strategy for any bidder $i \in \mathcal{B}$ with signal p_i is given by

$$d^*(p_i) = \begin{cases} 4000p_i & \text{if } \ p_i \leqslant 1/2\\ 6000 - \frac{2000}{p_i} & \text{if } \ p_i > 1/2. \end{cases}$$

To compute each bidder's interim utility we need to differentiate two cases, given by the two regions over which the signal p_i determines the equilibrium strategies.

Case 1: $p_i \leqslant 1/2$. Fix $1 \leqslant k \leqslant 4$. In this case, the bidder i's type is $p_i \leqslant 1/2$, which implies that in all realizations of signals under which he is the winner, the second-highest signal $y \leqslant 1/2$. Thus, the final price the winner will pay is $4000y$ because we focus on a symmetric equilibrium.

$$\begin{aligned}
U(p_i, 1|D, p_i \leqslant 1/2) &= p_i 6000 + (1-p_i)2000 - 2000\\
&= 4000p_i\\
U(p_i, 2|D, p_i \leqslant 1/2) &= \int_0^{p_i} (4000p_i - 4000y)dy\\
&= 2000p_i^2\\
U(p_i, 3|D, p_i \leqslant 1/2) &= \int_0^{p_i} (4000p_i - 4000y)(2y)dy\\
&= \frac{4000}{3}p_i^3\\
U(p_i, 4|D, p_i \leqslant 1/2) &= \int_0^{p_i} (4000p_i - 4000y)\left(3y^2\right)dy\\
&= 1000{p_i}^4.
\end{aligned}$$

Case 2: $p_i > 1/2$. When bidder i's type is $p_i > 1/2$, we need to analyze two sub-cases, given by the regions where the second-highest signal y is contained. The first one is where $y \leqslant 1/2$ and the second one is where $1/2 \leqslant y \leqslant p_i$. Both regions entailed different equilibrium bids for the highest losing bidder. In the first case, the price the winner must pay is $4000y$, whereas in the second one, the price is $6000 - \frac{2000}{y}$.

$$
\begin{aligned}
U(1, p_i|D, p_i > 1/2) &= 4000p_i \\
U(2, p_i|D, p_i > 1/2) &= \int_0^{1/2} (4000p_i - 4000y)\, dy + \int_{1/2}^{p_i} \left[p_i \left(\frac{2000}{y} - 2000 \right) + (1-p_i)(-2000) \right] dy \\
&= 2000p_i - 500 + 1000\,(1 - 2p_i + 2p_i \ln(2p_i)) \\
&= 500 + 2000p_i \ln(2p_i) \\
U(3, p_i|D, p_i > 1/2) &= \int_0^{1/2} (4000p_i - 4000y)\,(2y) dy + \int_{1/2}^{p_i} \left[p_i \left(\frac{2000}{y} - 2000 \right) + (1-p_i)(-2000) \right] (2y) dy \\
&= 2000p_i^2 - 1000p_i + \frac{500}{3} \\
U(4, p_i|D, p_i > 1/2) &= \int_0^{1/2} (4000p_i - 4000y)\,(3y^2) dy + \int_{1/2}^{p_i} \left[p_i \left(\frac{2000}{y} - 2000 \right) + (1-p_i)(-2000) \right] (3y^2) dy \\
&= 1000p_i^3 - 250p_i + \frac{125}{2}.
\end{aligned}
$$

Integrating over the signal p_i, we can recover bidder's i ex-ante utility for each $1 \leqslant k \leqslant 4$ as follows:

$$
U(k|D) = \int_0^{1/2} U(k, p_i|D, p_i \leqslant 1/2) dp_i + \int_{1/2}^{1} U(k, p_i|D, p_i > 1/2) dp_i.
$$

This yields

$$
\begin{aligned}
U(1|D) &= 2000 \\
U(2|D) &= 1000 \ln(2) - \frac{125}{3} \\
U(3|D) &= \frac{625}{2} \\
U(4|D) &= \frac{1425}{8}.
\end{aligned}
$$

Entry decisions Let $q(E, D)$ denote the probability with which a bidder enters an equity auction when the two sellers differentiate in their chosen security designs—i.e., one chooses debt to run his auction and the other chooses equity. Consequently, $1 - q(E, D)$ denotes the probability to enter the debt auction.

The ex-ante utility of joining an equity auction when all bidders follow such an entry strategy corresponds to

$$\sum_{k=1}^{4}\binom{3}{k-1}q(E,D)^{k-1}[1-q(E,D)]^{4-k}U(k|E),$$

where k corresponds the total number of participant bidders and $U(k|E)$ denotes bidder i's ex ante utility conditional on having k participants in the auction.

Likewise, the ex-ante utility of joining a debt auction is

$$\sum_{k=1}^{4}\binom{3}{k-1}(1-q(E,D))^{k-1}\,q(E,D)^{4-k}U(k|D).$$

The equilibrium mixed strategy $q(E,D)$ must satisfy

$$\begin{aligned}&(1-q)^3U(1|E)+3q(1-q)^2U(2|E)+3q^2(1-q)U(3|E)+q^3U(4|E)\\=&q^3U(1|D)+3q^2(1-q)U(2|D)+3(1-q)^2qU(3|D)+(1-q)^3U(4|D).\end{aligned}$$

Solving the equation, we obtain that $q(E,D)\approx 0.463016$.

A.2 Seller Security Choice

To find the equilibrium strategies of sellers, we first must compute a Seller's expected payoffs conditional on the number of buyers that enter the auction. Because all auctions are predicted to be efficient, the expected total surplus conditional on the number of buyers and regardless of security choice is

$$\begin{aligned}
\mathbb{E}[\text{Surplus}|k = 0] &= 0 \\
\mathbb{E}[\text{Surplus}|k = 1] &= \int_0^1 [4000y]dy \\
&= 2000 \\
\mathbb{E}[\text{Surplus}|k = 2] &= \int_0^1 [4000y](2y)dy \\
&= \frac{8000}{3} \\
\mathbb{E}[\text{Surplus}|k = 3] &= \int_0^1 [4000y](3y^2)dy \\
&= 3000 \\
\mathbb{E}[\text{Surplus}|k = 4] &= \int_0^1 [4000y](4y^3)dy \\
&= 3200.
\end{aligned}$$

So the expected payoffs for the seller conditional on the security and the number of buyers is total surplus minus buyer surplus. For equity, that is

$$\begin{aligned}
V(0|E) &= 0 \\
V(1|E) &= 0 \\
V(2|E) &= \frac{8000}{3} - 2(2250\ln(3) - 2000) \\
&= \frac{20000}{3} - 4500\ln(3) \\
V(3|E) &= 3000 - 3\left(\frac{8000}{3} - 2250\ln(3)\right) \\
&= 6750\ln(3) - 5000 \\
V(4|E) &= 3200 - 4\left(\frac{3375}{2}\ln(3) - 1750\right) \\
&= 10200 - 6750\ln(3).
\end{aligned}$$

For debt, it is

$$
\begin{aligned}
V(0|D) &= 0 \\
V(1|D) &= 0 \\
V(2|D) &= \frac{8000}{3} - 2\left(1000\ln(2) - \frac{125}{3}\right) \\
&= 2750 - 2000\ln(2) \\
V(3|D) &= 3000 - 3\left(\frac{625}{2}\right) \\
&= \frac{4125}{2} \\
V(4|D) &= 3200 - 4\left(\frac{1425}{8}\right) \\
&= \frac{4975}{2}.
\end{aligned}
$$

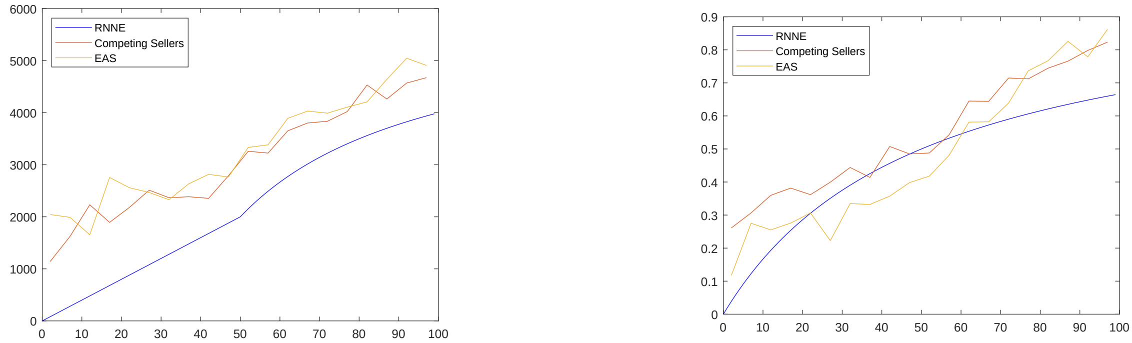
Given that buyers randomize uniformly when faced with the same security, expected payoffs when both sellers choose equity are $\frac{3775}{2} - \frac{3375}{8}\ln(3) \approx 1424.02$. When both choose debt, expected payoffs are $\frac{54475}{32} - 750\ln(2) \approx 1182.48$. We can also compute the payoffs for sellers when they choose different securities. Given the previously calculated probability of entering the equity auction of 0.463016, the payoffs for the seller choosing equity are approximately 1282.05, and payoffs for the seller choosing debt are approximately 1304.11.

These payoffs imply that sellers' dominant strategy under competition is to use equity bids for their auction. Thus, the overall prediction under competition is that both sellers will earn 1424.02. The expected total surplus is 4900 (so the average surplus in each market is expected to be 2450) and expected buyer surplus is 1025.98.

B Additional Empirical Results

Table 9: Summary Statistics

	Mean	Std. Dev.
CRT Score (0 to 3)	1.32	1.16
Female	0.69	0.46
Age	22.57	3.14
English	0.23	0.42
Economics	0.34	0.48
Subjects	126.00	



(a) Second-price debt

(b) Second-price equity

Figure 11: Comparison of average bidding functions between this paper and Breig et al. (2022). RNNE refers to the risk-neutral Nash equilibrium, Competing Sellers uses data from the experiment described in this paper, and EAS uses data from Breig et al. (2022).

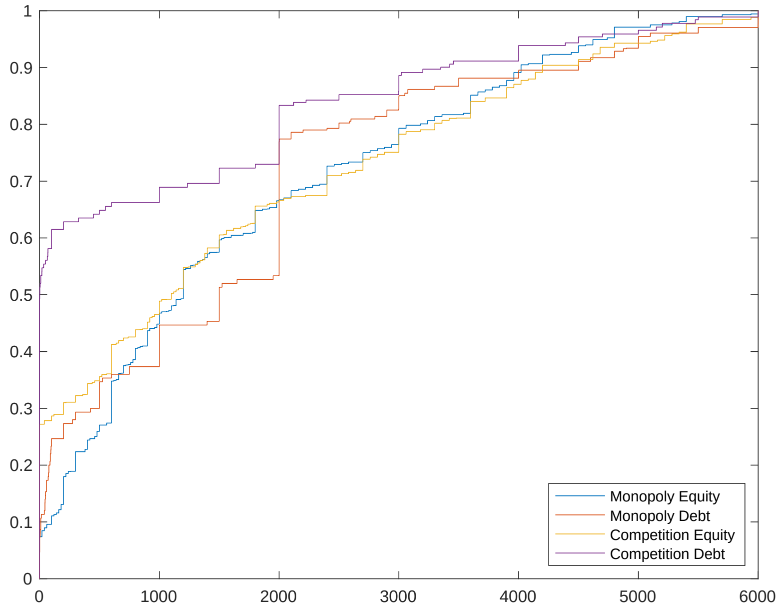
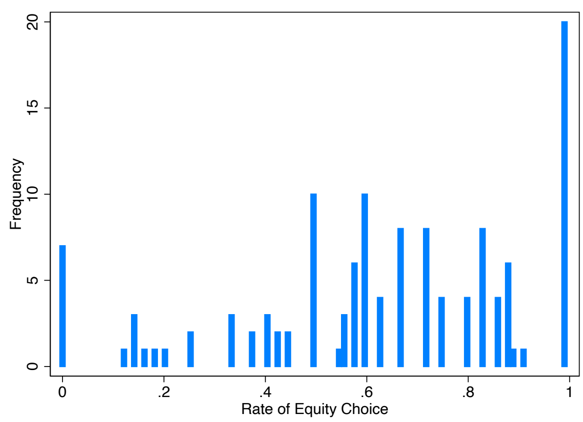
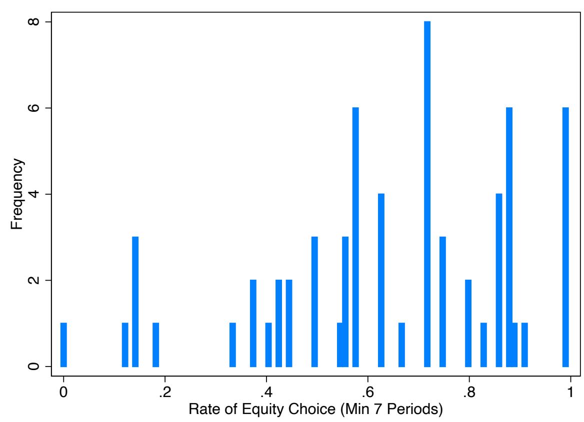


Figure 12: Revenue by security and competition treatment. This figure presents the empirical revenue conditional on the winning buyer's signal and the realized price of the auction, but not the outcome of the auction. For instance, a buyer with a signal of 80 that won the auction at a price of 10% would contribute 20% of their weight in the sample to a revenue of 200 and 80% of their weight to a revenue of 600.



(a) Rates from all subjects



(b) Rates from subjects with at least 7 choices

Figure 13: Histogram of rates of sellers choosing equity

Table 10: Overbidding rates by seller treatment

	(1) Binary Overbid	(2) Binary Overbid	(3) Binary Overbid	(4) Binary Overbid
Monopolistic	-0.041	-0.033	-0.016	-0.059
	(0.030)	(0.031)	(0.047)	(0.040)
Competitive	-0.076**	-0.040	-0.049	-0.065*
	(0.036)	(0.029)	(0.056)	(0.038)
Round			-0.0017	0.0017
			(0.0029)	(0.0022)
Constant	0.73***	0.63***	0.74***	0.62***
	(0.012)	(0.017)	(0.021)	(0.023)
Security	Debt	Equity	Debt	Equity
Observations	1130	1696	1130	1696

Notes: Linear regression with subject-level fixed-effects and standard errors clustered at the subject level. Significance indicated by: *** p<0.01, ** p<0.05, * p<0.1.

Table 11: Misallocation & buyer surplus (competitive auctions only)

	(1) Misallocation	(2) Misallocation	(3) Avg. Buyer Surplus	(4) Avg. Buyer Surplus
# Buyers=2			-1315.2***	-1922.4***
			(233.3)	(159.5)
# Buyers=3	331.3	89.0	-2005.7***	-2099.5***
	(204.9)	(99.9)	(199.0)	(149.6)
# Buyers=4	468.3**	301.0*	-2113.3***	-2290.4***
	(207.6)	(174.4)	(278.5)	(152.1)
Constant	120.3	322.2***	1944.4***	2161.6***
	(78.4)	(58.1)	(168.1)	(142.9)
Security	Debt	Equity	Debt	Equity
Observations	79	199	136	256

Notes: Linear regression with session- and round-level fixed-effects and robust standard errors. Significance indicated by: *** p<0.01, ** p<0.05, * p<0.1.

Table 12: Relationship between security choice as a buyer and covariates

	(1) Equity Chosen	(2) Equity Chosen	(3) Equity Chosen
Quiz 1 Score (percentage)	0.27*	0.29**	0.29**
	(0.14)	(0.14)	(0.14)
Quiz 2 Score (percentage)	-0.063	-0.019	-0.037
	(0.14)	(0.14)	(0.14)
Age	-0.0071	-0.0052	-0.0048
	(0.013)	(0.013)	(0.013)
Female	-0.012	-0.0035	0.0060
	(0.067)	(0.072)	(0.069)
English	0.12	0.13	0.16*
	(0.090)	(0.091)	(0.091)
Economics	0.12	0.12	0.11
	(0.074)	(0.074)	(0.073)
CRT Score (0 to 3)	-0.040	-0.031	-0.013
	(0.028)	(0.031)	(0.031)
Understood Rules (1 to 5)	-0.067	-0.086**	-0.100**
	(0.042)	(0.043)	(0.045)
Understood Strategy (1 to 5)	0.025	0.032	0.044
	(0.046)	(0.048)	(0.048)
Rate Overbid Equity		0.21	0.19
		(0.16)	(0.16)
Rate Overbid Debt		-0.13	-0.12
		(0.16)	(0.16)
Rate Dom. Equity		-0.093	-0.073
		(0.15)	(0.15)
Rate Dom. Debt		0.21	0.20
		(0.15)	(0.15)
Rate Equity as Seller			0.28***
			(0.10)
Constant	0.75**	0.61*	0.41
	(0.33)	(0.35)	(0.36)
Observations	424	424	424

Notes: Linear regression with session-level fixed-effects and standard errors clustered at the subject level. Significance indicated by: *** p<0.01, ** p<0.05, * p<0.1.

Table 13: Order effects on buyers' auction choice

	(1) Auction 1 Chosen	(2) Auction 1 Chosen
DE	-0.15**	-0.16**
	(0.073)	(0.073)
ED	0.024	0.023
	(0.069)	(0.069)
EE	0.040	0.038
	(0.065)	(0.065)
Round		-0.0017
		(0.0031)
Constant	0.55***	0.59***
	(0.054)	(0.086)
Observations	840	840

Notes: Linear regression with subject-level fixed-effects and standard errors clustered at the subject level. The independent variables indicate the security used by Auctions 1 and 2 respectively (DE indicates that Auction 1 was debt-bid and Auction 2 was equity-bid). the omitted category is DD. Significance indicated by: *** p<0.01, ** p<0.05, * p<0.1.

Table 14: Effect of Seller Treatment on Revenue

	(1) Revenue	(2) Revenue
Monopolistic	-90.9	-189.0
	(88.3)	(147.8)
Competitive	-357.4***	-851.8***
	(78.1)	(140.3)
Equity		-158.7
		(112.0)
Monopolistic × Equity		187.8
		(184.7)
Competitive × Equity		799.7***
		(192.8)
Constant	1763.7***	1843.0***
	(56.0)	(84.7)
Observations	1470	1470

Notes: Linear regression with session-level fixed-effects. Standard errors are clustered at the market level, so each pair of competitive auctions belongs to its own cluster. Significance indicated by: *** p<0.01, ** p<0.05, * p<0.1.

Table 15: Revenue by security and number of bidders (competitive auctions only)

	(1) Revenue	(2) Revenue
# Buyers=3	1369.1***	719.5***
	(373.5)	(208.4)
# Buyers=4	1517.2	1389.5***
	(919.6)	(364.0)
Constant	1173.5***	1787.0***
	(227.1)	(146.3)
Security	Debt	Equity
Observations	79	199

Notes: Linear regression with session- and round-level fixed-effects and robust standard errors. Significance indicated by: *** p<0.01, ** p<0.05, * p<0.1.

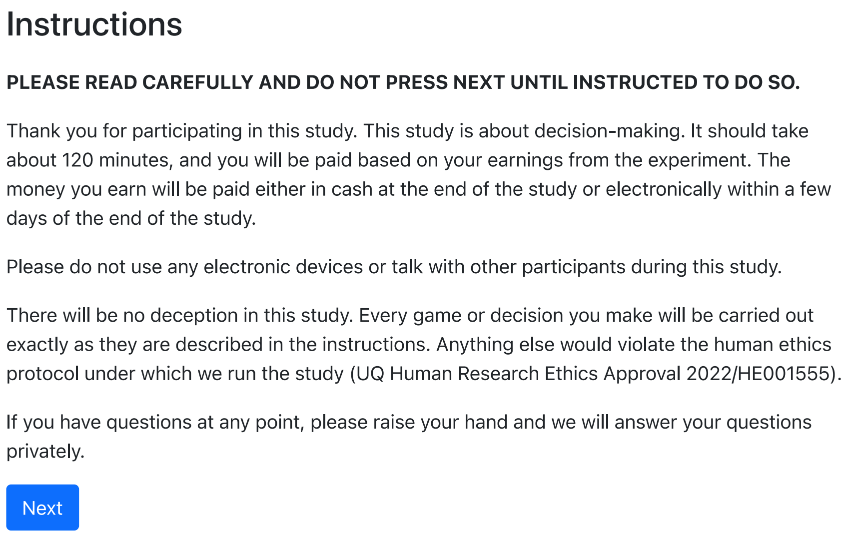
Table 16: Security choice by seller with covariates

	(1) Equity	(2) Equity	(3) Equity	(4) Equity
Competitive	0.22*	0.20*	0.21*	0.19
	(0.11)	(0.11)	(0.11)	(0.12)
Round	0.0088**	0.0082**	0.0084**	0.0082**
	(0.0039)	(0.0038)	(0.0038)	(0.0039)
Competitive × Round	-0.011**	-0.0097*	-0.0098*	-0.0089
	(0.0052)	(0.0053)	(0.0053)	(0.0054)
Quiz 1 Score (percentage)		-0.043	-0.038	-0.070
		(0.11)	(0.11)	(0.11)
Quiz 2 Score (percentage)		0.033	0.049	0.014
		(0.091)	(0.093)	(0.089)
Age		-0.0068	-0.0055	-0.0039
		(0.0080)	(0.0076)	(0.0077)
Female		-0.035	-0.048	-0.022
		(0.057)	(0.052)	(0.047)
English		-0.0060	-0.0025	-0.078
		(0.053)	(0.056)	(0.053)
Economics		0.052	0.050	0.013
		(0.049)	(0.046)	(0.046)
CRT Score (0 to 3)		-0.053**	-0.047*	-0.032
		(0.022)	(0.025)	(0.024)
Understood Rules (1 to 5)		0.052*	0.045*	0.051*
		(0.026)	(0.025)	(0.026)
Understood Strategy (1 to 5)		-0.035	-0.036	-0.043
		(0.030)	(0.029)	(0.030)
Rate Overbid Equity			0.024	0.071
			(0.13)	(0.13)
Rate Overbid Debt			0.12	0.056
			(0.13)	(0.13)
Rate Dom. Equity			-0.011	0.039
			(0.13)	(0.13)
Rate Dom. Debt			0.079	0.050
			(0.12)	(0.11)
Rate Equity as Buyer				0.22***
				(0.059)
Constant	0.46***	0.66***	0.50**	0.41*
	(0.090)	(0.21)	(0.22)	(0.22)
Observations	840	840	840	807

Notes: Linear regression with session-level fixed-effects and standard errors clustered at the seller level. Significance indicated by: *** p<0.01, ** p<0.05, * p<0.1.

C Experimental Screenshots

Below we copy screenshots of what subjects saw in the experiment.



Instructions

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 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 game or decision you make will be carried out exactly as they are described in the instructions. Anything else would violate the human ethics protocol under which we run the study (UQ Human Research Ethics Approval 2022/HE001555).

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

Next

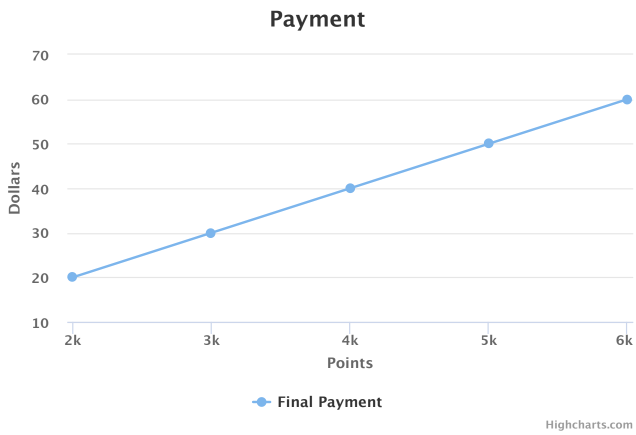
Figure 14: Page one of the introduction.

Instructions

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

In this study, you will receive points based on the choices you and other participants make. Your dollar earnings at the end of the study will depend on how many points you receive. **You will be paid a $20 participation fee and will receive $1 for each 100 points you earn.**

At the end of the study, we will select **one** round at random to be the one that counts. Your points will be determined based on the outcome of that round. Each round is equally likely to be chosen. Because each round may be the one that counts, it is in your best interest to make each choice as if it were going to be implemented.



Important: The amount of points you receive determines how much you are paid at the end of the experiment. It is in your best interest to maximise the number of points you receive in each task.

Figure 15: Second page of introduction.

Instructions for the first ten rounds

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

In this part of the experiment, you will participate in 10 auction rounds. Each auction begins with the computer randomly pairing you with another participant. The player that you are paired with in a round is selected independently of who you play with in any other round. You will not know the player you are paired with.

Before each round, you will be provided with 2000 points.

In each auction you will bid for the opportunity to make a risky investment. The cost of making the investment is the 2000 points that you are provided with at the beginning of the round. However, this investment generates revenue. The revenue of the investment is either 2000 points or 6000 points. Each bidder has a different likelihood of the investment having a revenue of 6000 points, and the likelihoods are uniformly distributed between 0 out of 100 and 100 out of 100. Each bidder will know their own likelihood, but will not know the likelihood of the person they are bidding against. If you do not win the auction, you will keep the 2000 points you were initially provided with.

Important: The bids in this auction will be slightly different to auctions you may have seen before. The winner will be the player with the highest bid, and the "price" will be equal to the loser's bid. In addition both players will make either "points" or "percentage" bids in the auctions.

Percentage-Bids: If the auction is in percentage-bids, both players will make their bids in terms of percentages. The winner will be the player with the highest bid, and the "price" will be equal to the loser's bid. However, the amount the winner pays may depend on the revenue that the investment generates. The winner pays a percentage of their revenue equal to the price. If both players make the same bid, the winner is chosen randomly, and the price is equal to their bid. For instance, suppose that Player 1 bids 20% while Player 2 bids 45%. Then Player 2 wins the auction and the price is equal to 20%. Player 2 then invests their 2000 points, but receives (1-0.2)x6000=4800 points if the revenue is high and (1-0.2)x2000=1600 points if the revenue is low. Player 1 loses the auction and keeps the 2000 points they were provided with.

Point-Bids: If the auction is in point-bids, both players will make their bids in terms of points. If the revenue is higher than the price, then the winner will pay the price. If the revenue is lower than the price, then the winner pays all of the revenue. If both players make the same bid, the winner is chosen randomly, and the price is equal to their bid. For instance, suppose that Player 1 bids 3500 while Player 2 bids 4500. Then Player 2 wins the auction and the price is equal to 3500. Player 2 then invests their 2000 points. If the revenue is 2000 points, player 2 will pay only the 2000 points as the revenue is lower than the price. However, if the revenue is instead 6000 points, Player 2 pays 3500 points. Player 1 loses the auction and keeps the 2000 points they were provided with.

In the odd rounds both players will bid with percentage-bids and in the even rounds both players will bid with point-bids .

The next page contains a few more examples to familiarise you with how these auctions works. Take your time and make sure you understand how it works. After the examples, there will be a short quiz about the rules of this game.

Next

Figure 16: Instructions for rounds 1-10.

Examples

Example 1 of an auction with percentage-bids: Alice and Bob participate in this type of auction. Alice finds out that her project has a 53% chance of generating a high revenue, while Bob finds out that his project has an 81% chance of generating the high revenue.
Alice bids 30% and Bob bids 43%. Then Alice loses the auction and is guaranteed a payoff of 2000 points.
Bob wins the auction and has an 81% chance of receiving (1 - 0.3) × 6000 = 4200 points and a 19% chance of receiving (1 - 0.3) × 2000 = 1400 points.

Example 1 of an auction with point-bids: Alice and Bob participate in this type of auction. Alice finds out that her project has a 53% chance of generating a high revenue, while Bob finds out that his project has an 81% chance of generating the high revenue.
Alice bids 1000 points and Bob bids 1800 points. Then Alice loses the auction and is guaranteed a payoff of 2000 points.
Bob wins the auction and has an 81% chance of receiving 6000 - 1000 = 5000 points and a 19% chance of receiving 2000 - 1000 = 1000 points.

Example 2 of an auction with percentage-bids: Carmen and Daron participate in this type of auction. Carmen finds out that her project has a 42% chance of generating a high revenue, while Daron finds out that his project has an 55% chance of generating the high revenue.
Carmen bids 27% and Daron bids 22%. Then Daron loses the auction and is guaranteed a payoff of 2000 points.
Carmen wins the auction and has a 42% chance of receiving (1 - 0.22) × 6000 = 4680 points and a 58% chance of receiving (1 - 0.22) × 2000 = 1560 points.

Example 2 of an auction with points-bids: Carmen and Daron participate in this type of auction. Carmen finds out that her project has a 42% chance of generating a high revenue, while Daron finds out that his project has an 55% chance of generating the high revenue.
Carmen bids 2400 points and Daron bids 2200 points. Then Daron loses the auction and is guaranteed a payoff of 2000 points.
Carmen wins the auction and has a 42% chance of receiving 6000 - 2200 = 3800 points, but because Daron's bid is higher than 2000, Carmen has a 58% chance of receiving 0 points.

Try it out: For each auction, players will be given an interactive figure that will help show what their payoffs will be, conditional on their choices. The figure will show the consequences of making certain bids. The figure on this page shows what your payoffs could be for various prices. Try out different prices below to make sure you understand the consequences of your choices.

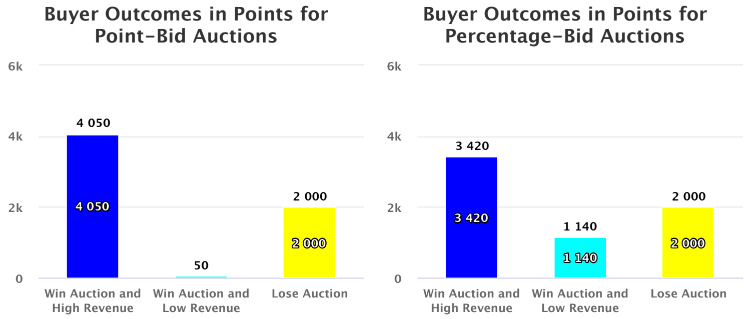
Click the blue bars to reveal the sliders.

0 6000

Price in point-bid auction: **1950**

0 100

Price in percentage-bid auction: **43**



When you are ready to continue, press next to answer some questions to test your understanding.

Next

Figure 17: Examples for rounds 1-10.

Quiz

Please answer the following questions. You will earn $1 for each question you answer correctly.

How is the auction winner decided?

- Another player chooses the winner
- The computer randomly chooses the winner from all bidders.
- The player with the highest bid wins; if there is a tie the computer will randomly choose the winner from the highest bidders.
- The first player to submit their bid is the winner

What will each player know about the chance of high revenue?

- Each player only knows their own chance.
- Each player knows their chance and the other player's chance.
- Each player knows their chance and learns the other player's chance after the auction.
- Neither player knows either player's chance.

How will the price of the auction be set?

- The price is randomly selected from the two bids.
- The price is equal to the highest bid.
- The price is equal to the second-highest bid.
- The price is a randomly selected value between the two bids.

In a percentage-bid auction, how is the price used when computing payoffs

- The auction's winner pays a percentage of their revenue equal to the price.
- The auction's winner receives a percentage of their revenue equal to the price.
- The auction's loser receives a percentage of their revenue equal to the price.
- The auction's loser pays a percentage of their revenue equal to the price.

In a percentage-bid auction, suppose that the other player bids 20% and you bid 10%. How many points will each player receive?

- You will receive 2000 points. The other player will receive 1600 points if the revenue is low and 4800 points if the revenue is high.
- You will receive 2000 points. The other player will receive 1800 points if the revenue is low and 5400 points if the revenue is high.
- You will receive 1600 points if the revenue is low and 4800 points if the revenue is high. The other player will receive 2000 points.

Figure 18: Quiz questions for rounds 1-10.

- You will receive 1800 points if the revenue is low and 5400 points if the revenue is high. The other player will receive 2000 points

In a percentage-bid auction, suppose that the other player bids 20% and you bid 80%. How many points will each player receive?

- You will receive 2000 points. The other player will receive 1600 points if the revenue is low and 4800 points if the revenue is high.
- You will receive 2000 points. The other player will receive 400 points if the revenue is low and 1200 points if the revenue is high.
- You will receive 1600 points if the revenue is low and 4800 points if the revenue is high. The other player will receive 2000 points.
- You will receive 400 points if the revenue is low and 1600 points if the revenue is high. The other player will receive 2000 points.

In a points-bid auction, how is the price used when computing payoffs

- The auction's winner pays either the price or their revenue, whichever is smaller.
- The auction's winner receives either the price or their revenue, whichever is smaller.
- The auction's loser pays either the price or their revenue, whichever is smaller.
- The auction's loser receives either the price or their revenue, whichever is smaller.

In a points-bid auction, suppose that the other player bids 1000 points and you bid 500 points. How many points will each player receive?

- You will receive 2000 points. The other player will receive 1000 points if the revenue is low and 5000 points if the revenue is high.
- You will receive 2000 points. The other player will receive 1500 points if the revenue is low and 5500 points if the revenue is high.
- You will receive 1000 points if the revenue is low and 5000 points if the revenue is high. The other player will receive 2000 points.
- You will receive 1500 points if the revenue is low and 5500 points if the revenue is high. The other player will receive 2000 points.

In a points-bid auction, suppose that the other player bids 1000 points and you bid 5500 points. How many points will each player receive?

- You will receive 2000 points. The other player will receive 1000 points if the revenue is low and 5000 points if the revenue is high.
- You will receive 2000 points. The other player will receive 0 points if the revenue is low and 500 points if the revenue is high.
- You will receive 1000 points if the revenue is low and 5000 points if the revenue is high. The other player will receive 2000 points.
- You will receive 0 points if the revenue is low and 500 points if the revenue is high. The other player will receive 2000 points.

Figure 19: Quiz questions for rounds 1-10 (continued).

Quiz answers

You got 2 questions correct.

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

Question 1: How is the auction winner decided?
Correct Answer: The player with the highest bid wins; if there is a tie the computer will randomly choose the winner from the highest bidders.
Your Answer: The computer randomly chooses the winner from all bidders.

Question 2: What will each player know about the chance of high revenue?
Correct Answer: Each player only knows their own chance.
Your Answer: Each player knows their chance and the other player's chance.

Question 3: How will the price of the auction be set?
Correct Answer: The price is equal to the second-highest bid.
Your Answer: The price is equal to the highest bid.

Question 4: How will the price of the auction be set?
Correct Answer: The auction's winner pays a percentage of their revenue equal to the price.
Your Answer: The auction's winner receives a percentage of their revenue equal to the price.

Question 5: In a percentage-bid auction, suppose that the other player bids 20% and you bid 10%. How many points will each player receive?
Correct Answer: You will receive 2000 points. The other player will receive 1800 points if the revenue is low and 5400 points if the revenue is high.
Your Answer: You will receive 2000 points. The other player will receive 1800 points if the revenue is low and 5400 points if the revenue is high.

Question 6: In a percentage-bid auction, suppose that the other player bids 20% and you bid 80%. How many points will each player receive?
Correct Answer: You will receive 2000 points. The other player will receive 1800 points if the revenue is low and 5400 points if the revenue is high.
Your Answer: You will receive 2000 points. The other player will receive 400 points if the revenue is low and 1200 points if the revenue is high.

Question 7: In a points bid, how is the price used when computing payoffs
Correct Answer: The auction's winner pays either the price or their revenue, whichever is smaller.
Your Answer: The auction's winner receives either the price or their revenue, whichever is smaller.

Question 8: In a points-bid auction, suppose that the other player bids 1000 points and you bid 500 points. How many points will each player receive?
Correct Answer: You will receive 2000 points. The other player will receive 1500 points if the revenue is low and 5500 points if the revenue is high.
Your Answer: You will receive 2000 points. The other player will receive 1500 points if the revenue is low and 5500 points if the revenue is high.

Question 9: In a points-bid auction, suppose that the other player bids 1000 points and you bid 5500 points. How many points will each player receive?
Correct Answer: You will receive 1000 points if the revenue is low and 5000 points if the revenue is high. The other player will receive 2000 points.
Your Answer: You will receive 2000 points. The other player will receive 0 points if the revenue is low and 500 points if the revenue is high.

Next

Figure 20: Quiz answers for rounds 1-10.

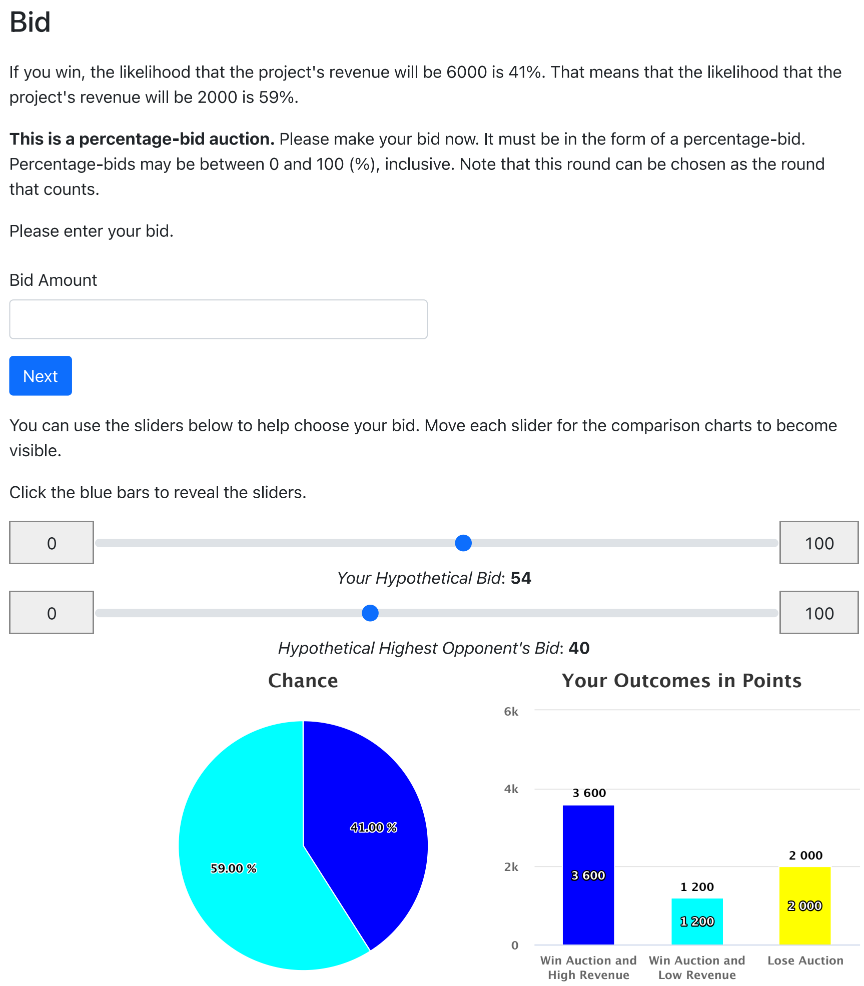


Figure 21: Bid page for an Automated round with a percentage-bid auction.

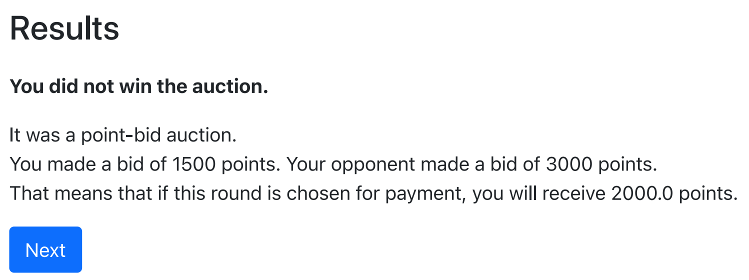


Figure 22: Losing bidder results for a two-player point-bid auction.

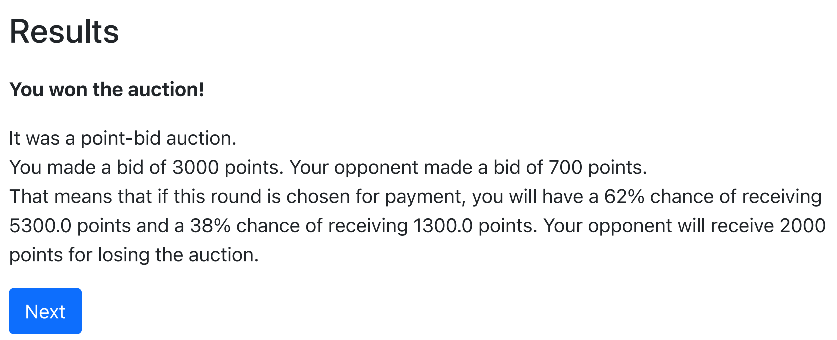


Figure 23: Results page for winner of a point-bid auction.

Instructions for the next 20 rounds

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

In this part of the experiment, you will participate in 20 auction rounds. Each auction will either be a 3-player auction or a 6-player auction. At the beginning of each round, each player will be randomly assigned the role of buyer or seller. The seller will choose whether the buyers will bid in points or percentages. The buyers will receive signals, as in the first 10 rounds, and then make bids.

3-Player Auction auction: In a 3-Player Auction auction, you will be randomly paired with two other participants. Two players will be buyers and one will be a seller. The seller will choose whether the two buyers bid in either points or percentages. The buyers will then participate in an auction which functions the same as the auction from the first ten rounds.

6-Player Auction auction: In a 6-Player Auction auction, you will be randomly paired with five other participants. Four players will be buyers and two will be sellers. The sellers will each choose the type of bid that can be submitted in their auction, either points or percentages. The buyers will then be told what type of auction the sellers chose and then they will be able to choose which auction to enter. If only one buyer enters an auction they will win the auction with a bid of zero and thus capture all of the potential revenue of the investment. If the auction has more than one buyer it will operate similar to the first ten auctions with the highest bid winning the auction and the second-highest bid being the "price".

Seller's Payment: Sellers will receive the amount that the buyers pay as a result of the auction. If no buyers of only buyer enters a seller's auction, they will receive zero points. However, in addition to any points earned in the auction, all sellers will receive an endowment of 2000 points.

In the odd rounds players will compete in 3-player auctions and in the even rounds both players will compete in 6-player auctions .

The next page contains a few more examples to familiarise you with how this works. Take your time and make sure you understand how it works. After the examples, there will be a short quiz about the rules of this game.

Next

Figure 24: Instructions for rounds 11-30.

Examples

Example of a 3 person auction: Alice, Bob and Fred participate in this type of auction. Fred is chosen as the seller and Alice and Bob as buyers. Fred chooses percentage-bids as the format of the auction. Alice finds out that her project has a 53% chance of generating a high revenue, while Bob finds out that his project has an 81% chance of generating the high revenue.
Alice bids 30% and Bob bids 43%. Then Alice loses the auction and is guaranteed a payoff of 2000 points.
Bob wins the auction and has an 81% chance of receiving (1 - 0.3) × 4200 = 3420 points and a 19% chance of receiving (1 - 0.3) × 2000 = 1400 points. Fred as the seller has a 81% chance of receiving 0.3 × 6000 + 2000 = 3800 points and a 19% chance of receiving 0.3 × 2000 + 2000 = 2600 points.

Example 1 of a 6 person auction: Alice, Bob, Carmen, Daron, Ethan and Fred participate in this type of auction. Fred and Ethan are chosen as the two sellers while the rest are buyers. Fred decides that his auction will use percentage-bids. Ethan decides that his auction will use points bids. Alice and Bob choose to join Fred's auction. Daron and Carmen choose to enter Ethan's auction.

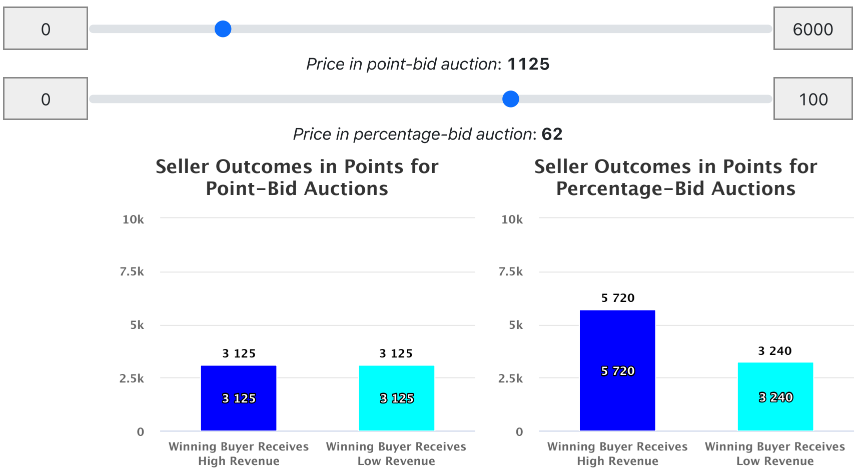
Alice finds out that her project has a 53% chance of generating a high revenue, while Bob finds out that his project has an 81% chance of generating the high revenue.
Alice bids 30% and Bob bids 43%. Then Alice loses the auction and is guaranteed a payoff of 2000 points.
Bob wins the auction and has an 81% chance of receiving (1 - 0.3) × 4200 = 3420 points and a 19% chance of receiving (1 - 0.3) × 2000 = 1400 points. Fred, as the seller has a 81% chance of receiving 0.3 × 6000 = 1800 points and a 19% chance of receiving 0.3 × 2000 = 600 points. Combined with the seller endowment of 2000 points Fred will earn either 3800 points or 2600 points.

Carmen finds out that her project has a 42% chance of generating a high revenue, while Daron finds out that his project has an 55% chance of generating the high revenue.
Carmen bids 2400 points and Daron bids 2200 points. Then Daron loses the auction and is guaranteed a payoff of 2000 points.
Carmen wins the auction and has a 42% chance of receiving 6000 - 2200 = 3800 points, but because Daron's bid is higher then 2000, Carmen has a 58% chance of receiving 0 points. Ethan as the seller has a 42% chance of receiving 2200 points and a 58% chance of receiving 2000 points. Combined with the seller endowment of 2000 points Ethan will earn either 4200 points or 4000 points.

Important: In every auction, the seller does not know the percentage chances of the bidders' revenue being high or low.

Try it out: For each auction, players will be given an interactive figure that will help show what their payoffs will be, conditional on their choices. When you are a buyer, you the figure will show the consequences of making certain bids. The figure on this page is what you will see as a seller, and it shows what your payoffs could be for various prices. Try out different prices below to make sure you understand the consequences of your choices.

Click the blue bars to reveal the sliders.



When you are ready to continue, press next to answer some questions to test your understanding.

Next

Figure 25: Examples for rounds 11-30.

Quiz

Please answer the following questions. You will earn $1 for each question you answer correctly.

What determines if the auction uses percentage or point bids?

- It is randomly chosen each round
- It rotates each round
- The seller chooses for their auction
- The winner of the previous round chooses

There are three players in a percentage-bid auction. Player 1 bids 30%, Player 2 bids 20%, Player 3 bids 10%. What would the price of the auction be?

- 30%
- 20%
- 10%

In the 6-player auction how many buyers are in each auction?

- Two buyers
- It depends on which auction each buyer chooses to enter
- Four buyers

Next

Figure 26: Quiz questions for rounds 11-30.

Quiz answers

You got 2 questions correct.

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

Question 1: What determines if the auction uses percentage or point bids?
Correct Answer: The seller chooses for their auction
Your Answer: It is randomly chosen each round

Question 2: There are three players in a percentage-bid auction. Player 1 bids 30%, Player 2 bids 20%, Player 3 bids 10%. What would the price of the auction be?
Correct Answer: 20%
Your Answer: 20%

Question 3: In the 6-player auction how many buyers are in each auction?
Correct Answer: It depends on which auction each buyer chooses to enter
Your Answer: It depends on which auction each buyer chooses to enter

Next

Figure 27: Quiz answers for rounds 11-30.

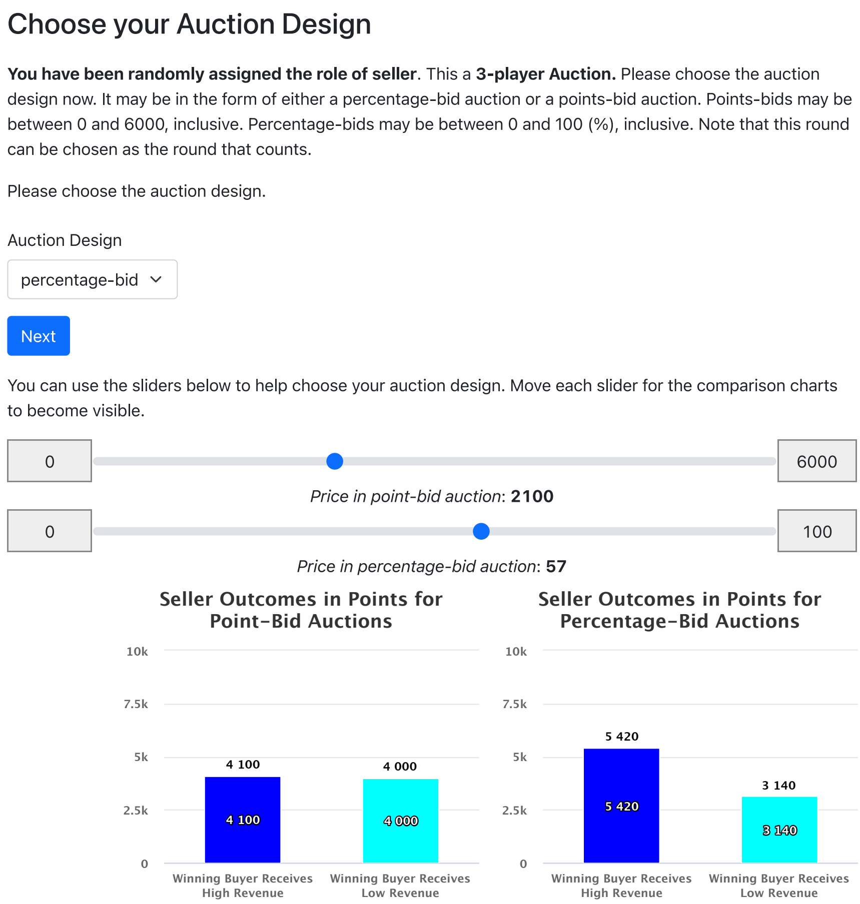


Figure 28: Seller's auction design page in the Monopolistic treatment.

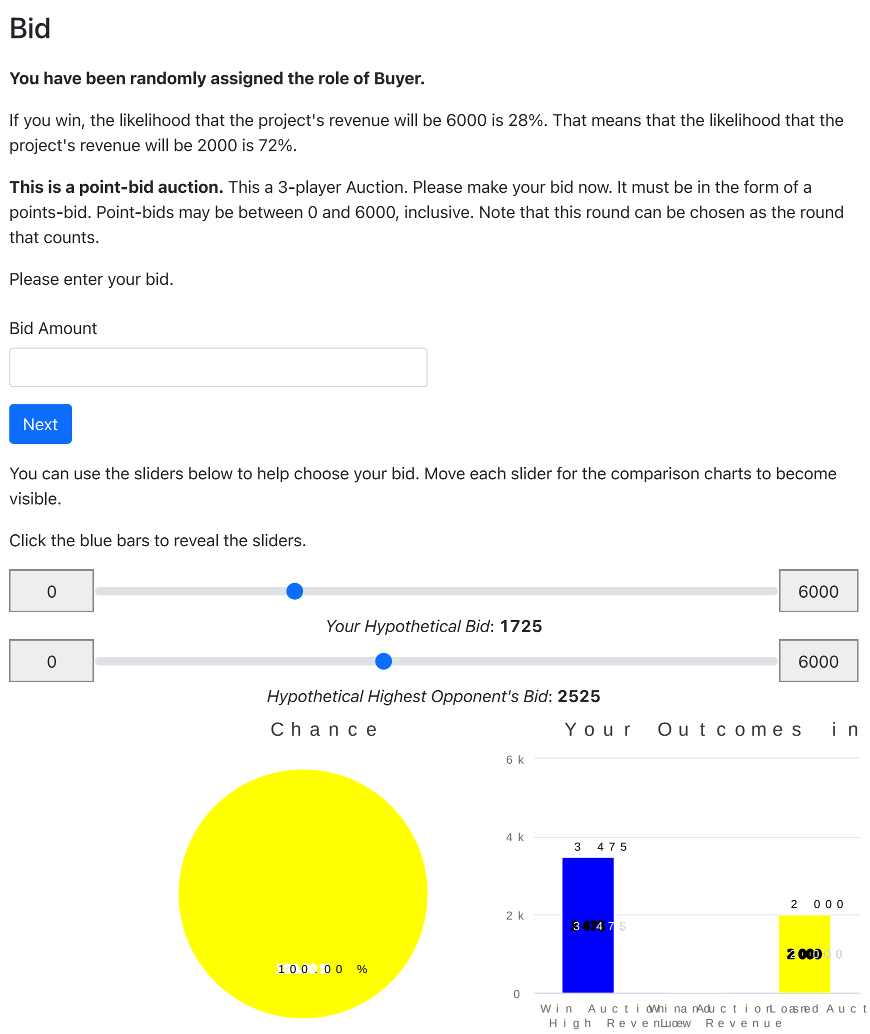


Figure 29: Bid page for a point-bid auction in the Monopolistic treatment.

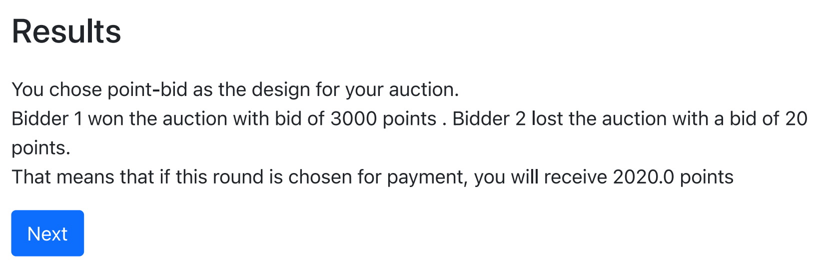


Figure 30: Seller's Results page for a three-player point-bid auction.

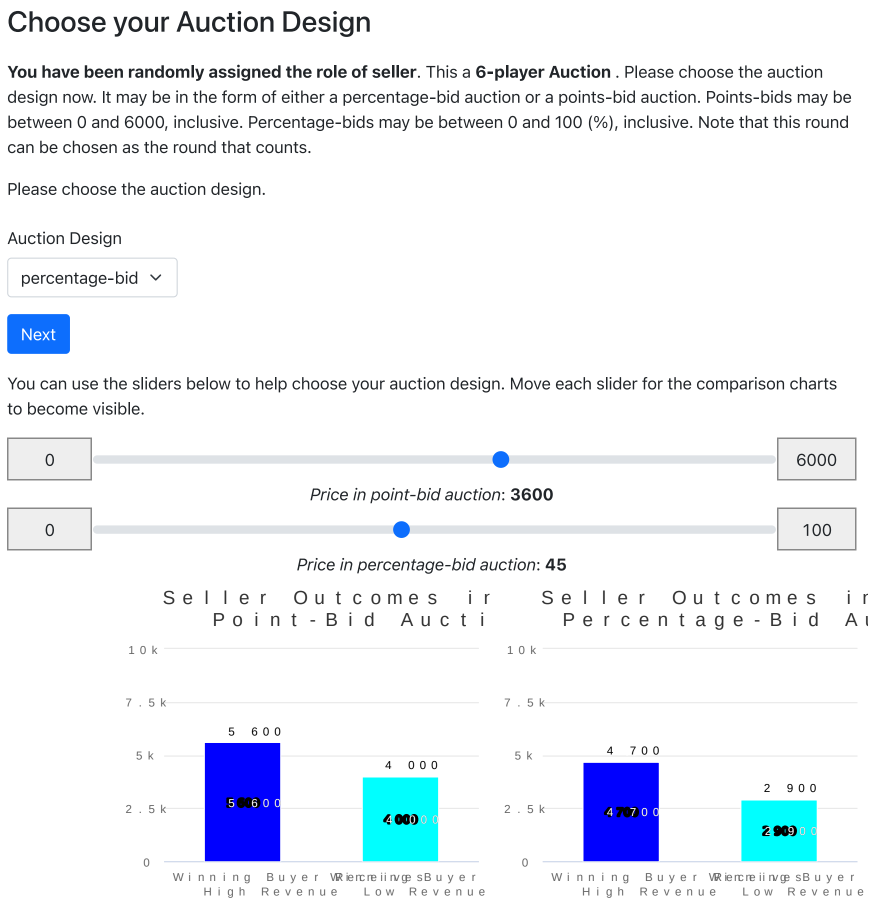


Figure 31: Seller's auction design page in the Competitive treatment.

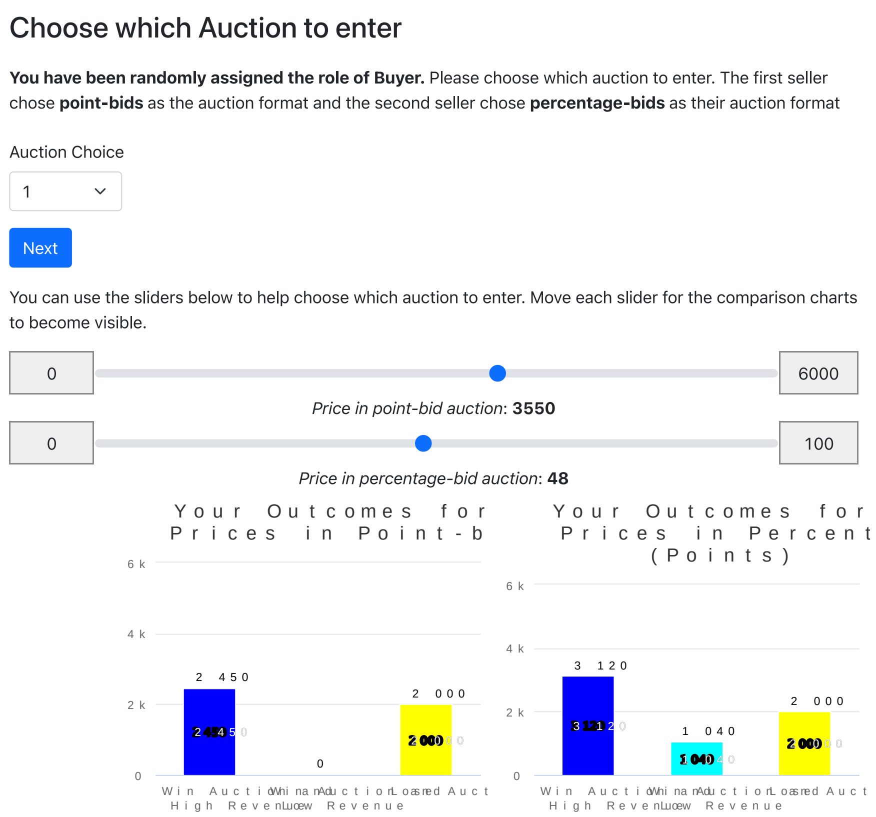


Figure 32: Buyer's auction choice page in the Competitive treatment.

Bid

If you win, the likelihood that the project's revenue will be 6000 is 21%. That means that the likelihood that the project's revenue will be 2000 is 79%.

This is a percentage-bid auction. This a 6-player Auction. **3 buyers, including yourself chose to join this auction.** Please make your bid now. It must be in the form of a percentage-bid. Percentage-bids may be between 0 and 100 (%), inclusive. Note that this round can be chosen as the round that counts.

Please enter your bid.

Bid Amount

20

Next

You can use the sliders below to help choose your bid. Move each slider for the comparison charts to become visible.

Click the blue bars to reveal the sliders.

0 | 100

Your Hypothetical Bid: **40**

0 | 100

Hypothetical Highest Opponent's Bid: **55**

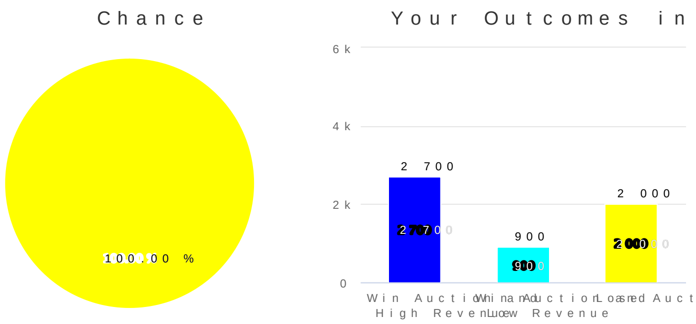


Figure 33: Bid page in the Competitive treatment.

Results

The round was a 6-player Auction.
There were 4 buyers in the auction you chose, including yourself. It was a point-bid auction.

You did not win the auction.
You made a bid of 2500 points. That means that if this round is chosen for payment, you will receive 2000.0 points.
The winning bid was 3400 points. The second highest bid was 2700 points.

Next

Figure 34: Results for a losing bidder in the Competitive treatment.

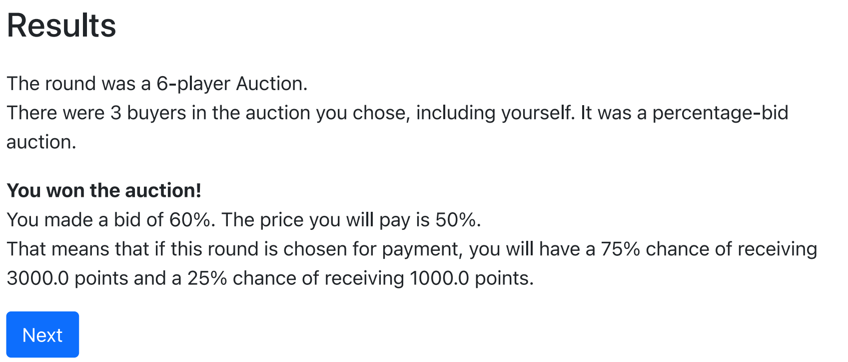


Figure 35: Results for a winning bidder in the Competitive treatment.

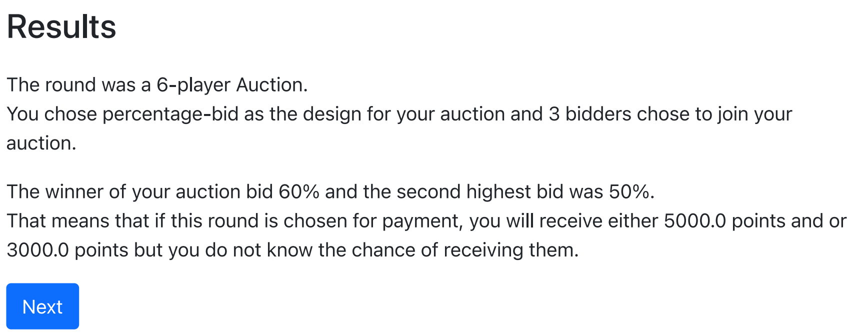


Figure 36: Results for a seller in the Competitive treatment.