A Classroom Experiment: Exploring Bid-Rent Theory

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Abstract
This paper proposes an experiment for the urban economics classroom to teach the intuition behind bid-rent curves. Classroom experiments seek to engage students in the active learning of material by developing their inductive reasoning skills—turning data to models. The challenge with classroom experiments is that they can be hard to scale. This experiment was developed for a class of 90 students, and can be scaled down to smaller classes between 20-30 students. It uses a first-price sealed-bid auction with multiple winners to allocate "parcels of land" which only vary in quality by their distance to the city center. Using the data collected from the experiment, students can derive the bid-rent curves of various agents and observe how learning occurs across game rounds.

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1 Introduction

Over the last 20 years, a number of studies have explored the adoption of classroom games and their impact on learning.[6;7;8;11] The general consensus is that the use of hands-on experiments in the classroom improves student attitudes towards economics and their performance in the class. Though, high start-up costs[6] for instructors in the form of setting up and learning how to conduct a classroom experiment limits the willingness for instructors to adopt such techniques. Recent surveys of economics instructors in the US would suggest that adoption may have reverted and less instructors today use experiments in class than did a decade ago.[2] One way that past scholars have reduced some of these costs is by sharing, and then indexing, experiments that work in their classrooms.[5] The cost can be lowered further still by directly providing materials that instructors can port into their courses.

Much of the attention in this domain is on the effectiveness and availability of classroom experiments for introductory courses. Only about 14% of experiments listed by

Brauer and Delemeester are geared towards upper division courses.[5] Experiments also hold value outside introductory courses particularly by developing inductive reasoning skills. This paper provides the procedure and complementary assignments to a classroom experiment for an urban economics class.

Classroom experiments, especially non-computerized ones, are infrequent for urban economics courses. The most common experiments discuss Tiebout sorting or bid rent functions.[4;9] One of the primary challenges of the existing experiments is scaling them up to work with larger classes.

This paper adapts Bergman et al.'s (2009) bid rent experiment to a large classroom setting (>60 students). The new experiment uses a blind auction through any online surveying platform (e.g. Google Forms, Qualtrics, SurveyMonkey, etc.) in combination with an easy to use shiny application*. The experiment relies on a first-price sealed-bid auction with multiple winners to allocate "parcels of land" which only vary in quality by their distance to the city center. The use of online surveys speeds up the process of allocating the properties and collecting data for use after the experiment concludes. Additionally, having a spatial visualization of the data after each round from the shiny application allows students to observe trends in the data and discuss their intuition with peers during the experiment.

1.1 Background on Bid Rent

When purchasing land, individuals acquire two goods (land and location) for a single price. This implies the possibility of exchanging a purchasers quantity of land for the location of that land. William Alonso (1964) was the first to note this relationship as it applied to the urban context—a trade-off between land accessibility, land area, and price.[1]

The beginnings of this relationship—the bid rent function—can be traced back to J. H. von Thünen.[3] Von Thünen built off of Ricardo's (1817) theory of rents by shifting focus from differences in soil fertility to differences in distance from a market as a way to explain heterogeneous land costs.[10] Alonso extended von Thünen's view of transportation costs from farmers to firms and commuters. Alonso's model helped to generalize the relationship between distance from center and economic activity.

Bid rent functions remain a core concept used to explain city shape in urban economics. The underlying principle being that land is allocated to the user who can derive the greatest net benefit from a given location, and thus is willing to pay the highest rent for it. But, this bid rent† for land is determined after other production or living expenses are covered.‡ Thus, willingness to pay for land declines with distance from the center as commuting costs eat up more of the budget leaving less to pay for land.

To build a working understanding of the bid rent function let's take a central business district (CBD) as the fixed employment hub, and say agents face commuting costs that rise linearly with distance. Each agent is assumed to have a fixed income, consume one unit of land, and allocate its budget between land consumption, commuting, and other goods. Within this framework, different types of agents face the trade-off in distinct ways. Households receive their income through working and balance the benefit of cheaper, larger lots farther from the CBD against the burden of longer commutes; firms earn their money by selling goods and face additional costs from

*found at ericwilken.com

†The amount someone is willing to pay for land is known as bid rent, hence bid rent curve or function.

‡David Ricardo coined this idea known as the leftover principle.

households such as labor or freight costs. The bid rent function is then derived to represent the set of land prices and distances at which an agent is indifferent. At each distance from the CBD, it shows the highest rent a user is willing to pay while still meeting their other costs and preserving their desired level of utility or profit.

Creating bid rent functions for individuals within the city is straight forward mathematically, but when students are asked to solve the general spatial equilibrium of multiple types of agents they often struggle in determining which groups will reside in each part of the city. I think this is due, in part, to the challenge for some to think of how graphs and equations represent reality. This experiment helps students to experience first-hand the competition between offices, manufacturers, and commuters as they compete for land. It is meant to replace a traditional introductory lecture on bid-rent curves and require students to on their own develop the theory from the data collected in class.

2 Experimental Setup

2.1 Overview

The exercise can be run in medium to large classes in approximately 45–60 minutes. It is designed for classes greater than 30 students (90 students in the original design), but it can easily be adapted for smaller sections. The primary goal of the experiment is to give students a concrete, hands-on understanding of how simple economic assumptions translate into patterns of land use in cities. By competing for parcels of land, students see how differences in income and transportation costs generate distinct bid-rent functions and why certain types of agents end up closer to or farther from the central business district. The experiment is flexible and can also be used to show contexts such as taxes or land-use policies, and can be framed to explore how the model's outcomes compare with the actual outcomes in a classroom setting.

2.2 Materials

To run this experiment, the instructor will use a mix of computer projection and paper handouts. On the day of the experiment, the instructor needs to bring the experimental instructions, student in-class worksheets, and ensure access to a projector.[§] This experiment can be done without a projector, but without one you will not be able to show the spatial allocation of properties around the city which is one of the more valuable components of this experiment. Instructors need to ask students to bring laptops (or devices which access the internet) and writing implements. Devices are needed by students to submit their bids and data from the class to be used by all students for homework.

2.3 Procedure

Students are faced with a fictitious city in which they want to rent property. The fake city—I usually let the students decide the name—has properties available to rent from 1 to 10 units away from the central business district (CBD). Figure 1 shows a birds eye view of the city before any parcels are allocated. Students will bid on properties in an auction to determine the allocation.

Each student is given a role sheet assigning them to one of the three types (A, B, C) along with an income endowment I, and a

[§] Materials provided in the Appendix.

transport cost t per distance x. From these parameters, they derive their feasible bid-rent function:

$$\text{Rent}(x) \le I - t \cdot x,$$

The bid rent curves which I find to work the best for a class of 90 students over distances $x = 1$ to $x = 10$ are:

$$\begin{aligned} R_A(x) &= 120 - 15x \\ R_B(x) &= 100 - 10x \\ R_C(x) &= 65 - 5x \end{aligned}$$

where x is distance from the central business district. The intercepts reflect the income or maximum willingness to pay for land at the CBD, while the slopes represent the transport costs per unit of distance.

Type A begins with the highest endowment but has the highest transportation cost, indicating that central locations are especially valuable for them. Type C begins with the lowest endowment but can travel the cheapest, making them the residual users at the urban fringe. Type B falls between the two. Each type is designed to reflect a particular group within cities: type A are commercial businesses, type B are manufacturers, and type C are commuters. The theoretical boundaries between Types A and B occurs at $x = 4$, and the boundary between Type B and C occurs at $x = 7$.

For smaller classes (≤ 30 students), you will want to create a city that only includes properties that are between $x = 1$ and $x = 6$. In this context, you should create the underlying bid rent curves of each type to have theoretical boundaries at $x = 2$ and $x = 4$.

The instructor collects the two bids per student, their name, and their type identification using an online survey platform and then visualizes the results using the included shiny application.

The underlying auction the shiny application solves follows a first-priced sealed bid auction with multiple winners: Students submit bids for *distances* (rings) rather than for specific parcels. Let $x \in \{1, 2, \ldots 10\}$ index distance from the CBD and let ring x contain K_x identical parcels. Each student i may place up to two blind bids in total (typically on two different rings of their choice). The underlying auction is a first–price, sealed–bid auction with multiple winners per distance x.

Formally, let S be the set of students not yet assigned a parcel (initially all students). For ring x, consider the set of valid bids $\{b_i(x) : i \in S\}$ and sort them

$$b_{(1)}(x) \;\ge\; b_{(2)}(x) \;\ge\; \cdots,$$

Award the K_x parcels to the top K_x *distinct* bidders from S (breaking ties at random). Because this is *first price*, each winner pays exactly their own bid, so for a winner i in ring x the payment is $p_i(x) = b_i(x)$ and the profit is

$$\pi_i(x) \;=\; I_i - t_i x - C_{i,\text{other}} \;-\; p_i(x).$$

Remove all winners at ring x from S and proceed to $x + 1$. The process continues "from the center outward" until either parcels or bidders are exhausted. It is possible that a student does not earn a parcel due to a poor bidding strategy. Any students without a parcel at the end of each round should earn a profit $\pi_i(x) \;= -10$.

The experiment concludes with a debrief that compares the observed allocation with the theoretical predictions. Students are asked to hypothesize why offices might cluster near the center, manufacturers the middle rings, and commuters on the fringe. They are asked to reflect on how transport costs and income endowments influence this pattern. Discussion tries to highlight individual student strategies, and ask them to comment on how changes to transport costs would shift their decision making. From the data, students are then asked to create bid rent curves from the data using a spreadsheet program and solve the theoretical boundaries where each land use type should have dominated. The following class will formalize the model and build out assumptions required to rigorously define the theory.

Worked Example of Auction. Using the above bid rent curves, suppose ring $x = 2$ has $K_2 = 1$ parcel and the submitted sealed bids (all valid) are

$$b_1 = 90 \quad b_2 = 80 \quad b_3 = 55$$

Ordering gives $90 \geq 80 \geq 55$, so bidder 1 wins the single parcel at ring 2 and pays $p_1 = 90$, if we assume this person to be the office type then they earn

$$\pi_1 = (120 - 15 \cdot 2) - 90 = 90 - 90 = 0.$$

By the single-parcel rule, bidder 1 exits the market and is no longer considered at larger x. Now consider ring $x = 3$ with $K_3 = 2$ parcels and the remaining bids

$$b_2 = 68$$
$$b_3 = 49$$

These two highest valid bids fill the two parcels: Biddor 2 pays $p_2 = 68$ and if we assume them to be the manufacturer earns

$$\pi_2 = (100 - 10 \cdot 3) - 68 = 70 - 68 = 2,$$

and Biddor 3 pays $p_3 = 49$ and if we assume them to be a commuter earns

$$\pi_3 = (65 - 5 \cdot 3) - 49 = 50 - 49 = 1.$$

2.4 Extension: Land Use Policy

This experiment can be adapted to explore a variety of urban topics. Bergman et al. (2009) offer several "treatments" in their experimental design which either adjust endowments or transportation costs to explore how type specific shocks impact the spatial distribution of the city.[4] This experiment can be adjusted in the same way. It is best suited to explore land use regulations due to the use of projected visuals.

In this variation, the instructor imposes a zoning rule that bans type B from locating within the inner five rings of the city. Under this restriction, type B may only bid for parcels located in rings $x = 6$ through $x = 10$, while Type A and Type C users continue to bid freely across all distances. This is implemented into the auction by restricting the algorithm to not consider bids by B types for banned distances or by simply telling students that they cannot bid for properties that they are banned from. The current shiny app does not yet accommodate this extension.

This extension reflects a stylized version of real-world zoning ordinances that emerged during the industrial era to reduce land-use conflicts. Historically, manufacturing activities (Type B) produced externalities—noise, odor, and heavy transport traffic—that lowered the amenity value of nearby land. By restricting industrial use near the central business district (CBD), cities sought to preserve high-value commercial and residential space for cleaner, higher-income uses. This setup allows students to visualize how urban form is not determined solely by market forces, but also by policy choices that shape who can access specific parts of the city.

This exclusion forces manufacturers to locate farther from the CBD, raising their transportation costs but lowering their rents. As a result, middle-distance parcels ($x = 4$–6) that were previously occupied by manufacturers become available to residential users (Type C), who now move inward to fill that gap. Office users (Type A) continue to dominate the central rings but may face slightly lower bids since manufacturing no longer competes for those locations. The overall outcome is a spatial pattern with offices concentrated in the center, residential users in the middle, and manufacturers are pushed to the fringe.

3 Group Discussion and Follow-Up Assignments

3.1 Discussion

After completing the experiment, instructors should facilitate a structured discussion that helps students interpret the patterns they observe. The goal is to have students use their first-hand experiences and observations of cities to make sense of the information collected through the experiment.

Begin the discussion by asking students to describe where each group—Types A, B, and C—ended up locating within the city. Typically, Type A (high-income, high transport cost) dominates the central rings, Type B (moderate income, moderate transport cost) locates in the middle, and Type C (low income, low transport cost) occupies the fringe.

Ask students to brainstorm who these types might represent in a real-world city. Common analogies include:

- **Type A:** Corporate headquarters, or professional services who value proximity to clients.
- **Type B:** Light manufacturing firms or warehouses which are balancing access to transportation infrastructure and workers.
- **Type C:** Households, who are more willing to travel in exchange for lower rents and larger land parcels.

This is a great opportunity to discuss the heterogeneity that exists within each of these types. Not all companies are large enough to have an office in the city center and households vary in income which often changes where they are located within the city. Have students think about what they see in the world that the model is not reflecting. Some examples might include:

- This city has a single employment center. Many metropolitan areas (e.g., Los Angeles, Dallas–Fort Worth, Atlanta) have multiple employment subcenters, producing multiple peaks in land values and rents rather than a smooth decline from one center.
- High income households typically do live further away from the city center. Low income households, on the other hand, often live much closer to the center of the city.
- Redlining, exclusionary zoning, and racial segregation mean many of our current spatial patterns reflect power and history, not bid-rent equilibria.

Once students have generated hypotheses about who these types represent, guide them to connect their explanations back to the theoretical bid-rent functions. Share with students the endowment and transportation costs of each type in the experiment. Ask:

- Why does the group with the highest endowment and highest transportation costs reside primarily in the center of the city? What would happen if a group had a low endowment and high transportation costs?
- How do differences in income and transport cost interact to produce this ordering?
- What would happen if all groups faced the same transport cost or

earned the same income?

This part of the discussion should make explicit that the spatial pattern is a direct result of optimizing behavior under the assumption that each group chooses the most profitable (or utility-maximizing) location given its constraints.

3.2 Assignment

Following the discussion, I transition the class toward a complementary assignment[¶] that builds the theoretical foundations of the bid-rent model then compares this theory to the data from class. This activity helps students formalize the logic they just observed experimentally. The assignment is best started during class so groups can compare reasoning and equations before completing it at home.

3.2.1 Deriving the Bid-Rent Curve

The first part of the assignment has students formalize the decision making they did in class and solve for outcomes. Students are provided with the income (I_i), and transport cost (t_i) parameters for each of the three types (A, B, and C). The assignment then guides students through the process of formally constructing and interpreting the bid-rent model.

Students first derive each group's bid-rent function and plot them together on a shared set of axes to visualize. They then solve for the theoretical boundary points between types, identifying the distances at which two groups are just indifferent between locations. Finally, students extend the exercise to a more general setting by incorporating additional non-transportation costs for firms in preparation for more advanced problem set questions.

3.2.2 Testing the Theory

In the second part of the assignment, students analyze the data generated from the experiment. Working individually or in small groups, students construct empirical bid-rent curves that trace the observed relationship between the winning bid and distance. Students are asked to provide descriptive statistics about the mean distance from the central business district for each type (A, B, and C) and the average winning bid for each distance.

Students then assess how closely the experimental outcomes align with theoretical predictions and provide potential explanations for any discrepancies.

3.3 Regulation Discussion

After students have fully interpreted the unregulated market, instructors can introduce a new round of discussion focusing on how land-use regulation modifies these outcomes. This can be done with or without playing the extended version of the experiment.

The discussion should emphasize that the regulation does not change preferences or costs directly; it constrains the set of feasible locations. Students can discuss:

- Why might a city implement such a ban in the first place?
- Do we have enough information to determine if the regulation increased social welfare or merely redistributed who wins and loses from the competition for urban land? What is the students' intuition?

[¶]Located in the appendix.

4 Conclusion

Classroom experiments give students a sense of agency over their learning and have been shown to enhance engagement and interest in economics. Despite their pedagogical value, these activities can be costly to adopt initially, particularly due to the time and expertise required to understand the experimental design and logistics. This experiment was developed with these challenges in mind. It provides instructors with all the materials necessary to implement it meaningfully, including a clear procedure, visualizer tool, guided discussion questions, and a follow-up assignment that reinforces key theoretical and empirical insights.

The design of this experiment combines in-person conversations with the use of popular survey platforms to help reduce the implementation time. Additional attention is given to lowering setup costs by using freely available tools, clearly labeled datasets, and automated templates for data entry and visualization. Discussion questions and assignment prompts are included to extend the learning experience without additional design work, allowing instructors to easily adapt the exercise to different class sizes and formats. Future published classroom experiments should seek to also reduce startup costs by pairing instructional materials with ready-to-use assignments that help instructors integrate experimentation seamlessly into their teaching.

References

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[11] Michael Watts and William E. Becker. A little more than chalk and talk: Results from a third national survey of teaching methods in undergraduate economics courses. 39(3):273–286.

A Figures

Figure 1: City X's Available Parcels

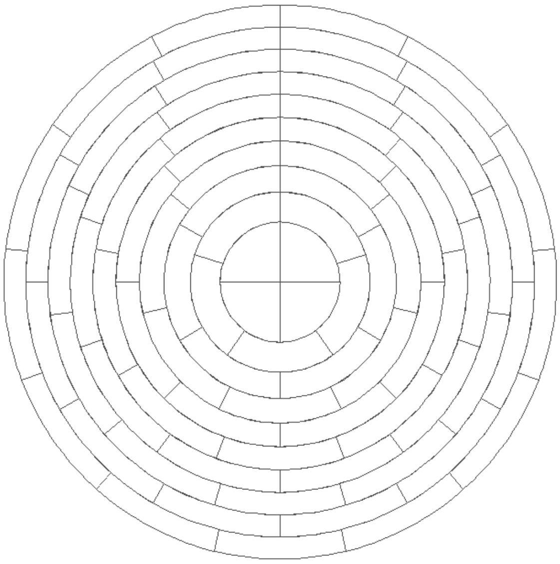


Figure 2: Bid Rent Curve to Spatial Rings Around CBD

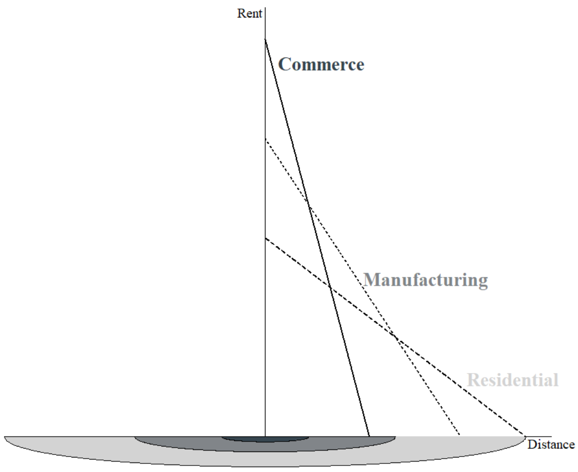
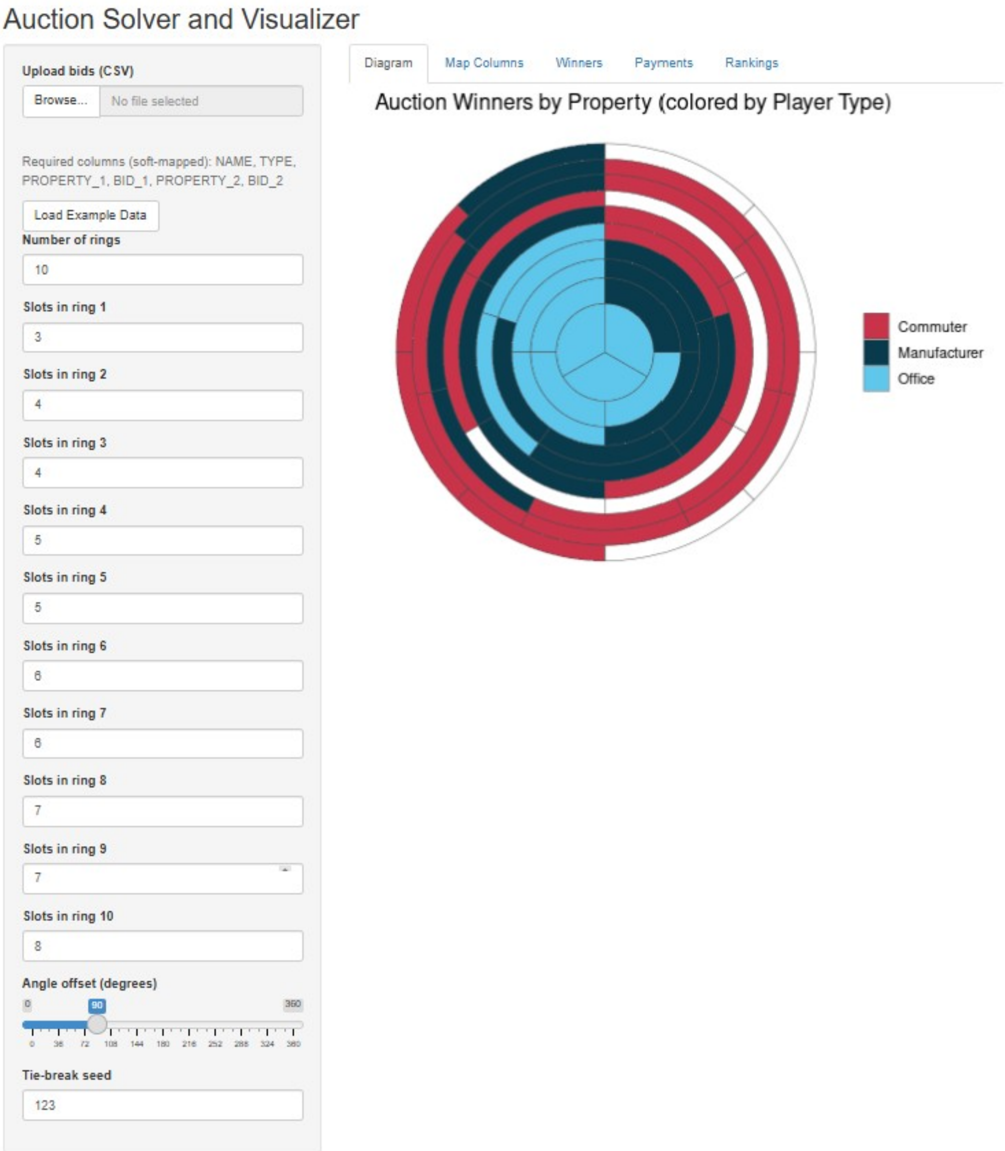


Figure 3: Shiny Application: Visualizer



B Verbal Instructions

Please pull out your laptops and a pen or pencil as I pass out the worksheets for today's class. These worksheets will have information on them that I want you to keep private and not share with others. It will make the experiment more fun and improve the data that we collect.

Pass out student handouts

Today you all are going to participate in an experiment about the structure of cities. You will make a series of decisions about where to live around our city while trying to maximize your earnings.[‖]

Again, your goal in this experiment is to maximize your individual profit each round. Securing housing is important. If you do not successfully win a plot of land in a given round you will earn negative profit for that round.

I want you to imagine a city located around a single business district.

Pull up a picture of the birds eye view of the city

The business district is located at the very center of this city. The parcels closest to the center represent the most beneficial locations as everyone works in the center of the city and must commute. The distance that you commute is determined by the number of rings away from the center you reside.

There are a limited number of parcels located around the city that you can bid on. The number of parcels increases with distance away from the city center. The parcels are identical except in their distance from the city center. Parcels located on the same concentric ring away from the business district are considered equidistant from the center.

Each of you have been assigned a type (A, B, or C). You'll see your type, income, and transportation costs on the worksheet I just passed out. You will use this information to bid on land around out city. Your income is the set amount of money you receive each round. You are purchasing two goods each round: transportation and land. Before you place any bids, you must lower your income by any transportation costs which would be needed to live there. You will never be able to bet your entire income as a bid for a piece of land because you will always have some transportation cost.

Pull up the link to the submission survey

You will submit your bids online through **Survey Platform** at **link**. You will be able to bid on two parcels each round. You can only win one parcel. If both of your bids would have won, you will win the closer parcel and be removed from consideration for the other one. Each round I need you to include the following in your survey: your name, your experimental type, the property distance you are bidding on, and your bid amount.

Your profit each round is the amount of money you have left over after your transportation and land costs. If you do not win any parcel, your profit will be negative ten (-10). Keep track of your profit throughout the experiment. The participant from each type—A, B, and C—who earns the highest total profit will receive a reward.

[‖] You should select a name for the city or have students select a name for the city.

Please work individually. Do not communicate or share information with others during the experiment, as this could influence bidding behavior and distort the results. Make sure your name and type are recorded correctly on your sheet or form, and double-check that each bid you submit is clear and legible. If you have any procedural questions, ask them now—once we begin, no clarifications will be provided until the experiment concludes.

C Student In-Class Handouts

General Instructions — Type A

This is an experiment in economic decision making. You are going to be asked to decide where you would like to live around our classroom city. There are three groups of buyers in this game: Type A, Type B, and Type C. You are competing to earn the most profit possible.

Your Type: A

Your Income and Per-Distance Transportation Costs are unique to your group. Use these values to determine the maximum you can bid for any one property before placing any bids.

Your Income is: $120

Your Per-Distance Transportation Cost is: $15 per unit

Example

Suppose you have an income of $100 and a transportation cost of $10 per distance (x). Using the distance and winning bid below let's calculate the total transit cost and the overall profit for the round assuming we won.

Round	Distance (x)	Total Transit Cost	Winning Bid	Profit
1	4	??	50	??

To calculate total transit cost you take the per-unit transit cost included in your worksheet and multiply it by the distance you live from the city center.

$TotalTransitCost = Distance * TransitCost = 4units * \$10perunit = 40$

To calculate profit you will find your leftover income after all expenses are removed.

$\pi = Income - TotalTransportationCosts - LandBid = \$100 - \$40 - \$50 = \$10$

At the end of the experiment, the participant from each type who earns the highest total profit will receive a reward.

Earnings Record Sheet — Type A

Name: **Date:**

Bidding Instructions.

In each round, you will submit two bids for parcels that are two different distances from the city center. Record your bids, whether you won that parcel, and your resulting profit. Your profit is calculated as your income minus transportation costs minus your bid (if you win). If you do not win any parcel in a given round, your earnings for that round are -$10.

Record Bids.

You may only win one parcel total. You will see on the projector which parcel you win each round.

Round	**Distance (x)**	**Your Bid**	**Win?**
1			
1			
2			
2			
3			
3			
4			
4			

Record Profit.

If you do not win any parcel in a round pick one at random and set the profit to -$10.

Round	**Distance (x)**	**Total Transit Cost**	**Winning Bid**	**Profit**
1				
2				
3				
4				

General Instructions — Type B

This is an experiment in economic decision making. You are going to be asked to decide where you would like to live around our classroom city. There are three groups of buyers in this game: Type A, Type B, and Type C. You are competing to earn the most profit possible.

Your Type: B

Your Income and Per-Distance Transportation Costs are unique to your group. Use these values to determine the maximum you can bid for any one property before placing any bids.

Your Income is: $100

Your Per-Distance Transportation Cost is: $10 per unit

Example

Suppose you have an income of $100 and a transportation cost of $10 per distance (x). Using the distance and winning bid below let's calculate the total transit cost and the overall profit for the round assuming we won.

Round	**Distance (x)**	**Total Transit Cost**	**Winning Bid**	**Profit**
1	4	??	50	??

To calculate total transit cost you take the per-unit transit cost included in your worksheet and multiply it by the distance you live from the city center.

$TotalTransitCost = Distance * TransitCost = 4units * \$10perunit = 40$

To calculate profit you will find your leftover income after all expenses are removed.

$\pi = Income - TotalTransportationCosts - LandBid = \$100 - \$40 - \$50 = \$10$

At the end of the experiment, the participant from each type who earns the highest total profit will receive a reward.

Earnings Record Sheet — Type B

Name: **Date:**

Bidding Instructions.

In each round, you will submit two bids for parcels that are two different distances from the city center. Record your bids, whether you won that parcel, and your resulting profit. Your profit is calculated as your income minus transportation costs minus your bid (if you win). If you do not win any parcel in a given round, your earnings for that round are -$10.

Record Bids.

You may only win one parcel total. You will see on the projector which parcel you win each round.

Round	Distance (x)	Your Bid	Win?
1			
1			
2			
2			
3			
3			
4			
4			

Record Profit.

If you do not win any parcel in a round pick one at random and set the profit to -$10.

Round	Distance (x)	Total Transit Cost	Winning Bid	Profit
1				
2				
3				
4				

General Instructions — Type C

This is an experiment in economic decision making. You are going to be asked to decide where you would like to live around our classroom city. There are three groups of buyers in this game: Type A, Type B, and Type C. You are competing to earn the most profit possible.

Your Type: C

Your Income and Per-Distance Transportation Costs are unique to your group. Use these values to determine the maximum you can bid for any one property before placing any bids.

Your Income is: $65

Your Per-Distance Transportation Cost is: $5 per unit

Example

Suppose you have an income of $100 and a transportation cost of $10 per distance (x). Using the distance and winning bid below let's calculate the total transit cost and the overall profit for the round assuming we won.

Round	Distance (x)	Total Transit Cost	Winning Bid	Profit
1	4	??	50	??

To calculate total transit cost you take the per-unit transit cost included in your worksheet and multiply it by the distance you live from the city center.

$TotalTransitCost = Distance * TransitCost = 4units * \$10perunit = 40$

To calculate profit you will find your leftover income after all expenses are removed.

$\pi = Income - TotalTransportationCosts - LandBid = \$100 - \$40 - \$50 = \$10$

At the end of the experiment, the participant from each type who earns the highest total profit will receive a reward.

Earnings Record Sheet — Type C

Name: **Date:**

Bidding Instructions.

In each round, you will submit two bids for parcels that are two different distances from the city center. Record your bids, whether you won that parcel, and your resulting profit. Your profit is calculated as your income minus transportation costs minus your bid (if you win). If you do not win any parcel in a given round, your earnings for that round are -$10.

Record Bids.

You may only win one parcel total. You will see on the projector which parcel you win each round.

Round	Distance (x)	Your Bid	Win?
1			
1			
2			
2			
3			
3			
4			
4			

Record Profit.

If you do not win any parcel in a round pick one at random and set the profit to -$10.

Round	Distance (x)	Total Transit Cost	Winning Bid	Profit
1				
2				
3				
4				

D Post-Experiment Assignment

Urban Economics, Fall 2025 **Name (Print):** ______________________
In-Class Experiment 1
Due XXX Student ID ______________________

Please write all answers in legible handwriting in the space provided or on additional sheets of paper. Points will be deducted if I cannot read what you wrote. You will turn this problem set in on XXX as a single PDF document. You can find resources in XXX on how to upload as a pdf.

Exploring Bid Rent Functions

"Bid Rent" is a phrase used to describe the maximum amount of rent that a land user is willing to pay for a specific location, given their need for accessibility and their other costs.

In our experiment today, you unknowingly used a bid rent to participate in the auction each round. The three types in class (A, B, and C) had the following incomes (I) and transportation costs (t):

Type A: I = 120; t = 15
Type B: I = 100; t = 10
Type C: I = 65; t = 5

1. The Linear Bid Rent Function. Using the definition for bid rent above along with the specific parameters from our experiment, write equations which reflect the maximum rent that each type (i) is willing to pay as a function of distance ($R_i(x)$). *Distance is represented by x in the equation.*

2. Plot the Bid Rent Curves. Take the bid rent functions you found above and plot them onto the same graph. Plot distance on the x-axis and the maximum willingness to pay for rent ($R_i(x)$) on the y-axis. *Hint: You should have three straight lines which intersect somewhere between $x = 1$ and $x = 10$.*

3. Boundaries of Groups. At what distances from the city center do multiple types of buyers have the same willingness to pay for land? Find the value of x such that $R_A(x) = R_B(x)$, $R_B(x) = R_C(x)$ and $R_A(x) = R_C(x)$.

What does this all mean?

4a. What does it mean for firms to have the same willingness to pay? What do you imagine is the economic significance of these equivalences?

4b. What does it mean when one bid rent function is above another? Specifically, wins an auction when $R_A(x) > R_B(x)$?

4c. Determine the distances from the city center that will be occupied by each type. Be specific about who would theoretically win at each distance from the city center given everyone was paying at their maximum willingness to pay.

5. Other Costs!! Some groups face costs related to distance costs that they must take into consideration before bidding for their land. Many firms do not "commute" but have to pay to move freight and paying for the labor of their employees. Let's try to derive a bid rent curve when a firm faces different costs.

Suppose a firm makes \$200. They are looking to purchase one unit of land at the price of $P(x)$. The labor cost of the firm is given by:

$$L(x) = 40 - 3 * x$$

The firm also faces freight costs given by:

$$F(x) = 50 + 9 * x$$

Assume the firm has no other income or costs other than those provided above. What is the firm's maximum willingness to pay for land $R_{firm}(x)$.

Working with Data.

In this section you will take the data from class and empirically estimate the bid rent functions you worked with for the first time in this assignment.

6. Using Excel, or the analysis software of your choice, create a single scatter plot graph which plots each type separately. You can represent the points as different shapes or colors to distinguish between the groups.

- Add a line of best fir to each type so you have three lines on a single graph with all of the data points represented.
- Label your graph clearly with titles and axes labels, and include a legend to differentiate the trendlines for Group A, Group B, and Group C.
- Print off a copy of this graph to turn in with this assignment.

7. Where does the data suggest that each type has the same willingness to pay for land? Is this similar or different than the theoretical prediction from priot? *Roughly at what distance from the city center do each of the curves intersect?*

8. Compute the mean distance from the center of the city for each type (A, B, C). Calculate the mean winning bid for each distance x. Write up the results below.

9. Use these descriptive statistics to assess in what ways the theoretical results are similar or different from the data collected.