Instructor's Manual for Experiments with Economic Principles

Theodore Bergstrom,
University of California Santa Barbara

John H. Miller,
Carnegie Mellon University

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Introduction

A Book of Recipes

This manual provides recipes for running the experiments in *Experiments with Principles of Economics*. A good recipe book is detailed enough so that a careful novice can follow instructions and produce good dishes. Just as an experienced cook often adapts a cookbook's recipes by substituting ingredients or adjusting proportions, you may want to do some things differently from the way proposed here. Feel free. In our experience, these experiments are robust to changes in details, both deliberate and inadvertent.

The second part of this manual reports on our classroom experiences with each of these experiments. There are fairly detailed descriptions of the outcomes in one or more classes where we have conducted each experiment. This may give you a better idea of what to expect when you run the experiment.

Ingredients–Resources and Facilities Required

Classroom

The classroom does not require any special design, but it should be possible for students to get up and walk around to trade with each other. The room should have either a blackboard or an overhead projector so that transaction prices can be posted for all to see.

Instructor(s)

One instructor can run the market single-handedly. If you can arrange it, a teaching assistant is extremely useful. The assistant can help run the experiment, maintain payoff records, and grade homework. If you don't

have an assistant, you can assign one or two students from the class to help manage incoming sales contracts and record the results on the blackboard.[1]

Time Required

The classroom experiments can be run either in 80-minute or in 50-minute class sessions. An 80-minute class provides ample time to conduct the experiment, to discuss and interpret events, and to help the students get started on their lab reports. Most of the experimental chapters include three related sessions. In a 50-minute class, if time runs short, you can omit the last session of any experiment without ruining the experiment.

In our own teaching, we have allocated two class meetings to most chapters. The first meeting is devoted largely to carrying out the experiment and the second is spent on explaining the related economic theory. Those who are use this book as a supplement to a standard textbook may want to replace some or all of our discussion with material from that text.

Instructional Materials

You will need the following instructional materials:

- Personal Information Sheets. For most of the experiments, you need to provide each student with a *personal information sheet*, which specifies the role that the student will play in each experimental session. This manual includes original copies of all of the personal information sheets needed for every experiment. You will need to photocopy enough copies to distribute to your class.

- Sales Contracts. For many experiments, transactions between a buyer and a seller must be recorded on a "sales contract." The manual includes originals which can be photocopied for distribution.

- Red and Green Paper Strips (Optional). We have found it useful, though not essential, in the first experiment or two to give each student one strip of red and one strip of green colored paper, which they can use as flags to indicate whether they are buying or selling. Someone who wants to buy holds up a green strip (money is green) and someone who wants to sell holds up a red strip (apples are red). A buyer who wants to find a seller looks for somebody holding up a red strip. A

[1] In trading-pit experiments, you can simply ask one or two of the first students to finish trading to help you record the remaining transactions.

seller looks for a potential trading partner who is holding up a green strip. The strips are not traded and students can keep them to use in other experiments.

- Other Stuff to Bring to Class. A stapler is useful for sticking together documents, like sales contracts, that you may want to use for recording students' profits. A few large brown envelopes can serve the same purpose. Bring a couple of pens or markers to record things and to lend to students who lose their pencils. A laptop computer with a spreadsheet on it is useful for recording the outcomes of experiments. (While you could enter the data into the laptop during class, as transactions are reported, we found it less hectic to collect the paper sales contracts and to enter the results into a spreadsheet after class.)

Class Size

The experiments are designed to work smoothly with classes varying in size from fifteen to sixty students. However, most of these experiments can, with minor adaptations be applied to a classes of 100 or more students.

We have used these experiments in an Economics Principles class of 500 students at the University of California Santa Barbara. The experiments were run by teaching assistants in recitation sections of about 50 students each, which met once a week. Lectures and quizzes were administered by the instructor to the entire class in a large lecture hall. Since many teaching assistants have limited experience in lecturing, we think that running the experiments is a good application of comparative advantage.

General Procedures for Experiments

Student Preparation and Incentives

For each experiment, students should be urged to read through the introduction and work the warm-up exercises before coming to class.

In most of the experiments, students make profits designated in "laboratory dollars." It is a good idea to give them some incentive to regard these dollars as valuable. We have used a grade incentive, where 10% of the course grade depends on one's score in the experiments. We explained to the students that although there will be "good days" and "bad days" over the course of the semester, any student who comes to class regularly,

pays attention to the experimental instructions, and makes an effort to make profits will do well over the course of the term.

We thought of charging a "lab fee" of about $25 to everyone who registered for the course, with the proceeds of the lab fees being redistributed to students in proportion to their profits in the experiments. Unfortunately, this idea is too reasonable to be accepted by the administration at most universities. One of us was able to persuade his university to provide a fund of about $10 per student. We told the students that if they chose to invest $20 in the profit fund, then the total fund consisting of student investments plus the university's contribution would be divided among student investors in proportion to their profits in the classroom markets.[2] Most students chose to participate and in response to a questionnaire, most said that they liked playing for money and that they played more carefully because there was something at stake.

Transactions, Rounds, and Sessions

In order to understand the way that our experiments are designed, it is useful to distinguish among *transactions*, *rounds of trading*, and *market sessions*. A *transaction* is a deal between a buyer and a seller, consummated in the form of a filled-in sales contract which is delivered to the market manager. A *round* of trading begins when the market manager declares trade to be open and ends when transactions cease. Rounds within a given session are repetitions of the same experiment with the same market fundamentals. Rounds are repeated to allow students a chance to revise their behavior in subsequent rounds based on what they have learned about market opportunities from observing the prices at which others bought and sold in previous rounds. A market *session* typically includes two or more rounds of trading.

ID numbers, Personal Information Sheets, and Sales Contracts

We suggest that at the first class meeting, you assign an ID number to each student in the class.[3] Tell students that they will have the same ID number

[2] We know of one instructor who has succeeded in persuading a corporate donor to provide prize money for classroom experiments.

[3] One of us uses the *last* four or five digits of each student's social security number. The other assigns numbers sequentially. In a class with multiple sections, it is useful to use a student's section number as the leading digit of his or her ID number.

for the entire term.[4]

At the beginning of each experiment, every student will be given a Personal Information Sheet that assigns the student his or her economic role for each Session. Students should write their ID numbers on their Personal Information Sheets and turn them in at the end of the experiment. You can photocopy these Personal Information Sheets for each experiment from the corresponding chapter of this manual. Detailed instructions accompany each experiment.

You should also photocopy a stack of sales contracts, on which students who reach an agreement will record their ID numbers, the price, and any other relevant details of the transaction. We have printed a separate page of sales contracts for each experiment. Although these sales contracts differ slightly from each other, if you want to save paper, you can use sales contracts from Experiment 1 for any of the first 6 experiments.

Collecting, Recording and Posting Results

In relatively small classes (25-30 or less), you may want to require students to copy the data that they will need to complete their Lab Notes from the blackboard after the last round of each experiment. In larger classes, as the number of transactions gets bigger, recording this information becomes tedious, and consumes a substantial amount of class time.

For relatively large classes, we suggest that after class you record this information from the sales contracts and post it in a conveniently accessible form. Even for small classes, we have found that students appreciate this posting. A class web site is a particularly convenient place to post results. You can even post the transaction information in spreadsheet format (as well as in text format) to make it easy for students to process the data with a spreadsheet.

We recommend that after each round, you staple together the sales contracts that students have turned in. Then after class, you can use these contracts to record the relevant information from each transaction. Although students are asked to record their Buyer Values or Seller Costs and their ID numbers on the sales contracts, this information is not entirely reliable.

In our experience, there are usually a few students who report their Buyer Values or Seller Costs incorrectly on the Personal Information Sheets. Therefore we suggest that you also ask students to sign and turn in their

[4] At the second (and third) experiment, a few students may have forgotten their ID numbers and you will have to look these up and remind them.

Personal Information Sheets before they leave at the end of the experiment.[5] This gives you accurate information about each student's Buyer Value and Seller Cost. It also gives you an independent verification of the number of students of each type participating in the experiment.

Posting the Distribution of Types

For several of these experiments, you will need to inform students after the experiment is over of the distribution of Seller Costs and Buyer Values of persons participating in the experiment. You can, if you wish, determine this distribution during the experiment and post it on the blackboard for students to copy. In the Quick Start section for each experiment, we give you tables that allow you to do this quickly. Alternatively, if you are posting the results for students to copy at a later time, you may want to calculate this distribution from the Personal Information Sheets that students turn in at the end of class.[6]

Occasionally, we have tried to determine the distribution of agent types by asking buyers and sellers of each type in turn to raise their hands. Our experience is that hand-raising surveys are often time-consuming and confusing. Perhaps as revenge for the tedium they have endured in high school, students are remarkably adept at subverting hand counts. Some are likely to be daydreaming at the time you ask for a show of hands, some raise their hand at the wrong time, some are able to suspend their arms in an indecipherable position halfway between up and down. You may wish to do an occasional hand-raising survey between rounds of a session, just to focus students' attention on market conditions.

Keep in mind that while actually trading, the students do not know the distribution of Buyer Values and Seller Costs. One of the remarkable features of decentralized markets is that although individuals know only their own values or costs and some scraps of information acquired by higgling and haggling, the outcome of the trading process is typically quite close to that predicted by the intersection of the supply and demand curves.

[5] To give students an incentive to turn in their Personal Information Sheets after class, we tell them that if they fail to turn these sheets in, they will not receive attendance credit for this experiment, nor will they be credited with their earnings Even with this warning, a few students are likely to forget to turn in their sheets after the first experiment or two. It is probably a good idea to stand near the door at the end of the class period and ask students to hand you their Information Sheets as they leave.

[6] Each method has its advantages and disadvantages. In large classes, P.I. sheets occasionally get lost while they are being handed out, or a student walks out early. On the other hand, students sometimes forget to turn in their P.I. sheets at the end of class.

Part I

Instructions and Materials

Experiment 1

Supply and Demand: The Apple Market

Objectives of This Experiment

In this experiment we expect that students will achieve the following:

- Become acquainted with the mechanics of a simple trading-pit environment.
- Learn to record experimental data and make simple statistical calculations with it.
- Learn to apply the concepts of competitive supply and demand to a very simple market.
- Learn to draw supply and demand curves corresponding to given market data, and to read market data from given supply and demand curves.
- Learn to compare results in an experimental market with the theoretical predictions of the competitive model.
- Begin to understand the benefit of having an abstract *theory* for predicting the effects of changes in the environment.
- Learn to test a proposed theory by confronting it with experimental data.

General Discussion

Students are given Personal Information Sheets that tell them their roles as suppliers or demanders in each of the two sessions of this experiment. In every round of trading, a supplier can sell either one bushel or none, and a demander can buy either one bushel or none.

In each round, suppliers and demanders are asked to move around the room and try to make a deal by agreeing on a price. A seller with Seller Cost $\$C$ who sells a bushel of apples for price $\$P$ will get profits of $\$P - \$C$, and a buyer with Buyer Value $\$V$ who buys a bushel of apples at price $\$P$ will get profits of $\$V - \$P$. When a demander and a supplier agree on a price, they must fill out a *sales contract* and deliver it to the *market manager* (the instructor or teaching assistant). As each contract is turned in, the market manager records the price, Buyer Value, and Seller Cost on the blackboard.

Detailed Instructions and Comments

Student preparation

If it is convenient, encourage students to prepare for the experiment by reading the instructions and working the Warm-up exercises from their textbook before coming to class. Though prior preparation is helpful, it is not essential. We have often run this experiment successfully at the first class meeting.

Personal Information Sheets and Sales Contracts

Distributing Information Sheets

We have prepared six different types of personal information sheets, labeled A, B, C, D, E, and F.[1] To ensure that you distribute nearly equal numbers of each type of personal information sheets, we suggest that you clip together "six-packs" of sheets, containing one of each of the six types. Make enough of these six-packs so that you have at least one sheet for every student who might possibly come to class. Distribute as many complete six-packs as you can and then pass out the top sheets from the last six-pack until everyone

[1] Since some roles are more profitable than others, the personal information sheets are arranged so that students who get very profitable roles in one session will have unprofitable roles in the other. We have also attempted to give as many people as possible a chance to be suppliers in one session and demanders in the other.

has a sheet. Make a note of the number of complete six-packs and the type of the last sheet that you distributed.

Example:

> If the most students who might come to class is 35, you would prepare 6 six-packs. If 33 students came to class, you would then distribute the entire contents of 5 six-packs and Types A, B, and C from the sixth.

Sales Contracts

You will need a stack of "sales contracts" which can be photocopied from the original included in this manual. Each transaction between a buyer and a seller must be recorded on a sales contract. The number of transactions in a single round of trading will be smaller than half of the number of students in the class. Since you will have about four rounds, you should have at least two contracts for each student in the class. If you make extras, they will not go to waste, since sales contracts will be used in several other experiments.

First Session–Round 1

Before Trading Starts

After distributing personal information sheets, briefly explain the rules of trading and the way that profits of buyers and sellers are calculated. Then work through the Warm-up exercises in the students' instructions with the class. Ask if there are any questions.

Remind students of the following:

- They can not buy or sell *more than* one bushel of apples in a round.
- They do not *have to* make a trade. It is better to make no trade than to trade at a loss.
- Each pair of traders should turn in only *one* sales contract for their transaction.
- Students should return to their seats after they have traded and turned in a sales contract.

The Trading Process

When there are no further questions, tell the class that the first trading round has begun. Encourage students to get out of their seats and move

around the classroom to make deals.[2] Suppliers should seek demanders, and demanders should seek suppliers. When a supplier and a demander reach an agreement, they should come to the front of the room and pick up and fill out a sales contract on which they record their identification numbers, the price that they agree on, the supplier's Seller Cost, and the demander's Buyer Value. They should then bring the sales contract to the market manager. As each sales contract is turned in, the market manager (or an assistant) records the price, Seller Cost, and Buyer Value on the blackboard, using a format similar to Table 1.1. Students who have not yet transacted are thus able to observe the transaction prices as they are recorded.[3]

Table 1.1: Blackboard Record of Transactions

Trade	Price	Seller Cost	Buyer Value
1			
2			
3			
4			
5			
...			

Typically, trading proceeds briskly and few students are inclined to wait and watch the record of trades on the blackboard. There is an early flurry of trade and then trading activity comes to a halt (usually within 5 minutes for a class of 50 students). In the first round of Session 1, there may be a few students who don't yet get it and who haven't been able to make a trade, even though opportunities for profitable trades are still available. Occasionally, after all other transactions have been recorded, two persons may be "deadlocked" in an argument about the price. If this seems to be taking too much time, you may want to call the attention of other students to this impasse. Someone will probably make a competing offer, leading to a quick conclusion of trading. When trading has stopped, you should declare that this round of trading is over. Because this is an entirely new experience to students, Round 1 of Session 1 will probably take twice as long as future sessions.

[2]Some instructors may find it convenient to designate an area of the classroom as a "trading pit" and ask students to come to this area to make trades.

[3]Our experience is that students don't look at these as much as one might expect.

After Trade Stops

After trading stops, calculate (at least approximately) the average price of trades made in Round 1 and report this information to the class. Then staple together all of the sales contracts collected from Round 1, stacked roughly in the order that you collected them.

After the round is over, ask the students to look at the list of transactions and see whether anyone lost money in trading.[4] If they find such a transaction, point out that nobody needs to make a money-losing trade, since you can always get a zero profit by not trading. Before starting another round, ask the students to think about whether, in the light of the information about trading prices in the first round, they could have found a better deal than they did in the first round.

First Session–Later Round(s)

When the first round of trading is completed, the market manager should ask students again if they have any questions about the rules of trading. The market manager should now tell students that they are going to try the same market again, and that everyone will play the same market role as they did in the first session, but that this time they will have some experience in the market, and therefore may have a better idea of what choices to make. Ask those who made trades to compare the price they paid or received to the average price in Round 1.

Before you begin Round 2, emphasize that this is a second round of the *first* session and *not a new session.* Buyer Values and Seller Costs in this second round remain the same as they were in the first round. Repeat this reminder at least one more time than you think is necessary. Most students hear you the first time. But you want to catch the ones who didn't. Tell students to begin Round 2.

Depending on time available and the extent to which prices seem to be converging to the predicted competitive price, the instructor may want to run more than two rounds. Of course in this experiment, as in future experiments, the instructor must realize that there is a tradeoff between scientific accuracy and the efficient use of students' time. More rounds per session are likely to result in prices that converge more closely to competitive equilibrium prices, but running several rounds with the same old setup is

[4]Since the record on the blackboard lists only prices, Seller Costs, and Buyer Values, you can determine this without identifying (and embarrassing) the person who made the loss.

likely to bore the students.

If this is a relatively small class, you can ask students to copy the record of transactions for the last round of this session into the appropriate table in the Lab Notes found in their textbooks. If this is a large class, it will be more convenient for the students if you wait until after class to record the results from the sales contracts and either post the results on the Internet or make them available in some other way.

Session 2

At the beginning of Session 2, the market manager should remind students that they must now look at their Personal Information Sheets to determine the roles that they will play in Session 2. This is also a good time to ask whether students have any more questions about the workings of this market experiment.

Distribution of Types

After both sessions of the experiment have been completed, you should report the number of buyers and sellers of each type in a table similar to Table Q.1.4. This may be written on the blackboard for students to copy or posted somewhere so that students can record this information at a later time.

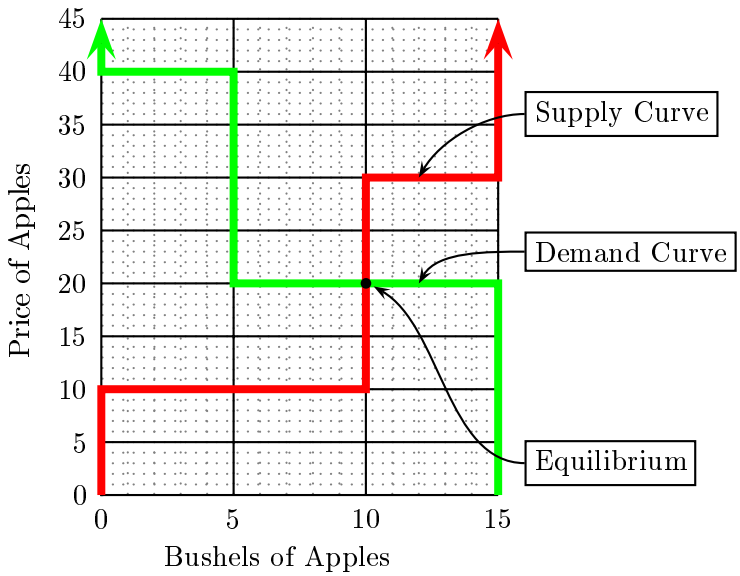
In the Quick Start section of these instructions, you will find tables that show the number of suppliers and demanders with each Buyer Value, given the number of complete six-packs distributed and the type of the last sheet handed out.

Predictions of the Competitive Model

Supply and Demand Curves

Figures 1.1 and 1.2 show the supply and demand curves for each of the two sessions for a class of 30 students. In Session 1, there are twice as many low-cost as high-cost suppliers and twice as many low-value demanders as high-value demanders. In Session 2, the proportions are reversed for both suppliers and demanders. Although the numbers of demanders and suppliers of each type in your class are unlikely to be exactly the same as those shown here, the proportions will be similar enough so that the important qualitative features of competitive equilibrium will be the same.[5]

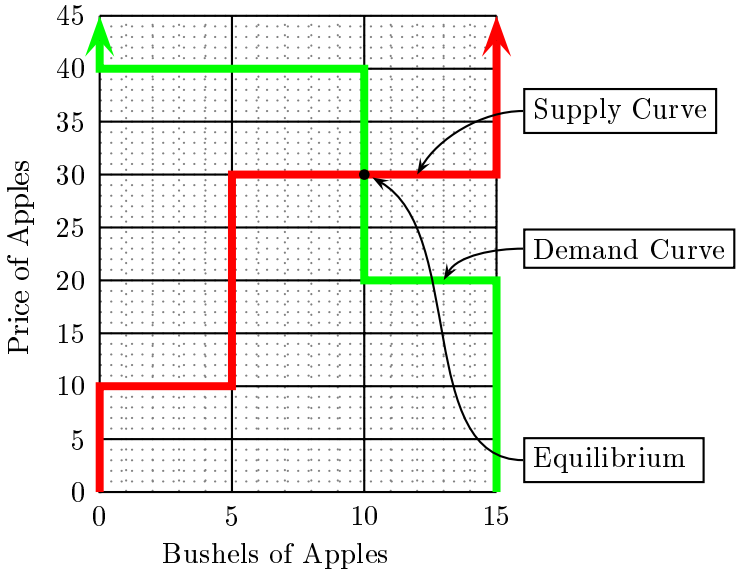
Figure 1.1: Supply and Demand in Session 1



The equilibrium price is $20 in the first round and $30 in the second. In equilibrium for the first round, all of the low-cost suppliers and none of the high-cost suppliers will sell apples. All of the high-value and some of the low-value demanders will buy apples. In equilbrium for the second round, all of the low-cost and some of the high-cost suppliers will sell apples. All of the high-value and none of the low-value demanders will buy apples.

[5]Students will be asked as part of their homework to draw the actual supply and demand curves, given the numbers of suppliers and demanders of each type in their classroom experiment.

Figure 1.2: Supply and Demand in Session 2



Quick Start for Experiment 1: The Apple Market

We have found that when we go to class, it is nice to have a set of capsule instructions to use as a quick reminder of what happens next. We also like to have information at our fingertips about how to calculate the distribution of Sellers Costs and Buyer Values.

This section also contains copies of the Personal Information Sheets and sales contracts and detailed instructions about how many to photocopy and bring to class.

Capsule Instructions: The Apple Market

- Distribute as many *complete* six-packs of Personal Information Sheets (one sheet per student) as possible, and then pass out the sheets (in order) from the remaining six-pack until everyone has a sheet.
- Work through the Warm-up Exercises. Ask if students have any questions.
- Begin Session 1.
  - Open trading in Round 1. As completed Sales Contracts are turned in, record price, Seller Cost, and Buyer Value on the blackboard.
  - Discuss results of Round 1. Point out any trades where one party took a loss. Estimate average of recorded prices. Ask students who paid more or sold for less than average to think about whether they could hold out for a better price in the next round.
  - Ask if students have any questions about rules or procedures.
  - Before the second round starts, remind students that they are still in Session 1. (If you don't emphasize this, someone is likely to use the Session 2 information in this round.)
  - Open trading in Round 2. As completed Sales Contracts are turned in, record price, Seller Cost, and Buyer Value on the blackboard.*
- Begin Session 2.
  - Remind students that they are now in Session 2.
  - Open trading in Round 1. As completed Sales Contracts are turned in, record price, Seller Cost, and Buyer Value on the blackboard.
  - Discuss results of Round 1.
  - Open trading in Round 2. As completed Sales Contracts are turned in, record price, Seller Cost, and Buyer Value on the blackboard.*
- Announce the distribution of Buyer Values and Seller Costs for each session.*
- Collect Personal Information Sheets from all traders.

The items marked * denote data that students should copy into their lab notes, either during class or from information that the instructor will post after class.

Distribution of Types

Record the following information after you distribute the P.I. sheets:

Number of complete six-packs distributed (=N) _____

Type of Last P.I. sheet distributed _____

Use this information and Tables Q.1.2 and Q.1.3 to determine the number of suppliers and demanders of each type present in the classroom. After trading is over, post the results in a table like Table Q.1.4

Table Q.1.2: Distribution of Agent Types in Session 1

Type of Last Sheet	A	B	C	D	E	F
Low-Cost Supplier	2N	2N	2N	2N+1	2N+1	2N
High-Cost Supplier	N	N	N	N	N+1	N
High-Value Demander	N+1	N+1	N+1	N+1	N+1	N
Low-Value Demander	2N	2N+1	2N+2	2N+2	2N+2	2N

Table Q.1.3: Distribution of Agent Types in Session 2

Type of Last Sheet	A	B	C	D	E	F
Low-Cost Supplier	N	N+1	N+1	N+1	N+1	N
High-Cost Supplier	2N+1	2N+1	2N+1	2N+1	2N+1	2N
High-Value Demander	2N	2N	2N+1	2N+1	2N+2	2N
Low-Value Demander	N	N	N	N+1	N+1	N

Table Q.1.4: Distribution of Types

Type of Trader	Number in Session 1	Number in Session 2
Low-Cost Supplier (SC=$10)		
High-Cost Supplier (SC=$30)		
High-Value Demander (BV=$40)		
Low-Value Demander (BV=$20)		

What to Post for Students' Lab Notes

In order to do their homework, students will need the following information:

- For the last round of each session, a list of the price, the seller's Seller Cost, and the buyer's Buyer Value in each transaction. Students should enter this information in Tables 1.4 and 1.5 of their Lab Notes.[6]
- The information that you entered in Table Q.1.4 on the distribution of Buyer Values and Seller Costs. Students should copy this into Tables 1.6 and 1.7 of their Lab Notes.[7]

[6] It is nice, but not essential, for this information to be entered in the order in which the sales contracts were turned in. In small classes, this information can be copied from the blackboard. In large classes, it is often preferable to stack the sales contracts from each session and use them later to prepare these lists for posting after class.

[7] If there was any confusion or chaos in the distribution of sheets, you can recalculate these distributions by collecting all of the Personal Information sheets after class and determining the distribution of Buyer Values and Seller Costs from the number of sheets of each type that were turned in.

Materials to Be Photocopied

Personal Information Sheets

We have prepared six different types of personal information sheets, labeled A, B, C, D, E, and F. You should photocopy enough copies so that each student gets one sheet. To ensure that you distribute nearly equal numbers of each type of personal information sheets, we suggest that you make up "six-packs" of these sheets, containing one sheet of each of the six types. Distribute as many complete six-packs as you can and then pass out the top sheets from the last six-pack until everyone has a sheet. Make a note of the number of six-packs and the type of the last sheet you distribute.

Sales Contracts

You will also need a stack of sales contracts, which can be photocopied from the originals included here. You should have about three sales contracts for each student in the class. (These are printed three contracts to a page, so the pages should be cut in three before class.) If you make extras, they will not go to waste, since the same kind of sales contracts can be used in other experiments.

TYPE A **Student ID Number** _____

The Apple Market

Personal Information Sheet

Please hand this sheet in at the end of the session.

Session 1

In this trading session you are an *Apple Demander*. Your *Buyer Value* is \$40. If you buy a bushel of apples for price $\$P$, your profit is $\$40 - P$. If you don't buy any apples, your profit is \$0.

If you bought apples, record the price you paid and the profit you made in the table below. If you did not buy any apples, mark an X under Price and 0 under Profit.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit ($= \$40 - P$)		

.....

Session 2

In this trading session, you are an *Apple Supplier*. Your *Seller Cost* is \$30. If you sell a bushel of apples for price $\$P$, your profit is $\$P - 30$. If you don't sell any apples, your profit is \$0.

If you sold apples, record the price and the profit you made in the table below. If you did not sell any apples, mark an X under Price and 0 under Profit.

Record of Prices and Profits

	Round 1	Round 2	Round 3
Price Received			
Profit ($=P - \$30$)			

TYPE B **Student ID Number** _____

The Apple Market

Personal Information Sheet

Please hand this sheet in at the end of the session.

Session 1

In this trading session you are an *Apple Demander*. Your *Buyer Value* is \$20. If you buy a bushel of apples for price $\$P$, your profit is $\$20 - P$. If you don't buy any apples, your profit is \$0.

If you bought apples, record the price you paid and the profit you made in the table below. If you did not buy any apples, mark an X under Price and 0 under Profit.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit ($= \$20 - P$)		

.....

Session 2

In this trading session, you are an *Apple Supplier*. Your *Seller Cost* is \$10. If you sell a bushel of apples for price $\$P$, your profit is $\$P - 10$. If you don't sell any apples, your profit is \$0.

If you sold apples, record the price and the profit you made in the table below. If you did not sell any apples, mark an X under Price and 0 under Profit.

Record of Prices and Profits

	Round 1	Round 2	Round 3
Price Received			
Profit ($=P - \$10$)			

TYPE C **Student ID Number** _____

The Apple Market

Personal Information Sheet

Please hand this sheet in at the end of the session.

Session 1

In this trading session you are an *Apple Demander*. Your *Buyer Value* is \$20. If you buy a bushel of apples for price $\$P$, your profit is $\$20 - P$. If you don't buy any apples, your profit is \$0.

If you bought apples, record the price you paid and the profit you made in the table below. If you did not buy any apples, mark an X under Price and 0 under Profit.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit ($= \$20 - P$)		

.....

Session 2

In this trading session you are an *Apple Demander*. Your *Buyer Value* is \$40. If you buy a bushel of apples for price $\$P$, your profit is $\$40 - P$. If you don't buy any apples, your profit is \$0.

If you bought apples, record the price you paid and the profit you made in the table below. If you did not buy any apples, mark an X under Price and 0 under Profit.

Record of Prices and Profits

	Round 1	Round 2	Round 3
Price Paid			
Profit ($= \$40 - P$)			

TYPE D **Student ID Number** _____

The Apple Market

Personal Information Sheet

Please hand this sheet in at the end of the session.

Session 1

In this trading session, you are an *Apple Supplier*. Your *Seller Cost* is \$10. If you sell a bushel of apples for price $\$P$, your profit is $\$P - 10$. If you don't sell any apples, your profit is \$0.

If you sold apples, record the price and the profit you made in the table below. If you did not sell any apples, mark an X under Price and 0 under Profit.

Record of Prices and Profits

	Round 1	Round 2
Price Received		
Profit ($=P-\$10$)		

Session 2

In this trading session you are an *Apple Demander*. Your *Buyer Value* is \$20. If you buy a bushel of apples for price $\$P$, your profit is $\$20 - P$. If you don't buy any apples, your profit is \$0.

If you bought apples, record the price you paid and the profit you made in the table below. If you did not buy any apples, mark an X under Price and 0 under Profit.

Record of Prices and Profits

	Round 1	Round 2	Round 3
Price Paid			
Profit ($= \$20-P$)			

TYPE E **Student ID Number** _____

The Apple Market

Personal Information Sheet

Please hand this sheet in at the end of the session.

Session 1

In this trading session, you are an *Apple Supplier*. Your *Seller Cost* is \$30. If you sell a bushel of apples for price $\$P$, your profit is $\$P - 30$. If you don't sell any apples, your profit is \$0.

If you sold apples, record the price and the profit you made in the table below. If you did not sell any apples, mark an X under Price and 0 under Profit.

Record of Prices and Profits

	Round 1	Round 2
Price Received		
Profit ($=P-\$30$)		

Session 2

In this trading session you are an *Apple Demander*. Your *Buyer Value* is \$40. If you buy a bushel of apples for price $\$P$, your profit is $\$40 - P$. If you don't buy any apples, your profit is \$0.

If you bought apples, record the price you paid and the profit you made in the table below. If you did not buy any apples, mark an X under Price and 0 under Profit.

Record of Prices and Profits

	Round 1	Round 2	Round 3
Price Paid			
Profit ($=\$40-P$)			

TYPE F **Student ID Number** _____

The Apple Market

Personal Information Sheet

Please hand this sheet in at the end of the session.

Session 1

In this trading session, you are an *Apple Supplier*. Your *Seller Cost* is \$10. If you sell a bushel of apples for price $\$P$, your profit is $\$P - 10$. If you don't sell any apples, your profit is \$0.

If you sold apples, record the price and the profit you made in the table below. If you did not sell any apples, mark an X under Price and 0 under Profit.

Record of Prices and Profits

	Round 1	Round 2
Price Received		
Profit ($=P-\$10$)		

Session 2

In this trading session, you are an *Apple Supplier*. Your *Seller Cost* is \$30. If you sell a bushel of apples for price $\$P$, your profit is $\$P - 30$. If you don't sell any apples, your profit is \$0.

If you sold apples, record the price and the profit you made in the table below. If you did not sell any apples, mark an X under Price and 0 under Profit.

Record of Prices and Profits

	Round 1	Round 2	Round 3
Price Received			
Profit ($=P-\$30$)			

Sales Contract: *Session* ____ *Round* ____

Price _____

Seller's ID _____ *Seller Cost* _____

Buyer's ID _____ *Buyer Value*_____

Sales Contract: *Session* ____ *Round* ____

Price _____

Seller's ID _____ *Seller Cost* _____

Buyer's ID _____ *Buyer Value*_____

Sales Contract: *Session* ____ *Round* ____

Price _____

Seller's ID _____ *Seller Cost* _____

Buyer's ID _____ *Buyer Value*_____

Experiment 2

Shifting Supply Curves

Objectives of This Experiment

In this section, we expect students to achieve the following:

- Learn to analyze shifts in the supply curve and their effects on equilibrium prices.
- Gain experience with a market where sellers can sell more than one unit.
- Observe that an increase in aggregate supply may decrease, rather than increase, total revenue of suppliers.
- Learn that fixed costs do not change the short-run supply curve.
- Gain an understanding of the economics of industries like fishing and agriculture where supplies, and hence prices, fluctuate over time.
- Begin to see how supply and demand curves can be used to predict the effects of changed market conditions on prices and quantities.

General Discussion

The fish-market experiment explores the effects of a supply curve shift on the price and quantity. The demand curve stays constant throughout the experiment. This experiment also introduces the notion of sunk costs.

Fishermen have arrived on the beach with their catch from the night before. Their only costs are a $10 sunk cost that each fisherman has paid to

refuel his boat before going out to fish. In the first session, every fisherman catches just one fish and the competitive equilibrium price is $20, more than enough to cover the sunk costs.

In the second session, fishermen all catch three fish. The number of fish available exceeds the number of demanders, and since each demander can use only one fish, there is excess supply even at zero price. The competitive equilibrium price is zero.

We suggest that you ask the students to read Sections A.1 and A.2 of the Appendix along with the discussion in this chapter. Section A.1 introduces straight-line demand and supply curves. Section A.2 provides further discussion of comparative statics methods.

Detailed Instructions and Comments

Time required

Within a 50-minute class meeting, it is easily possible to run two or three rounds of each of the two sessions and to have some discussion of shifting supply curves. Our experience has been that convergence to competitive behavior is slower for this experiment than for most. We have typically found it satisfactory to run two rounds of Session 1 and three rounds of Session 2.

After distributing personal information sheets, work through the Warm-up exercises with the class. Ask if there are any questions.

In each round of trading, as contracts are turned in, record the price and the demander's Buyer Value for each transaction on the blackboard as in Table 2.1. (We don't need to record Seller Costs, since all sellers have zero marginal costs and $10 sunk costs.)

Table 2.1: Blackboard Record of Transactions

Trade	Price	Buyer Value
1		
2		
3		
4		
5		
...		

Trading in Session 1

In this session, each fisherman has caught only one fish. The competitive equilibrium price is \$20. Typically, prices in the initial round of trading are well below the competitive price.

Since the number of fish caught is smaller than the number of persons with Buyer Values of \$20 or more, at the end of trading there will be several demanders who did not get a fish and who would profit by paying any amount less than \$20 for a fish.

After trading stops, ask whether anyone has any fish left to sell. There is not likely to be anyone. (If there is, ask whether anyone wants to make an offer for this fish.) Now ask for a show of hands of people with Buyer Values of \$20 or more who did not get a fish. There should be about N hands, where N is the number of complete six-packs that you distributed. Ask how many of these left-out demanders would be willing to pay \$19 for a fish. Suggest to sellers who sold cheaply that they think about what they could get for a fish if they had held out for more.

In the second round of trading, you can expect transaction prices to be closer to \$20 than they were in the first round. If the price is still quite far from \$20, and if you have enough time, you may want to run a third round.

Trading in Session 2

In this session, each fisherman has caught 3 fish. Remind fishermen that after they have sold their first fish, they can try to find another buyer and to sell a second and a third fish.

In this session, the total number of fish caught exceeds the number of demanders, and so the equilibrium price is zero.

In the first round of trading, most transactions take place at prices much higher than the competitive price. At the end of the first round, ask for a show of hands of people with at least one unsold fish. Then ask how many have two fish left, and how many have three fish left. Now ask if there is any demander who did not buy a fish. There shouldn't be. (If there is, ask whether any fisherman wants to make a deal with this demander.) Ask demanders to think about whether they can expect to get a better price in the next round.

Our experience is that in the second round, the price falls substantially and in a third round it falls even further, getting close to zero.

Competitive Equilibrium Predictions

Figures 2.1 and 2.2 show the supply and demand curves that would be found in a class of 36 students.

Figure 2.1: Supply and Demand in Session 1

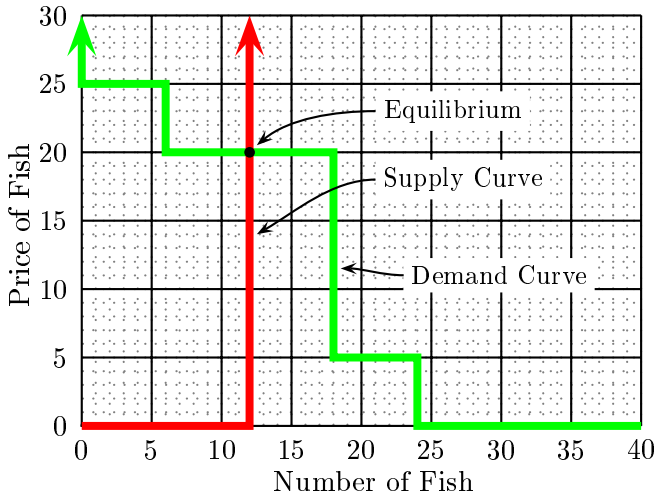
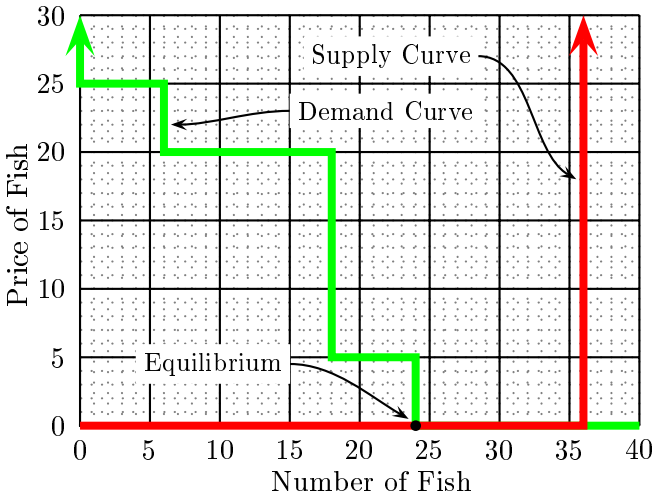


Figure 2.2: Supply and Demand in Session 2



Quick Start for Experiment 2: The Fish Market

Here you will find materials that you are likely to want to have with you during the experiment, including capsule instructions and tables to use for determining the distribution of Buyer Values, the number of fishermen, and the number of fish caught in each session.

You will also find Personal Information Sheets and Sales Contracts for photocopying, and instructions on how many to prepare and how to distribute them.

Capsule Instructions: Shifting Supply Curves

- Distribute as many complete six-packs of PI sheets as you can. If the last sheet from the remaining six-pack would be a Type E, replace it by a Type A.
- Work through the Warm-up exercises with the class. Ask if there are any questions about the rules.
- Begin Session 1.
  - Open trading in Round 1. As completed contracts are turned in, record the price and Buyer Value on the blackboard.
  - When trading stops, point out any trades where the buyer or seller lost money. Estimate the average price in this round. Ask if any demanders who did not get a fish would be willing to pay \$19 for one.
  - Before starting Round 2, remind students that they are still in Session 1, and begin Round 2. Ask if there are any questions.
  - If the price is not yet close to equilibrium and you have time, you can run Round 3. If you don't run Round 3, ask students to cross out Round 3 on their P.I. sheets.
  - If students are recording transactions from the blackboard, give them time to record these for the last round of Session 1.
- Remind students that they are now in Session 2 and begin the session.
  - When trading stops, ask how many fishermen have at least one fish left. Ask whether any demanders did not get a fish. Ask if any fishermen have a fish that they would like to sell for, say, \$2.
  - Begin Round 2. Proceed as with Round 1.
  - If there is time, run a third round of Session 2.
  - If students are recording transactions from the blackboard, give them time to record these for the last round of Session 2.
- Report the distribution of Buyer Values and the total number of fish caught in each session and ask students to copy this information to their Lab Reports.
- Collect Personal Information Sheets.

Distribution of Types

Record the following information after you distribute the P.I. sheets:

Number of complete six-packs distributed (=N) _____

Type of Last P.I. sheet distributed _____

Use this information and Tables Q.2.2 and Q.2.4 to complete Table Q.2.3 and Q.2.5, and post these tables for the students.

Table Q.2.2: Distribution of Buyer Values (Both Sessions)

Type of Last Sheet	A	B	C	D	E*	F
Buyer Value $25	N	N	N	N	N	N
Buyer Value $20	2N+1	2N+1	2N+2	2N+2	2N+3	2N
Buyer Value $5	N	N	N	N	N	N

* This assumes that if the last sheet to be distributed would be a Type E, it will be replaced by a Type A.

Table Q.2.3: Distribution of Demander Types

Buyer Value	Number of Demanders
$25	
$20	
$ 5	

Table Q.2.4: Number of Fishermen and Number of Fish Caught

Type of Last Sheet	A	B	C	D	E	F
Number of Fishermen	2N	2N+1	2N+1	2N+2	2N+2	2N
Fish Caught in Session 1	2N	2N+1	2N+1	2N+2	2N+2	2N
Fish Caught in Session 2	6N	6N+3	6N+3	6N+6	6N+6	6N

Table Q.2.5: Number of Fishermen and Fish Caught

Session	Number of Fishermen	Number of Fish Caught
Session 1		
Session 2		

What to Post for Students' Lab Notes

Students will need the following information for their Lab Notes:

- For the last round of each session, a list that records the price and the buyer's Buyer Value. Students will enter this in Tables 2.1 and 2.2 of their Lab Notes.
- The distribution of Buyer Values as recorded in Table Q.2.3. This is the same for both sessions. Students should record this information in Table 2.3 of their Lab Notes.
- The number of fishermen and the number of fish caught in each session, as recorded in Table Q.2.5. Students should record this in Table 2.4 of their Lab Notes.

Materials to Be Photocopied

Personal Information Sheets

There are six types of personal information sheets for this experiment. Make enough copies so that each student who might come to class will get one, and make one extra Type A sheet. Four of these types (labelled A, C, E, and F) are Fish Demanders in all sessions, and two types (labelled B and D) are Fishermen in all sessions.

Clip these personal information sheets together in six-packs, where each six-pack includes sheets of types A–F. Distribute as many of the *complete* six-packs as you can. Then pass out sheets from the top of the remaining six-pack. From the last six-pack, do not distribute a Type E, unless you also distribute a Type F. If the last sheet would be a Type E, distribute an extra Type A instead.[1]

Sales Contracts

You will also need a stack of sales contracts. Three sales contracts for each student in the class should be sufficient. In a pinch, you could use sales contracts made for Session 1. The only difference is that these contracts do not ask sellers to state their Seller Costs.

[1] No great harm will be done if you end with a Type E, but if you do so, the demand curve will differ slightly between the two sessions.

TYPE A **Student ID Number** _____

The Fish Market

Demander's Personal Information Sheet

Session 1:

In this session, you are a fish demander with a Buyer Value of $20. You can buy at most one fish. If you buy a fish, your profit is $20 *minus* the price that you pay. If you don't buy a fish, your profit is zero. In the table below, record the price that you paid and your profits for each round.

Record of Prices and Profits

	Round 1	Round 2	Round 3
Price Paid			
Profit (= \$20−P)			

.....

Session 2:

In this session, you are a fish demander with a Buyer Value of $20. You can buy at most one fish. If you buy a fish, your profit is $20 *minus* the price that you pay. If you don't buy a fish, your profit is zero. In the table below, record the price that you paid and your profits for each round.

Record of Prices and Profits

	Round 1	Round 2	Round 3
Price Paid			
Profit (= \$20−P)			

TYPE B **Student ID Number** _____

The Fish Market

Fisherman's Personal Information Sheet

Session 1:

Today you have 1 fish to sell at the Fish Market. You have already spent $10 on fuel for your boat. Your profits equal the total amount you received for your fish *minus* $10. If you don't sell any fish, you have a LOSS of $10. Record the prices received for your fish and your profit or loss below.

Record of Prices and Profits

	Round 1	Round 2	Round 3
Price of Fish			
− Fixed Cost	$10	$10	$10
Profit			

Session 2:

Today you have 3 fish to sell at the Fish Market. You have already spent $10 on fuel for your boat. Your profits equal the total amount you received for your fish *minus* $10. If you don't sell any fish, you have a LOSS of $10. Record the prices received for your fish and your profit or loss below.

Record of Prices and Profits

	Round 1	Round 2	Round 3
Price of First Fish			
Price of Second Fish			
Price of Third Fish			
−Sunk Cost	$10	$10	$10
Profit			

TYPE C **Student ID Number** _____

The Fish Market

Demander's Personal Information Sheet

Session 1:

In this session, you are a fish demander with a Buyer Value of $20. You can buy at most one fish. If you buy a fish, your profit is $20 *minus* the price that you pay. If you don't buy a fish, your profit is zero. In the table below, record the price that you paid and your profits for each round.

Record of Prices and Profits

	Round 1	Round 2	Round 3
Price Paid			
Profit (= \$20−P)			

.....

Session 2:

In this session, you are a fish demander with a Buyer Value of $20. You can buy at most one fish. If you buy a fish, your profit is $20 *minus* the price that you pay. If you don't buy a fish, your profit is zero. In the table below, record the price that you paid and your profits for each round.

Record of Prices and Profits

	Round 1	Round 2	Round 3
Price Paid			
Profit (= \$20−P)			

TYPE D **Student ID Number** _____

The Fish Market

Fisherman's Personal Information Sheet

Session 1:

Today you have 1 fish to sell at the Fish Market. You have already spent $10 on fuel for your boat. Your profits equal the total amount you received for your fish *minus* $10. If you don't sell any fish, you have a LOSS of $10. Record the prices received for your fish and your profit or loss below.

Record of Prices and Profits

	Round 1	Round 2	Round 3
Price of Fish			
− Fixed Cost	$10	$10	$10
Profit			

Session 2:

Today you have 3 fish to sell at the Fish Market. You have already spent $10 on fuel for your boat. Your profits equal the total amount you received for your fish *minus* $10. If you don't sell any fish, you have a LOSS of $10. Record the prices received for your fish and your profit or loss below.

Record of Prices and Profits

	Round 1	Round 2	Round 3
Price of First Fish			
Price of Second Fish			
Price of Third Fish			
−Sunk Cost	$10	$10	$10
Profit			

TYPE E **Student ID Number** _____

The Fish Market

Demander's Personal Information Sheet

Session 1:

In this session, you are a fish demander with a Buyer Value of $25. You can buy at most one fish. If you buy a fish, your profit is $25 *minus* the price that you pay. If you don't buy a fish, your profit is zero. In the table below, record the price that you paid and your profits for each round.

Record of Prices and Profits

	Round 1	Round 2	Round 3
Price Paid			
Profit (= \$25−P)			

.....

Session 2:

In this session, you are a fish demander with a Buyer Value of $5. You can buy at most one fish. If you buy a fish, your profit is $5 *minus* the price that you pay. If you don't buy a fish, your profit is zero. In the table below, record the price that you paid and your profits for each round.

Record of Prices and Profits

	Round 1	Round 2	Round 3
Price Paid			
Profit (= \$5−P)			

TYPE F **Student ID Number** _____

The Fish Market

Demander's Personal Information Sheet

Session 1:

In this session, you are a fish demander with a Buyer Value of $5. You can buy at most one fish. If you buy a fish, your profit is $5 *minus* the price that you pay. If you don't buy a fish, your profit is zero. In the table below, record the price that you paid and your profits for each round.

Record of Prices and Profits

	Round 1	Round 2	Round 3
Price Paid			
Profit (= \$5−P)			

Session 2:

In this session, you are a fish demander with a Buyer Value of $25. You can buy at most one fish. If you buy a fish, your profit is $25 *minus* the price that you pay. If you don't buy a fish, your profit is zero. In the table below, record the price that you paid and your profits for each round.

Record of Prices and Profits

	Round 1	Round 2	Round 3
Price Paid			
Profit (= \$25−P)			

Sales Contract: *Session* _____ *Round* _____

Price _____ *Buyer Value*_____

Seller's ID _____

Buyer's ID _____

Sales Contract: *Session* _____ *Round* _____

Price _____ *Buyer Value*_____

Seller's ID _____

Buyer's ID _____

Sales Contract: *Session* _____ *Round* _____

Price _____ *Buyer Value*_____

Seller's ID _____

Buyer's ID _____

Experiment 3

A Sales Tax

Objectives of This Experiment

In this experiment, we expect students to:

- Learn how to draw and read step-function supply and demand curves when there are more than two types of buyers and sellers.
- Learn about the way that a sales tax shifts the supply curve or the demand curve.
- Learn to determine who will bear the cost of a sales tax.
- Observe the equivalence between a tax collected from suppliers and an equal tax collected from demanders.
- Learn to identify and measure the revenue collected by a tax and the excess burden imposed by a tax.
- Learn to analyze the effects of subsidies, using supply and demand analysis.

General Discussion

In the first session of this experiment, there is no sales tax. In the second session, there is a sales tax paid by suppliers, and in the third session, there is a sales tax of the same amount, paid by demanders rather than suppliers. The pre-tax supply and demand curves are the same for all three sessions.

In the first session, with no tax, the market environment is similar to that in Experiment 1, but instead of just two types of suppliers and demanders, there are six different types of each. Because there are more types of suppliers and demanders, the supply and demand curves look more like the conventional, smooth curves found in textbooks. You can explain to students that smooth curves are the limit of stepwise curves as the steps become small.

In the second session, sellers must pay a sales tax of \$15 when they sell a bushel of apples. This tax is implemented by reducing the seller's profits from $\$P - \$C$ to $\$P - \$C - \$15$, where $\$P$ is the sales price and $\$C$ is the seller's Seller Cost.

In the third session, the tax is collected from buyers instead of from sellers. The tax is implemented by reducing a buyer's profits from $\$V - \$P$ to $\$V - \$P - \$15$, where $\$P$ is the sales price and $\$V$ is the buyer's Buyer Value.

If your class did not do Experiment 2, you may want to ask them to read Sections A.1 and A.2 of the Appendix along with the discussion in this chapter. Section A.1 introduces straight-line demand and supply curves. Section A.2 provides further discussion of comparative statics methods.

Detailed Instructions and Comments

Time Required

The sales-tax experiment can be conducted in a 50-minute class meeting. In an 80-minute class, there is time for running the experiment and conducting discussion.

Personal Information Sheets

In each session there are 6 types of suppliers and 6 types of demanders. Participants will learn their roles for each session from Personal Information Sheets distributed at the beginning of class.

Managing the Personal Information Sheets for this experiment requires a little more care than was needed for the first experiment. The tricky part is that we want to have the same aggregate supply and demand functions in all three sessions, and we want all students to have approximately equal total payoffs over the three sessions. We also would like to switch each student's role between sessions. Keep in mind that we cannot expect to know in advance how many students will show up for class. We have constructed the

Personal Information Sheets so that you can accomplish these purposes by distributing the sheets according to the simple procedure outlined below. [1]

- There are 12 "regular types" of Personal Information Sheets, Types 1-12, and one "extra type" Type X. Clip together enough 12-packs of Personal Information Sheets consisting Types 1-12 so that there is at least one sheet for each student who might come to class. Also bring two copies of the Type X Personal Information Sheet to class.

- Distribute to the class as many full 12-packs as possible. Think of the remaining 12-pack as consisting of clusters of 3, types 1-3, 4-6, 7-9, and 10-12. Distribute as many of these full clusters of 3 as you can. If the number of students in class is not divisible by 3, then you will have one or two students left without sheets. Give these students sheets of Type X. If three or more latecomers arrive after you have distributed the sheets, but before trading has started, arrange to give them regular sheets (in clusters of three).

Example:

If 27 students come to class, distribute two full 12-packs plus sheets of Types 1-3 from a third 12-pack. If 28 students come, distribute two full 12-packs, sheets 1-3 from a third 12-pack and one sheet of Type X. If 29 students come, distribute two full 12-packs, sheets 1-3 from a third 12-pack, and two sheets of Type X. If a latecomer shambles in after you have distributed sheets to 29 students, but before trading has started, retrieve the two Type X sheets and distribute sheets of Types 4-6 to the latecomer and the two students who had Type X sheets.

Tips on Running This Experiment

At the beginning of each session in which there is a sales tax, discuss the way that profits are calculated for sellers and for buyers. Numerical examples work well. For example, before Session 2, you might ask the students: "In this session, suppliers must pay a $15 sales tax. If a demander with Buyer Value $40, buys a bushel of apples from a supplier with Seller Cost $18 for a

[1] Note for the curious. Each of the four subgroups of Personal Information Sheet types, 1-3, 4-6, 7-9, and 10-12, has the property that the roles assigned to the three sheets in the group in the 3 sessions constitute a *Latin square*. Thus the total demand and supply coming from any one of these groups is the same in all three sessions. The two auxiliary types of sheets each assign students the same role in all 3 sessions. This means that if Personal Information Sheets are distributed according to our rules, aggregate demand and supply are the same in all sessions.

price of \$35, what will be the profits of the seller? (Answer \$2.) What will be the profits of the buyer? (Answer \$5.)" You can also try an example in which the seller loses money.

Emphasize that when sellers pay the tax, a supplier who chooses not to sell any apples does not *have to pay the sales tax.*

Remind students that on their Sales Contracts, where sellers are asked to record their Seller Costs, they should write their Seller Costs, *not including* the sales tax.

Predictions of the Competitive Model

Let us look at the predictions of the competitive model for a class of 24 students. In this case, $N = 2$, $K = 0$, and the last regular sheet distributed is of Type 12. There are exactly two suppliers with each of the possible Seller Costs and two demanders with each of the possible Buyer Values. The supply and demand curves for this market are shown in Figures 3.1 and 3.2.

Figure 3.1 shows that in competitive equilibrium without a sales tax, the quantity sold is 10 and the price is in the range from \$23-25. With the tax, the supply curve shifts upwards and the new equilibrium is at a quantity of 6 and a price in the range from \$30-33. Figure 3.2 shows that with a tax paid by demanders, the competitive equilibrium quantity is 6, and the price is in the range from \$15-18.

Figure 3.1: Suppliers Pay the Tax

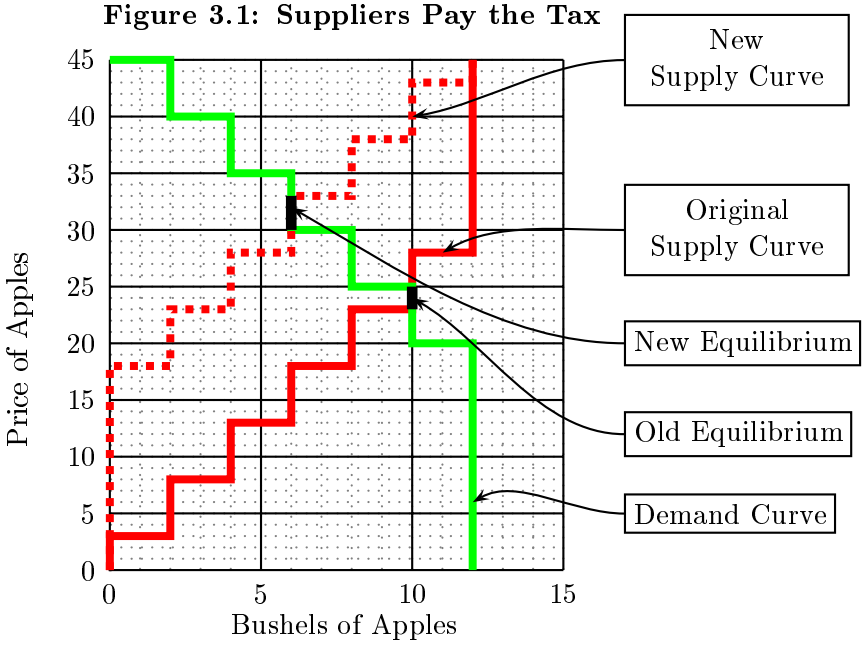
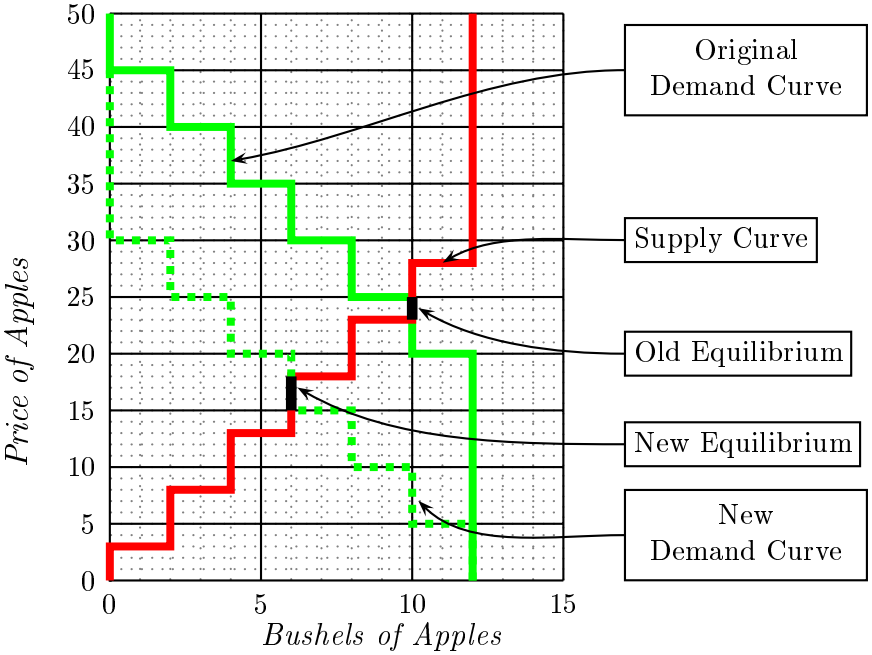


Figure 3.2: Demanders Pay the Tax



Quick Start for Experiment 3: A Sales Tax

Here you will find materials that you are likely to want during the experiment, including capsule instructions and tables to use for determining the distribution of Seller Costs and Buyer Values in each session. You will also find Personal Information Sheets and Sales Contracts for photocopying, and instructions on how many to prepare and how to distribute them.

Capsule Instructions: A Sales Tax

- Distribute as many *complete* 12-packs, consisting of sheets of Types 1-12 as possible. From the remaining 12-pack, distribute as many clusters of three (1–3, 4–6, etc.) as possible. If the number of students present is not divisible by three, give the remaining students sheets of Type X.
- Make sure that everyone understands the trading procedures and payoffs.
- Begin Session 1 (no taxes).
  - Open trading in round 1. As completed Sales Contracts are turned in, record price, Seller Cost, and Buyer Value on the blackboard.
  - After the first round, ask students if they have any questions. Before the second round, remind students that they are still in Session 1.
  - Open trading in round 2.† As completed Sales Contracts are turned in, record price, Seller Cost, and Buyer Value on the blackboard.
  - Ask students to copy the record of transactions from the last round of this session into their Lab Reports.
- Begin Session 2 (sellers pay a $15 tax).
  - Remind students that they are now in Session 2, and that sellers must pay a $15 sales tax on every sale they make.
  - Open trading and proceed as in Session 1.
- Begin Session 3 (buyers pay a $15 tax).
  - Remind students that they are now in Session 3, and that buyers must pay a $15 sales tax on every purchase.
  - Open trading in round 1 and proceed as in Session 1.
- Report the distribution of Buyer Values and Seller Costs. Ask students to copy this information into their Lab Reports. Collect Personal Information Sheets.

† We have usually found two rounds of each session to be sufficient.

Distribution of Types

Record the following information after you distribute the P.I. sheets:

Number of complete 12-packs distributed (=N) _____

Type of Last Regular P.I. sheet distributed _____

Number of Type X sheets distributed (=K) _____

From figures Q.3.1 and Q.3.2, you can determine the distribution of Seller Costs and Buyer Values in your class, given the number N of full twelve-packs, the number K of Type X sheets, and the type of the last regular sheet that you have distributed.

Table Q.3.1: Distribution of Seller Costs

	Type of Last Regular Sheet			
Seller Cost	3	6	9	12
28	N	N	N+1	N
23	N+1	N+1	N+1	N
18	N+K+1	N+K+1	N+K+1	N+K
13	N	N+1	N+1	N
8	N	N	N	N
3	N	N	N	N

Table Q.3.2: Distribution of Buyer Values

	Type of Last Regular Sheet			
Buyer Value	3	6	9	12
20	N	N	N	N
25	N	N+1	N+1	N
30	N	N+1	N+1	N
35	N+1	N+1	N+1	N
40	N	N	N+1	N
45	N	N	N+1	N

Table Q.3.3: Distribution of Types of Agents

Seller Cost	Number in Market	Buyer Value	Number in Market
28		20	
23		25	
18		30	
13		35	
8		40	
3		45	

What to Post for Students' Lab Notes

For their Lab Notes, students will need:

- A list of all transactions in the last round of each of the three sessions. For each transaction, the list should include the price, the seller's Seller Cost, and the buyer's Buyer Value. Students should enter this information in Tables 3.3–3.5 of their Lab Notes.
- The distribution of Buyer Values and Seller Costs which you recorded in Table Q.3.3. If you distributed P.I. sheets according to instructions, this will be the same for all three sessions. Students should record this in Table 3.6 of their Lab Notes.

Materials to Be Photocopied

Personal Information Sheets

There are twelve regular types of Personal Information Sheets, Types 1-12, and one extra type, Type X. Photocopy and clip together enough 12-packs of Personal Information Sheets consisting Types 1-12 so that there is at least one sheet for each student who might come to class. Also make two copies of the Type X Personal Information Sheet.

Distribute as many *complete* 12-packs, consisting of sheets of Types 1-12 as possible. From the remaining 12-pack, distribute as many clusters of three (1–3, 4–6, etc.) as possible. If the number of students present is not divisible by three, give the remaining students sheets of Type X. If three or more latecomers arrive after you have distributed Personal Information sheets, arrange to give them regular sheets (in clusters of three).

Sales Contracts

You will also need about three sales contracts for each student who might come to class. These should be photocopied from the original found here and the copied sheets should be cut make three contracts from each sheet. If you want to save paper and have left-over sales contracts form Experiment 1, you can use these. The only difference is that these contracts remind students to report the Buyer Values or Seller Costs on their P.I. sheets rather than their after-tax values or costs.

TYPE 1 **Student ID Number** _____

Sales Tax Experiment
Personal Information Sheet

Session 1:

In this market session you are an `Apple Supplier` and your `Seller Cost` for a bushel of apples is $23.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit (=P−$23)		

Session 2

In this session you are an `Apple Supplier` and your `Seller Cost` is $18. If you sell a bushel of apples, you must pay a Sales Tax of $15 in addition to your Seller Cost. If you don't sell any apples, you do not have to pay the tax or pay your Seller Cost.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit (= P − $18 − $15)		

Session 3

In this session you are an `Apple Demander` and your `Buyer Value` for a bushel of apples is $35. If you buy a bushel of apples, you must pay a Sales Tax of $15 in addition to the price you pay to the buyer.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit (= $35−$P$−$15)		

TYPE 2 **Student ID Number** _____

Sales Tax Experiment
Personal Information Sheet

Session 1:

In this market session you are an `Apple Supplier` and your `Seller Cost` for a bushel of apples is $18.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit ($=P-\$18$)		

Session 2

In this session you are an `Apple Demander` and your `Buyer Value` for a bushel of apples is $35. In this session, you do not have to pay a sales tax, but suppliers do.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit ($=\$35-P$)		

Session 3

In this session you are a `Supplier` and your `Seller Cost` for a bushel of apples is $23. You don't have to pay any Sales Tax, but buyers do.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit ($=P-\$23$)		

TYPE 3 **Student ID Number** _____

Sales Tax Experiment
Personal Information Sheet

Session 1:

In this market session you are an `Apple Demander` and your `Buyer Value` for a bushel of apples is $35.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit (= \$35−P)		

Session 2

In this session you are an `Apple Supplier` and your `Seller Cost` is $23. If you sell a bushel of apples, you must pay a Sales Tax of $15 in addition to your Seller Cost. If you don't sell any apples, you do not have to pay the tax or pay your Seller Cost.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit (= P − \$23 − \$15)		

Session 3

In this session you are a `Supplier` and your `Seller Cost` for a bushel of apples is $18. You don't have to pay any Sales Tax, but buyers do.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit (=P−\$18)		

TYPE 4 **Student ID Number** _____

Sales Tax Experiment
Personal Information Sheet

Session 1:

In this market session you are an `Apple Demander` and your `Buyer Value` for a bushel of apples is $25.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit (= \$25−P)		

Session 2

In this session you are an `Apple Demander` and your `Buyer Value` for a bushel of apples is $30. In this session, you do not have to pay a sales tax, but suppliers do.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit (= \$30−P)		

Session 3

In this session you are a `Supplier` and your `Seller Cost` for a bushel of apples is $13. You don't have to pay any Sales Tax, but buyers do.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit (=P−\$13)		

TYPE 5 **Student ID Number** _____

Sales Tax Experiment
Personal Information Sheet

Session 1:

In this market session you are an `Apple Demander` and your `Buyer Value` for a bushel of apples is $30.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit (= \$30−P)		

Session 2

In this session you are an `Apple Supplier` and your `Seller Cost` is $13. If you sell a bushel of apples, you must pay a Sales Tax of $15 in addition to your Seller Cost. If you don't sell any apples, you do not have to pay the tax or pay your Seller Cost.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit (= P − \$13 − \$15)		

Session 3

In this session you are an `Apple Demander` and your `Buyer Value` for a bushel of apples is $25. If you buy a bushel of apples, you must pay a Sales Tax of $15 in addition to the price you pay to the buyer.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit (= \$25−P−\$15)		

TYPE 6 **Student ID Number** _____

Sales Tax Experiment
Personal Information Sheet

Session 1:

In this market session you are an `Apple Supplier` and your `Seller Cost` for a bushel of apples is $13.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit (=P−$13)		

Session 2

In this session you are an `Apple Demander` and your `Buyer Value` for a bushel of apples is $25. In this session, you do not have to pay a sales tax, but suppliers do.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit (= $25−$P$)		

Session 3

In this session you are an `Apple Demander` and your `Buyer Value` for a bushel of apples is $30. If you buy a bushel of apples, you must pay a Sales Tax of $15 in addition to the price you pay to the buyer.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit (= $30−$P$−$15)		

TYPE 7 **Student ID Number** _____

Sales Tax Experiment
Personal Information Sheet

Session 1:

In this market session you are an `Apple Supplier` and your `Seller Cost` for a bushel of apples is $28.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit (=P−$28)		

Session 2

In this session you are an `Apple Demander` and your `Buyer Value` for a bushel of apples is $45. In this session, you do not have to pay a sales tax, but suppliers do.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit (= $45−$P$)		

Session 3

In this session you are an `Apple Demander` and your `Buyer Value` for a bushel of apples is $40. If you buy a bushel of apples, you must pay a Sales Tax of $15 in addition to the price you pay to the buyer.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit (= $40−$P$−$15)		

TYPE 8 **Student ID Number** _____

Sales Tax Experiment
Personal Information Sheet

Session 1:

In this market session you are an `Apple Demander` and your `Buyer Value` for a bushel of apples is $45.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit (= \$45−P)		

Session 2

In this session you are an `Apple Demander` and your `Buyer Value` for a bushel of apples is $40. In this session, you do not have to pay a sales tax, but suppliers do.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit (= \$40−P)		

Session 3

In this session you are a `Supplier` and your `Seller Cost` for a bushel of apples is $28. You don't have to pay any Sales Tax, but buyers do.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit (=P−\$28)		

TYPE 9 **Student ID Number** _____

Sales Tax Experiment
Personal Information Sheet

Session 1:

In this market session you are an `Apple Demander` and your `Buyer Value` for a bushel of apples is $40.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit (= \$40−P)		

Session 2

In this session you are an `Apple Supplier` and your `Seller Cost` is $28. If you sell a bushel of apples, you must pay a Sales Tax of $15 in addition to your Seller Cost. If you don't sell any apples, you do not have to pay the tax or pay your Seller Cost.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit (= P − \$28 − \$15)		

Session 3

In this session you are an `Apple Demander` and your `Buyer Value` for a bushel of apples is $45. If you buy a bushel of apples, you must pay a Sales Tax of $15 in addition to the price you pay to the buyer.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit (= \$45−P−\$15)		

TYPE 10 **Student ID Number** _____

Sales Tax Experiment
Personal Information Sheet

Session 1:

In this market session you are an `Apple Demander` and your `Buyer Value` for a bushel of apples is $20.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit (= \$20−P)		

Session 2

In this session you are an `Apple Supplier` and your `Seller Cost` is $3. If you sell a bushel of apples, you must pay a Sales Tax of $15 in addition to your Seller Cost. If you don't sell any apples, you do not have to pay the tax or pay your Seller Cost.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit (= P − \$3 − \$15)		

Session 3

In this session you are a `Supplier` and your `Seller Cost` for a bushel of apples is $8. You don't have to pay any Sales Tax, but buyers do.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit (=P−\$8)		

TYPE 11 **Student ID Number** _____

Sales Tax Experiment
Personal Information Sheet

Session 1:

In this market session you are an `Apple Supplier` and your `Seller Cost` for a bushel of apples is $3.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit (=P−$3)		

Session 2

In this session you are an `Apple Supplier` and your `Seller Cost` is $8. If you sell a bushel of apples, you must pay a Sales Tax of $15 in addition to your Seller Cost. If you don't sell any apples, you do not have to pay the tax or pay your Seller Cost.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit (= P − $8 − $15)		

Session 3

In this session you are an `Apple Demander` and your `Buyer Value` for a bushel of apples is $20. If you buy a bushel of apples, you must pay a Sales Tax of $15 in addition to the price you pay to the buyer.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit (= $20−$P$−$15)		

TYPE 12 **Student ID Number** _____

Sales Tax Experiment
Personal Information Sheet

Session 1:

In this market session you are an `Apple Supplier` and your `Seller Cost` for a bushel of apples is $8.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit (=P−$8)		

Session 2

In this session you are an `Apple Demander` and your `Buyer Value` for a bushel of apples is $20. In this session, you do not have to pay a sales tax, but suppliers do.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit (= $20−$P$)		

Session 3

In this session you are a `Supplier` and your `Seller Cost` for a bushel of apples is $3. You don't have to pay any Sales Tax, but buyers do.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit (=P−$3)		

TYPE X **Student ID Number** _____

Sales Tax Experiment
Personal Information Sheet

Session 1:

In this market session you are an `Apple Supplier` and your `Seller Cost` for a bushel of apples is `$18`.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit (=P−$18)		

Session 2

In this session you are an `Apple Supplier` and your `Seller Cost` is `$18`. If you sell a bushel of apples, you must pay a Sales Tax of `$15` in addition to your Seller Cost. If you don't sell any apples, you do not have to pay the tax or pay your Seller Cost.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit (= P − $18 − $15)		

Session 3

In this session you are a `Supplier` and your `Seller Cost` for a bushel of apples is `$18`. You don't have to pay any Sales Tax, but buyers do.

Record of Prices and Profits

	Round 1	Round 2
Price Paid		
Profit (=P−$18)		

Sales Contract: *Session* ____ *Round* ____

Price _____

Seller's ID _____ **Seller Cost* _____

Buyer's ID _____ **Buyer Value*_____

*Report SC or BV from your P.I. sheet (not accounting for taxes).

Sales Contract: *Session* ____ *Round* ____

Price _____

Seller's ID _____ **Seller Cost* _____

Buyer's ID _____ **Buyer Value*_____

*Report SC or BV from your P.I. sheet (not accounting for taxes).

Sales Contract: *Session* ____ *Round* ____

Price _____

Seller's ID _____ **Seller Cost* _____

Buyer's ID _____ **Buyer Value*_____

*Report SC or BV from your P.I. sheet (not accounting for taxes).

Experiment 4

Prohibited Markets

Objectives of This Experiment

In this experiment, students will see that supply and demand analysis is a powerful tool in studying markets where trade is illegal, but enforcement is imperfect. Students should learn the following:

- Prohibitions against buying and selling a good are usually only partially effective.
- Confiscation and fines for selling drugs shift the supply curve upwards.
- Prohibition is likely to increase the price and decrease the quantity of a commodity sold.
- The total amount of money spent on a substance may be larger if trade in this substance is prohibited than if free trade is allowed.
- Prohibition of addictive substances is likely to cause only a small decrease in *consumption* by addicts, and an increase in *expenditure* by addicts on the prohibited good (because the cost rises).
- Even if government authorities resell confiscated stocks of the prohibited good, confiscation will tend to increase the street price and lower the quantity sold, because it will increase costs to suppliers.

General Discussion

This experiment introduces a market for illegal drugs. The market includes two kinds of demanders; recreational users and addicts. Drug suppliers all

have identical costs and can supply up to two units of the commodity.

In the first session the government does not interfere with the market and the competitive equilibrium price is equal to the suppliers' marginal cost.

In the second session, the police confiscate and destroy half of the drugs sold by each supplier and force sellers to pay a $5 fine. The competitive equilibrium price rises to a level high enough to induce suppliers to sell drugs despite the cost of confiscation and fines. This higher price shuts out the recreational users, but leaves the addicts in the market. The total amount of money spent on drugs is higher than when drug sales are legal.

In the third session, the police again confiscate half of the drugs that are sold and collect a $5 fine from suppliers. This time, however, the police offer to resell the confiscated drugs to the original buyer at the same price the supplier charged. The result of this session surprises most students. Since with the police reselling confiscated drugs, all drugs that are produced reach demanders, students expect that the quantity consumed will be the same as when the substance is legal. Instead, however, the confiscation activities push the supply curve up enough so that the equilibrium price is such that only addicts continue to consume drugs.

Detailed Instructions and Comments

You will probably need at least two rounds in the first session to reach a price that is close to competitive equilibrium. In the second and third sessions, the first round is likely to come fairly close to equilibrium. In a 50-minute class, you should easily be able to complete two rounds of the first session and at least one round of the second session, with some time for discussion. In an 80-minute class, there is time to do the third session and time for discussion or helping the students to get started on their Lab Reports.

About half of the students in class are suppliers. Half of the remaining students are addicts and half are recreational users. Each supplier can sell up to two units. Each demander can consume at most one unit. Suppliers have a Seller Cost of $10 for each unit of drugs that they sell. In the sessions where there is confiscation, they must sell either zero or two units. Be sure to remind sellers that they can sell up to two units.

Suppliers who sell two units must sell to two different buyers. One of these two sales (selected at random) will be intercepted, the drugs confiscated, and and the seller will be fined $5. When they bring two contracts to the market manager, the market manager randomly selects one of the two

contracts and declares that it has been confiscated. The supplier must pay the $10 production cost for both units produced, as well as the $5 fine, but only receives the revenue from the sale that was not seized by the police. The demander who was supposed to receive the confiscated unit does not get this unit and does not have to pay for it. Demanders whose purchases were intercepted can seek another supplier and try again to make a purchase.

Addicts have a Buyer Value of $30 for a unit of drugs, but an addict who does not buy any drugs suffers severe withdrawal symptoms and consequently a LOSS of $20. Recreational users have a Buyer Value of $15 for a unit of drugs. If they do not buy any drugs, they have no withdrawal symptoms and simply get zero profits.

Predictions of the Competitive Model

Supply and demand curves for the three sessions are drawn below for a class with 40 students. There are 10 addicts, 10 recreational users, and 20 suppliers, Notice the following:

- The addicts get a Buyer Value of $30 if they purchase a unit of drugs, and a loss of $20 if they do not purchase any. Therefore, their willingness-to-pay for a unit of drugs is $50.

- In Session 3, where the police resell confiscated drugs, there will be zero supply at prices below $25. At prices above $25, each supplier will want to supply 2 units, and one of these two units will fall into the hands of the police, who resell it to the original buyers.

The supply and demand curves for Session 1, with no government interference, are displayed in Figure 4.1. Equilibrium occurs at a price of $10, with 20 units sold.

In Session 2, the government's policy of confiscating and destroying drugs increases suppliers' costs, shifts the horizontal portion of the supply curve upward by $15, and moves the vertical portion of the supply curve inward from 40 units to 20 units.[1] The new equilibrium is at a price of $25, with 10 units consumed, all by addicts.

In Session 3, the government's policy of confiscating and reselling confiscated drugs also increases suppliers' costs and hence shifts the horizontal

[1] With the fine, it costs each seller $(2 \times \$10) + \$5 = \$25$ to produce a unit that reaches the market. Since there are 20 sellers and 1 unit is now the most that any one seller can get to the consumers, the supply curve becomes vertical at a supply of 20

Figure 4.1: Supply and Demand-Session 1

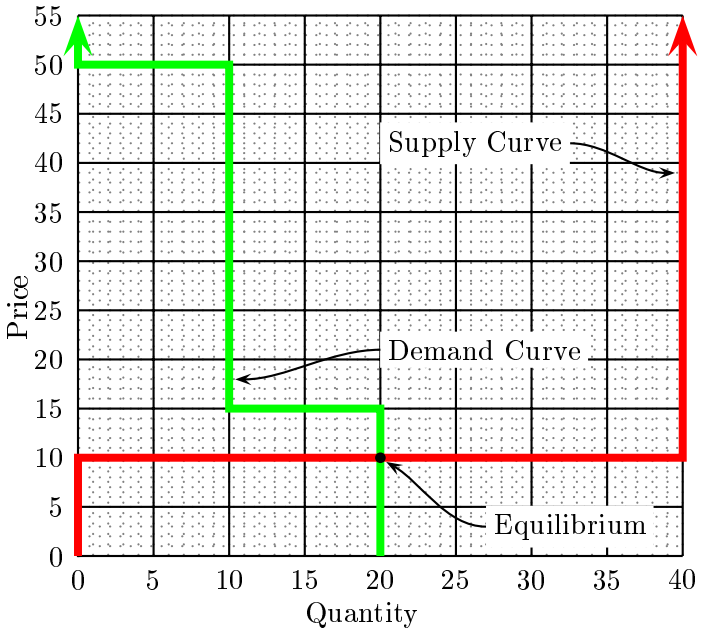


Figure 4.2: Supply and Demand-Session 2

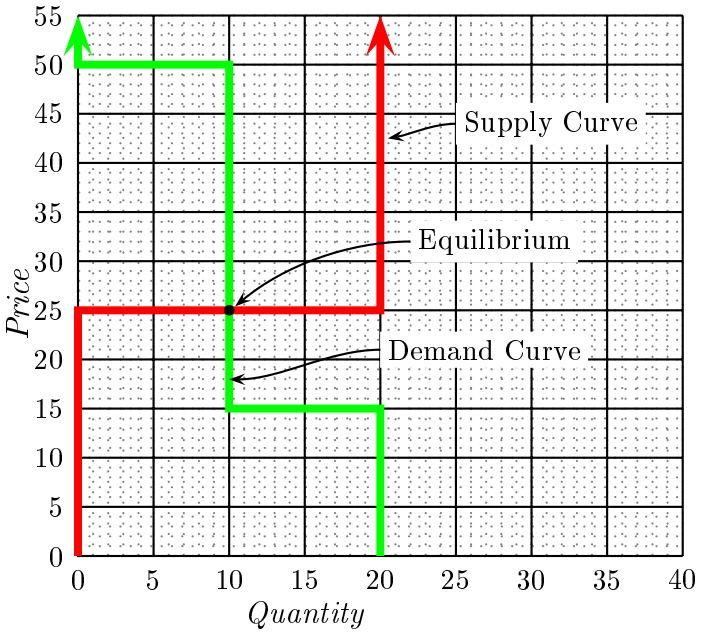
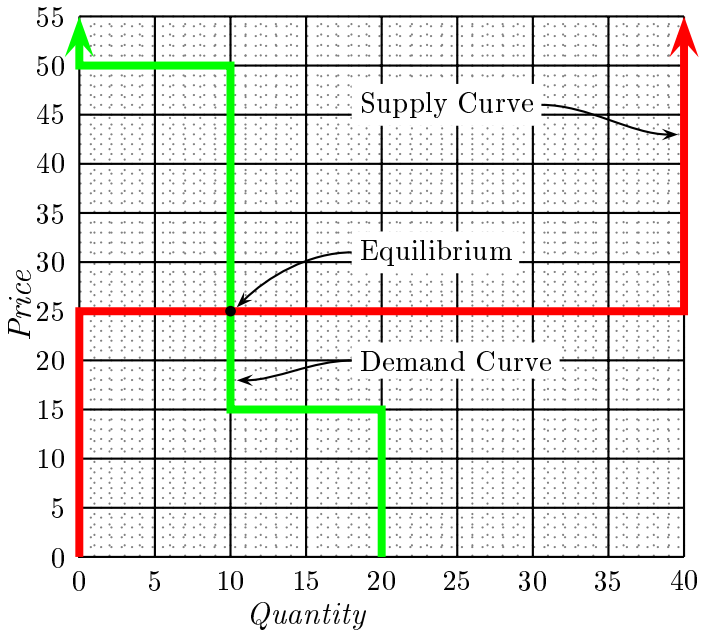


Figure 4.3: Supply and Demand-Session 3



portion of the supply curve upward by \$15. Because confiscated goods are resold rather than destroyed, the vertical portion of the supply curve remains at 40 units rather than 20 units. The remarkable thing to notice is that the the equilibrium price and quantity are the same as in Session 2, where the confiscated drugs were destroyed.

Quick Start for Experiment 4: Prohibition

Capsule Instructions: Prohibition

- Distribute as many *complete* four-packs of Personal Information Sheets as possible (one sheet per student), and then pass out Type A sheets to the remaining students.
- Work through the Warm-up Exercises.
- Begin Session 1 (no prohibition).
  - Open trading in Round 1. As completed Sales Contracts are turned in, record price and Buyer Value on the blackboard.
  - Before the second round starts, remind students that they are still in Session 1. Ask if there are any questions.
  - Open trading in Round 2. As completed Sales Contracts are turned in, record price and Buyer Value on the blackboard.†
- Begin Session 2 (confiscation with no resale).
  - Remind students that this is Session 2. Police randomly select and confiscate *one* of each seller's contracts. The seller of a confiscated unit pays a $5 fine, plus the production cost. The buyer does *not* get the good (or pay the seller) and is free to seek a new deal.
  - Open trading in Round 1. Confiscate one of each seller's contracts, and inform the buyer that this trade is nullified. Record price and Buyer Value of *realized* trades on the blackboard.
  - Proceed to later rounds.† Students should record transactions in the last round in their Lab Notes.
- Begin Session 3 (confiscation with resale).
  - Remind students that this is Session 3. Police confiscate as in Session 2, but the buyer buys the confiscated unit from the police at the price contracted with the seller.
  - Open trading in Round 1. As completed Sales Contracts are turned in, make confiscations and offer buyers the option to buy from police. Record price and Buyer Value of completed transactions.
  - Proceed to later rounds.† Students should record last round's transactions in their Lab Notes.
- Announce the number of suppliers, addicts, and recreation users, for students to record in their Lab Notes.
- Collect Personal Information Sheets.

† We recommend 2-3 rounds of Session 1, and 1-2 rounds of Sessions 2 and 3.

Distribution of Types

Record the following information after you distribute the P.I. sheets:

Number of complete four-packs distributed (=N) _____

Number of extra Type A sheets distributed (=K) _____

After the experiment is concluded, you should post the following table for students to use in their Lab Notes, where you replace N with the number of complete four-packs distributed and K with the number of extra Type A sheets distributed.

Table Q.4.1: Number of Suppliers and Demanders

Participant Type	Number
Suppliers	$2\ N+K$
Addicted Demanders	N
Casual Demanders	N

What to Post for Students' Lab Notes

Students will need the following information for their Lab Notes.

- The number of suppliers, the number of addicted demandes, and the number of casual demanders participating in the experiment. These can be derived from Table Q.4.1. Students will need to copy this information into Table 4.1 of their Lab Notes.
- A list of the prices and Buyer Values for each transaction in the last round of each session. They need to copy this information into Table 4.2 of their Lab Notes.

Materials to Be Photocopied

Personal Information Sheets

We have prepared four different types of personal information sheets, labeled as A, B, C, and D. Make up enough "four-packs" of sheets, containing one

sheet of each of the four types, so that you have at least one sheet for every student who might come to class. Also make three extra Type A sheets. Distribute as many complete four-packs as you can. Give type A sheets to the remaining students.[2] Make a note of the number of four-packs and the number of extra Type A sheets distributed.

Sales Contracts

You should have about four sales contracts for each student in the class. Sales contracts are the same as those used in Experiment 2. If you have left-over sales contracts from Experiment 1, you could use these as well. (In this case you can tell sellers that they don't need to enter their Seller Costs on the sales contract.)

[2] This procedure guarantees that the demand curve will be the same in all three sessions of the experiment.

TYPE A **Student ID Number** _____

The Drug Market
Personal Information Sheet

Please hand this sheet in at the end of the session.

Session 1

In this session you are a drug supplier. You can sell either 0,1 or 2 units. Your Seller Cost for each unit that you sell is $10. You have no fixed costs and the government will not interfere with your market activities.

Record of Prices and Profits

	Round 1	Round 2
Price of First Unit		
Price of Second Unit		
Total Costs		
Total Profit		

Session 2

In this session you are a drug supplier. You can sell either 0 or 2 units. If you sell 2 units, the police will intercept one of them and fine you $5. You are not paid for the sale that is intercepted. Your total costs are $25.

	Round 1	Round 2
Price in Successful Sale		
Total Profit (=Sale Price −$25)		

Session 3

In this session you are a drug supplier. You can sell either 0 or 2 units. If you sell 2 units, the police will intercept one of them and fine you $5. You are not paid for the sale that is intercepted. Your total costs are $25.

	Round 1	Round 2
Price in Successful Sale		
Total Profit (=Sale Price −$25)		

TYPE B **Student ID Number** _____

The Drug Market
Personal Information Sheet

Please hand this sheet in at the end of the session.

Session 1

In this session, you are an Addict. You find it extremely painful to go without the drug. If you buy a unit of drugs for price P, you will have a profit (loss) of \$30$-P$. If you don't buy any drugs, you will suffer a LOSS of \$20.

	Round 1	Round 2
Price		
Profit (Loss)		

Session 2

In this session you are a drug supplier. You can sell either 0 or 2 units. If you sell 2 units, the police will intercept one of them and fine you \$5. You are not paid for the sale that is intercepted. Your total costs are \$25.

	Round 1	Round 2
Price in Successful Sale		
Total Profit (=Sale Price $-$\$25)		

Session 3

In this session, you are a Casual Demander who enjoys but is not addicted to the drug. If you obtain a unit of drugs, you will receive a Buyer Value of \$15. If you do not obtain any drugs, your profit will be \$0.

	Round 1	Round 2
Price Paid		
Profit (= \$15$-P$)		

TYPE C **Student ID Number** _____

The Drug Market
Personal Information Sheet

Please hand this sheet in at the end of the session.

Session 1

In this session, you are a Casual Demander who enjoys but is not addicted to the drug. If you obtain a unit of drugs, you will receive a Buyer Value of $15. If you do not obtain any drugs, your profit will be $0.

	Round 1	Round 2
Price Paid		
Profit (= \$15−P)		

Session 2

In this session, you are an Addict. You find it extremely painful to go without the drug. If you buy a unit of drugs for price P, you will have a profit (loss) of \$30−P. If you don't buy any drugs, you will suffer a LOSS of $20.

	Round 1	Round 2
Price		
Profit (Loss)		

Session 3

In this session you are a drug supplier. You can sell either 0 or 2 units. If you sell 2 units, the police will intercept one of them and fine you \$5. You are not paid for the sale that is intercepted. Your total costs are \$25.

	Round 1	Round 2
Price in Successful Sale		
Total Profit (=Sale Price −\$25)		

TYPE D **Student ID Number** _____

The Drug Market
Personal Information Sheet

Please hand this sheet in at the end of the session.

Session 1

In this session you are a drug supplier. You can sell either 0,1 or 2 units. Your Seller Cost for each unit that you sell is $10. You have no fixed costs and the government will not interfere with your market activities.

Record of Prices and Profits

	Round 1	Round 2
Price of First Unit		
Price of Second Unit		
Total Costs		
Total Profit		

Session 2

In this session, you are a Casual Demander who enjoys but is not addicted to the drug. If you obtain a unit of drugs, you will receive a Buyer Value of $15. If you do not obtain any drugs, your profit will be $0.

	Round 1	Round 2
Price Paid		
Profit (= \$15−P)		

Session 3

In this session, you are an Addict. You find it extremely painful to go without the drug. If you buy a unit of drugs for price P, you will have a profit (loss) of \$30−P. If you don't buy any drugs, you will suffer a LOSS of $20.

	Round 1	Round 2
Price		
Profit (Loss)		

Sales Contract: *Session* ____ *Round* ____

Price _____ *Buyer Value*_____

Seller's ID _____

Buyer's ID _____

Sales Contract: *Session* ____ *Round* ____

Price _____ *Buyer Value*_____

Seller's ID _____

Buyer's ID _____

Sales Contract: *Session* ____ *Round* ____

Price _____ *Buyer Value*_____

Seller's ID _____

Buyer's ID _____

Experiment 5

A Minimum Wage

Objectives of This Experiment

This experiment is easily performed, but rich in economic content. Students will be exposed to the following economic concepts:

1. A rudimentary theory of a firm.
    - There is a difference between the marginal contribution to revenue of an extra laborer and the average revenue per laborer.
    - Profit maximizers should hire an additional unit of labor so long as the extra revenue the laborer brings in exceeds the laborer's wage.
2. The effects of a legislated minimum wage.
    - If the legal minimum wage exceeds the equilibrium wage, then minimum wage legislation will reduce total employment and increase the number of people who seek employment.
    - A legal minimum wage that is higher than the equilibrium wage will raise wages rise for those who remain employed, but will reduce total employment. Therefore the minimum wage can either increase or decrease *total income* of laborers–depending on the shape of the demand curve for labor.
    - If the equilibrium wage exceeds the legislated minimum wage, then the minimum wage will have no effect on wages or employment.
3. The notions of voluntary and involuntary unemployment.

- Students will be taught how to calculate both the amount of voluntary and involuntary unemployment from experimental data.
- Voluntary unemployment is defined as the number of persons who are unemployed and would not choose to take a job at the average wage paid to laborers.
- Involuntary unemployment is defined as the number of persons who are unemployed, but would like to take a job at the average wage paid to laborers.
- Even without a minimum wage there may be some "frictional unemployment."

4. In markets with price ceilings that are lower than the equilibrium price, there will be "shortages" rather than unemployment. At the legal maximum price for a good with such a price ceiling, more units will be demanded than suppliers will be willing to supply.

General Discussion

The first session of this experiment introduces a labor market in which labor is demanded by profit-maximizing firms. Firms can hire either zero, one, or two laborers. A firm's revenue is \$20 if it hires one unit of labor and \$30 if it hires two units. Thus, the marginal value product of the first employee is \$20 and that of the second is \$10. Each laborer can work for only one firm. Some laborers have a low **opportunity cost** of working (\$5) and others have a high opportunity cost (\$12).

In the first session, the market operates without a minimum wage rate. Supply and demand curves for this market will be approximately as drawn in Figure 5.1.

In the second session, a legal minimum wage rate is introduced. This minimum wage rate is binding and has the effect of increasing both the wage rate and the amount of involuntary unemployment.

In the third session, the firms are able to hire up to 4 workers. A firm's revenue is \$30 if it hires one laborer, \$55 if it hires two, \$75 if it hires 3, and \$95 if it hires 4 laborers. Therefore the firm's marginal value product is \$30 for its first laborer, \$25 for its second, \$20 for its third, and \$20 for its fourth. The minimum wage law remains in place, but in this session, the demand curve for labor is sufficiently high that the competitive equilibrium wage exceeds the legal minimum wage, and the minimum wage constraint is not binding.

Detailed Instructions and Comments

Time Required

In a 50-minute class, there is sufficient time to run all three sessions and to have a moderate amount of discussion. In an 80-minute class, there is time for an extended discussion period.

Preparation for the Experiment

Before trading starts, we suggest that you go through the Warm-up exercises in the textbook with the class. These exercises will help employers and laborers to understand the way that firms' profits are calculated.

Distribute equal numbers of Types A and B Personal Information Sheets until about 3/4 of the class have sheets. Give Type C sheets to the remaining 1/4 of the class. Small deviations from these proportions will not harm the experiment. Latecomers can be given sheets of any type. Type C's will be employers in all sessions. Give each Type C a packet of 4 short and 3 long form Employment Records.

In the first two sessions, one or two rounds should be sufficient to get close to competitive equilibrium. For Session 3, you may want to run up to 3 rounds.

For each round of each session, the market manager should also maintain an "unemployment register." In each round, laborers who do not find employment should report to the market manager, who will add their ID numbers and reservation wages to the unemployment register.

Conduct of Sessions

In the first session, firms can hire up to two laborers. A laborer can take only one job. When a laborer and a firm agree on a wage, the firm records the laborer's ID number, reservation wage, and the wage paid to that laborer, on its employment record for that round. When a firm has hired as many laborers as it intends to, it should bring its employment record to the market manager, who will record the wages paid to each worker on the blackboard. (You should retain these employment records to record the market outcomes and check for any inconsistencies after the class is over.)

In each round, as trading draws to a close, ask those students who did not find employment to add their ID numbers and reservation wage to the unemployment register at the front of the class.

After each round of each session, survey the class to determine the involuntary unemployment rate. Ask students to raise their hands if they did not get a job and would have liked to work at the average wage for the round. Also, ask employers to raise their hands if they would have liked to hire more workers at the average wage for this round. You may also want to ask how many of these employers would like to hire more than one additional worker. This is a good time for a short, informal discussion of the meaning of voluntary and involuntary unemployment.

At the end of the class session, remember to ask students to write their ID numbers on their Personal Information Sheets and turn them in.

Predictions of the Competitive Model

Figure 5.1 displays competitive supply and demand curves for conditions similar to those that will apply to your classroom market. This figure also shows the equilibrium wage rate and amount of employment, with and without a legal minimum wage. In the absence of a minimum wage, the market equilibrium is at the point A, with a wage of \$10, and employment of 9 laborers. With a minimum wage of \$15, the equilibrium price and output are at the point B, with a market wage of \$15 and employment of 6 laborers.

Figure 5.1: Labor Market, Sessions 1 and 2

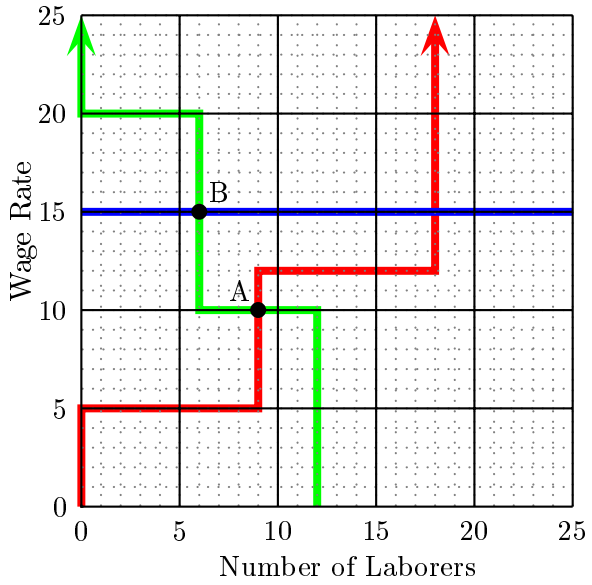
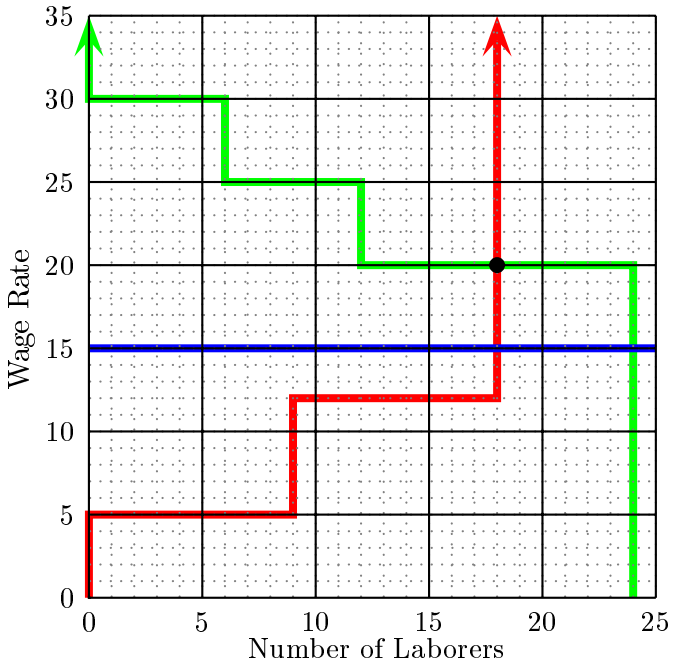


Figure 5.2 shows supply and demand curves for labor for a market similar to the one you will conduct in Session 3. In this case, a minimum wage of \$15 is seen to be nonbinding. The competitive equilibrium wage is 20, with total employment of 18.

Figure 5.2: Labor Market, Session 3



Quick Start for Experiment 5: A Minimum Wage

Capsule Instructions: A Minimum Wage

- Distribute equal numbers of Types A and B sheets until about 3/4 of the class have sheets. Give Type C sheets to the remaining 1/4. Give each employer a packet of employment records.
- Work through the Warm-up Exercises
- Begin Session 1 (no minimum wage).
  - Open trading in Round 1.
  - As Employment Records are turned in, record the Firm's ID, the wages it paid to each of its workers, and the reservation wage of each laborer on the blackboard.
  - When trading ceases, have the unemployed workers sign the Unemployment List.
  - After trading, poll the class to see how many workers are unemployed, how many would want to work at the average wage paid in this round, and how many employers would have liked to hire more labor at the average wage.
  - Open trading in later rounds. Proceed as in Round 1. Ask students to copy the record of transactions in the last round into their Lab Reports.
- Begin Session 2 (binding minimum wage).
  - Remind students that this is Session 2. Conditions are the same as in Session 1, except that there is a legal minimum wage of $15.
  - Proceed as in Session 1.
- Begin Session 3 (non-binding minimum wage).
  - Remind students that this is Session 3. Firms can now hire up to 4 workers. The minimum wage remains $15.
  - Proceed as in Session 1.
- Announce the number of laborers of each type and the number of firms. Post the unemployment statistics from the last round of each session, and ask students to record this information in their Lab Reports.
- Collect the Personal Information Sheets from all traders.

Recording Experimental Data

Record the following information after you distribute the P.I. sheets:

Number of firms _____

Number of laborers of each type _____

If you distributed the sheets according to the instructions, there will be an even number of laborers in each session. Half of the laborers will have reservation wages of $5 and half will have reservation wages of $12. You should post this information for the students in a format like Table Q.5.1.

Table Q.5.1: Distribution of Types: Firms and Workers

Numbers of:	Session 1	Session 2	Session 3
Firms			
Laborers with $5 Reservation Wage			
Laborers with $12 Reservation Wage			

You should also post Table Q.5.2. The information needed for this table comes from the unemployment lists for the last round of each session.

Table Q.5.2: Unemployment by Reservation Wages

	Number of Unemployed Workers with:	
	$5 reservation wage	$12 reservation wage
Session 1		
Session 2		
Session 3		

Finally, you should post information in the format of Tables Q.5.3 (for Sessions 1 and 2) and Table Q.5.4 (for Session 3), reporting the wages paid by each firm in the last round of each session.

Table Q.5.3: Wages and Firm Profits in Session –

Firm ID	Wages Paid to	
	Worker 1	Worker 2

Table Q.5.4: Wages and Firm Profits in Session 3

Firm ID	Wages Paid to			
	Worker 1	Worker 2	Worker 3	Worker 4

What to Post for Students' Lab Notes

- A table in the format of Table Q.5.1, reporting the number of firms and the number of laborers with each reservation wage. Students should copy this into Table 5.9 of their Lab Notes.
- The number of unemployed by Reservation wage for each session. This can be reported in the format of Table Q.5.2. Students should copy this into Table 5.8 of their Lab Notes.
- Lists showing the wages paid by each firm in the last round of each session. For Sessions 1 and 2, this information should be in the format of Table Q.5.3 and for Session 3 it should be in the format of Table Q.5.4. Students should copy this information into Tables 5.5–5.7 of their Lab Notes.

Materials to Be Photocopied

Personal Information Sheets

Make equal numbers of Form A and Form B sheets so that you will have enough of these sheets in total for 3/4 of the class. Make enough copies of Form C for the remaining 1/4 of the class.

Distribute equal numbers of Form A and of Form B until about 3/4 of the students in class have sheets. Distribute Form C to the remaining 1/4 of the class. (Small deviations from the 3/4-1/4 proportions will not matter, but it is desirable to distribute equal numbers of type A and B forms.)

Employment Records and Unemployment Registers

Make about one copy for each student who might come to class of the sheet containing short and long form employment record sheets. Cut these apart to separate the two record sheets on each page.

Distribute four copies of the short and three copies of the long form employment records to each of the firms.

Make seven copies of the Unemployment Register.

TYPE A **Student ID Number** _____

Minimum Wage Experiment
Laborer's Information Sheet

Session 1

In this session, if you are unemployed, you can get a reservation wage of $12. If you get a job, you will *not* get your reservation wage, but instead you will get the wage agreed on.

Record of Employment and Wages

Write "U" under "Wage Received" if unemployed.

	Round 1	Round 2
Wage Received		

Session 2

In this session, if you are unemployed, you can get a reservation wage of $5. If you get a job, you will *not* get your reservation wage, but instead you will get the wage agreed on. You are not allowed to accept a job for less than the legal minimum wage, which is $15.

Record of Employment and Wages

Write "U" under "Wage Received" if unemployed.

	Round 1	Round 2
Wage Received		

Session 3

In this session, if you are unemployed, you get a reservation wage of $12. If you get a job, you will *not* get your reservation wage, but instead you will get the wage agreed on. You are not allowed to accept a job for less than the legal minimum wage, which is $15.

Record of Employment and Wages

Write "U" under "Wage Received" if unemployed.

	Round 1	Round 2	Round 3
Wage Received			

TYPE B **Student ID Number** _____

Minimum Wage Experiment
Laborer's Information Sheet

Session 1

In this session, if you are unemployed, you can get a reservation wage of $5. If you get a job, you will *not* get your reservation wage, but instead you will get the wage agreed on.

Record of Employment and Wages

Write ''U'' under "Wage Received" if unemployed.

	Round 1	Round 2
Wage Received		

Session 2

In this session, if you are unemployed, you get a reservation wage of $12. If you get a job, you will *not* get your reservation wage, but instead you will get the wage agreed on. You are not allowed to accept a job for less than the legal minimum wage, which is $15.

Record of Employment and Wages

Write ''U'' under "Wage Received" if unemployed.

	Round 1	Round 2
Wage Received		

Session 3

In this session, if you are unemployed, you can get a reservation wage of $5. If you get a job, you will *not* get your reservation wage, but instead you will get the wage agreed on. You are not allowed to accept a job for less than the legal minimum wage, which is $15.

Record of Employment and Wages

Write ''U'' under "Wage Received" if unemployed.

	Round 1	Round 2
Wage Received		

TYPE C **Student ID Number** _____

Minimum Wage Experiment

Firm's Information Sheet

Session 1:

In this session, the value of your output is $20 if you hire one laborer and $30 if you hire two. Your profits are the value of your output *minus* the total amount of wages you pay.

	Round 1	Round 2
Value of Ouput		
Total Wages Paid		
Profit		

Session 2

In this session, the value of your output is $20 If you hire one laborer and $30 if you hire two. Your profits are the value of your output *minus* the total amount of wages you pay. The legal minimum wage is $15.

	Round 1	Round 2
Value of Ouput		
Total Wages Paid		
Profit		

Session 3

In this session, you can hire up to four laborers. The value of your ouput is $30 if you hire one laborer, $55 if you hire two, $75, if you hire three, and $95 if you hire four.. The legal minimum wage is $15. Your profits are the value of your output *minus* the total amount of wages you pay.

	Round 1	Round 2
Value of Ouput		
Total Wages Paid		
Profit		

Employment Record

Short Form–Used in Sessions 1 and 2

Employer's ID _____

Worker's ID Number	Worker's Reservation Wage	Wage Paid to Worker

Session _____ Round _____

Employment Record

Long Form–Used in Session 3

Employer's ID _____

Worker's ID Number	Worker's Reservation Wage	Wage Paid to Worker

Session 3 Round _____

Session _____ Round _____

Unemployment Register

ID Number or Name	Res. Wage	ID Number or Name	Res. Wage

Experiment 6

Externalities

Objectives of This Experiment

In this experiment, students are introduced to the following ideas:

- When there are negative externalities, competitive trading can lead to inefficient outcomes.
- It is not, in general, efficient to eliminate negative externalities entirely.
- An appropriately chosen sales tax can improve efficiency when there are negative externalities.
- Negative externalities can also be regulated in an efficient way by means of a fixed supply of marketable pollution permits.

General Discussion

In this experiment, every trade imposes a negative externality on all market participants. In the first session there is no government interference in trading and the resulting competitive equilibrium has "too many" trades. In the second session, a "pollution tax" is imposed on each trade. This tax is set to be approximately equal to the total cost of negative externalities caused by a trade. (The revenue collected from the tax is divided equally among all participants in the experiment.) In competitive equilibrium with the pollution tax, the only trades that take place are those that make positive net profits when the total amount of pollution damage they cause is subtracted from the buyer's and seller's profits. In the third session, pollution control is managed by means of marketable pollution permits. At

the beginning of this session, some traders receive pollution permits. The number of pollution permits issued is equal to the number of trades consistent with maximizing total profits, net of pollution damage, of all persons in the experiment. Everyone who sells a unit of output (lawn ornaments) must present a pollution permit, along with the regular sales contract. Those who do not own pollution permits initially can buy them from individuals who are endowed with pollution permits.

Detailed Instructions and Comments

Time Required

The first two sessions of this experiment can be conducted easily within a 50-minute class meeting. If things go smoothly, you will also have time for one, or perhaps two, rounds of the third session. In an 80-minute class, there is sufficient time for all three sessions, and for a substantial amount of discussion.

Personal Information Sheets

In each session of this experiment there are 6 types of suppliers and 6 types of demanders. The procedure for distributing Personal Information Sheets is the same as that used in the Sales Tax experiment:

- There are 12 "regular types" of Personal Information Sheets, Types 1-12, and one "extra" type, Type X. Clip together enough 12-packs of Personal Information Sheets consisting of Types 1-12 so that there is at least one sheet for each student who might come to class. Also bring two copies of the Type X Personal Information Sheet.

- Distribute as many full 12-packs as possible. Think of the remaining 12-pack as consisting of clusters of 3; types 1-3, 4-6, 7-9, and 10-12. Distribute as many of these full clusters of 3 as you can. Record, for your later reference, the type of the last sheet distributed.

- If the number of students in class is not divisible by 3, then you will have one or two students left without sheets. Give these students sheets of Type X. If three or more latecomers arrive after you have distributed the sheets, but before trading has started, arrange to give them regular sheets (in clusters of three).

Pollution Permits

Before each round of Session 3 begins, you should distribute pollution permits to $3N$ students where N is the number of full twelve-packs of Personal Information Sheets distributed. We recommend that the permits be given to persons of Types 5, 8, and 11. (Types 5 and 11 are demanders with relatively low Buyer Values and type 8 is a supplier with a high Seller Cost. In equilibrium, these individuals should not use the pollution permits themselves, but should sell them to suppliers with low Seller Costs.)

Procedures for Sessions 1 and 2

Before trading begins, announce that in all sessions of this experiment, each lawn ornament that is sold will cause a total of \$20 worth of pollution damage. This damage will be distributed equally among all participants in the experiment. Inform the students of the number M of participants in the experiment. Calculate $d = \$20/M$ (you may want to round d to a multiple of \$.10), and announce to the class that lawn ornament that is sold causes negative externalities worth $\$d$ to each participant in the experiment.

In Session 1, trading and recording of trades proceeds exactly as in previous market experiments. Where the number of trades made is T and the damage caused by each trade to each participant is d, every person who participated in the experiment (even those who didn't make any trades) will have pollution damages of $\$Td$.

In Session 2, trading proceeds as in Session 1. As before, pollution costs are subtracted from the profits of each person who participates in the experiment. A \$20 "pollution tax" is collected from each supplier who sells a lawn ornament. The total revenue from the pollution tax is distributed in equal shares to all participants in the experiment. Thus if there are M participants in the experiment, in a round of Session 2 where there are T trades and $\$20T/M$ will be added to each participant's profits.

Procedures for Session 3

Session 3 is more complex than any of the market experiments that we have done so far because it involves two simultaneous markets—the lawn ornament market and the pollution permit market. Lawn ornament suppliers can not supply ornaments until they have obtained permits. The amount that a supplier is willing to pay for a permit depends on the price that she can expect to receive for a lawn ornament.

At the beginning of this session, you should inform students of the number of pollution permits that have been issued. To help students get an idea of what prices to expect in the lawn ornament market, you should point out that the demand curve is the same in Session 3 as it was in Session 2, and the number of pollution tickets issued in Session 3 is close to (perhaps the same as) the number of lawn ornaments that were sold in Session 2. You can then suggest, more or less subtly, that the competitive equilibrium price of lawn ornaments in Session 3 is likely to be similar to that in Session 2.

We have found that the market for pollution permits operates more smoothly if we allow students who want to act as middlemen to buy pollution permits and resell them. Accordingly, we reserve space on these tickets to mark the ID number of, and price paid by, the first buyer, second buyer, and third buyer.[1]

We have run these simultaneous markets in two different ways, either of which works reasonably well. We describe both methods here. You can take your pick. Whichever method you use, make sure that every lawn ornament seller turns in a pollution permit along with the sales contract for the lawn ornament.

Method 1 is to designate one area of the room as the Permits Trading Pit and another area as the Ornaments Trading Pit. Students should go to the appropriate trading pit when they want to buy or sell permits or lawn ornaments. In this simultaneous market, it is helpful to make information on all trades publicly available as soon as possible. Therefore, it is a good idea to have a separate pit manager for each trading pit and to have this pit manager post the results of every trade in either market as soon as it occurs. This means that the manager of the Permits Trading Pit should ask everyone who buys a pollution permit to report the transaction price, but not to turn in the permit, as soon as a trade is made.

Method 2 is for the market manager to run two simultaneous "double oral auctions." The manager first opens the pollution permit market, by asking somebody to propose a price at which she will sell a permit, then asking if there are any buyers at that price. If there are multiple buyers, select one of them and ask the buyer and seller to fill out and transfer the permit. If there are no buyers, solicit an offer from a buyer. Adjust the price until there is a sale. Now open the Lawn Ornament market by

[1] The only one of these prices that needs to be recorded for the students' lab notes is the price at which the permit is sold to the supplier who ultimately uses it. If you are rewarding students for their total profits in this experiment, you can determine the profits or losses made by pollution traders from the information on the permits that are turned in.

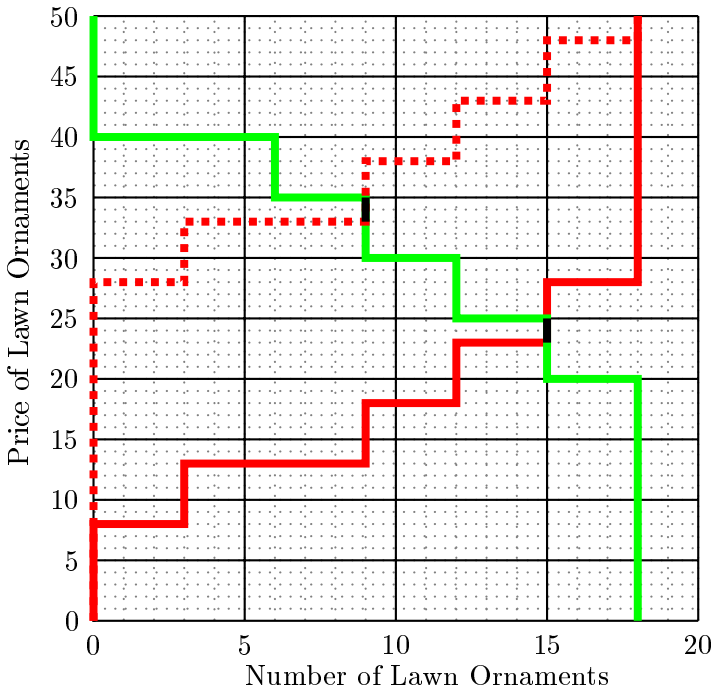
soliciting as high an offer to buy as you can get. If there are no sellers at that price, return to the Permits market and adjust the price until you get further transactions. Alternate between the two markets as you see fit until essentially all of the pollution permits have been sold to ornament sellers who in turn sell ornaments to demanders.

Predictions of the Competitive Model

The Lawn Ornaments Market

Figure 6.1 shows the supply and demand curves for a class of 36 students. In the absence of a sales tax, the supply and demand curves are as shown by the solid lines in Figure 6.1. The equilibrium price range for lawn ornaments is \$23-\$25, and the equilibrium quantity is 15. With the \$20 sales tax, the supply curve shifts to the dotted curve. With the tax in place, the equilibrium price range is \$33-\$35, and the equilibrium quantity is 9.

Figure 6.1: Externalities and a Sales Tax



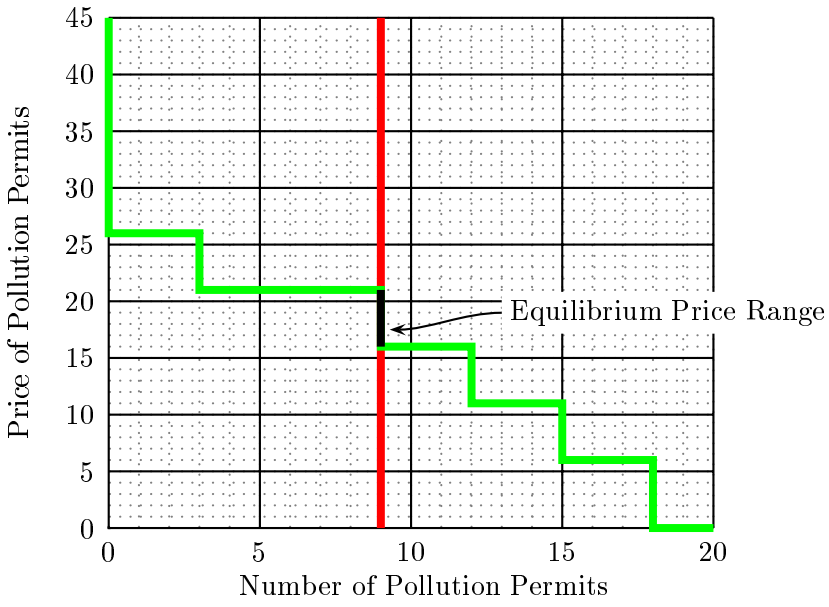
In competitive equilibrium with no sales tax, the total amount of profits that traders made on transactions is \$285. Total pollution damage suffered

by all persons in the experiment is $15 \times \$20 = \$300$. Therefore total profits, net of pollution damage are $\$285 - \$300 = -\$15$. With a sales tax of \$20, total after-tax profits from transactions are \$63. Total pollution damage is $9 \times \$20 = \$180$. Total tax revenue collected and rebated is \$180. Total profits, net of pollution damage and inclusive of tax rebates is therefore equal to \$63.

The Pollution Permits Market in Session 3

If you distribute 36 Personal Information Sheets as described above, then, since $N = 3$ and you are asked to distribute $3N$ permits, you will distribute 9 pollution permits and 9 lawn ornaments will be sold. We see from Figure 6.1 that if 9 lawn ornaments are sold, the competitive equilibrium price of lawn ornaments must be in the range from \$33-\$35. If the price of lawn ornaments is expected to take the average value (\$34) in this interval, then the willingness-to-pay of a supplier who has Seller Cost C for a pollution ticket is $\$34 - C$. The demand curve for pollution permits is then as shown in Figure 6.2. The supply curve is vertical at a quantity of 9 units. The supply curve for pollution permits intersects the demand curve in the range of prices from \$16 to \$21.

Figure 6.2: Demand and Supply for Pollution Permits



Quick Start for Experiment 6: Externalities

Here you will find materials that you are likely to want to have with you during the experiment, including capsule instructions and tables to use for determining the distribution of Seller Costs and Buyer Values in each session. You will also find Personal Information Sheets and Sales Contracts for photocopying, and instructions on how many to prepare and how to distribute them.

Capsule Instructions: Externalities

Procedure:

- Distribute as many *complete* 12-packs, consisting of sheets of Types 1-12 as possible. From the remaining 12-pack, distribute as many clusters of three (1–3, 4–6, etc.) as possible. If the number of students present is not divisible by three, give sheets of Type X to the remaining students.
- Announce that each lawn ornament sold imposes total damage of \$20, which is $d = \$20/(\text{number of participants})$ on *each* participant.
- Begin Session 1 (no controls).
  - Open trading in Round 1. As completed Sales Contracts are turned in, record price, Seller Cost, and Buyer Value on the blackboard.
  - If you run a second round, remind students that this is still Session 1.
- Begin Session 2 (pollution tax on sellers). Remind students that this is Session 2, and that for each trade, the seller must pay a tax of \$20. Proceed as in Session 1.
- Begin Session 3 (pollution permits required).
  - Remind students that this is Session 3, and that in order to sell a lawn ornament, each seller must turn in a pollution permit along with her sales contract.
  - Distribute pollution permits to students of Types 5, 8, and 11. (Number distributed should equal $3N$ where N is the number of complete twelve-packs distributed.)
  - Open trading in Round 1. As sales contracts are turned in, be sure that the seller also turns in a filled-out pollution permit. Record price, Seller Cost, Buyer Value, and Price Paid for Permit on the blackboard.
  - Proceed to further rounds.
- Collect the Personal Information Sheets from all traders and record the distribution of Buyer Values and Seller Costs.

Recording Market Information

Record the following information after you distribute the P.I. sheets:

Number of complete 12-packs distributed (=N) _____

Number of Type X sheets distributed (=K) _____

Type of Last P.I. sheet distributed _____

Number of Pollution Permits Issued[2] _____

Damages, Pollution Tax, and Permits

You should also post the cost of the damage d caused to each market participant by each lawn ornament produced. Recall that d is approximately (approximately because you may choose to round to the nearest \$.10) equal to \$20/number of participants.

You should post the amount of the Pollution tax, which is \$20 (unless you choose a different tax) per unit, and you should post the number of pollution tickets that were issued.

Transaction Information

For the last round of Session 1 and 2, you should post the price, Seller Cost and Buyer Value in each lawn ornament transaction. For Session 3, with each transaction you should also record the amount that the seller paid for the pollution permit used with that sale. (If the seller used a permit that was given to her initially, record the average price paid for pollution permits here.)

Distribution of Types

From figures Q.6.1 and Q.6.2, you can determine the distribution of Seller Costs and Buyer Values in your class, given the number N of full twelve-packs, the number K of Type X sheets, and the type of the last regular sheet that you have distributed. Use this information to complete Table Q.6.3, which you should post for students to enter into their Lab Notes.

[2]Not needed if you do not run Session 3

Table Q.6.1: Distribution of Seller Costs

Seller Cost	Type of Last Regular Sheet			
	3	6	9	12
28	N	N	N+1	N
23	N+1	N+1	N+1	N
18	N+K+1	N+K+1	N+K+1	N+K
13	2N	2N+1	2N+1	2N
8	N	N	N	N

Table Q.6.2: Distribution of Buyer Values

Buyer Value	Type of Last Regular Sheet			
	3	6	9	12
20	N	N	N	N
25	N	N+1	N+1	N
30	N	N+1	N+1	N
35	N+1	N+1	N+1	N
40	2N	2N	2N+2	2N

Table Q.6.3: Buyer Values and Seller Costs

Seller Cost	Number of Suppliers	Buyer Value	Number of Demanders
28		20	
23		25	
18		30	
13		35	
8		40	

What to Post for Students' Lab Notes

For their Lab Notes, students will need the following information:

- The pollution cost that each lawn ornament imposes on every Effluvian.
- The pollution tax rate charged in Session 2.
- The number of pollution permits issued in Session 3.
- The number of persons with each Seller Cost and Buyer Value as reported in Table Q.6.3. Students should copy this information into Table 6.2 of their Lab Notes.
- For Sessions 1 and 2, a list of the price, Seller Cost, and Buyer Value in each trade. Students should record this information in Tables 6.3 and 6.4 of their Lab Notes.
- For Session 3, for each transaction the price of the lawn ornament, the Buyer Value, the Seller Cost, and the price that the Seller paid to obtain his or her pollution permit.

Materials to Be Photocopied

Personal Information Sheets

Make up enough Personal Information sheets of Types 1-12 so that there is one sheet for each student. Also make two Type X sheets. Distribute as many *complete* 12-packs (one sheet per person), consisting of sheets of Types 1-12 as possible. From the remaining 12-pack, distribute as many clusters of three (1–3, 4–6, etc.) as possible. If the number of students present is not divisible by three, give sheets of Type X to the remaining students.

Sales Contracts and Personal Information Sheets

Prepare approximately two sales contracts for each student in the class and about 3/4 as many pollution permits as the number of students in class. Since these are printed three-to-a-page, they need to be cut apart after photocopying. You can use left-over sales contracts from Experiments 1 or 3 if you remind students that in Session 2, sellers should report their before-tax Seller Costs.

TYPE 1 **Student ID Number** _____

Externalities Experiment

Session 1:

In this session you are a lawn ornament `Supplier` with Seller Cost `$23`. If you sell a lawn ornament, your profit is the price you received, minus your Seller Cost, minus the cost of pollution damage. If you don't sell one, you have a loss equal to the cost of pollution damage.

Record of Prices and Profits

	Price	Seller Cost	Poll.Damage	Profit
Round 1				
Round 2				

Session 2

In this session you are a lawn ornament `Supplier` and your `Seller Cost` is `$18`. If you sell a lawn ornament, your profit is the price you received, minus your Seller Cost, minus your Pollution Tax, minus the total pollution cost. If you don't sell one, you have a loss equal to the total pollution cost.

Record of Prices and Profits

	Price	Seller Cost	Tax Paid	Poll. Damage	Profit
Round 1					
Round 2					

Session 3

In this session you are a lawn ornament `Demander` with `Buyer Value` `$35`. If you buy a lawn ornament, your profit is your Buyer Value minus the price you paid, minus the cost of pollution damage. If you don't buy a lawn ornament, you have a loss equal to the cost of pollution damage.

Record of Prices and Profits

	Buyer Value	Price	Poll.Damage	Profit
Round 1				
Round 2				

TYPE 2 **Student ID Number** _____

Externalities Experiment

Session 1:

In this session you are a lawn ornament `Supplier` with Seller Cost `$18`. If you sell a lawn ornament, your profit is the price you received, minus your Seller Cost, minus the cost of pollution damage. If you don't sell one, you have a loss equal to the cost of pollution damage.

Record of Prices and Profits

	Price	Seller Cost	Poll.Damage	Profit
Round 1				
Round 2				

Session 2

In this session you are a lawn ornament `Demander` with `Buyer Value` `$35`. If you buy a lawn ornament, your profit is your Buyer Value minus the price you paid, minus the cost of pollution damage. If you don't buy a lawn ornament, you have a loss equal to the cost of pollution damage.

Record of Prices and Profits

	Buyer Value	Price	Poll.Damage	Profit
Round 1				
Round 2				

Session 3

In this session you are a lawn ornament `Supplier` with Seller Cost `$23`. To sell a lawn ornament, you need a pollution permit. If you buy a permit and sell a lawn ornament, your profit is the price you got for the lawn ornament, minus the price you paid for the permit, minus your seller cost, minus the cost of pollution damage. If you don't sell a lawn ornament or buy a permit, you have a loss equal to the cost of pollution damage.

Record of Prices and Profits

	Price	Seller Cost	Cost of Permit	Poll. Damage	Profit
Round 1					
Round 2					

TYPE 3 **Student ID Number** _____

Externalities Experiment

Session 1:

In this session you are a lawn ornament `Demander` with Buyer Value `$35`. If you buy a lawn ornament, your profit is your Buyer Value minus the price you paid, minus the cost of pollution damage. If you don't buy one, you have a loss equal to the cost of pollution damage.

Record of Prices and Profits

	Buyer Value	Price	Poll.Damage	Profit
Round 1				
Round 2				

Session 2

In this session you are a lawn ornament `Supplier` and your `Seller Cost` is `$23`. If you sell a lawn ornament, your profit is the price you received, minus your Seller Cost, minus your Pollution Tax, minus the total pollution cost. If you don't sell one, you have a loss equal to the total pollution cost.

Record of Prices and Profits

	Price	Seller Cost	Tax Paid	Poll. Damage	Profit
Round 1					
Round 2					

Session 3

In this session you are a lawn ornament `Supplier` with Seller Cost `$18`. To sell a lawn ornament, you need a pollution permit. If you buy a permit and sell a lawn ornament, your profit is the price you got for the lawn ornament, minus the price you paid for the permit, minus your seller cost, minus the cost of pollution damage. If you don't sell a lawn ornament or buy a permit, you have a loss equal to the cost of pollution damage.

Record of Prices and Profits

	Price	Seller Cost	Cost of Permit	Poll. Damage	Profit
Round 1					
Round 2					

TYPE 4 **Student ID Number** _____

Externalities Experiment

Session 1:

In this session you are a lawn ornament `Demander` with Buyer Value `$25`. If you buy a lawn ornament, your profit is your Buyer Value minus the price you paid, minus the cost of pollution damage. If you don't buy one, you have a loss equal to the cost of pollution damage.

Record of Prices and Profits

	Buyer Value	Price	Poll.Damage	Profit
Round 1				
Round 2				

Session 2

In this session you are a lawn ornament `Demander` with `Buyer Value` `$30`. If you buy a lawn ornament, your profit is your Buyer Value minus the price you paid, minus the cost of pollution damage. If you don't buy a lawn ornament, you have a loss equal to the cost of pollution damage.

Record of Prices and Profits

	Buyer Value	Price	Poll.Damage	Profit
Round 1				
Round 2				

Session 3

In this session you are a lawn ornament `Supplier` with Seller Cost `$13`. To sell a lawn ornament, you need a pollution permit. If you buy a permit and sell a lawn ornament, your profit is the price you got for the lawn ornament, minus the price you paid for the permit, minus your seller cost, minus the cost of pollution damage. If you don't sell a lawn ornament or buy a permit, you have a loss equal to the cost of pollution damage.

Record of Prices and Profits

	Price	Seller Cost	Cost of Permit	Poll. Damage	Profit
Round 1					
Round 2					

TYPE 5 **Student ID Number** _____

Externalities Experiment

Session 1:

In this session you are a lawn ornament `Demander` with Buyer Value `$30`. If you buy a lawn ornament, your profit is your Buyer Value minus the price you paid, minus the cost of pollution damage. If you don't buy one, you have a loss equal to the cost of pollution damage.

Record of Prices and Profits

	Buyer Value	Price	Poll.Damage	Profit
Round 1				
Round 2				

Session 2

In this session you are a lawn ornament `Supplier` and your `Seller Cost` is `$13`. If you sell a lawn ornament, your profit is the price you received, minus your Seller Cost, minus your Pollution Tax, minus the total pollution cost. If you don't sell one, you have a loss equal to the total pollution cost.

Record of Prices and Profits

	Price	Seller Cost	Tax Paid	Poll. Damage	Profit
Round 1					
Round 2					

Session 3

In this session you are a lawn ornament `Demander` with `Buyer Value` `$25`. If you buy a lawn ornament, your profit is your Buyer Value minus the price you paid, minus the cost of pollution damage. If you don't buy a lawn ornament, you have a loss equal to the cost of pollution damage.

Record of Prices and Profits

	Buyer Value	Price	Poll.Damage	Profit
Round 1				
Round 2				

TYPE 6 **Student ID Number** _____

Externalities Experiment

Session 1:

In this session you are a lawn ornament `Supplier` with Seller Cost `$13`. If you sell a lawn ornament, your profit is the price you received, minus your Seller Cost, minus the cost of pollution damage. If you don't sell one, you have a loss equal to the cost of pollution damage.

Record of Prices and Profits

	Price	Seller Cost	Poll.Damage	Profit
Round 1				
Round 2				

Session 2

In this session you are a lawn ornament `Demander` with `Buyer Value` `$25`. If you buy a lawn ornament, your profit is your Buyer Value minus the price you paid, minus the cost of pollution damage. If you don't buy a lawn ornament, you have a loss equal to the cost of pollution damage.

Record of Prices and Profits

	Buyer Value	Price	Poll.Damage	Profit
Round 1				
Round 2				

Session 3

In this session you are a lawn ornament `Demander` with `Buyer Value` `$30`. If you buy a lawn ornament, your profit is your Buyer Value minus the price you paid, minus the cost of pollution damage. If you don't buy a lawn ornament, you have a loss equal to the cost of pollution damage.

Record of Prices and Profits

	Buyer Value	Price	Poll.Damage	Profit
Round 1				
Round 2				

TYPE 7 **Student ID Number** _____

Externalities Experiment

Session 1:

In this session you are a lawn ornament `Supplier` with Seller Cost `$28`. If you sell a lawn ornament, your profit is the price you received, minus your Seller Cost, minus the cost of pollution damage. If you don't sell one, you have a loss equal to the cost of pollution damage.

Record of Prices and Profits

	Price	Seller Cost	Poll.Damage	Profit
Round 1				
Round 2				

Session 2

In this session you are a lawn ornament `Demander` with `Buyer Value` `$40`. If you buy a lawn ornament, your profit is your Buyer Value minus the price you paid, minus the cost of pollution damage. If you don't buy a lawn ornament, you have a loss equal to the cost of pollution damage.

Record of Prices and Profits

	Buyer Value	Price	Poll.Damage	Profit
Round 1				
Round 2				

Session 3

In this session you are a lawn ornament `Demander` with `Buyer Value` `$40`. If you buy a lawn ornament, your profit is your Buyer Value minus the price you paid, minus the cost of pollution damage. If you don't buy a lawn ornament, you have a loss equal to the cost of pollution damage.

Record of Prices and Profits

	Buyer Value	Price	Poll.Damage	Profit
Round 1				
Round 2				

TYPE 8 **Student ID Number** _____

Externalities Experiment

Session 1:

In this session you are a lawn ornament `Demander` with Buyer Value `$40`. If you buy a lawn ornament, your profit is your Buyer Value minus the price you paid, minus the cost of pollution damage. If you don't buy one, you have a loss equal to the cost of pollution damage.

Record of Prices and Profits

	Buyer Value	Price	Poll.Damage	Profit
Round 1				
Round 2				

Session 2

In this session you are a lawn ornament `Demander` with `Buyer Value` `$40`. If you buy a lawn ornament, your profit is your Buyer Value minus the price you paid, minus the cost of pollution damage. If you don't buy a lawn ornament, you have a loss equal to the cost of pollution damage.

Record of Prices and Profits

	Buyer Value	Price	Poll.Damage	Profit
Round 1				
Round 2				

Session 3

In this session you are a lawn ornament `Supplier` with Seller Cost `$28`. To sell a lawn ornament, you need a pollution permit. If you buy a permit and sell a lawn ornament, your profit is the price you got for the lawn ornament, minus the price you paid for the permit, minus your seller cost, minus the cost of pollution damage. If you don't sell a lawn ornament or buy a permit, you have a loss equal to the cost of pollution damage.

Record of Prices and Profits

	Price	Seller Cost	Cost of Permit	Poll. Damage	Profit
Round 1					
Round 2					

TYPE 9 **Student ID Number** _____

Externalities Experiment

Session 1:

In this session you are a lawn ornament `Demander` with Buyer Value `$40`. If you buy a lawn ornament, your profit is your Buyer Value minus the price you paid, minus the cost of pollution damage. If you don't buy one, you have a loss equal to the cost of pollution damage.

Record of Prices and Profits

	Buyer Value	Price	Poll.Damage	Profit
Round 1				
Round 2				

Session 2

In this session you are a lawn ornament `Supplier` and your `Seller Cost` is `$28`. If you sell a lawn ornament, your profit is the price you received, minus your Seller Cost, minus your Pollution Tax, minus the total pollution cost. If you don't sell one, you have a loss equal to the total pollution cost.

Record of Prices and Profits

	Price	Seller Cost	Tax Paid	Poll. Damage	Profit
Round 1					
Round 2					

Session 3

In this session you are a lawn ornament `Demander` with `Buyer Value` `$40`. If you buy a lawn ornament, your profit is your Buyer Value minus the price you paid, minus the cost of pollution damage. If you don't buy a lawn ornament, you have a loss equal to the cost of pollution damage.

Record of Prices and Profits

	Buyer Value	Price	Poll.Damage	Profit
Round 1				
Round 2				

TYPE 10 **Student ID Number** _____

Externalities Experiment

Session 1:

In this session you are a lawn ornament `Demander` with Buyer Value `$20`. If you buy a lawn ornament, your profit is your Buyer Value minus the price you paid, minus the cost of pollution damage. If you don't buy one, you have a loss equal to the cost of pollution damage.

Record of Prices and Profits

	Buyer Value	Price	Poll.Damage	Profit
Round 1				
Round 2				

Session 2

In this session you are a lawn ornament `Supplier` and your `Seller Cost` is `$8`. If you sell a lawn ornament, your profit is the price you received, minus your Seller Cost, minus your Pollution Tax, minus the total pollution cost. If you don't sell one, you have a loss equal to the total pollution cost.

Record of Prices and Profits

	Price	Seller Cost	Tax Paid	Poll. Damage	Profit
Round 1					
Round 2					

Session 3

In this session you are a lawn ornament `Supplier` with Seller Cost `$13`. To sell a lawn ornament, you need a pollution permit. If you buy a permit and sell a lawn ornament, your profit is the price you got for the lawn ornament, minus the price you paid for the permit, minus your seller cost, minus the cost of pollution damage. If you don't sell a lawn ornament or buy a permit, you have a loss equal to the cost of pollution damage.

Record of Prices and Profits

	Price	Seller Cost	Cost of Permit	Poll. Damage	Profit
Round 1					
Round 2					

TYPE 11 **Student ID Number** _____

Externalities Experiment

Session 1:

In this session you are a lawn ornament `Supplier` with Seller Cost `$8`. If you sell a lawn ornament, your profit is the price you received, minus your Seller Cost, minus the cost of pollution damage. If you don't sell one, you have a loss equal to the cost of pollution damage.

Record of Prices and Profits

	Price	Seller Cost	Poll.Damage	Profit
Round 1				
Round 2				

Session 2

In this session you are a lawn ornament `Supplier` and your `Seller Cost` is `$13`. If you sell a lawn ornament, your profit is the price you received, minus your Seller Cost, minus your Pollution Tax, minus the total pollution cost. If you don't sell one, you have a loss equal to the total pollution cost.

Record of Prices and Profits

	Price	Seller Cost	Tax Paid	Poll. Damage	Profit
Round 1					
Round 2					

Session 3

In this session you are a lawn ornament `Demander` with `Buyer Value` `$20`. If you buy a lawn ornament, your profit is your Buyer Value minus the price you paid, minus the cost of pollution damage. If you don't buy a lawn ornament, you have a loss equal to the cost of pollution damage.

Record of Prices and Profits

	Buyer Value	Price	Poll.Damage	Profit
Round 1				
Round 2				

TYPE 12 **Student ID Number** _____

Externalities Experiment

Session 1:

In this session you are a lawn ornament `Supplier` with Seller Cost `$13`. If you sell a lawn ornament, your profit is the price you received, minus your Seller Cost, minus the cost of pollution damage. If you don't sell one, you have a loss equal to the cost of pollution damage.

Record of Prices and Profits

	Price	Seller Cost	Poll.Damage	Profit
Round 1				
Round 2				

Session 2

In this session you are a lawn ornament `Demander` with `Buyer Value` `$20`. If you buy a lawn ornament, your profit is your Buyer Value minus the price you paid, minus the cost of pollution damage. If you don't buy a lawn ornament, you have a loss equal to the cost of pollution damage.

Record of Prices and Profits

	Buyer Value	Price	Poll.Damage	Profit
Round 1				
Round 2				

Session 3

In this session you are a lawn ornament `Supplier` with Seller Cost `$8`. To sell a lawn ornament, you need a pollution permit. If you buy a permit and sell a lawn ornament, your profit is the price you got for the lawn ornament, minus the price you paid for the permit, minus your seller cost, minus the cost of pollution damage. If you don't sell a lawn ornament or buy a permit, you have a loss equal to the cost of pollution damage.

Record of Prices and Profits

	Price	Seller Cost	Cost of Permit	Poll. Damage	Profit
Round 1					
Round 2					

TYPE X **Student ID Number** _____

Externalities Experiment

Session 1:

In this session you are a lawn ornament `Supplier` with Seller Cost `$18`. If you sell a lawn ornament, your profit is the price you received, minus your Seller Cost, minus the cost of pollution damage. If you don't sell one, you have a loss equal to the cost of pollution damage.

Record of Prices and Profits

	Price	Seller Cost	Poll.Damage	Profit
Round 1				
Round 2				

Session 2

In this session you are a lawn ornament `Supplier` and your `Seller Cost` is `$18`. If you sell a lawn ornament, your profit is the price you received, minus your Seller Cost, minus your Pollution Tax, minus the total pollution cost. If you don't sell one, you have a loss equal to the total pollution cost.

Record of Prices and Profits

	Price	Seller Cost	Tax Paid	Poll. Damage	Profit
Round 1					
Round 2					

Session 3

In this session you are a lawn ornament `Supplier` with Seller Cost `$18`. To sell a lawn ornament, you need a pollution permit. If you buy a permit and sell a lawn ornament, your profit is the price you got for the lawn ornament, minus the price you paid for the permit, minus your seller cost, minus the cost of pollution damage. If you don't sell a lawn ornament or buy a permit, you have a loss equal to the cost of pollution damage.

Record of Prices and Profits

	Price	Seller Cost	Cost of Permit	Poll. Damage	Profit
Round 1					
Round 2					

Pollution Permit

This permit can be resold, but can only be used for the designated round.

Original Owner's ID _____ Session _____ Round_____

First Buyer's ID_____ Price at Sale _____

Second Buyer's ID_____ Price at Sale _____

Third Buyer's ID_____ Price at Sale _____

Pollution Permit

This permit can be resold, but can only be used for the designated round.

Original Owner's ID _____ Session _____ Round_____

First Buyer's ID_____ Price at Sale _____

Second Buyer's ID_____ Price at Sale _____

Third Buyer's ID_____ Price at Sale _____

Pollution Permit

This permit can be resold, but can only be used for the designated round.

Original Owner's ID _____ Session _____ Round_____

First Buyer's ID_____ Price at Sale _____

Second Buyer's ID_____ Price at Sale _____

Third Buyer's ID_____ Price at Sale _____

Sales Contract: *Session* _____ *Round* _____

Price _____

Seller's ID _____ **Seller Cost* _____

Buyer's ID _____ *Buyer Value*_____

*In Session 2, sellers should not include tax in reported Seller Cost.

Sales Contract: *Session* _____ *Round* _____

Price _____

Seller's ID _____ **Seller Cost* _____

Buyer's ID _____ *Buyer Value*_____

*In Session 2, sellers should not include tax in reported Seller Cost.

Sales Contract: *Session* _____ *Round* _____

Price _____

Seller's ID _____ **Seller Cost* _____

Buyer's ID _____ *Buyer Value*_____

*In Session 2, sellers should not include tax in reported Seller Cost.

Experiment 7

Monopoly and Cartels

Objectives of This Experiment

In this experiment, students explore the main ideas of the theory of monopoly and of collusion. Among the principles we expect them to learn are the following:

- A cartel with perfect enforcement of quotas will choose the output that maximizes total profits of cartel members.
- Higher prices do not necessarily mean higher revenue for a cartel or a monopoly, since higher prices can mean fewer units sold.
- If a cartel can enforce *quantity* quotas, it will be in the interests of its members to charge the profit-maximizing price, even if pricing agreements cannot be enforced directly.
- If cartel agreements cannot be enforced, some individual cartel members will find that they can increase their profits by violating an agreement that maximizes total profits in the industry.
- If the distribution of Buyer Values is different among different identifiable groups in the population, for example students and non-students, then it may be in the interest of a cartel to price-discriminate.
- The total of demanders' profits and suppliers' profits is typically lower if there is a monopoly than it is in competitive equilibrium.

General Discussion

This experiment introduces the ideas of monopoly, collusion, and price discrimination.

The first session is a thought experiment in which students decide on the pricing strategy that they would use if they were monopolists.

In the second session of the experiment, firms can meet and set a production quota for each firm. The market manager will enforce agreed-on quotas.

In the third session, firms again meet to set production quotas, but this time the market manager will not enforce quotas. Firms do not have to abide by posted prices, but can offer any kind of discounts they wish. If it is logistically convenient, you can allow some firms to transact outside the classroom.

The fourth session of the experiment allows price discrimination. In this session, the market manager will again enforce the cartel's agreement. Some of the demanders will have "student ID's,' and some will not. (These consist of the words "I AM A STUDENT" written at the top of their Personal Information Sheets.) Firms are allowed to charge lower prices to those who display a student ID than they charge to others.

Detailed Instructions and Comments

Time Required

One round of Sessions 2 and 4 is sufficient. If time permits, it will probably be interesting to run a second round of Session 3. In a 50-minute class there is time for the first three sessions and some discussion, including speculation about what would happen in the fourth session. In an 80-minute class there is ample time to run all four sessions and to have a discussion.

Running Session 1

The point of this session is to get everybody in the class to think about a monopoly's decision problem. At the beginning of the session, you should post a demand table showing the distribution of Buyer Values in the class resulting from the Personal Information sheets that have just been distributed. (This same distribution will apply in Session 2.) It is also a good idea to draw the corresponding demand curve.

Students must write their decision on their Personal Information Sheet. To give them an incentive to work this out carefully, you can tell them that their profits (what they would actually make, not what they might claim to make) will be counted toward their winnings for the day. It is up to you whether you want to encourage students to talk with each other about the answers.

Running Session 2

Before the session begins, designate 6 students, one of each type A–F, to be firms for the session.[1] Those who are firms are not allowed to also be buyers in that round. Give a Firm Record Sheet of the kind appropriate for the session to each student designated as a firm.

Give the firms time to meet and set a production quota for each firm. Quotas must be agreed on by majority vote in the committee. The market manager will enforce agreed-on quotas. If the profit-maximizing output for the cartel happens to be divisible by 6, the cartel is likely to reach an agreement that gives each firm a quota of 1/6 of the profit-maximizing output. If the number is not divisible by 6, the cartel may have trouble deciding what to do about the remainder. If they are not able to reach early agreement on this matter, you may want to suggest that they use coin tosses.

After the quota has been set, every firm gets a section of blackboard where it posts a price. Prices, once posted, can not be changed. Firms should quote prices in whole dollars. Urge demanders to buy *if and only if* they can make at least $1 profit on the transaction, and to buy from a supplier with the lowest available price.

When trading is completed, collect all of the Firm Record Sheets. Check whether each firm has satisfied its quota and disallow all sales by any firm that exceeds its quota. On the blackboard, record each firm's quota, price, and number of units sold. Students should copy this information into their Lab Reports.

Running Session 3

Before the first round of this session begins, designate 6 students, one of each type A–F, to be firms for the session and give them Firm Record Sheets. In

[1] In a very large class, you can give more students a chance to participate in firms by letting firms be "management teams" with 2-3 students in each team. In a small class, you may want to have fewer firms in the cartel.

this session, again give the firms time to meet and to set production quotas and/or prices. This time, tell them that these are voluntary agreements, which will not be enforced by the market manager. Allow firms to post any price they like. But announce both to demanders and to firms that firms are allowed to offer discounts to any buyer at any time they wish. Try to separate the locations of firms in the classroom as much as possible, to make it difficult for them to monitor each others' activities. If it is convenient, you may want to allow some firms to set up their operation outside of the classroom (in which case you would announce the location of these outside firms to all the demanders).

When trading is completed, collect all of the Firm Record Sheets. On the blackboard, record each firm's quota, price, and number of units sold. Depending on time available and the results of the first round, you may choose to run a second round of Session 3.[2] Our experience has been that students enjoy a second round and often the results are quite interesting. After the last round of Session 3, students should copy the information from the blackboard into their Lab Reports.

Running Session 4

Designate 6 different students, one of each type A–F, to be firms for the session and give them Firm Record Sheets. In this session, firms are allowed to price discriminate, by charging a lower price to demanders who show a Student's Personal Information Sheet. Give firms time to meet and set quotas. In this session, they can set separate quotas for the number of tickets that each firm can sell to students and to non-students, and they can recommend student and non-student prices. Quotas must be decided by majority vote. The market manager will enforce the quantity quotas. Tickets cannot be resold.

When trading is completed, collect all of the Firm Record Sheets. Ask cartel members to tell you the quota assigned to each firm. Check whether each firm has satisfied its quotas and disallow all sales by any firm that exceeds its quotas. On the blackboard, record each firm's quota, price, and number of units sold. Students should copy this information into their Lab Reports.

When trading ends, collect Firm Record Sheets and verify that quota agreements have been satisfied. On the blackboard, record each firm's quota,

[2] One of the authors has the same 6 students as firms in both rounds of Session 3. The other author typically selects 6 new students for the second round. Either way seems to work fine.

price, and number of units sold. Also record the number of sales from students to non-students. Students should copy this information into their Lab Reports.

Predicted Behavior

Sessions 1 and 2: Monopoly and Enforceable Cartels

If the number of demanders is divisible by 6, then 1/6 of the demanders will have Buyer Values of \$21, 1/2 will have Buyer Values of \$16, and 1/3 will have Buyer Values of \$11. If the number of demanders is not divisible by 6, the proportions will differ slightly from this, but the profit-maximizing prices turn out to be the same.

Let us work out the profit-maximizing price when there are 36 demanders. Since demanders are supposed to buy if and only if they can make at least \$1 profit by doing so, there are three interesting prices for a monopolist to consider: \$20, \$15, and \$10. Recall that marginal cost is \$5. At a price of \$20, 6 units would be sold for a profit of \$120 − \$30 = \$90. At a price of \$15, 24 units would be sold[3] for a profit of \$360 − \$120 = \$240. At a price of \$10, 36 units would be sold for a profit of \$360 − \$180 = \$180. Therefore the profit-maximizing price for a monopolist would be \$15. At this price he would sell 24 units.

In Session 2, a cartel of 6 members would maximize its total profit by giving each member a quota of 4 units to sell and recommending a price of \$15. In this example, the profit-maximizing quantity for the monopolist is divisible by 6, so the 6 cartel-members can each get an equal share of monopoly profits by dividing the output equally. If the profit-maximizing quantity is not divisible by 6, cartel members may want to use coin-flipping to allocate the remainder after dividing by 6.

Session 3: No Cartel Enforcement

If efforts to collude break down, then you can expect the price to be driven close to the competitive equilibrium price. Since each firm can produce as many units as it likes at a constant marginal cost of \$5, the supply curve is a horizontal line at a height of \$5. The competitive equilibrium price is \$5. At this price, every demander in the market would buy a ticket.

[3] The 6 \$21 BV's and the 18 \$16 BV's would be willing to pay \$15.

Session 4: Price Discrimination

In Session 4, if the number of demanders is divisible by 6, then half of the demanders will be students and half will be non-students. Of the non-students, 1/3 have Buyer Values of \$21 and 2/3 have Buyer Values of \$16. Of the students, 1/3 have Buyer Values of \$16 and 2/3 have Buyer Values of \$11. If a class has 36 demanders, then a discriminating monopolist who charged \$20 to non-students would have profits of \$120 − \$30 = \$90 and a discriminating monopolis who charged \$15 to non-students would have profits of \$270 − \$90 = \$180 from this market segment. Thus the profit-maximizing price to charge non-students is \$15. A discriminating monopolist who charged \$15 to students would have profits of \$90 − \$30 = \$60 and a discriminating monopolist who charged \$10 to students would have profits of \$180 − \$90 = \$90 from this market segment. So the profit-maximizing price to charge students is \$10.

Quick Start for Experiment 7: Monopoly and Cartels

Capsule Instructions: Monopoly and Cartels

- Distribute as many *complete* six-packs of Personal Information Sheets as you can. If 1 or 2 students remain, give them Type A sheets. If 3,4, or 5 students remain, give Types A, B, and C to the first 3 and Type A to any remaining students.
- Work through Warm-up exercises 7.1–7.11 with the class.
- Announce the distribution of Buyer Values among demanders in this class and draw the demand curve on the blackboard. Tell students that this demand curve will apply in all sessions of this experiment.
- Begin Session 1.
  - Tell students to pretend that they are monopolists and that the demand curve they face is the one that you have drawn on the blackboard. They can produce as many units as they like at a cost of $5 each and demanders will buy if they can earn at least $1 in profit.
  - Ask students to record the price they choose to charge, the quantity they will sell, and their profits on their Personal Information Sheets.
- Select 6 students, one with each type of sheet A–F to be firms in Session 2.
- Begin Session 2 (cartel with enforcement).
  - Allow the firms to meet and set an output quota for each firm. Firms may also recommend a price, but this price will not be directly enforced.
  - Give each firm blackboard space on which to post a price. This price cannot be changed during the round. To buy, a demander adds his ID number to the seller's Firm Record Sheet. (Each demander can buy only one unit.)
  - Collect Firm Record Sheets. Announce each firm's quota, price, and number of units sold. Disallow sales by any firm that exceeds its quota.
- Select one person of each type A–F to be firms in Session 3. Announce that the demand curve is the same as in Session 2.

(continued on next page)

Capsule Instructions: (continued)

- Begin Session 3 (cartel without enforcement).
  - Firms meet to set quotas, as in Session 2, but in this session, the market manager will *not* enforce agreed-on quotas or prices.
  - Each firm posts a price. Firms may change this posted price and/or give secret discounts from the posted price. Buyers are encouraged to negotiate the best deal possible.
  - Collect Firm Record Sheets. Announce each firm's quota, price, and number of units sold.
  - You may run additional rounds of Session 3. Only the last round needs to be recorded in Lab Reports.
- Work through Warm-up exercises 7.12-7.14 (if time permits).
- Select one person of each type A–F to be firms in Session 4.
- Announce the distributions of Buyer Values for student and for non-student demanders, and draw separate demand curves for each of these two groups.
- Begin Session 4 (cartel with enforcement and price discrimination).
  - Firms meet and set separate quotas for sales to students to non-students. The market manager will enforce compliance to these quotas. The cartel may also recommended prices, but these will not be enforced.
  - Each firm is given blackboard space and is allowed to post a non-student price and a student price. Students can be asked to show their ID cards (which are attached to their forms) to get the student price.
  - Collect Firm Record Sheets. Announce each firm's quotas, price, and number of units sold. Disallow sales by any firm that exceeds its quota for either students or non-students.
- At the end of the experiment, collect Personal Information Sheets from all traders for your records.

Recording Market Information

Record the following information after you distribute the P.I. sheets:

Number of complete 6-packs distributed (=N) _____
Number of additional sheets distributed after complete 6-packs (=K) _____

Distribution of Types

The distribution of Buyer Values in the entire population and in the subpopulations of students and nonstudents depends on the number N of full six-packs and the number K of additional sheets passed out. If you have distributed the sheets according the rules specified in the capsule instructions, this relation is described by Tables Q.7.1, Q.7.2, and Q.7.3.

Table Q.7.1: Distribution of Buyer Values: Entire Market

	Number of Additional Sheets (K)					
Buyer Value	0	1	2	3	4	5
21	N-1	N-1	N-1	N	N	N
16	3N-3	3N-2	3N-1	3N-1	3N	3N+1
11	2N-2	2N-2	2N-2	2N-2	2N-2	2N-2

Table Q.7.2: Distribution of Buyer Values: Non students

	Number of Additional Sheets (K)					
Buyer Value	0	1	2	3	4	5
21	N-1	N-1	N-1	N	N	N
16	2N-2	2N-1	2N	2N	2N+1	2N+2
11	0	0	0	0	0	0

The distribution of buyer values among students depends only on the number N of complete six-packs and not on the number of additional sheets distributed. This distribution is given in Table Q.7.3.

Table Q.7.3: Distribution of Buyer Values: Students

Buyer Value	Number of Students
21	0
16	N-1
11	2N-2

You now have sufficient information to complete Tables Q.7.4 and Q.7.5, which you should post for students so that they can complete their Lab Notes.

Table Q.7.4: Distribution of Buyer Values: Sessions 2–3

Buyer Value	Number of Demanders
$21	
$16	
$11	

Table Q.7.5: Distribution of Demander Types: Session 4

Type and Buyer Value	Number of Demanders
Nonstudent with B. V. $21	
Nonstudent with B. V. $16	
Nonstudent with B. V. $11	
Student with B. V. $21	
Student with B. V. $16	
Student with B. V. $11	

Sales, Revenue, and Buyer Values

In order to complete their Lab Notes and their homework, students will need information about quotas, sales and revenues of firms and about the Buyer Values of demanders who bought tickets. You can give this information in either of two ways: 1) You can post all of the Firms' Record Sheets collected in the last round of each session and let the students use this information to complete the tables in the Lab Notes, or 2) You can save the students some work by using this information to complete Tables Q.7.6–Q.7.11 and posting these filled out tables.

Table Q.7.6: Sales and Revenue in Session 2

Firm ID	Firm's Quota	Number of Units Sold	Firm's Total Revenue

In Table Q.7.7 record the number of demanders with each Buyer Value who *actually bought* tickets in this Session 2. (This should not be confused with the distribution of Buyer Values of all the demanders who participated in the experiment.)

Table Q.7.7: Buyers in Session 2

Buyer Value	Number of Buyers
\$21	
\$16	
\$11	

Table Q.7.8: Sales and Revenue in Session 3

Firm ID	Firm's Quota	Number of Units Sold	Firm's Total Revenue

In Table Q.7.9 record the number of demanders with each Buyer Value who *actually bought* tickets in this Session 3.

Table Q.7.9: Buyers in Session 3

Buyer Value	Number of Buyers
$21	
$16	
$11	

Table Q.7.10: Prices and Sales for Students and Nonstudents

Firm ID	Student Quota	Non-student Quota	Units Sold to Students	Units Sold to Non-Students	Revenue from Students	Revenue from Non-Students

In Table Q.7.11 record the number of demanders with each Buyer Value who *actually bought* tickets in this Session 4.

Table Q.7.11: Buyers in Session 4

Buyer Value	Number of Buyers
$21	
$16	
$11	

What to Post for Students' Lab Notes

Students will need the following information for their Lab Notes.

- The distribution of Buyer Values in the entire population for Sessions 2 and 3, taken from Table Q.7.4. Students should record this in Table 7.5 of their Lab Notes.
- The distribution of Buyer Values in the subpopulations of students and non-students, taken from Table Q.7.5. Students should record this in Table 7.6 of their Lab Notes.
- The sales and revenue of each firm in Sessions 2-4, taken from Tables Q.7.6, Q.7.8, and Q.7.10. Students should record this in Tables 7.7, 7.9, and 7.11 of their Lab Notes.
- The distribution of Buyer Values among those who bought airline tickets in Sessions 2–4, taken from Tables Q.7.7, Q.7.9, and Q.7.11. Students should record this in Tables 7.8, 7.10, and 7.12 of their Lab Notes.

Materials to Be Photocopied

Personal Information Sheets

Make enough 6-packs of Personal Information Sheets of Types A–F so that there is a sheet for every student who might come to class. Also make two extra copies of the Type A sheet.

In class, distribute as many full 6-packs as you can. If, after you have done this, there are 1 or 2 students without sheets, give them Type A sheets. If there are 3 or more students left, hand out one sheet each of Types A, B, and C, and then give Type A sheets to any remaining students.

Firm Record Sheets

Make 18 copies of the Firm Record Sheet that is used in Sessions 2 and 3, and 6 copies of the Firm Record Sheets that is used in Session 4.

In each round of each session, give a Firm Record Sheet to each student who plays the role of a firm.

TYPE A **Student ID Number** _____

Monopoly Experiment
Personal Information Sheet

Session 1

In this session you are a monopolist facing the demand curve described by your instructor. Write the price that you choose to charge, the quantity that you can sell at that price and the profits you will make.

Price $ _____ Quantity _____ Profit $ _____

Session 2

In this market session your Buyer Value is `$16`.

Price Paid	
Profit (= \$16−P)	

Session 3

In this market session your Buyer Value is `$16`.

	Round 1	Round 2
Price Paid		
Profit (= \$16−P)		

Session 4

In this market session your Buyer Value is `$16`.

Price Paid	
Profit (= \$16−P)	

NON-STUDENT

TYPE B **Student ID Number** _____

Monopoly Experiment
Personal Information Sheet

Session 1

In this session you are a monopolist facing the demand curve described by your instructor. Write the price that you choose to charge, the quantity that you can sell at that price and the profits you will make.

Price $ _____ Quantity _____ Profit $ _____

Session 2

In this market session your Buyer Value is $21.

Price Paid	
Profit (= \$21−P)	

Session 3

In this market session your Buyer Value is $16.

	Round 1	Round 2
Price Paid		
Profit (= \$16−P)		

Session 4

In this market session your Buyer Value is $21.

Price Paid	
Profit (= \$21−P)	

NON-STUDENT

TYPE C **Student ID Number** _____

Monopoly Experiment
Personal Information Sheet

Session 1

In this session you are a monopolist facing the demand curve described by your instructor. Write the price that you choose to charge, the quantity that you can sell at that price and the profits you will make.

Price $ _____ Quantity _____ Profit $ _____

Session 2

In this market session your Buyer Value is `$16`.

Price Paid	
Profit (= \$16−P)	

Session 3

In this market session your Buyer Value is `$21`.

	Round 1	Round 2
Price Paid		
Profit (= \$21−P)		

Session 4

In this market session your Buyer Value is `$16`.

Price Paid	
Profit (= \$16−P)	

NON-STUDENT

TYPE D **Student ID Number** _____

Monopoly Experiment
Personal Information Sheet

Session 1

In this session you are a monopolist facing the demand curve described by your instructor. Write the price that you choose to charge, the quantity that you can sell at that price and the profits you will make.

Price $ _____ Quantity _____ Profit $ _____

Session 2

In this market session your Buyer Value is `$16`.

Price Paid	
Profit (= \$16−P)	

Session 3

In this market session your Buyer Value is `$11`.

	Round 1	Round 2
Price Paid		
Profit (= \$11−P)		

Session 4

In this market session your Buyer Value is `$11`.

Price Paid	
Profit (= \$11−P)	

I AM A STUDENT

TYPE E **Student ID Number** _____

Monopoly Experiment
Personal Information Sheet

Session 1

In this session you are a monopolist facing the demand curve described by your instructor. Write the price that you choose to charge, the quantity that you can sell at that price and the profits you will make.

Price $ _____ Quantity _____ Profit $ _____

Session 2

In this market session your Buyer Value is `$11`.

Price Paid	
Profit (= \$11−P)	

Session 3

In this market session your Buyer Value is `$16`.

	Round 1	Round 2
Price Paid		
Profit (= \$16−P)		

Session 4

In this market session your Buyer Value is `$11`.

Price Paid	
Profit (= \$11−P)	

I AM A STUDENT

TYPE F **Student ID Number** _____

Monopoly Experiment
Personal Information Sheet

Session 1

In this session you are a monopolist facing the demand curve described by your instructor. Write the price that you choose to charge, the quantity that you can sell at that price and the profits you will make.

Price $ _____ Quantity _____ Profit $ _____

Session 2

In this market session your Buyer Value is `$11`.

Price Paid	
Profit (= \$11−P)	

Session 3

In this market session your Buyer Value is `$11`.

	Round 1	Round 2
Price Paid		
Profit (= \$11−P)		

Session 4

In this market session your Buyer Value is `$16`.

Price Paid	
Profit (= \$16−P)	

I AM A STUDENT

Firm Record Sheet: Cartel Experiment

(For use in Session 2 or 3)

Firm's ID _____ Session _____

Quota Agreed on (if any) _____

Buyer's ID	Buyer Value	Price	Buyer's ID	Buyer Value	Price

Firm Record Sheet: Session 4
Cartel Experiment

Firm's ID Number _____

Quota for Non-students _____ Quota for Students _____

For each sale, record the buyer's ID and Buyer Value and the price at which you sold to this buyer. If the buyer showed a student ID, put a * in the column marked "Student?"

Buyer's ID	Buyer Value	Price	Student?	Buyer's ID	Buyer Value	Price	Student?

Experiment 8

Entry and Exit

Objectives of This Experiment

This experiment helps students to explore the behavior of profit-maximizing firms operating in a competitive environment. We expect the students to develop some understanding of:

- Technological facts of life for firms
  - Limited capacity
  - Factor inputs that can be varied in the short and in the long run
  - Fixed and variable costs
- Market forces in an industry with free entry
  - Short and long run supply curves
  - When do firms enter an industry?
  - When do firms exit an industry?
  - Short run equilibrium
  - Long run equilibrium

General Discussion

The restaurant experiment illustrates the concepts of short-run and long-run equilibrium, of fixed and variable costs, and of entry and exit from the industry. Each round consists of two stages. In the first stage, students decide whether to open a restaurant. Students are informed of the market

demand curve for restaurant meals and then are asked, in sequence, to declare whether or not they intend to open restaurants. Because the process of invitation is sequential, each student who chooses to open a restaurant knows how many restaurants have been opened so far.

Those who open a restaurant must pay a fixed cost of $20 and a constant marginal cost of $5 per meal sold, until they reach their maximum capacity of 4 customers (one meal per customer). In the second stage, students who have opened restaurants post prices (which they may change during the course of the round) and demanders find the cheapest meals available.

In this market, the long run competitive equilibrium price of meals is $10 and the equilibrium number of firms is one-fourth of the number of meals that would be demanded at a price of $10.

In the first round of play, the number of restaurants that open will probably not be equal to the long-run equilibrium number of restaurants. If too many restaurants enter, at least some of them will lose money. If too few enter, they will make profits that will tempt new entrants in the second round of play.

The second round begins with a new opportunity for students to decide whether to open a restaurant. Students now have a better idea of the number of restaurants that can profitably operate. In this round, there is a good chance that the outcome will be a long-run competitive equilibrium, where no restaurant is losing money and where none could profit from entering the industry. If long-run equilibrium is not reached in two rounds, you may want to run a third round.

The second session of this experiment introduces a Sales Tax of $3 per meal. This tax increases the long-run competitive equilibrium price to $13 and reduces the number of firms that can be sustained in equilibrium. The adjustment process toward equilibrium is interesting to observe, because there is typically over-capacity in the first round. In later rounds, firms leave the industry, the price rises, and equilibrium is restored at a higher price with fewer firms and less output.

Detailed Instructions and Comments

Time Required

In a 50-minute class, you will probably be able to run two rounds of the first session and one round of the second session. In an 80-minute class, you can run at least two rounds for each of the two sessions and have time for discussion. For this experiment, we recommend taking plenty of time in

between rounds to discuss the appropriate actions to take in the presence of fixed costs and when to enter or exit the industry. If time is short, it is not essential to run enough rounds to reach long-run equilibrium. Once students see what happens in the first few rounds, they are happy to discuss and speculate in an intelligent way about what would happen if there were time to run more rounds.

Personal Information Sheets and Customer Lists

In this experiment, everyone is a demander and everyone also has an opportunity to be a supplier.

Since suppliers all have identical costs, there is no need to put cost information on the personal information sheets. At the beginning of class, tell students that in both sessions, there is a fixed cost of $20 for opening a restaurant and a variable cost of $5 per meal sold. In the second session, there is also a $3 sales tax per meal sold.

Clip together several 4-packs of Personal Information sheets, consisting of one sheet each of types A-D. Distribute as many of these full 4-packs as possible to your class. Distribute Type X information sheets to the remaining students and to any late-comers.

Give a "Restaurant Customer List," to each student who opens a restaurant. You will need approximately the same number of Restaurant Customer List as the number of students in class.

Steps in Running the Market

After you have handed out personal information sheets (as discussed above) and answered any questions that students have about the experiment, you will be prepared to begin the first round of the first session. In this round, you should proceed as follows:

- Determine the demand schedule for restaurant meals by asking for a show of hands to determine the number of students with Buyer Values of $24, $18, $12, and $8, respectively. If you wish, you may record this information on the blackboard by making a table and/or drawing a demand curve. Alternatively, you may simply ask students to make their own observations based on what they see. It is not necessary to give students precise information about the market demand curve. In the real world, firms must base their entry decisions on market surveys that provide only approximate information about demand.

- Tell the students that you are going to ask each of them in sequence whether they want to open a restaurant. With each new entrant, announce to the class the number of restaurants that are now open and ask whether anyone else wants to open a restaurant. Continue this process until nobody else wants to open a restaurant. Students who choose to open a restaurant have to pay a $20 fixed cost. Those who choose not to open a restaurant will not be allowed to sell meals in this round.

- Give each student who has chosen to open a restaurant a spot at the blackboard where he or she can post a price. Tell restaurant operators that they can change their posted prices at any time.

- When trading has ceased for any round of trade, collect the filled in restaurant customer lists from restaurant operators, calculate the profits of each restaurant operator, and write these results on the blackboard.

After the first round, it is a good idea to hold a discussion about what has happened; whether firms have made money, and whether more or fewer firms are likely to enter in the second round. After answering questions, begin a second round by asking students in succession whether they want to open restaurants. From there, proceed as you did in the first round.

The second session works in essentially the same way as the first session, but with the addition of a sales tax. The equilibrium number of firms with the sales tax is smaller than that without the sales tax. Accordingly, you are likely to see excess capacity in the first round of the second session. If this happens, some students will probably have to sell meals at a price that is above marginal cost but below average cost. This is a good opportunity to talk about the fact that "sunk costs are sunk."

Predictions of the Competitive Model

The demand curve has steps at prices of $24, $18, $12, and $8. The vertical portion of the demand curve where the price drops from $12 to $8 occurs at a quantity that is a multiple of 4. A demand curve like this is shown in Figures 8.1-8.3 below. Figure 8.1 illustrates a case in which "too many" restaurants enter the industry. As the supply curve shows, at any price greater than the marginal cost of $5, the supply is 28 units. Since each restaurant has a capacity of 4, this means that 28/4=7 firms entered the

industry. The short-run supply and demand curves intersect at a price of \$8. In short-run competitive equilibrium, therefore, each firm has revenue of $\$8 \times 4 = \$32$. Each firm has total costs of $\$20 + 4 \times \$5 = \$40$, so each loses \$8.

Figure 8.1: Short Run with Excess Capacity

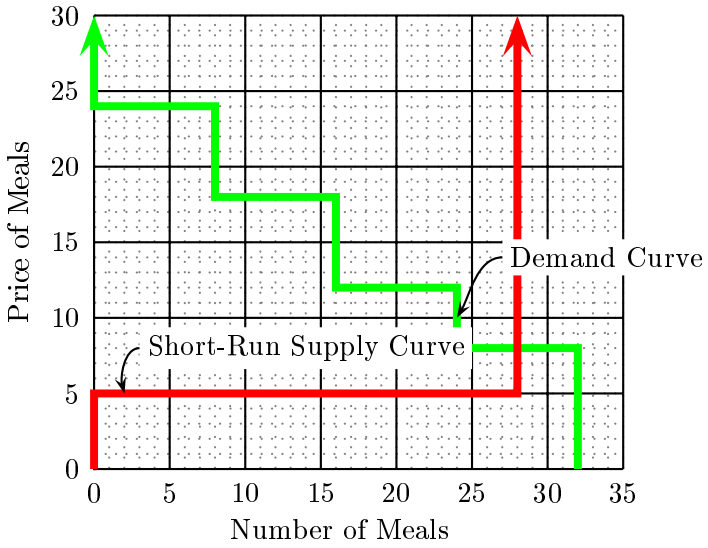


Figure 8.2 shows a case of "short capacity." The demand curve is the same as in Figure 8.1, but the industry has only 5 firms, and so the supply curve becomes vertical at an output of 20. The short-run equilibrium price is \$12, and all firms in the industry make profits of \$8. A potential entrant could also make a profit, so the market is not at a long-run equilibrium.

Figure 8.3 has the same demand curve as Figures 8.1 and 8.2, but there are now 6 entrants. The supply curve is now vertical at a quantity of 24. The supply curve meets the demand curve in a vertical segment where the quantity is 24 and the price ranges from \$8 to \$12. At any price between \$10 and \$12, the firms who have entered want to stay in business, while a potential entrant realizes that if it entered, the price would fall to \$8 and the entrant would lose money. It follows that there is a long run equilibrium with 6 firms, a total output of 24, and a price somewhere in the range between \$10 and \$12.

Figure 8.2: Short Run with Short Capacity

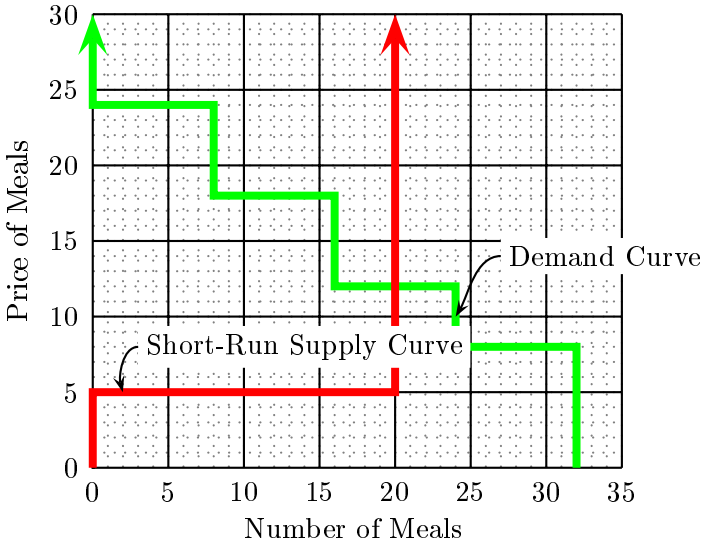
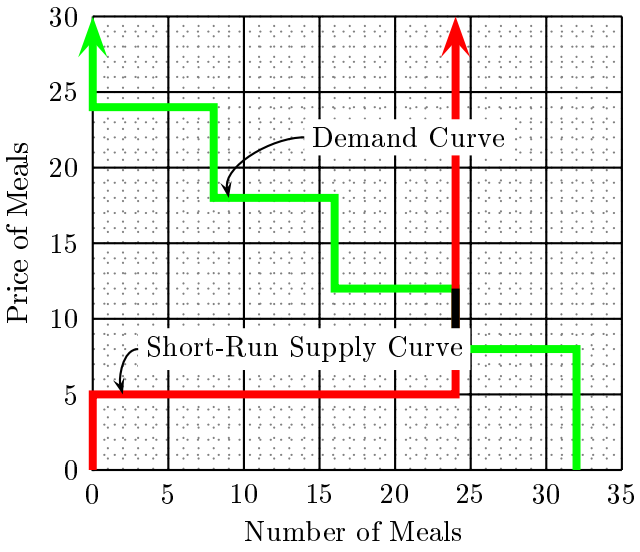


Figure 8.3: Long Run Equilibrium



Quick Start for Experiment 8: Entry and Exit

Capsule Instructions: Entry and Exit

- Distribute as many *complete* four-packs of A–D as possible. Give Type X sheets to the remaining students.
- Make sure that students understand restaurants' cost structure and capacities.
- Get and post a rough count of the number of buyers at each Buyer Value ($24, $18, $12, and $8).
- Begin Session 1.
  - Stage 1: Ask students, in succession, to announce publicly whether they want to open up a restaurant *for this round*. Give each restaurant-opener some blackboard space and a Restaurant Customer List.
  - Stage 2: Restaurant owners post their prices and sell meals as discussed in the detailed instructions.
  - Collect each owner's Restaurant Customer List and post each restaurant's profits. Briefly discuss the outcome with the class.
  - For Round 2, repeat Stage 1 and 2 as above.
  - Continue for as many rounds as you like (typically until the number of entrants stabilizes). Collect the final Restaurant Customer Lists.
- Begin Session 2 (sellers pay a $3 tax per meal sold).
  - Remind students that this is Session 2. Sellers pay a $3 sales tax on every meal, so variable cost is now $8 per meal.
  - Proceed with Stages 1 and 2 as in Session 1.
- Collect Personal Information Sheets and record the distribution of Buyer Values.

Recording Market Information

Record the following information after you distribute the P.I. sheets:

Number of complete 4-packs distributed (=N) _____

Number of Type X sheets distributed (=K) _____

Distribution of Buyer Values

You can determine the distribution of Buyer Values from Table Q.8.1 and post them in the format of Table Q.8.2.

Table Q.8.1: Distribution of Buyer Values

Buyer Value	Number of Demanders
24	N
18	N
12	N
8	N+K

Table Q.8.2: Distribution of Buyer Values

Buyer Value	Number of Buyers
24	
18	
12	
8	

Prices Received by Restaurants

For *each* round of each session, you should post the amounts that each of the restaurants charged for each meal that they sold. This can be posted in tables in the format of Table Q.8.3.

Table Q.8.3: Prices Charged by Restaurants

Restaurant Owner's ID	Prices Paid by Restaurant Customers			

What to Post for Students' Lab Notes

Students will need the following information for their Lab Notes

- The distribution of Buyer Values, taken from Table Q.8.2. They should record this information in Table 8.2 of their Lab Notes.
- A list of the sales and prices charged by each restaurant in *the first and last* rounds of Sessions 1 and 2. This information can be retrieved from the restaurants' customer lists and presented in the format of Table Q.8.3. Students should copy this information into Tables 8.3–8.6

Materials to Be Photocopied

Personal Information Sheets

Personal Information Sheets are included here for photocopying. Make enough copies of Types A-D so that there is one copy for every student who might come to class. Make 3 copies of Type X. Clip together several 4-packs consisting of one sheet each type A-D. Distribute as many of these full 4-packs as possible to your class. Distribute Type X information sheets to the remaining students and to late-comers.

Restaurant Customer Lists

Make about twice as many copies of the "Restaurant Customer List" as the number of students in class. In each round of the experiment, give a Restaurant Customer List to each student who elects to open a restaurant.

TYPE A **Student ID Number** _____

Customer's Personal Information Sheet

Session 1

In this Session, your Buyer Value for a Restaurant Meal is $24. If you buy a meal for price P your profit will be $24—P. If you don't buy a meal, your profit is 0.

You can purchase at most one meal, whether or not you choose to open a restaurant.

Customer's Record of Prices and Profits

	Price Paid	Profit
Round 1		
Round 2		
Round 3		

Session 2

In this Session, your Buyer Value for a Restaurant Meal is $12. If you buy a meal for price P your profit will be $12—P. If you don't buy a meal, your profit is 0.

You can purchase at most one meal, whether or not you choose to open a restaurant.

Customer's Record of Prices and Profits

	Price Paid	Profit
Round 1		
Round 2		
Round 3		

TYPE B **Student ID Number** _____

Customer's Personal Information Sheet

Session 1

In this Session, your Buyer Value for a Restaurant Meal is $18. If you buy a meal for price P your profit will be $18 − P. If you don't buy a meal, your profit is 0.

You can purchase at most one meal, whether or not you choose to open a restaurant.

Customer's Record of Prices and Profits

	Price Paid	Profit
Round 1		
Round 2		
Round 3		

Session 2

In this Session, your Buyer Value for a Restaurant Meal is $18. If you buy a meal for price P your profit will be $18 − P. If you don't buy a meal, your profit is 0.

You can purchase at most one meal, whether or not you choose to open a restaurant.

Customer's Record of Prices and Profits

	Price Paid	Profit
Round 1		
Round 2		
Round 3		

TYPE C **Student ID Number** _____

Customer's Personal Information Sheet

Session 1

In this Session, your Buyer Value for a Restaurant Meal is $12. If you buy a meal for price P your profit will be $12—P. If you don't buy a meal, your profit is 0.

You can purchase at most one meal, whether or not you choose to open a restaurant.

Customer's Record of Prices and Profits

	Price Paid	Profit
Round 1		
Round 2		
Round 3		

Session 2

In this Session, your Buyer Value for a Restaurant Meal is $24. If you buy a meal for price P your profit will be $24—P. If you don't buy a meal, your profit is 0.

You can purchase at most one meal, whether or not you choose to open a restaurant.

Customer's Record of Prices and Profits

	Price Paid	Profit
Round 1		
Round 2		
Round 3		

TYPE D **Student ID Number** _____

Customer's Personal Information Sheet

Session 1

In this Session, your Buyer Value for a Restaurant Meal is $8. If you buy a meal for price P your profit will be $8 − P. If you don't buy a meal, your profit is 0.

You can purchase at most one meal, whether or not you choose to open a restaurant.

Customer's Record of Prices and Profits

	Price Paid	Profit
Round 1		
Round 2		
Round 3		

Session 2

In this Session, your Buyer Value for a Restaurant Meal is $8. If you buy a meal for price P your profit will be $8 − P. If you don't buy a meal, your profit is 0.

You can purchase at most one meal, whether or not you choose to open a restaurant.

Customer's Record of Prices and Profits

	Price Paid	Profit
Round 1		
Round 2		
Round 3		

TYPE X **Student ID Number** _____

Customer's Personal Information Sheet

Session 1

In this Session, your Buyer Value for a Restaurant Meal is $8. If you buy a meal for price P your profit will be $8—P. If you don't buy a meal, your profit is 0.

You can purchase at most one meal, whether or not you choose to open a restaurant.

Customer's Record of Prices and Profits

	Price Paid	Profit
Round 1		
Round 2		
Round 3		

Session 2

In this Session, your Buyer Value for a Restaurant Meal is $8. If you buy a meal for price P your profit will be $8—P. If you don't buy a meal, your profit is 0.

You can purchase at most one meal, whether or not you choose to open a restaurant.

Customer's Record of Prices and Profits

	Price Paid	Profit
Round 1		
Round 2		
Round 3		

Customer List: Session ____ Round ____

Restaurant Owner's ID _____

	ID Number	Buyer Value	Price
1.			
2.			
3.			
4.			

Total Revenue____ Total Cost ____ Profit ____

Customer List: Session ____ Round ____

Restaurant Owner's ID _____

	ID Number	Buyer Value	Price
1.			
2.			
3.			
4.			

Total Revenue____ Total Cost ____ Profit ____

Experiment 9

Network Externalities

Objectives of This Experiment

In this experiment we expect that students will accomplish the following:

- Learn the definition of *network externalities* and be able to identify examples from the real world.
- Observe the dynamics of externalities in a competitive market and understand that new technologies often need to reach *critical mass.*
- Learn about *competing standards* and be able to identify examples from the real world.
- Learn about *Lock-in effects* and their impact on the dynamics of industries.
- See that the economic principles that they have learned apply to industries with exciting new technologies as well as to more established ones.

Detailed Instructions and Comments

There are six types of Personal Information Sheets, A-F. Pass out as many full six-packs as you can and then pass out as many sheets as you can from the last six-pack. Record the number N of full six-packs and the number K of additional sheets distributed.

Session 1, Network Externalities

The Personal Information Sheets tell students their *Initial Values* for a phone. Each student's Buyer Value will depend on the total number of units sold, and will be equal to his or her Initial Value times a *Network Externality Factor* (NEF). Where N is the number of full six-packs distributed, the network externality factor (NEF) depends on the number of phones that are sold during the current round in the way specified by Table 9.1.

Table 9.1: Network Externality Factors in Session 1

If Number of Phones Sold is Between	Network Externality Factor is
1 and N	1
$N+1$ and $2N$	2
$2N+1$ and $3N$	3
$3N+1$ and $4N$	4
$4N+1$ and $5N$	5
$5N+1$ and $7N$	6

We suggest that you tell the students that approximately 1/6 of the persons in class have each of the initial values running from 1 to 6.

Display a table like Table 9.1 in which you substitute for N the number of six-packs actually distributed in your class, and work through the Warm-up exercise for Session 1.

Round 1

For the first round of this session, tell students that they can purchase a Picture Phone for $15 by writing their ID numbers and Initial Values on the market manager's Record of Sales sheet. Remind students that their Buyer Values will depend on the *total number of buyers during this round*. (Not on the number of buyers at the time they make their purchase.) Also remind them that the price will not change at any time during the round.

Ask those who have purchased a phone to move to a designated area of the room, so that everyone can see the number of persons who have bought phones so far. At the end of the round, post the number of sales and the corresponding NEF. Ask students to record this information in their Lab Notes.

For the first round, if any positive number of Picture Phones is sold, at least some buyers will lose money. The most likely outcome is that a few optimistic souls buy phones, but they are left stranded and most (or all) of them lose money.

If you want to promote discussion at this point, you can do the following: When buying (if there is any) stops, ask how many students would have been willing to pay \$15 if the NEF had been 6. Only about half of the students should raise their hands. Point out that the NEF would be 6 only if more than 5/6 of the students ordered phones. Then ask how many would have been willing to pay if the NEF had been 5 and make a similar comparison. (You can keep going with this line of questioning all the way down to 1 if you wish, but to save time, we suggest that you leave the rest of these comparisons for homework.)

Round 2

For Round 2 of this experiment, tell students that firms have discovered cheaper ways of making phones, and that they now cost only \$11 to produce. Then post a price of \$11 and open the market as in Round 1. This time we can not be sure what will happen. Our experience is that this can go either way. If buyers are pessimistic about what others will do, there may be only a handful of purchases, the NEF may not rise above 1, and anyone who bought a phone will be sorry. But if optimistic beliefs are sufficiently widespread, these beliefs will be self-fulfilling. If all of the individuals with Initial Values of 6 and 5 buy phones, then if someone with an Initial Value of 4 buys a phone the NEF reaches 3. At this point, the market has achieved critical mass. Buyer Values will be \$12 or more for all individuals with Initial Values of 4 or higher. If all individuals with Initial Value 4 also buy phones, then when anyone with Initial Value 3 buys a phone, the NEF reaches 4 and the Buyer Value is \$12 or higher for everyone with Initial Value greater than 3.

Further Rounds if Needed

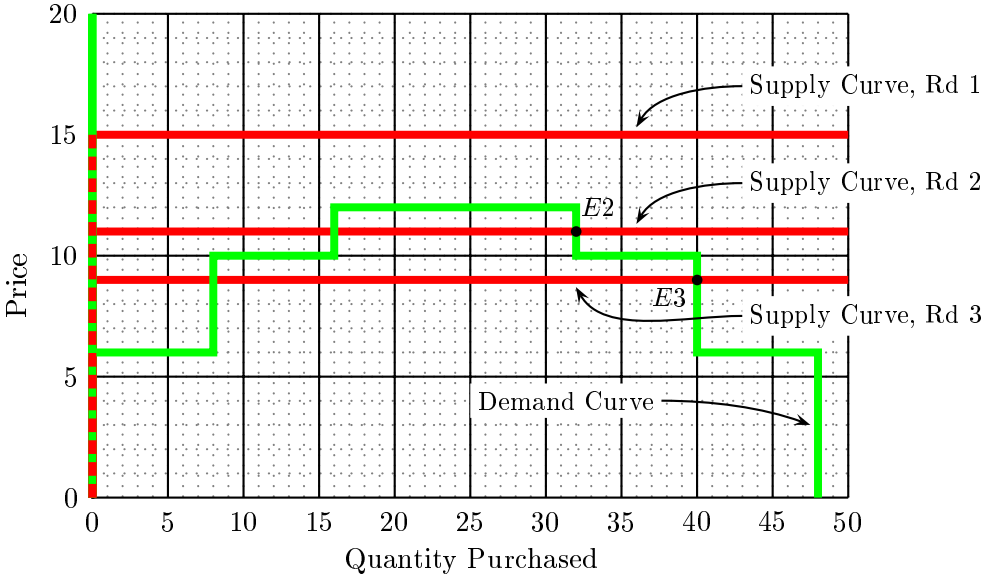
If buyers in Round 2 reached critical mass and everyone (or nearly everyone) with Initial Values of 3 or higher bought a phone, then you can skip round 3 and proceed to Session 2. If critical mass was not reached, begin Round 3 by telling students that production costs have fallen to \$9. Post a price of \$9 and open the market. At a price of \$9, there are two equilibria, one in which no units are sold and one in which all persons with Initial Values of 2

or higher buy phones. So far, in our experience, we have not failed to reach critical mass and achieve the high-sales equilibrium with a price of \$9. If your class does not achieve this equilibrium, then you can do the following: Announce that you are going to subsidize the Picture Phone industry to get it started. Offer to sell the first N units at a price of \$5. You can mention that it often happens that governments subsidize new technologies to get them started. Examples are the railroads, airlines, and the internet. In these cases, the industry sometimes (but not always—e.g. nuclear fusion) reaches critical mass and eventually produces total profits that are more than sufficient to repay the cost of the subsidy.

Demand and Supply Curves for Session 1

In Figure 9.1 we have drawn the demand curve for a class with 48 students and the supply curves for each of the three rounds. In Round 1, with the good supplied at a price of \$15, the only equilibrium is an outcome with no phones sold. For Round 2, with a price of \$11, there are two equilibria, one with no phones sold and one (labeled $E2$) with 32 phones sold. For Round 3, with a price of \$9, there are two equilibria, one with no phones sold and one (labeled $E3$) with 40 phones sold.

Figure 9.1: Demand and Supply for Session 1



Session 2, Competing Standards

In Session 2 consumers are all identical. A consumer's Buyer Value for a computer operating system depends on the number of other consumers who use the *same* operating system according to the schedule found in Table 9.2

Table 9.2: Buyer Values of OS in Session 2

Number of Users of OS Type	Buyer Value
1 and N	\$10
$N+1$ and $2N$	\$20
$2N+1$ and $3N$	\$30
$3N+1$ and $4N$	\$40
$4N+1$ and $5N$	\$50
$5N+1$ or more	\$60

Start Session 2 by working through the Warm-up exercises for Session 2. Display a table like Table 9.2 in which you substitute for N the number of six-packs actually distributed in your class.

Choose 3 volunteers to be the sellers of competing operating systems. Try to get bright, alert students to play this role.[1]

Remind everyone that there will be at least two rounds of play in this session, and that the same firms can stay in business for multiple rounds. Point out that firms may want to sell below cost or even bribe consumers (sell at a negative price) in the first round in order to gain market share.

Round 1

Give each supplier a Sales Record Sheet and some blackboard space where they can advertise their prices. Firms are allowed to change their prices or offer discounts at any time. Firms can also advertise the number of units that they have sold. If it is convenient, designate an area of the room for users of each firm's operating system to gather after they have made their purchases. Each buyer should write his or her ID number and price paid on the seller's Record of Sales and then move to the area designated for users of that seller's operating system to gather.

When trading in Round 1 ceases, calculate the profits for each firm. Determine whether any firms are forced into bankruptcy, and allow any other

[1] If you have a fairly large class, you may want to require your sellers to be partnerships.

firms to declare bankruptcy if they wish. Bankruptcy rules are as follows. Any with a market share of less than 1/6 of the number of demanders is automatically bankrupt. After any round, if none of the three firms have gone bankrupt, you can hasten the final outcome by "inspecting the books" of the weakest firm, pointing out how much money it has lost, its small customer base, and its poor prospects. You can then declare that the firm cannot find credit to sustain itself through another round and (sadly) must declare bankruptcy. With bankruptcy comes limited liability. Firms that have gone bankrupt will lose at most \$50 for the session.

Round 2 and Higher

In Round 2, buyers have to buy new copies of operating systems (Version 2.0), but if they stay with the same operating system that they used in the previous round, they don't have to pay the learning cost of \$15. Sellers can attempt to recruit customers from other firms by offering discounts to persons who used other operating systems in the past.

When trading in Round 2 ceases, calculate the profits for each firm. Again declare any bankruptcies, voluntary or involuntary.

Proceed to further rounds as desired. A third or even a fourth round will often be interesting and entertaining.

Session 3, New Improved Product

(It is best if you can run this session for at least two rounds, since then the new entrant can afford to subsidize entry in Round 1 and recoup losses in Round 2.) In Session 3, Buyer Values for the old operating systems are determined exactly as in Session 2. The new operating system, however, has higher Buyer Values for each level of use, as displayed in Table 9.3.

The firm that had the largest customer base at the end of Session 2 can remain in business at the start of Session 3. (If there is a tie for the largest number of customers, flip a coin.) Others must drop out. Consumers who buy the old operating system in Session 3 will not have to pay a learning cost. Consumers who buy the new operating system will have to pay a learning cost of \$20.

- Display to the class a table like Table 9.3 in which you substitute for N the number of six-packs actually distributed in your class.

- Choose a volunteer or pair of volunteers to run the new firm.

Table 9.3: Buyer Values of OS in Session 3

Number of Users of OS Type	Buyer Value of Old Technology	Buyer Value of New Technology
1 and N	\$10	\$15
$N+1$ and $2N$	\$20	\$30
$2N+1$ and $3N$	\$30	\$45
$3N+1$ and $4N$	\$40	\$60
$4N+1$ and $5N$	\$50	\$75
$5N+1$ or more	\$60	\$90

- Allow the firm that had the largest customer base at the end of Session 2 to stay in business. Other firms from Session 2 must leave.
- Suggest that the new firm may want to offer discounts or even bribes to build a customer base.
- Open trading for Round 1, following the same procedures used in Session 2.
- Continue with further rounds as time permits.

Quick Start for Experiment 9: Networks

Capsule Instructions: Network Externalities

- Distribute as many *complete* six-packs of Personal Information Sheets (one sheet per student) as possible, and then pass out sheets in order from the remaining six-pack until everyone has a sheet.
- Post the table of Network Externality Factors for Sessions 1 and 2.
- Make sure that everyone understands the payoffs.
- Begin Session 1, Round 1
  - Designate part of the room as the phone-owner's area.
  - Announce that phones are sold competitively at a price of \$15.
  - Invite those who want to buy to write their ID's and Initial Values on the Sales Record Sheet at the front of the room. Remind buyers that after buying, they should go to the phone-owner's area.
  - As buyers appear, record the current number of phones sold and the current Network Externality Factor on the blackboard.
  - When no more buyers appear, announce the profits or losses of all buyers.
  - Tell students to record the number of buyers and the final Network Externality Factor for their Lab Notes.
- Begin Session 1, Round 2
  - Remind students that they are still in Session 1.
  - Tell students that new discoveries have lowered marginal cost of producing phones to \$11 and that competition has forced the price to \$11.
  - Proceed as in Round 1
- If buyers reached critical mass in Round 2 and sales were approximately $4N$ or higher, omit Rounds 3 and 4. If not, begin Session 1, Round 3—Proceed as in Session 1, Round 2, with a price of \$9. If buyers do not reach critical mass this time, proceed to Round 4 in which you subsidize the first $N + 1$ buyers, by offering to sell Picture Phones to them at a price of \$5.

(continued on next page)

Capsule Instructions: Network Externalities

(continued)

- Begin Session 2.
  - Do the Warm-up exercise for Session 2. Remind students that there is a $15 learning cost for switching systems (and for buying one's first system).
  - Choose 3 volunteers to sell competing operating systems. Give each seller a Sales Record Sheet. Let sellers name their systems and post prices on the blackboard.
  - When consumers have finished purchasing for this round, calculate profits of firms and determine if there are bankruptcies. Sellers whose market share falls below 1/6 go bankrupt and must leave the market. You may decide to impose additional bankruptcies in the interest of speeding up the experiment. Sellers may also voluntarily declare bankruptcies. Losses of bankrupt sellers are limited to $50.
  - Continue with enough rounds so that there is a monopolist or at least a highly dominant firm.
- Begin Session 3.
  - Select the leading firm from Session 2 to stay in business.
  - Post the Buyer Values for the new technology. Remind students that the learning cost is $20 for the new technology and $0 for the old technology.
  - Ask for a volunteer to start the new firm.
  - Run at least two rounds, so that new entrant has a chance to recoup losses incurred while building a user base.

Posting for Students' Lab Notes

Number of complete 6-packs distributed (=N) _____

Number of additional sheets distributed (=K) _____

If you distributed N six-packs and K additional sheets, then the number of demanders with Initial Values $1, \ldots, K$ will be $N+1$ and the number with Initial Values $K+1, \ldots, 6$ will be N. Complete Table Q.9.4 and post it for the students to enter into their Lab Notes.

Table Q.9.4: Distribution of Initial Values

Initial Value	Number of Demanders
1	
2	
3	
4	
5	
6	

Where N is the number of complete six-packs distributed, the table of Network Externality Factors is given in Table Q.9.5, which should be posted for the students' Lab Notes.

Table Q.9.5: Network Externality Factors

If Number of Phones Sold is Between	Network Externality Factor is
1 and N	1
$N+1$ and $2N$	2
$2N+1$ and $3N$	3
$3N+1$ and $4N$	4
$4N+1$ and $5N$	5
$5N+1$ and $7N$	6

You should also post Table Q.9.6 which records the price of Picture

Phones, the number of Picture Phones sold, and the Network Externality Factor in each round.

Table Q.9.6: Prices and Quantities: Session 1

Round Number	1	2	3	4
Price of Picture Phones				
Number of Phones Sold				

Students will need to complete Table Q.9.7 for their lab reports. You can either complete this table for them using information found on the Record of Sales for each round, or you can simply post the Records of Sales.

Table Q.9.7: Buyers by Initial Value

Initial Value	Number of Buyers			
	Round 1	Round 2	Round 3	Round 4
1				
2				
3				
4				
5				
6				

For Session 2, record and post the information requested in Tables Q.9.8, Q.9.9, and Q.9.10, and for Session 3, record and post the information requested in Tables Q.9.11 and Q.9.12 for Session 3.

Table Q.9.8: Firm A in Session 2

Round	Units Sold	Highest Price	Lowest Price	Total Revenue
1				
2				
3				
4				

Table Q.9.9: Firm B in Session 2

Round	Units Sold	Highest Price	Lowest Price	Total Revenue
1				
2				
3				
4				

Table Q.9.10: Firm C in Session 2

Round	Units Sold	Highest Price	Lowest Price	Total Revenue
1				
2				
3				
4				

Table Q.9.11: Old Firm in Session 3

Round	Units Sold	Highest Price	Lowest Price	Total Revenue
1				
2				
3				
4				

Table Q.9.12: New Firm in Session 3

Round	Units Sold	Highest Price	Lowest Price	Total Revenue
1				
2				
3				
4				

Materials to Be Photocopied

Personal Information Sheets

Make enough copies of Personal Information Sheets A–F so that there is one sheet for everyone who might come to class. Clip together six-packs containing one sheet of each type. Distribute as many complete six-packs as you can, and then distribute sheets to remaining students, starting with A and going as far as you need to.

Record Sheets

Make 4 copies of the Record of Sales sheet for Session 1, and make about 20 copies of the Sales Record Sheets to be used in Sessions 2 and 3.

TYPE A **Student ID Number** _____

Personal Information Sheet

Please hand this sheet in at the end of the session.

Session 1—Network Externalities

In this session your *Initial Value* for a picture phone is $1. Your *Buyer Value* is your *Initial Value* times the *Network Externality Factor*.

Record of Values, Prices and Profits

	Round 1	Round 2	Round 3	Round 4
Initial Value (IV)	1	1	1	1
Network Externality Factor (NEF)				
Buyer Value =IV×NEF				
Price Paid				
Profit =BV-Price				

Session 2—Competing Standards

You must pay a $15 learning cost when you buy your first Operating System. Each time you switch systems, you must pay this $15 cost again.

Record of Values, Prices and Profits

	Round 1	Round 2	Round 3	Round 4
OS Seller's ID				
Buyer Value				
Learning Cost (LC)				
Price Paid				
Profit =BV-Price-LC				

Session 3–New, Improved Technology

If you adopt the new, improved operating system, your learning costs are $20. If you use the old OS, you have no learning costs.

Record of Values, Prices and Profits

	Round 1	Round 2	Round 3	Round 4
OS Seller's ID				
Buyer Value				
Learning Cost (LC)				
Price Paid				
Profit =BV-Price-LC				

TYPE B **Student ID Number** _____

Personal Information Sheet

Please hand this sheet in at the end of the session.

Session 1—Network Externalities

In this session your *Initial Value* for a picture phone is $2. Your *Buyer Value* is your *Initial Value* times the *Network Externality Factor.*

Record of Values, Prices and Profits

	Round 1	Round 2	Round 3	Round 4
Initial Value (IV)	2	2	2	2
Network Externality Factor (NEF)				
Buyer Value =IV×NEF				
Price Paid				
Profit =BV-Price				

Session 2—Competing Standards

You must pay a $15 learning cost when you buy your first Operating System. Each time you switch systems, you must pay this $15 cost again.

Record of Values, Prices and Profits

	Round 1	Round 2	Round 3	Round 4
OS Seller's ID				
Buyer Value				
Learning Cost (LC)				
Price Paid				
Profit =BV-Price-LC				

Session 3–New, Improved Technology

If you adopt the new, improved operating system, your learning costs are $20. If you use the old OS, you have no learning costs.

Record of Values, Prices and Profits

	Round 1	Round 2	Round 3	Round 4
OS Seller's ID				
Buyer Value				
Learning Cost (LC)				
Price Paid				
Profit =BV-Price-LC				

TYPE C **Student ID Number** _____

Personal Information Sheet

Please hand this sheet in at the end of the session.

Session 1—Network Externalities

In this session your *Initial Value* for a picture phone is $3. Your *Buyer Value* is your *Initial Value* times the *Network Externality Factor*.

Record of Values, Prices and Profits

	Round 1	Round 2	Round 3	Round 4
Initial Value (IV)	3	3	3	3
Network Externality Factor (NEF)				
Buyer Value =IV×NEF				
Price Paid				
Profit =BV-Price				

Session 2—Competing Standards

You must pay a $15 learning cost when you buy your first Operating System. Each time you switch systems, you must pay this $15 cost again.

Record of Values, Prices and Profits

	Round 1	Round 2	Round 3	Round 4
OS Seller's ID				
Buyer Value				
Learning Cost (LC)				
Price Paid				
Profit =BV-Price-LC				

Session 3–New, Improved Technology

If you adopt the new, improved operating system, your learning costs are $20. If you use the old OS, you have no learning costs.

Record of Values, Prices and Profits

	Round 1	Round 2	Round 3	Round 4
OS Seller's ID				
Buyer Value				
Learning Cost (LC)				
Price Paid				
Profit =BV-Price-LC				

TYPE D **Student ID Number** _____

Personal Information Sheet

Please hand this sheet in at the end of the session.

Session 1—Network Externalities

In this session your *Initial Value* for a picture phone is $4. Your *Buyer Value* is your *Initial Value* times the *Network Externality Factor.*

Record of Values, Prices and Profits

	Round 1	Round 2	Round 3	Round 4
Initial Value (IV)	4	4	4	4
Network Externality Factor (NEF)				
Buyer Value =IV×NEF				
Price Paid				
Profit =BV-Price				

Session 2—Competing Standards

You must pay a $15 learning cost when you buy your first Operating System. Each time you switch systems, you must pay this $15 cost again.

Record of Values, Prices and Profits

	Round 1	Round 2	Round 3	Round 4
OS Seller's ID				
Buyer Value				
Learning Cost (LC)				
Price Paid				
Profit =BV-Price-LC				

Session 3–New, Improved Technology

If you adopt the new, improved operating system, your learning costs are $20. If you use the old OS, you have no learning costs.

Record of Values, Prices and Profits

	Round 1	Round 2	Round 3	Round 4
OS Seller's ID				
Buyer Value				
Learning Cost (LC)				
Price Paid				
Profit =BV-Price-LC				

TYPE E **Student ID Number** _____

Personal Information Sheet

Please hand this sheet in at the end of the session.

Session 1—Network Externalities

In this session your *Initial Value* for a picture phone is $5. Your *Buyer Value* is your *Initial Value* times the *Network Externality Factor*.

Record of Values, Prices and Profits

	Round 1	Round 2	Round 3	Round 4
Initial Value (IV)	5	5	5	5
Network Externality Factor (NEF)				
Buyer Value =IV×NEF				
Price Paid				
Profit =BV-Price				

Session 2—Competing Standards

You must pay a $15 learning cost when you buy your first Operating System. Each time you switch systems, you must pay this $15 cost again.

Record of Values, Prices and Profits

	Round 1	Round 2	Round 3	Round 4
OS Seller's ID				
Buyer Value				
Learning Cost (LC)				
Price Paid				
Profit =BV-Price-LC				

Session 3–New, Improved Technology

If you adopt the new, improved operating system, your learning costs are $20. If you use the old OS, you have no learning costs.

Record of Values, Prices and Profits

	Round 1	Round 2	Round 3	Round 4
OS Seller's ID				
Buyer Value				
Learning Cost (LC)				
Price Paid				
Profit =BV-Price-LC				

TYPE F **Student ID Number** _____

Personal Information Sheet

Please hand this sheet in at the end of the session.

Session 1—Network Externalities

In this session your *Initial Value* for a picture phone is $6. Your *Buyer Value* is your *Initial Value* times the *Network Externality Factor.*

Record of Values, Prices and Profits

	Round 1	Round 2	Round 3	Round 4
Initial Value (IV)	6	6	6	6
Network Externality Factor (NEF)				
Buyer Value =IV×NEF				
Price Paid				
Profit =BV-Price				

Session 2—Competing Standards

You must pay a $15 learning cost when you buy your first Operating System. Each time you switch systems, you must pay this $15 cost again.

Record of Values, Prices and Profits

	Round 1	Round 2	Round 3	Round 4
OS Seller's ID				
Buyer Value				
Learning Cost (LC)				
Price Paid				
Profit =BV-Price-LC				

Session 3–New, Improved Technology

If you adopt the new, improved operating system, your learning costs are $20. If you use the old OS, you have no learning costs.

Record of Values, Prices and Profits

	Round 1	Round 2	Round 3	Round 4
OS Seller's ID				
Buyer Value				
Learning Cost (LC)				
Price Paid				
Profit =BV-Price-LC				

Record of Sales–Session 1

Round________ Price________

Buyer's ID	Initial Value	Buyer's ID	Initial Value

Sales Record Sheet Seller's ID_____

Session _____ Round _____

Buyer's ID	Price	Buyer's ID	Price	Buyer's ID	Price

Experiment 10

Measuring Productivity

Objectives of This Experiment

In this experiment, we expect students to gain experience with the following:

- The concepts of fixed and variable factors in a production process.
- Definitions of average and marginal product of labor.
- The gains from specialization in a production process.
- The concept of eventually diminishing marginal product to a single variable factor.
- The notion of learning-by-doing.
- Experimental design in untangling confounding effects, such as learning-by-doing and diminishing marginal product.

General Discussion

In this experiment, students form workgroups of various sizes to perform a simple handicraft task, making paper airplanes. While the labor force is varied, the "capital goods," worktable, pen, and "company truck" are held constant. Raw materials (paper) is available in unlimited quantities. As the size of the workgroup is varied, students will measure the average and marginal products of labor. As students gain more experience with working in teams, they become better at it. Efforts can be made to measure and control for these learning-by-doing effects by repeating experiments with some group sizes after students have had more experience.

For the smaller group sizes, you can have several firms producing simultaneously during the timed sessions. You can then estimate output of firms as the average productivity of the firms of a given size.

Before the class meets, encourage students to practice making paper airplanes with the specifications given in the text and to measure their own outputs in a three-minute session.

Detailed Instructions and Comments

In a 50 minute period, you should be able to conduct trials with workgroups of 5, 10, 15, and 20 members, and if things are going quickly, with the entire class. In an 80 minute period, you can conduct trials with groups of all these sizes and at the end you can repeat the trials involving smaller groups in order to test for the effects of learning-by-doing.

Instructional Materials

Materials needed for this experiment include

- About 5 regular-sized sheets of paper for each student in class.
- A wastebasket or large cardboard box.
- A red pen and a manila folder for every 6 students in the class.
- A "worktable" for each 6 students in the class. These can be made by pushing two or three desks together or making similar arrangements.

Running the Sessions

Although you may have asked everybody to practice making paper airplanes at home, if your students are like ours, many of them will have either forgotten to do so, or will have found some seemingly more important way to spend their study time. Therefore, you may want to give everyone a chance to practice at the beginning of class. You can also encourage those who know how to make airplanes according to our specifications to show others how to do it.

For the first session, divide the class into workgroups of 5 students and appoint an "inspector" for each group. The inspector does not belong to the group and is asked to monitor the output of the group and to count the number of finished airplanes that fully satisfy specifications. Give the

workgroups about four minutes to organize and then give them three minutes to produce as many planes as possible. Record the number produced by each group, calculate the average output per group and record this number on the blackboard.

For the second, third, and fourth sessions, divide the class into as many workgroups of 10, 15, and 20 respectively as possible, appointing a supervisor for each group. Proceed as in the first session.

Optional Exercises

If you have enough time, and your class is not too large, you may want to start with a session in which firms have only one worker. In this case, give each student half-a-dozen sheets of paper and have each student make as many airplanes as possible in three minutes. Ask the students to report the number of airplanes that they successfully completed and calculate and record the average output per student on the blackboard.

If there is time, you can investigate "learning-by-doing" effects, by repeating the experiment with 5-person groups after you have completed the larger groups and comparing average productivity in this repeated session, with that in the initial session.

Posting for Students' Lab Notes

For each session, you will need to post the following information for students to enter in their Lab Notes: the number of workers per firm, the number of firms, and the total output produced by all firms.

Experiment 11

Comparative Advantage and Trade

Objectives of This Experiment

This experiment is intended to introduce students to the following ideas:

- The Linear Production Model
  - Productivity
  - Constant Returns to Scale
  - Absolute Advantage
  - Comparative Advantage
- The Effects of Trade
  - With constant returns to scale there are no gains to trade between people with identical tastes and technologies.
  - Trade between individuals with different technologies benefits both traders.
  - Trade occurs between individuals even if one has absolute advantage in everything.
  - With free trade, specialization occurs according to comparative advantage.
  - Competitive prices equalize total supply and demand for each good in the market.

Detailed Instructions and Comments

Time Required

In a 50-minute class, it should be possible to run one round of Session 1 and two rounds of Session 2. In an 80-minute class, there is also time for an extended discussion before and after each session.

Experimental Procedure

Select one-third of the class to be Richlanders and the remainder to be Poorlanders. (If class numbers are not divisible by 3, it is best to appoint the one or two "extra" students as assistants.) Preferably, the Richlanders should be sitting in a contiguous group. Give each Richlander two "Richlander's Report Sheets," one for Session 1 and one for Session 2 and give each Poorlander two "Poorlander's Report Sheets," one for each session. (Session 1 Report sheets are printed two-to-a-page and should be cut apart after duplication.)

Fish Tickets and Bread Tickets

Along with the Report Sheets, you will find a page of 20 Fish Tickets and a page of 20 Bread Tickets for Round 1 and also for Round 2. You should make one copy of each of these four pages for each two students in class. If convenient, use four different colors of paper for the four different types of ticket sheets. When you have copied these sheets, we suggest precutting the sheets so that individual tickets remain connected to the sheet, but can easily be torn off. Since many students will be ordering blocks of tickets of similar size, it is handy to be able to distribute batches of stuck-together tickets rather than individual tickets.

If you intend to record the results of the experiment and award prizes that depend on payoffs, it is a good idea to bring a stapler or two to class, so that students can staple the tickets that they hold at the end of trade to their report sheets.

Session 1–No Trade

In this session, there is no trading. Each student is asked to decide how to allocate time between producing fish and bread. The student should write this choice on a report sheet and return the report sheet to the market manager. When the sheets have been turned in, you can take a quick look

at them. Most students will have solved the problem correctly, but a few may not have caught on. If some students have not managed to equalize their output of fish and bread, you can point out to them what their payoff is and compare it to the payoff received by those who equalized output of the two goods. You can also ask someone else in the class to explain how she solved the problem.

After Session 1, it is useful to have a short classroom discussion in which students discuss whether there are any possibilities for mutually beneficial trade within their own countries. They should conclude that if everybody has the same endowments and preferences, and if there are not increasing returns to scale, then all individuals can do just as well by remaining self-sufficient as they would by specializing and then trading.

Session 2–Free Trade

Before trading starts in Session 2, we suggest that you try to initiate a debate about the likely effects of allowing free trade between Richlanders and Poorlanders. You might ask questions like: "Is poverty catching? Will free trade spread Poorland's poverty to Richland?" Or, taking the opposite view, "Will free trade allow Richlanders to exploit Poorlanders and make them even worse off?"

When the discussion is completed, check to see that all students understand the rules and the output possibilities. Every worker has 20 hours of labor to allocate between producing bread or fish. In **Richland**, it takes **1 hour** to produce a unit of **fish** and **1.5 hours** to produce a unit of **bread**. In **Poorland**, it takes **3 hours** to produce a unit of **fish** and **2 hours** to produce a unit of **bread**. Remind students that everyone will want to consume the two goods in equal amounts. An individual's payoff is equal to the *minimum* of the number of units of bread and of the number of units of fish that they have at the end of the round.[1] Also point out that, with the possibility of trade, you don't necessarily have to *produce* equal amounts of the two goods in order to be able to *consume* equal amounts.

Before trading starts, the market manager should appoint an assistant (a volunteer from the class if there is no teaching assistant) to distribute fish and bread tickets to the citizens of one country, while the market manager distributes tickets to those of the other. A student, after deciding on

[1] If students are being rewarded with money or grades for their performance, you may want to score Poorlanders' performances relative to other Poorlanders and Richlanders relative to other Richlanders. You could approximate this by doubling the winnings of each Poorlander for the purpose of scoring.

amounts of fish and bread to produce, should then obtain fish and bread tickets from the person distributing these tickets for his or her country. Students should be encouraged to talk with potential trading partners from the other country before making their production decisions. They may, if they wish, even make agreements to trade at specified terms, before they order their tickets.

After they have ordered their bread and fish tickets, students can trade fish and bread tickets with any student, from either country. Students should record their final holdings of bread and fish in the first round of this session on their Record Sheets for Session 2. The market manager should now survey the class to find out how many people in each country specialized in bread and in fish. The market manager should also ask several people who traded to report the rate at which they exchanged bread and fish.

If there is time, the market manager can now open a second round of Session 2. (If there is to be a second round, then students should discard their Round 1 bread and fish tickets, which will be of no use in the next round.) The procedure is exactly as in Round 1, with students first choosing their outputs, then making trades and recording their holdings at the end of trading in Round 2. When trading is completed, students should turn in their Session 2 Record Sheets. If scores on the final round are being recorded for money payoffs, ask students to attach their Round 2 final ticket holdings to their Record Sheets.

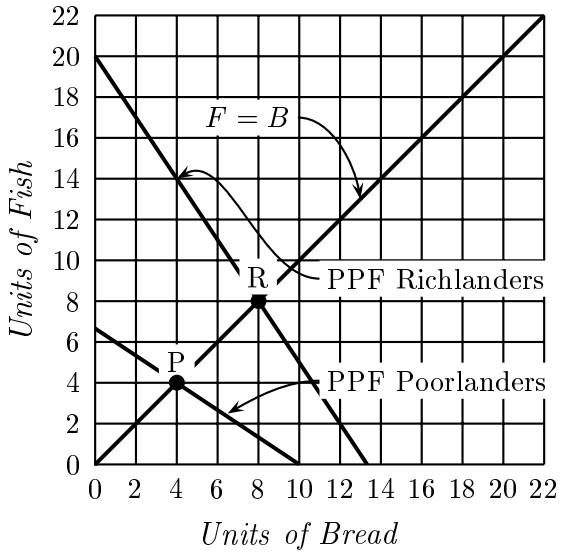
Predictions of the Competitive Model

Session 1–No trade

When no trade is allowed, the payoff to each inhabitant of Ricardo Island is proportional to the minimum of the number of units of fish and the number of units of bread that he or she produces. Therefore each person should try to produce equal amounts of fish and bread. Richlanders can find their best output choices by solving the simultaneous equations $F = B$ and $F+1.5B = 20$. (The solution is $F = B = 8$.) Poorlanders find their best output choices by solving the simultaneous equations $F = B$ and $3F + 2B = 20$. (The solution is $F = B = 4$.)

Figure 11.1 shows the production possibility sets for Richlanders and Poorlanders. The payoff-maximizing output for each type appears at the point where its production possibility set intersects the 45 degree line representing $F = B$.

Figure 11.1: Consumption and Production



Session 2–Free International Trade

In Session 2, with free international trade, we can expect that at least one of the two countries will specialize according to comparative advantage. In fact, the experiment is set up so that in competitive equilibrium, people in both countries specialize according to comparative advantage. When they participate in this experiment, most students do not have the analytical tools to allow them to calculate the competitive equilbrium prices, from the available information. Of course the power of competitive markets is that the participants don't need to understand the workings of the entire economy, but need only to have a grasp of their own production possibilities and payoff functions. Our experience has been that the participants quite quickly reach an output that is close to the predictions of competitive theory.

For this economy, any prices such that the ratio of the price of fish to the price of bread is between 2/3 and 3/2 will lead individuals in both countries to specialize, producing only the good in which they have comparative advantage. We have set things up so that when they do so, the worldwide total output of fish equals the worldwide total output of bread, so that supply equals demand.

The simplest of these competitive equilibria happens where the price of a unit of fish and the price of a unit of bread are equal. A Richlander would maximize her income by producing 20 fish and no bread, and trading 10

of these fish for 10 units of bread, giving her a consumption of 10 units of each good. When the prices of fish and bread are equal, a Poorlander would maximize his income by producing 10 units of bread and no fish, and trading 5 units of bread for 5 units of fish, giving him a consumption of 5 units of each good. These trades can be accomplished if each Richlander makes trades with two Poorlanders. Since there are twice as many Poorlanders as Richlanders, this combination of trades is possible, and so supply equals demand when the prices of bread and fish are equal.[2]

[2]Other competitive equilibrium prices occur where the price of fish is \$1, and the price of bread is p_b, where $2/3 < p_b < 3/2$. At these prices, as with equal prices, Richlanders will specialize in fish and Poorlanders will specialize in bread. Within this range, however, the larger is p_b, the greater will be the consumption of Poorlanders and the less the consumption of Richlanders. Specifically, in competitive equilbrium, Poorlanders would consume $\frac{10p_b}{1+p_b}$ units of each good and Richlanders would consume $\frac{20}{1+p_b}$ units of each good.

Quick Start for Experiment 11: Comparative Advantage

Capsule Instructions: Comparative Advantage

- Designate 1/3 of the class, seated in the same area of the classroom, as Richlanders and the remaining 2/3 as Poorlanders. Give a Session 1 Report Sheet and a Session 2 Report Sheet of the appropriate type to each student.
- Work through the Warm-up exercise and discuss the payoffs and the production possibilities.
- Begin Session 1 (economies without trade).
  - No trade is allowed within or between countries. Ask students to decide how to allocate their time between bread and fish, and to complete and turn in the Session 1 Report Form.
  - After the sheets are turned in, ask someone who got the answer right to explain the answer to the rest of the class.
- Before beginning Session 2, ask students to speculate on who will benefit and who will be harmed by the opening of free trade between countries.
- Begin Session 2 (free trade, within and between countries).
  - Stage 1. Students decide and record the quantities of fish and bread they will produce. They obtain the corresponding bread and/or fish tickets. Distribute one color of fish ticket and one color of bread ticket for the first round.
  - Stage 2. Students exchange tickets with one another. Only whole tickets can be exchanged—no fractions—but, two-for-one, etc., exchanges are allowed.
  - At the end of the round, ask traders to record their final holdings, calculate their profits, and turn in their tickets to the market manager.
  - If there is time for a second round, proceed to Round 2. Use the second color of fish ticket and the second color of bread ticket for Round 2.

Posting for Students' Lab Notes

For this Session, you should post the information requested in Tables Q.11.1 and Q.11.2 for Students' Lab Notes.

Table Q.11.1: Outcomes in Richland: Last Round of Session 2

Number of Students	Fish Output	Bread Output	Final Fish Holdings	Final Bread Holdings
	20	0	10	10
	8	8	8	8

Table Q.11.2: Outcomes in Poorland: Last Round of Session 2

Number of Students	Fish Output	Bread Output	Final Fish Holdings	Final Bread Holdings
	0	10	5	5
	4	4	4	4

In the last round of Session 2, you are likely to find that most Richlanders chose to produce 20 fish and no bread, and were able to trade 10 of their fish for 10 loaves of bread. Enter the number of such traders in the first line of Table Q.11.1. Some Richlanders probably chose to produce 8 fish and 8 loaves and made no trades. Enter the number of such traders in the second

line. There may be a few Richlanders who made other production decisions and/or had different trading outcomes. Record their production and final holdings in the remaining rows.

In the last round of Session 2, you are likely to find that most Poorlanders chose to produce no fish and 10 units of bread, and were then able to trade 5 loaves of bread for 5 fish. Enter the number of such traders in the first line of Table Q.11.2. Some Poorlanders probably chose to produce 4 fish and 4 loaves, and made no trades. Enter the number of such traders in the second line. For any Poorlanders who made other production decisions and/or had different trading outcomes, record their production and final holdings in the remaining rows.

Materials to Be Photocopied

Personal Information Sheets

Make enough copies of each of the two Poorlander Report Sheets, labeled for Sessions 1 and 2, for 2/3 of the class. Make enough copies of each of the two Richlander Report Sheets for 1/3 of the class. The Session 1 tickets are printed two-to-a-page, so you should cut them apart before coming to class.

Fish and Bread Tickets

Make one copy of the page of fish tickets and one copy of the page of bread tickets for each student that might come to class.

ID Number _____

Poorlander's Report, Session 1

In Session 1, where I can not trade with others, I choose to produce _____ units of fish and _____ units of bread. My payoff is the minimum of these two quantities, which is _____.

ID Number _____

Poorlander's Report, Session 1

In Session 1, where I can not trade with others, I choose to produce _____ units of fish and _____ units of bread. My payoff is the minimum of these two quantities, which is _____.

ID Number _____

Richlander's Report Session 1

In Session 1, where I can not trade with others, I choose to produce _____ units of fish and _____ units of bread. My payoff is the minimum of these two quantities, which is _____.

ID Number _____

Richlander's Report Session 1

In Session 1, where I can not trade with others, I choose to produce _____ units of fish and _____ units of bread. My payoff is the minimum of these two quantities, which is _____.

ID Number _____

Poorlander's Report, Session 2

First Round

In this round, I produced _____ units of fish and _____ _____ units of bread. After I finished trading, I was left with _____ units of fish and _____ units of bread. My payoff in this session is _____.

Last Round

In this round, I produced _____ units of fish and _____ _____ units of bread. After I finished trading, I was left with _____ units of fish and _____ units of bread. My payoff in this session is _____.

ID Number _____

Richlander's Report, Session 2

First Round

In this round, I produced _____ units of fish and _____ _____ units of bread. After I finished trading, I was left with _____ units of fish and _____ units of bread. My payoff in this session is _____.

Last Round

In this round, I produced _____ units of fish and _____ _____ units of bread. After I finished trading, I was left with _____ units of fish and _____ units of bread. My payoff in this session is _____.

1 Unit of Fish (Round 1)	1 Unit of Fish (Round 1)
1 Unit of Fish (Round 1)	1 Unit of Fish (Round 1)
1 Unit of Fish (Round 1)	1 Unit of Fish (Round 1)
1 Unit of Fish (Round 1)	1 Unit of Fish (Round 1)
1 Unit of Fish (Round 1)	1 Unit of Fish (Round 1)
1 Unit of Fish (Round 1)	1 Unit of Fish (Round 1)
1 Unit of Fish (Round 1)	1 Unit of Fish (Round 1)
1 Unit of Fish (Round 1)	1 Unit of Fish (Round 1)
1 Unit of Fish (Round 1)	1 Unit of Fish (Round 1)
1 Unit of Fish (Round 1)	1 Unit of Fish (Round 1)

1 Unit of Bread (Round 1)	1 Unit of Bread (Round 1)
1 Unit of Bread (Round 1)	1 Unit of Bread (Round 1)
1 Unit of Bread (Round 1)	1 Unit of Bread (Round 1)
1 Unit of Bread (Round 1)	1 Unit of Bread (Round 1)
1 Unit of Bread (Round 1)	1 Unit of Bread (Round 1)
1 Unit of Bread (Round 1)	1 Unit of Bread (Round 1)
1 Unit of Bread (Round 1)	1 Unit of Bread (Round 1)
1 Unit of Bread (Round 1)	1 Unit of Bread (Round 1)
1 Unit of Bread (Round 1)	1 Unit of Bread (Round 1)
1 Unit of Bread (Round 1)	1 Unit of Bread (Round 1)

1 Unit of Fish (Round 2)	1 Unit of Fish (Round 2)
1 Unit of Fish (Round 2)	1 Unit of Fish (Round 2)
1 Unit of Fish (Round 2)	1 Unit of Fish (Round 2)
1 Unit of Fish (Round 2)	1 Unit of Fish (Round 2)
1 Unit of Fish (Round 2)	1 Unit of Fish (Round 2)
1 Unit of Fish (Round 2)	1 Unit of Fish (Round 2)
1 Unit of Fish (Round 2)	1 Unit of Fish (Round 2)
1 Unit of Fish (Round 2)	1 Unit of Fish (Round 2)
1 Unit of Fish (Round 2)	1 Unit of Fish (Round 2)
1 Unit of Fish (Round 2)	1 Unit of Fish (Round 2)

1 Unit of Bread (Round 2)	1 Unit of Bread (Round 2)
1 Unit of Bread (Round 2)	1 Unit of Bread (Round 2)
1 Unit of Bread (Round 2)	1 Unit of Bread (Round 2)
1 Unit of Bread (Round 2)	1 Unit of Bread (Round 2)
1 Unit of Bread (Round 2)	1 Unit of Bread (Round 2)
1 Unit of Bread (Round 2)	1 Unit of Bread (Round 2)
1 Unit of Bread (Round 2)	1 Unit of Bread (Round 2)
1 Unit of Bread (Round 2)	1 Unit of Bread (Round 2)
1 Unit of Bread (Round 2)	1 Unit of Bread (Round 2)
1 Unit of Bread (Round 2)	1 Unit of Bread (Round 2)

Experiment 12

Adverse Selection

Objectives of This Experiment

This experiment introduces the following ideas:

- Market oucomes depend both on the amount of information available and who has this information.
- In market environments, people are likely to reveal only the information that it is in their interest to reveal.
- The population of items that appear in transactions is not always of the same quality as the overall population. This is the problem of **adverse selection**.

General Discussion

This experiment deals with asymmetric information in a used car market. The ideas explored are variations on a theme introduced by George Akerlof in his classic paper on "The Market for Lemons" [1]. Some used cars are good, and some are "lemons." Used car *sellers* know whether their cars are good or whether they are lemons, and they have higher reservation prices for good used cars than for lemons. Used car *buyers*, on the other hand, do not know whether a car is good or a lemon. They will get a payoff equal to the average value of the used cars that reach the market. What makes this market particularly interesting is that, because good used cars will reach the market only if the market price is higher than the current owners' reservation prices, the *quality* of used cars that reach the market will depend on the *price*

of used cars. And, of course, the price that demanders are willing to pay for used cars will depend on the average quality of used cars reaching the market.

For some distributions of reservation values and car qualities, the only equilibrium for this market is one in which the only cars that reach the market are lemons, despite the fact that the current owners' reservation prices for good used cars are lower than those of potential buyers. For other distributions there are two equilibria, one in which all cars reach the market and another in which only the lemons reach the market.

The third session is like the second session, except that the proportion of lemons in the population is large enough that the only equilibrium is the separating equilibrium in which only the lemons reach the market.

The final session can either be run or discussed as a thought experiment. In this session, each original car owner is able to display a certificate that credibly states whether her car is a good used car or a lemon, and car dealers are able to offer different prices for good used cars and for lemons.

Detailed Instructions and Comments

The first three sessions can be completed within 50 minutes. You can do all four sessions and have some time left over for discussion in 70 minutes.

Session 1

Before Session 1 begins, give every student a copy of the sheet marked "Session 1, Price Decisions." (These sheets are printed three-to-a-page and should be cut apart before distribution.)

Session 1 is designed to demonstrate to students the fact that the average quality of cars reaching the market depends on the price paid. This session is conducted as a thought experiment, in which each participant imagines himself to be a used-car dealer who is a local monopolist, and who sets a price and is able to purchase as many used cars as people will sell him at that price.

At prices below \$1600, the only people who will sell to the monopolist are lemon-owners. At any price above \$1600, all used-car owners will sell to the monopolist. Students are asked to specify what they will do in two situations. In Situation (i) there are 6 good used cars and 6 lemons in town. In Situation (ii) there are 4 good used cars and 8 lemons in town. Students should turn in their answers on the sheet marked Session 1, " Price Decisions."

After the decisions are turned in, the class should discuss the profit-maximizing procedure. In Situation (i), the dealer must pay \$1601 to get all used-car owners to sell their cars. At this price, the dealer would pay out $\$1,601 \times 12 = \$19{,}212$. The dealer would get 6 good cars which it could resell for \$3,500 and 6 lemons which it could resell for \$500. Thus its total revenue would be \$24,000, and its resulting profits would be \$4,788. At any positive price below \$1600, the dealer would get 6 lemons and no good cars. Thus if it is going to pay less than \$1600, it will do best to pay only \$1 for used cars. If it pays \$1 for used cars, it will be able to buy 6 lemons and no good cars. When it resells them it will have a total revenue of $\$500 \times 6 = \$3000$ and total profits of \$2994. The profit-maximizing thing to do in Situation (i) is to offer \$1601 for used cars.

In Situation (ii), if the dealer offers \$1601 for used cars, it will get 4 good used cars and 8 lemons. Its total costs will be \$19,212, and its total revenue will be $(\$3500 \times 4) + (\$500 \times 8) = \$18,000$. Thus it will suffer a *loss* of \$1212. If it offers a price of \$1, it will be able to purchase 8 lemons and no good used cars. Its costs will be \$8, and its revenue will be $\$500 \times 8 = 4,000$, so that it makes a profit of \$3,992. Thus the profit-maximizing price in Situation (ii) is \$1.

Session 2

In Session 2, the used-car market is competitive, and car buyers interact with sellers. Choose about 6 of the students to be used-car dealers; everyone else is a used-car owner.

Demanders are not permitted to show their Personal Information Sheets to dealers. At the time of the purchase, dealers do not know which cars are good and which are lemons. Explain to the dealers that each dealer's revenue will be equal to the number of cars that he purchased, times the average value of used cars purchased *by all dealers*.[1] For example, if 10 good used cars and 10 lemons were sold to all dealers, the average value of these cars would be

$$(\$3500 \times \frac{10}{20}) + (\$500 \times \frac{10}{20}) = \$2000.$$

A dealer who happened to buy 5 good cars and 1 lemon would therefore have a revenue equal to 6 times \$2000.

[1] If we made a dealer's revenue equal to the value of the cars that he actually purchased, then dealers would have strong incentives to learn which are the good cars and which are the lemons. Some students with good cars might secretly show their Personal Information sheets to prove the quality of their cars and some might make better deals with trusted friends.

Dealers should post their prices on their allocated blackboard spaces and start making purchases. For each sale, dealers should record the price and the seller's identification number on their Records of Purchases. The seller should not tell the buyer whether his car is good or a lemon. However, immediately after the sale, the seller should put a mark on the instructor's Quality Registration Sheet, indicating whether he sold a good used car or a lemon.[2] The instructor will use this sheet to calculate the average value of all used cars that were sold.

At the end of trading, dealers bring their Records of Purchases to the market manager. The instructor will then use the Quality Registration sheet to determine the number of good cars and the number of lemons that were sold and to calculate the average value of all cars purchased by dealers.

The instructor should now calculate and announce the profits of each dealer. The revenue of a dealer is equal to the number of cars that he purchased times the average value of used cars purchased by all dealers. A dealer's costs are equal to the amount of money he actually spent on purchases. If a total of 10 good used cars and 10 lemons were purchased, then a dealer who bought 3 used cars, each for a price of \$1700, would have total revenue of $\$2000 \times 3 = \$6000$, total costs of $\$1700 \times 3 = \$5100$, and profits of $\$6000 - \$5100 = 900$.

Our experience has been that in the first round of this session, at least one of the sellers will offer a price higher than \$1600 and that all of the cars will be sold. Not all of the dealers (nor all of the sellers of lemons) understand that if prices above \$1600 are offered, the average used car will be worth \$2000. Therefore the price at which most cars are sold falls considerably short of the \$2000 equilibrium price. To save time, we have usually chosen not to run a second round, but if the outcome of the first round is very different from equilibrium, you may want to run a second round, after a discussion of the first round's results.

When the last round of this session is completed, the market manager should report the prices paid by each dealer for each sale, so that students can record this information in their Lab Reports.

[2] In Session 2, you can expect that almost everyone will buy a car. Therefore in a large class, you may want to save time by skipping this registration for Session 2. You can ask after the round is over for a show of hands of those who did *not* sell their cars. You can then use this information to calculate the proportions of good cars and lemons sold.

Session 3

Session 3 is run in the same way as Session 2, except that in this session, 2/3 of the used cars are lemons and 1/3 are good cars. Choose 6 new used-car dealers for this session, and give each dealer a Record of Purchase and a space on the blackboard for posting prices.

Proceed with trading as in the previous session. At the end of trading, calculate and announce the number of good cars and lemons that were sold to dealers, the average value of used cars purchased, and the profits or losses of each dealer.

In Session 3, the only equilibrium is one in which only the lemons are sold and in which the price of used cars is about \$500. If all of the used cars were brought to market, the average value of these used cars to dealers would be \$1500, which is not enough to make the owners of good used cars want to sell. Our experience has been that in this session, some students make the mistake of offering a price exceeding \$1600. They will lose quite a lot of money. After the results of this session have been announced, offer the students an opportunity to play another round. This time, they are likely to be more cautious and prices are likely to be in the neighborhood of \$500.

When the last round of Session 3 is completed, you should report the prices paid by each dealer for each sale, so that students can record this information in their Lab Reports.

Session 4

Session 4 is similar to Session 2, except that each used-car owner is now allowed to show her Personal Information Sheet as proof that she has a good car or a lemon.

Choose 6 new dealers and give each a Record of Purchase and a space on the blackboard for posting prices.

After announcing the proportions of good cars and lemons, open the market for trade. Dealers are allowed to offer and post different prices to those whose Personal Information Sheets say that they have good used cars and those who have lemons. If the seller proves that her car is a good used car, the dealer should mark an asterisk next to the price.

When trading ceases, collect dealers' Records of Purchases, and calculate and announce each dealer's profit. A dealer's profit in this session is the value of the cars *he actually purchases* minus his expenditure on buying them.

Quick Start for Experiment 12: Adverse Selection

Capsule Instructions: Adverse Selection

- Distribute one Price Decision Sheet and one Personal Information Sheet to each student. P.I. sheets come in six-packs of sheets of Types A–F. Distribute as many complete six-packs as possible. Distribute as many of the remaining sheets as you need from the last six-pack, starting with Type A.
- Explain that used-car owners always know whether they have a good car or a lemon. To the original owner, a good car is worth \$1600 and a lemon is worth \$0. Used-car *dealers* can not tell cars' quality before they buy them. To dealers, good used cars are worth \$3500 and lemons are worth \$500.
- Begin Session 1 (a thought experiment).
  - Each student turns in a Price Decision Sheet which records the prices the student would pay for used cars as the only used-car *dealer* in a market in Situation (i) where there are 6 good used cars and 6 lemons and Situation (ii), where there are 4 good used cars and 8 lemons in the market.
  - The profit-maximizing answer in Situation (i) is \$1601 and in Situation (ii) is \$1. Ask a student who got the right answer to explain why.
- Begin Session 2 (equal numbers of good cars and lemons).
  - Appoint 6 students, one of each type A–F, to be dealers. All others are used-car owners. Give each dealer a Record of Purchase and a space on the blackboard for posting prices.
  - Announce that half the used cars are good and half are lemons, and open the market for trade. Dealers may post (and alter) their prices at will, and buyers may shop for the best price. Dealers record their sales on a Record of Purchase.
  - Inform students they after they sell a car, they must indicate on the instructor's Quality Registration Sheet whether the car was a good used car or a lemon. (In a large class, for Session 2, you can save some time by skipping this step and determining the types of cars sold by a show of hands after the round is over.)
  - At the end of trading, collect dealers' Records of Purchases.
  - Use the Quality Registration Sheet to determine the number of good cars and the number of lemons that were sold, and calculate the average value of all used cars that were sold.
  - Calculate and announce each dealer's profit. (A dealer's revenue is the number of used cars he purchased times the *average value of all used cars sold*. His costs are his actual expenditure on used cars.)

Capsule Instructions: continued

- Begin Session 3 (1/3 good cars and 2/3 lemons).
  - Appoint a new set of 6 dealers, one of each type A–F. Give each a Record of Purchase and a space on the blackboard for posting prices.
  - Remind students that this is Session 3, and announce that in this session approximately 2/3 of the cars are lemons and 1/3 are good cars.
  - Remind students that if they sell a car, they must indicate on the instructor's Quality Registration Sheet whether the car they sold was a lemon or a good car.
  - At the end of trading, collect the dealers' Records of Purchases.
  - Use the Quality Registration Sheet to calculate the average value of all used cars sold. Then calculate each dealer's profit by the same method used in Session 2 and announce the results.
- Begin Session 4 (quality certification, 1/3 good cars and 2/3 lemons).
  - Appoint a new set of 6 dealers, one of each type A–F. Give each a Record of Purchase and a space on the blackboard for posting prices.
  - Announce that in this session approximately 2/3 of the cars are lemons and 1/3 are good cars.
  - Tell students that in this session, car-owners are allowed to show their P.I. sheets to dealers. Dealers are allowed to offer different prices depending on whether the owner's P.I. sheet says "Good Used Car" or "Lemon."
  - A dealer's profit in this session is the value of the cars that *he actually purchased* minus his expenditure on buying these cars.
  - Dealers should put an asterisk by the price if the seller displays a "good car" sheet to the buyer, and no mark if the seller does not.
  - At the end of trading, collect dealers' Records of Purchases, and calculate and announce each dealer's profit. (Remember that in this session, each dealer's revenue is the value of the cars that he actually purchased.)

Posting for Students' Lab Reports

Record the following information after you distribute the P.I. sheets:

Number of complete six-packs distributed (=N) _____

Type of Last P.I. sheet distributed _____

From Tables Q.12.1 and Q.12.2, you can determine the distribution of car types in each session. You should post this information in the form of Table Q.12.3 at the start of each session.

Table Q.12.1: Distribution of Car Types in Session 2

	Type of Last Sheet Distributed					
	A	B	C	D	E	F
Good Cars	3N−2	3N−2	3N−1	3N−1	3N	3N−3
Lemons	3N−3	3N−2	3N−2	3N−1	3N−1	3N−3

Table Q.12.2: Distribution of Car Types in Sessions 3 and 4

	Type of Last Sheet Distributed					
	A	B	C	D	E	F
Good Cars	2N−2	2N−1	2N−1	2N−1	2N	2N-2
Lemons	4N−3	4N−3	4N−2	4N−1	4N−1	4N-4

Table Q.12.3: Distribution of Car Types

	Session 2	Session 3	Session 4
Number of Good Car Owners			
Number of Lemon Owners			

At the end of each round of trading, you should ask for a show of hands to determine the number of good cars and the number of lemons that were sold. Record this information for the last round of each session in Table Q.12.4 and post it for students to use in their Lab Notes.

Table Q.12.4: Types of Cars Sold

	Session 2	Session 3	Session 4
Number of Good Cars Sold			
Number of Lemons Sold			

Tables Q.12.5–Q.12.7 present information on purchases by dealers in the last round of each session. Students will need this information for their lab reports. You can obtain this information from the firms' Records of Cars Purchased.

Table Q.12.5: Purchases by Dealers: Session 2

Dealer's ID	Number of Cars Bought by Dealer	Dealer's Total Cost

Table Q.12.6: Purchases by Dealers: Session 3

Dealer's ID	Number of Cars Bought by Dealer	Dealer's Total Cost

Table Q.12.7: Purchases by Dealers: Session 4

	Expenditures		Number of	
Dealer's ID	Good Cars	Lemons	Good Cars	Lemons

Materials to Be Photocopied

Price Decision Sheets

Make enough copies of the Price Decision Sheet so that there is one for each person who might come to class. These sheets are printed three-to-a-page, so you will need to cut them apart.

Personal Information Sheets

Make enough copies of Personal Information Sheets of Types A–F so that there is one sheet for each person who might come to class.

Record Sheets

Make 5 copies of the Quality Registration Sheet.

Make about 30 copies of the Record of Cars Purchased sheets.

Session 1–Price Decisions

ID Number _____

Price in Situation i _____

Price in Situation ii _____

Session 1–Price Decisions

ID Number _____

Price in Situation i _____

Price in Situation ii _____

Session 1–Price Decisions

ID Number _____

Price in Situation i _____

Price in Situation ii _____

TYPE A **Student ID Number** _____

The Lemons Market
Personal Information Sheet

Please hand this sheet in at the end of the session.

Session 2

In this session, your used car is a `Good Used Car`. You are NOT allowed to show this information sheet to anyone else. If you sell your car, your profits for the round are equal to the price you received *minus* \$1600. If you did not sell your car, your profits for the round are zero.

Record of Sales Price and Profit

	Round 1	Round 2
Price Received (P)		
Profit ($=P-\$1600$)		

Session 3

In this session, your used car is a `Lemon`. You are NOT allowed to show this information sheet to anyone else. If you sell your car, your profits for the round are equal to the price you received. If you did not sell your car, your profits are zero.

Record of Sales Price and Profit

	Round 1	Round 2
Price Received (P)		
Profit ($=P$)		

Session 4

In this session, your used car is a `Lemon`. In this session, you may show this information sheet to a buyer to prove the type of your car. If you sell your used car, your profits for the round are equal to the price you receive. If you did not sell your car, your profits for the round are zero.

Record of Sales Price and Profit

	Round 1	Round 2
Price Received (P)		
Profit ($=P$)		

TYPE B **Student ID Number** _____

The Lemons Market
Personal Information Sheet

Please hand this sheet in at the end of the session.

Session 2

In this session, your used car is a `Lemon`. You are NOT allowed to show this information sheet to anyone else. If you sell your car, your profits for the round are equal to the price you received. If you did not sell your car, your profits are zero.

Record of Sales Price and Profit

	Round 1	Round 2
Price Received (P)		
Profit ($=P$)		

Session 3

In this session, your used car is a `Good Used Car`. You are NOT allowed to show this information sheet to anyone else. If you sell your car, your profits for the round are equal to the price you received *minus* \$1600. If you did not sell your car, your profits for the round are zero.

Record of Sales Price and Profit

	Round 1	Round 2
Price Received (P)		
Profit ($=P-\$1600$)		

Session 4

In this session, your used car is a `Good Used Car`. In this session, you may show this information sheet to a buyer to prove the type of your car. If you sell your used car, your profits for the round are equal to the price you received for the car *minus* \$1600. If you did not sell your car, your profits for the round are zero.

Record of Sales Price and Profit

	Round 1	Round 2
Price Received (P)		
Profit ($=P-\$1600$)		

TYPE C **Student ID Number** _____

The Lemons Market
Personal Information Sheet

Please hand this sheet in at the end of the session.

Session 2

In this session, your used car is a `Good Used Car`. You are NOT allowed to show this information sheet to anyone else. If you sell your car, your profits for the round are equal to the price you received *minus* \$1600. If you did not sell your car, your profits for the round are zero.

Record of Sales Price and Profit

	Round 1	Round 2
Price Received (P)		
Profit ($=P-\$1600$)		

Session 3

In this session, your used car is a `Lemon`. You are NOT allowed to show this information sheet to anyone else. If you sell your car, your profits for the round are equal to the price you received. If you did not sell your car, your profits are zero.

Record of Sales Price and Profit

	Round 1	Round 2
Price Received (P)		
Profit ($=P$)		

Session 4

In this session, your used car is a `Lemon`. In this session, you may show this information sheet to a buyer to prove the type of your car. If you sell your used car, your profits for the round are equal to the price you receive. If you did not sell your car, your profits for the round are zero.

Record of Sales Price and Profit

	Round 1	Round 2
Price Received (P)		
Profit ($=P$)		

TYPE D **Student ID Number** _____

The Lemons Market
Personal Information Sheet

Please hand this sheet in at the end of the session.

Session 2

In this session, your used car is a `Lemon`. You are NOT allowed to show this information sheet to anyone else. If you sell your car, your profits for the round are equal to the price you received. If you did not sell your car, your profits are zero.

Record of Sales Price and Profit

	Round 1	Round 2
Price Received (P)		
Profit ($=P$)		

Session 3

In this session, your used car is a `Lemon`. You are NOT allowed to show this information sheet to anyone else. If you sell your car, your profits for the round are equal to the price you received. If you did not sell your car, your profits are zero.

Record of Sales Price and Profit

	Round 1	Round 2
Price Received (P)		
Profit ($=P$)		

Session 4

In this session, your used car is a `Lemon`. In this session, you may show this information sheet to a buyer to prove the type of your car. If you sell your used car, your profits for the round are equal to the price you receive. If you did not sell your car, your profits for the round are zero.

Record of Sales Price and Profit

	Round 1	Round 2
Price Received (P)		
Profit ($=P$)		

TYPE E **Student ID Number** _____

The Lemons Market
Personal Information Sheet

Please hand this sheet in at the end of the session.

Session 2

In this session, your used car is a `Good Used Car`. You are NOT allowed to show this information sheet to anyone else. If you sell your car, your profits for the round are equal to the price you received *minus* \$1600. If you did not sell your car, your profits for the round are zero.

Record of Sales Price and Profit

	Round 1	Round 2
Price Received (P)		
Profit ($=P-\$1600$)		

Session 3

In this session, your used car is a `Good Used Car`. You are NOT allowed to show this information sheet to anyone else. If you sell your car, your profits for the round are equal to the price you received *minus* \$1600. If you did not sell your car, your profits for the round are zero.

Record of Sales Price and Profit

	Round 1	Round 2
Price Received (P)		
Profit ($=P-\$1600$)		

Session 4

In this session, your used car is a `Good Used Car`. In this session, you may show this information sheet to a buyer to prove the type of your car. If you sell your used car, your profits for the round are equal to the price you received for the car *minus* \$1600. If you did not sell your car, your profits for the round are zero.

Record of Sales Price and Profit

	Round 1	Round 2
Price Received (P)		
Profit ($=P-\$1600$)		

TYPE F **Student ID Number** _____

The Lemons Market
Personal Information Sheet

Please hand this sheet in at the end of the session.

Session 2

In this session, your used car is a `Lemon`. You are NOT allowed to show this information sheet to anyone else. If you sell your car, your profits for the round are equal to the price you received. If you did not sell your car, your profits are zero.

Record of Sales Price and Profit

	Round 1	Round 2
Price Received (P)		
Profit ($=P$)		

Session 3

In this session, your used car is a `Lemon`. You are NOT allowed to show this information sheet to anyone else. If you sell your car, your profits for the round are equal to the price you received. If you did not sell your car, your profits are zero.

Record of Sales Price and Profit

	Round 1	Round 2
Price Received (P)		
Profit ($=P$)		

Session 4

In this session, your used car is a `Lemon`. In this session, you may show this information sheet to a buyer to prove the type of your car. If you sell your used car, your profits for the round are equal to the price you receive. If you did not sell your car, your profits for the round are zero.

Record of Sales Price and Profit

	Round 1	Round 2
Price Received (P)		
Profit ($=P$)		

Record of Cars Purchased

In Session 4, put an asterisk next to the price if the seller proved that this car was good.

Session _____ Round _____

Car Dealer's ID _____

Seller's ID	Price	Seller's ID	Price

Quality Registration Sheet

Session _____ Round _____

Lemons Sold		Good Cars Sold	
Seller's ID	Seller's ID	Seller's ID	Seller's ID

Experiment 13

Auctions

Objectives of This Experiment

In this section students will accomplish the following:

- Learn about the procedures of some commonly-used (and some exotic) types of auctions.
- Participate in an English auction, a Dutch auction, a sealed-bid, first-price auction, and a sealed-bid, second-price auction.
- Learn to analyze several types of auctions and determine equilibrium strategies for them.
- Learn about private-values and common-values information environments.
- Understand the equivalence of an English auction and a sealed-bid, second-price auction in a private-values environment.
- Understand the equivalence of a Dutch auction and a sealed-bid, first-price auction in a private-values environment.
- Participate in two auctions with a common-values information environment ("pennies in a jar", and "bidding with information from an unreliable accountant").
- Participate in an escalation auction and try to understand what happens.

Detailed Instructions and Comments

This lesson contains two batches of experiments. The first batch consists of four Sessions, in which objects are sold, respectively, by English auction, Dutch auction, first-price, sealed-bid auction, and second-price, sealed-bid auction. These experiments can be carried out in a 50-minute class period. The second batch is optional. These experiments can be run while lecturing on the subject of auctions or used on some other day, just to liven up a tired lecture.

Auctions for the Experimental Session

For the four auction experiments, you will not need to distribute Personal Information Sheets. For each of the two sealed-bid auctions, each student will need to submit a bid on a small piece of paper. We distribute some 3×5 inch Post-its for this purpose. These are readily accessible, just the right size, and conveniently stick together. If you prefer, you can ask students to submit their bids on bits of scrap paper.

All four auctions in the first batch are "private values" auctions. That is, each student has a different Buyer Value for the object being sold. It is convenient to determine these Buyer Values from the last four digits of students' social security numbers. Social security numbers are approximately uniformly distributed, and most likely your class list includes the students' social security numbers, if you want to verify students' claims.[1]

If the last four digits of a student's social security number are 8734, then the student's valuations in the four types of auctions will be as given in Table 13.1:

Table 13.1: Buyer Values if Soc Sec number ends in 8734

Session	Buyer Value	General Rule
English Auction	34	Last two digits
Dutch Auction	66	100 minus last two digits
First-price, Sealed-bid	87	First two digits of last four
Second-price, Sealed-bid	13	100 minus first two digits of last four

Divide the class into three or four separate groups, where people in each

[1] If you have someone who doesn't have a social security number, or who doesn't know his social security number, you can assign him a random number by, for example, reading off the last four digits in the serial number of a dollar bill.

group are seated fairly close together. Separate auctions will be conducted with each group, in sequence. (This gives more students a chance to be active bidders, and it also gives students a chance to watch other groups in action.)

For the English auction, after you have explained the rules, ask a member of the first auction group to open bidding. Then ask if somebody has a higher bid. To be high bidder, a student must increase the previous bid by at least \$1. To speed the process, if the early bidding starts low, encourage students to raise the previous bid by at least \$5 at a time. When bidding seems stalled, say "Going once!, Going twice !" hesitate, and then say "Sold!" The object goes to the highest bidder at the highest bidder's bid. After the object is sold in each group, survey the group to determine the highest and second-highest Buyer Value in the group and record this information on the blackboard. Ask students to copy this information, as well as the highest bidder's bid, into their Lab Reports.

For the Dutch auction, explain that you will count slowly downwards from 100. The first student to say "Mine!" will get the object at the number called just before "Mine!" was said. Then start counting downwards for the first group. Record the price and the Buyer Value of the person who called "Mine!" Question group members to determine the second-highest Buyer Value for this group. Record the highest bid, the highest bidder's Buyer Value, and the second-highest Buyer Value on the blackboard and remind students to copy this information to their Lab Reports. Follow the same procedure with each of the remaining groups.

For the sealed-bid, first-price auction, students should record their ID numbers, their Buyer Values, and their bids on slips of paper. Collect these slips separately for each group. For each group, find the highest bid, the second-highest bid, the highest bidder's Buyer Value, and the second-highest bidder's Buyer Value. Record this information on the blackboard and ask students to copy it to their Lab Reports.

Explain to the students that in the sealed-bid, second-price auction, the object goes to the high bidder, but at the price bid by the *second-highest* bidder. Discuss the optimal bidding strategy for this auction. Before bidding starts, work through the Warm-up exercise on sealed-bid, second-price auctions. Proceed with bidding and record results in the same way as you did in the first-price, sealed-bid auction.

Auctions for a Discussion Session

The following experiments are simple. You may want to run some or all of them during a discussion session. The first two experiments illustrate the "winner's curse" in common value auctions. The third experiment is an escalation auction, which illustrates the likelihood of "overbidding" in contests like patent races or lawsuits.

Pennies in a jar

Before class begins, fill a peanut butter jar, or similar small widemouth jar, with pennies, count the number of pennies in the jar, and write this number down somewhere. At the beginning of a class discussion, start the jar of pennies passing around the class. Ask students to look at the jar of pennies, estimate the number of pennies, and pass it on to the next student. After looking at the jar, they should write their ID numbers, their estimates, and a bid for the cash equivalent of the jar's contents on a small slip of paper.[2] The jar will be circulating during your lecture. When all students have seen the jar, collect their slips of paper. Select the high bid and announce the number of pennies in the jar. The high bidder's profit or loss is the difference between the value of the pennies in the jar and the high bid. It is probably more convenient to "award" these profits (usually negative) in the form of real money rather than lab dollars.

The Unreliable Accountants

Make enough copies of the Accountants' Estimate Sheets, so that when they are cut apart, there is at least one estimate for each student in class. Cut the estimates apart and slip them into an envelope.

Separate the class into three or four groups. Explain that you are going to sell a carload of merchandise to each group. The actual value of each carload of merchandise is the same for each group. Buyers do not know the exact value of this merchandise, but each buyer will get an "accountant's estimate" of the value of the merchandise, by drawing a slip of paper from the envelope that you have prepared. Explain to the students that the average of the accountants' estimates is the true value of the merchandise, but that the slips are uniformly distributed at $10 intervals, running from $50 below to $50 above the actual value. Ask each student, after observing

[2] Post-its work nicely for this purpose.

an accountant's estimate, to write this estimate, his ID, and his bid on another scrap of paper and hand it in to the market manager.

Collect the bids separately from each group. Announce the actual value of the object. We have prepared estimate slips so that this value is $120. (If you want to use a different value, you can prepare your own estimate slips.) Find and announce the high bid in each group and the accountant's estimate received by the high bidder. Calculate the high bidder's profit or loss. Discuss the winner's curse.

The Escalation Auction

This auction could be conducted during any lecture, but it fits well here if you have time. To run an escalation auction, show the class a $1 bill and announce that you are going to auction it to the highest bidder. The unusual feature of this auction is that *both* the highest bidder and the second-highest bidder have to pay their bids. Make sure that students understand that the two highest bidders must pay their bids in real money, and that the dollar that you have displayed will go to the high bidder.

Conduct the bidding as in an English auction, starting at $.10 and proceeding in increments of $.10.

At first there are likely to be several bidders. The most dramatic point in the bidding usually comes when somebody who is currently the second-highest bidder realizes that he would be better off bidding more than $1 and winning the dollar than finishing second at a bid of close to $1. In our experience, bidding usually continues until the top bidder is bidding about $2.

When bidding ceases, collect their bids from the highest and second-highest bidder. Give the dollar to the highest bidder.

Quick Start for Experiment 13: Auctions

Capsule Instructions: Auctions

- Divide the class into 3 or 4 groups of equal size. Ask each person in class to write down his or her social security number on a scrap of paper.
- Session 1 (English Auction)
  - Remind students that Buyer Values for the object being sold are given by the last two digits of their social-security numbers. Explain the rules of an English auction.
  - Conduct a separate English auction for each group. For each group, record the winning bid, the highest bidder's ID number and Buyer Value. Determine the highest and second-highest Buyer Values in each group. Ask students to copy this information to their Lab Notes .
- Session 2 (Dutch Auction)
  - Buyer Values are found by subtracting Session 1 Buyer Values from 100.
  - Explain the rules. Conduct a separate Dutch auction for each group, and for each group, record the winning bid and the winning bidder's ID and Buyer Value. Determine the highest and second-highest Buyer Values in each group. Ask students to copy this information to their Lab Notes.
- Session 3 (First-price, Sealed-Bid Auction)
  - The object will be sold to the highest bidder at the price that he bids. Buyer Values are given by the first and second numbers of the last four digits of students' social security numbers.
  - Ask students to turn in bid sheets with their ID numbers, their Buyer Values and their bids. Collect each group's bids separately and find the highest bid, the highest bidder's Buyer Value, and the highest and second-highest Buyer Values to be found in the group. Ask the students to copy this information into their Lab Notes.
- Session 4 (Second-price, Sealed-Bid Auction)
  - The object will be sold to the highest bidder at the second-highest bid. Buyer Values are found by subtracting Session 3 Buyer Values from 100.
  - Proceed as in Session 3. Report all of the information requested for Session 3 and, in addition, report the second-highest bid.

Capsule Instructions: Additional Auctions

Common Values Experiments (to be conducted during discussion session)

- Pennies in a Jar
  - At the beginning of the class discussion, start a jar of pennies passing around the class. Students are to look at the jar, estimate the number of pennies in the jar, and write down their ID numbers, their estimates, and a bid for the cash equivalent of the jar's contents. Proceed with your lecture as the jar circulates.
  - When all students have seen the jar, ask them to turn in their bids. Select the high bid and announce the number of pennies in the jar. The high bidder's profit or loss is the difference between the value of the pennies in the jar and the high bid.
- The Unreliable Accountants
  - Divide the class into three or four groups.
  - Explain that accountants' estimates are, on average, correct, but can be as much as \$50 over the true value and as much as \$50 under the true value.
  - Let each student draw one accountant's estimate from the envelope containing the estimates.
  - Ask students to turn in their bids (with their ID numbers).
  - Collect the bids separately from each group. Announce the actual value of the object. Announce the high bid in each group and calculate the profit or loss of each winning bidder.

Escalation Auction

- This auction can be conducted during any lecture. The market manager announces that she is going to auction a dollar bill. It will go to the highest bidder, but both the highest bidder and the second-highest bidder have to pay their bids. Bidding is conducted as in an English auction.
- When bidding ceases, collect the second-highest bidder's bid. Collect the high bidder's bid minus \$1 from the high bidder.

Posting for Students' Lab Notes

Students will need the information in Tables Q.13.2–Q.13.4 for their Lab Notes. You can post these results on the blackboard at the end of the corresponding sessions.

Table Q.13.2: Outcome of English Auctions

	Group A	Group B	Group C	Group D
Highest Bid				
High Bidder's Buyer Value				
High Bidder's Profits				
Highest Buyer Value in Group				
Second-Highest Buyer Value				

Table Q.13.3: Outcome of Dutch Auction

	Group A	Group B	Group C	Group D
Winning Bid				
Winning Bidder's Buyer Value				
Winning Bidder's Profits				
Highest Buyer Value in Group				
Second-Highest Buyer Value				

Table Q.13.4: Outcome of Sealed-bid, First-price Auction

	Group A	Group B	Group C	Group D
Highest Bid				
High Bidder's Buyer Value				
High Bidder's Profits				
Highest Buyer Value in Group				
Second-Highest Buyer Value				

Table Q.13.5: Outcome of Sealed-bid, Second-price Auction

	Group A	Group B	Group C	Group D
Highest Bid				
Second Highest Bid				
High Bidder's Buyer Value				
High Bidder's Profits				
Highest Buyer Value				
Second-Highest Buyer Value				

Materials to Be Photocopied

The only material you need for the first batch of experiments is a packet of Post-Its or similar small blank pieces of paper.

If you run the counting pennies experiment, you will need a small jar of previously counted pennies and some Post-Its or small blank pieces of paper.

If you run the "Unreliable Accountant" experiment, you will want to photocopy the next page. This page contains 22 slips of paper containing "accountant's estimates" of the value of a carload of merchandise. The mean (and median) of these estimates is \$120. The highest estimate is \$170 and the lowest is \$70. (If you want to use different values, you can make your own batch of slips, with different numbers.) Make enough sheets so that there is at least one slip for each student in class. Cut the estimate slips apart and put them in a large envelope. In class, each student will draw one estimate from the envelope.

To auction a \$1 bill, you need a \$1 bill.

Estimated Value is $170.	Estimated Value is $170.
Estimated Value is $160.	Estimated Value is $160.
Estimated Value is $150	Estimated Value is $150.
Estimated Value is $140.	Estimated Value is $140.
Estimated Value is $130.	Estimated Value is $130.
Estimated Value is $120.	Estimated Value is $120.
Estimated Value is $110.	Estimated Value is $110.
Estimated Value is $100.	Estimated Value is $100.
Estimated Value is $90.	Estimated Value is $90.
Estimated Value is $80.	Estimated Value is $80.
Estimated Value is $70.	Estimated Value is $70.

Experiment 14

Bargaining

Objectives of This Experiment

In this experiment, we expect students to:

- Gain experience in a bargaining environment.
- Learn to "solve" simple sequential games by calculating the opponent's likely future moves and working backwards from the end.
  - Work through the logic of the "ultimatum game." The person offering the ultimatum must decide which offers would be accepted in order to determine what terms to offer.
  - Take this kind of reasoning one more step in the "two-stage bargaining game."
  - Extend sequential reasoning yet another step in the "three-stage bargaining game."
- Learn about the notion of subgame perfection.
- Observe that actual play in sequential bargaining games differs from the predictions based on subgame perfection.
- Grapple with the question of why predictions based on subgame perfection are not fulfilled.

Detailed Instructions and Comments

Time Required

In a 50-minute class, you can comfortably run one round of each of the three sessions, or two rounds of Session 1 and one round of Session 2. In an 80-minute class, there is time for two rounds of Session 1 and one round of each of the other sessions, and a discussion.

On Awarding Prizes

If the class is playing for money prizes, we suggest that for each round and each session, you allocate half of the prize money to sellers and half to buyers, and make a buyer's money winnings depend on his dollar profit relative to the sum of profits of all buyers and make a seller's money winnings depend on her dollar profit relative to the sum of all sellers.[1]

Detailed Procedures

The procedure for running each session of this experiment is presented in sufficient detail in the Capsule Instructions.

[1] If, instead, you make a person's winnings depend on her profits relative to the sum of everyone's profits, then a seller who is offered an ultimatum in which she gets a profit of $1 while the buyer gets a profit of $49, might actually improve her total money winnings by taking the "spiteful" action of rejecting the buyer's offer and reducing the buyer's profit from $49 to zero, at a cost of $1 to herself.

Quick Start for Experiment 14: Bargaining

Capsule Instructions: Bargaining

Materials:

- Session 1 bid sheets (one for each student in class). Session 2 and Session 3 bid sheets (one for every two students in class).

Procedures:

- Session 1 (the ultimatum game)
  - Begin Round 1. Designate half the class to be buyers and half to be sellers. Give a Session 1 bid sheet to each buyer.
  - Buyers write their bids and their ID numbers on the bid sheet.
  - Collect the bid sheets from buyers, shuffle them, and distribute one bid sheet to each seller.
  - Sellers mark their bid sheets, recording whether they accept or reject the bid, and enter their ID numbers.
  - Collect the completed bid sheets and write on the blackboard each offer made and whether it was accepted.
  - (Optional) Begin Round 2. Reverse the roles of buyers and sellers. Give a bid sheet to each of the persons who were sellers in Round 1, and proceed as in Round 1.
- Session 2 (two-stage bargaining)
  - Designate half the class to be buyers and half to be sellers. Give a Session 2 bid sheet to each buyer.
  - Buyers write their bids and their ID numbers on the bid sheet.
  - Collect the bid sheets from buyers, shuffle them, and distribute one bid sheet to each seller.
  - Sellers either accept their offers, or reject and write a counteroffer on the bid sheet.
  - Collect bid sheets from the sellers, keep the bid sheets marked "Accept" and return the bidsheets with counteroffers to the original bidder.
  - Buyers who received counteroffers mark "Accept" or "Reject," and return bid sheets to the market manager.
  - Collect the completed bid sheets. Record on the blackboard, each offer made, each counteroffer made, and whether it was accepted.

Capsule Instructions: continued

- Session 3 (three-stage bargaining)
  - Designate half the class to be buyers and half to be sellers. Give a Session 3 bid sheet to each buyer.
  - Buyers write their bids and their ID numbers on the bid sheet.
  - Collects the bid sheets from buyers, shuffle them, and distribute one bid sheet to each seller.
  - Sellers either accept their offers, or reject and write a counteroffer on the bid sheet.
  - Collect bid sheets from sellers, keep the bid sheets marked "Accept," and return the bid sheets with counteroffers to the original bidder.
  - Buyers who received counteroffers mark "Accept," or reject the counteroffer and make a second offer.
  - Collect bid sheets, keep the bid sheets marked "Accept," and return the bid sheets with second offers to the seller.
  - Seller marks "Accept" or "Reject."
  - Collect the completed bid sheets. Record, on the blackboard, each offer made, each counteroffer made, and each second offer made, as well as whether each offer and counteroffer was accepted.

Posting for Students' Lab Notes

In Table Q.14.1, record the offers made by each buyer in Session 1. In the column "A/R," write the letter "A" if the offer is accepted and "R" if it is rejected by the buyer.

Table Q.14.1: Offers and Outcomes: Session 1

Offer	A/R	Offer	A/R

Record the results of Session 2 in Table Q.14.2. In the first column, record the buyer's offer. If the seller accepted the offer, write an "A" in the second column. If the seller rejected the offer and made a counteroffer, then write the price that the seller counteroffered in the second column. If the seller made a counteroffer, then write either an "A" or an "R" in the third column, depending on whether the buyer accepted or rejected the counteroffer.

Table Q.14.2: Offers and Outcomes: Session 2

First Offer	A/C	A/R	First Offer	A/C	A/R

In Table Q.14.3 record the outcomes of all the bargains in Session 3 that *were settled without the buyer making a second offer.* (We will record other outcomes in a separate table.) In the first column, record the buyer's offer. If the seller accepted the buyer's initial offer, write an "A" in the second column. If the seller rejected the initial offer and made a counteroffer that was accepted, write the price that the seller counteroffered in the second column.

Table Q.14.3: Offers and (Easy) Outcomes: Session 3

First First Offer	A/C	First Offer	A/C

In Table Q.14.4, record the results of bargaining in those instances in Session 3 where the seller rejected the buyer's initial offer and the buyer rejected the seller's counteroffer. In the first column, record the buyer's first offer. In the second column, write the seller's counteroffer. In the third column, write the buyer's second offer. Write an "A" in the fourth column if the seller accepted the second offer or an "R" if the seller rejected the second offer.

Table Q.14.4: Hard Bargaining: Session 3

FirstOffer	Counteroffer	Second Offer	A/R

Materials to Be Photocopied

Make one copy of the Session 1 bid sheet for each student in class. Make one copy of each of the Session 2 and Session 3 bid sheets for every two students in class. Hand out bid sheets to buyers at the beginning of each session. In Session 1, you may hold two rounds, reversing the role of buyers and sellers in the second round.

Bicycle Bid Sheet–Session 1

Buyer's ID _____

Buyer's Offer _____

Seller's ID _____

Offer Accepted ☐

Offer Rejected ☐

Bicycle Bid Sheet–Session 2

Buyer's ID _____

Amount Bid _____

Seller's ID _____

Bid Accepted ☐

Bid Rejected ☐

Amount of Counteroffer _____

Buyer Accepts Counteroffer ☐

Buyer Rejects Counteroffer ☐

Bicycle Bid Sheet–Session 3

Buyer's ID _____

Buyer's First Bid _____

Seller's ID _____

First Bid Accepted ☐

Amount of Counteroffer _____

Buyer Accepts Counteroffer ☐

Buyer's Second Bid _____

Seller Accepts Second Bid ☐

Seller Rejects Second Bid ☐

Part II

Results in Previous Classes

Experiment 1

The Apple Market

Our first experience with running the apple market experiment was at the University of Michigan, in Winter 1995. Neither the instructor nor the students had previous experience with this kind of experiment. A total of 27 students participated. The experiment ran smoothly in just under 50 minutes and the results after two rounds of each session were strikingly close to competitive predictions.

Distribution of Types of Agents

Session 1

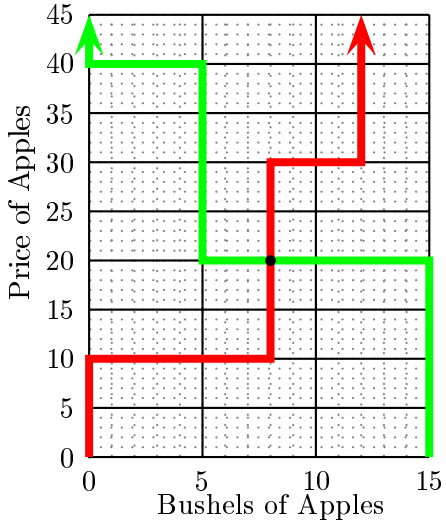
The number of students of each type who participated in Session 1 of this experiment is given by Table R.1.1.

Table R.1.1: Number and Types of Agents–Session 1

Type of Agent	Number of Agents	Value	Cost
Low-Cost Supplier	8	[redacted]	10
High-Cost Supplier	4	[redacted]	30
High-Value Demander	5	40	[redacted]
Low-Value Demander	10	20	[redacted]

Figure R.1.1 shows the competitive supply and demand curves that apply in this market environment.

Figure R.1.1: Supply and Demand–Session 1



In Session 1, the competitive equilibrium price is $20 and there are 8 transactions. All 8 of the low-cost suppliers supply apples and none of the high-cost suppliers supply. All 5 of the high-value demanders buy apples and 3 of the low-value demanders buy apples.

Session 2

The number of students of each type who participated in Session 2 of this experiment is given in Table R.1.2.

Table R.1.2: Number and Types of Agents–Session 2

Type of Agent	Number of Agents	Value	Cost
Low-Cost Supplier	5	[redacted]	10
High-Cost Supplier	9	[redacted]	30
High-Value Demander	9	40	[redacted]
Low-Value Demander	4	20	[redacted]

Figure R.1.2: Supply and Demand –Session 2

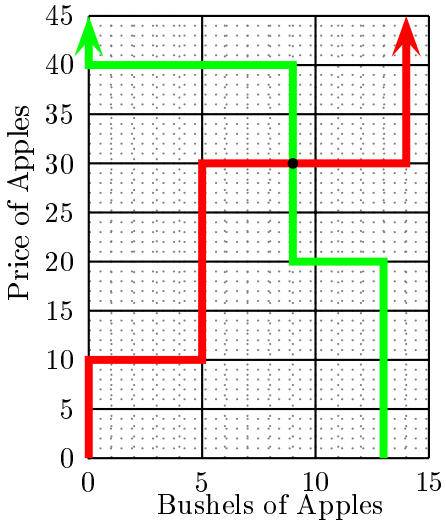


Figure R.1.2 shows the competitive equilibrium supply and demand curves for Session 2. In competitive equilibrium for Session 2, the price is $30, and there are 9 transactions.

Experimental Results

Session 1

Tables R.1.3 and R.1.4 record the transactions that took place in the two rounds of Session 1.

Table R.1.3: Record of Transactions–Session 1, Round 1

Trade	Price	Buyer's Value	Seller's Cost
1	29	40	10
2	20	40	10
3	32	40	30
4	18	20	10
5	20	20	10
6	15	20	10
7	18	40	10
8	35	40	30
9	19.75	20	10
10	19.75	20	10

Table R.1.4: Record of Transactions–Session 1, Round 2

Trade	Price	Buyer's Value	Seller's Cost
1	19	20	10
2	25	40	10
3	18	20	10
4	25	40	10
5	21	40	10
6	15	20	10
7	19	20	10
8	19.5	20	10
9	35	40	30
10	30.01	40	30

Session 2

Tables R.1.5 and R.1.6 record the transactions that were made in the two rounds of Session 2.

Table R.1.5: Record of Trades–Session 2, Round 1

Trade	Price	Buyer's Value	Seller's Cost
1	30	40	10
2	20	40	10
3	32	40	30
4	35	40	30
5	24	40	10
6	20	40	10
7	32	40	30
8	30.75	40	30
9	18	20	10
10	32	40	30

Table R.1.6: Record of Trades–Session 2, Round 2

Trade	Price	Buyer's Value	Seller's Cost
1	30	40	10
2	21	40	10
3	25	40	10
4	30.5	40	30
5	31	40	30
6	20	40	10
7	32	40	30
8	26	40	10
9	30.01	40	30

Comparing Equilibrium and Experiment

Session 1

Table R.1.7 compares the competitive equilibrium outcome with the actual experimental outcome for each round of Session 1.

Table R.1.7: How Well Did Competitive Model Predict?

	Competitive Prediction	Outcome Round 1	Outcome Round 2
Average Price	20	21.9	20.3
No. Low Cost Sellers	8	8	8
No. High Cost Sellers	0	2	2
No. High Value Buyers	5	5	5
No. Low Value Buyers	3	5	5
Number of Transactions	8	10	10
Total Profits	$180	$160	$160

Notice that the competitive model predicts the price quite closely, but the experimental outcome has two more transactions than the competitive prediction.

Session 2

Figure R.1.8 compares the experimental results in Session 2 to the predictions of the competitive model.

Table R.1.8: How Well Did the Competitive Model Predict?

	Competitive Prediction	Outcome Round 1	Outcome Round 2
Average Price	30	27.1	27.6
No. Low Cost Sellers	5	5	5
No. High Cost Sellers	4	4	5
No. High Value Buyers	9	9	9
No. Low Value Buyers	0	0	1
Number of Trades	9	9	10
Total Profits	$190	$190	$180

In both sessions, the average price was slightly below the competitive price and the number of transactions was one more than the competitive equilibrium number.

Related Experimental Research

The apple-market experiment is essentially the same as that used by Professor E.H. Chamberlin [2] in experiments run in his Harvard classroom, 50 years ago. These experiments stimulated Vernon Smith [7] to develop the modern standard of laboratory experiments with experimental markets. Smith describes his inspiration for this work in a delightful passage of an essay "Experimental Economics at Purdue," which can be found in *Papers in Experimental Economics* [8].

> "Experimental economics started at Purdue in the late fall of 1955 ... I had insomnia one night, and for reasons that entirely escape me, in the dead of night I found myself thinking about the classroom experiment that Ed Chamberlin used to perform with the Harvard graduate students to 'prove' the impossibility of perfect competition. I didn't take Chamberlin's course, ... but I did observe and participate in Ed Chamberlin's little 'experiment.' The scuttlebutt among the Harvard graduate students was that the whole exercise was sort of silly ...
>
> So there I was, wide-awake at 3 a.m., thinking about Chamberlin's 'silly' experiment. He gave each buyer a card with a maximum buying price for a single unit, and each seller a card with a minimum selling price for one unit. All of us were instructed just to circulate in the room, engage a buyer (or seller), negotiate a contract, or go on to find another buyer (or seller) and so on. If a buyer and a seller made a contract, they were to come to Chamberlin, reveal the price of the exchange, turn in their cards, and he would post the price on the blackboard for all to see. When it was all over, he would reveal the implicit supply and demand schedules, and we would learn the important lesson that supply and demand theory was worthless in explaining what had happened; namely that prices were not near the equilibrium, and neither was the quantity exchanged.
>
> The thought occurred to me that the idea of doing an experiment was right, but what was wrong was that if you were going to show that competitive equilibrium was not realizable

> ... you should choose an institution of exchange that might be more favorable to yielding competitive equilibrium. Then when such an equilibrium failed to be approached, you would have a more powerful result. This led to two ideas: (1) ... why not use the double oral auction procedure, used on the stock and commodity exchanges? ... (2) ... why not conduct the experiment in a sequence of trading 'days' in which supply and demand were renewed to yield functions that were daily flows?...
>
> The following January, I carried through my insomniacal plan. ... I am still recovering from the shock of the experimental results. The outcome was unbelievably consistent with competitive price theory. If these results are to be believed, what was being knocked down was Chamberlin's hypothesis of the unattainability of supply-and-demand theory. But the results *can't* be believed, I thought. It must be an accident, so I will take another class and do a new experiment with different supply-and-demand schedules.

In a series of carefully controlled laboratory experiments, Smith found that with a wide variety of shapes of supply and demand curves, the outcomes of the experiments are strikingly close to those predicted by supply-and-demand theory, usually by the second or third round of trading within a session. The papers describing this work have been collected and published in [8].

Our apple-market experiment differs from those of Chamberlin and Smith in having only two types of demanders and two types of suppliers, rather than "staircase" demand and supply curves with several types of demanders and suppliers. We follow Chamberlin, rather than Smith, in conducting the experiment in a trading-pit environment rather than a double-oral auction mediated by an auctioneer. We follow Smith, rather than Chamberlin, in running more than one round of trading with the same Buyer Values and Seller Costs .

Experiment 2

The Fish Market

Experimental Results

This experiment was run at the University of California Santa Barbara in the Winter Quarter of 1999, in a Principles of Economics class of 500 students. The experiments were run by graduate teaching assistants in 10 sections, each of which had about 50 students. The section meetings were 70-minute time periods.

The experiment differed in the following respects from the one in the current text. In the first session, fishermen did not have any fixed costs. Buyer Values were lower, and the competitive equilibrium price was $15 rather than $20.

Each section ran two rounds of Session 1. In the first round, the average price over the 10 sessions was $8.3 and in the second round the average price was $10.6. Both prices were well below the competitive equilibrium price of $15.[1]

Each section ran three rounds of Session 2. In the first round the average price was $7.27, in the second round the average price was $4.90, and in the third round the average price was $2.70.

In all rounds of all sessions, the quantities traded were identical to the competitive quantities in almost all sections.

[1] It would have been interesting to run a third round of this session, but in this class we used an older experimental design that had an additional session, and so we did not have time for a third round.

Related Experimental Literature

Vernon Smith [7] conducted experimental sessions in which the supply curves, like those in our experiment, were horizontal up to some capacity limit. In Smith's experiments, unlike in ours, demanders as well as suppliers could transact more than one unit.

When the demand curve crosses the supply curve in the horizontal region of the supply curve, the competitive prediction is that suppliers will sell at their marginal cost, for zero profit. In his experiment, Smith found that price was not driven all the way down to the suppliers' marginal cost. Smith remarked that in a later experiment where the participants were playing for money, the price converged closer to equilibrium than it did in his classroom experiments where there was no monetary reward.

Experiment 3

A Sales Tax

This is a report on the results of a class session at the University of Michigan in Winter, 1996. Thirty-four students participated, and the class was scheduled for 80 minutes. We conducted two rounds of each of the three sessions. The experiments were completed 50 minutes after the class began.

At the end of the experimental session, we spent 10-15 minutes discussing what we might expect to happen when a sales tax is collected from buyers or from sellers. Before students had a chance to do careful analysis of the results of the experiment, and before they were exposed to the theory of sales taxes, we asked them whether they would expect a tax paid by sellers to be better or worse for sellers than a tax paid by buyers. This led to a lively discussion in which students proposed several hypotheses, but came to no consensus.

Distribution of Types of Agents

Following the rules for distribution, we passed out two full 12-packs, the top nine sheets from a third 12-pack and one Type X sheet.

The resulting distribution of types for all three sessions of this experiment is given in Table R.3.1.

Table R.3.1: Distribution of Types for Sales Tax Experiment

Seller's Costs	Number in Market	Buyer's Value	Number in Market
3	2	45	3
8	2	40	3
13	3	35	3
18	4	30	3
23	3	25	3
28	3	20	2

Experimental Results and Competitive Predictions

Tables R.3.2, R.3.3, and R.3.4 report results from each of the three sessions, and compare these results to the predictions of competitive equilibrium theory.

In the figures below, we display for each session the competitive supply and demand curves, the competitive equilibrium price and quantity, and the time path of transaction prices in the second round of the session. This time path reports transaction prices in the order that the Sales Contracts were turned in to us.[1]

[1] We recorded transactions on the blackboard, so students who made later transactions were able to see the prices of earlier transactions. (Our impression is that few students paid attention to the prices on the board.)

Table R.3.2: Outcomes and Competitive Predictions Session 1

	Outcome Round 1	Outcome Round 2	Competitive Prediction
Average Price	24.1	25.07	25
Standard Dev. of Prices	3.8	1.27	0
Highest Seller Cost Trading	28	23	23
Lowest Buyer Value Trading	25	25	25
Number of Trades	14	14	14
Buyers' Total Profits	147.5	149	150
Sellers' Total Profits	130.5	149	148
Total Profits All	278	298	298

Figure R.3.1: No Sales Taxes, Round 1

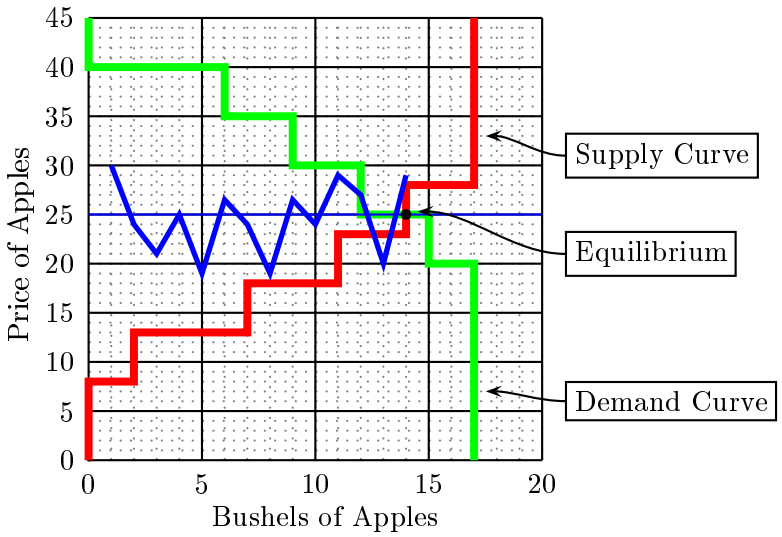


Figure R.3.2: No Sales Taxes, Round 2

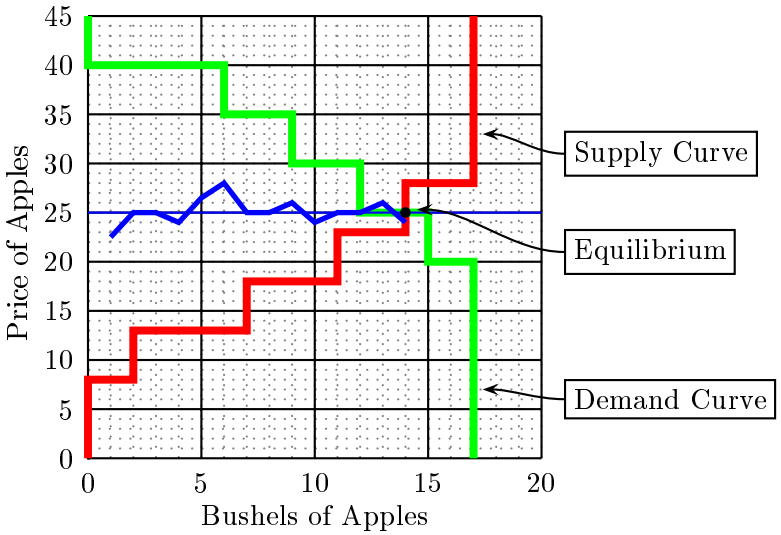


Table R.3.3: Outcomes and Competitive Predictions Session 2

	Outcome Round 1	Outcome Round 2	Competitive Prediction
Average Price	31.1	32.8	33
Standard Dev. of Prices	2.37	2.75	0
Highest Seller Cost Trading	18	18	18
Lowest Buyer Value Trading	35	30	35
Number of Trades	9	10	9
Buyers' Total Profits	80	61.75	63
Sellers' Total Profits	40	63.25	65
Total Profits All	120	125	128

Figure R.3.3: Sellers Pay Sales Tax, Round 1

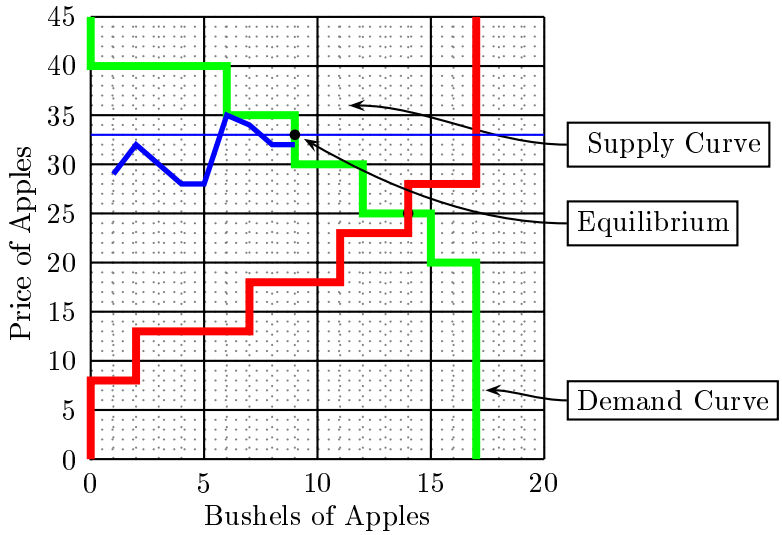


Figure R.3.4: Sellers Pay Sales Tax, Round 2

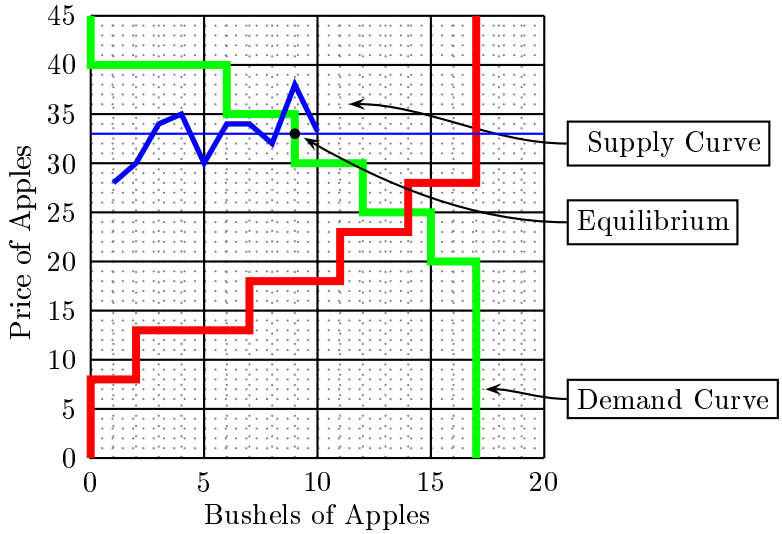


Table R.3.4: Outcomes and Competitive Predictions Session 3

	Outcome Round 1	Outcome Round 2	Competitive Prediction
Average Price	18.1	17.8	18
Standard Dev. of Prices	2.27	3.5	0
Highest Seller Cost Trading	18	18	18
Lowest Buyer Value Trading	35	35	35
Number of Trades	11	11	9
Buyers' Total Profits	46	59	63
Sellers' Total Profits	66	63	65
Total Profits All	112	122	128

Figure R.3.5: Buyers Pay Sales Tax, Round 1

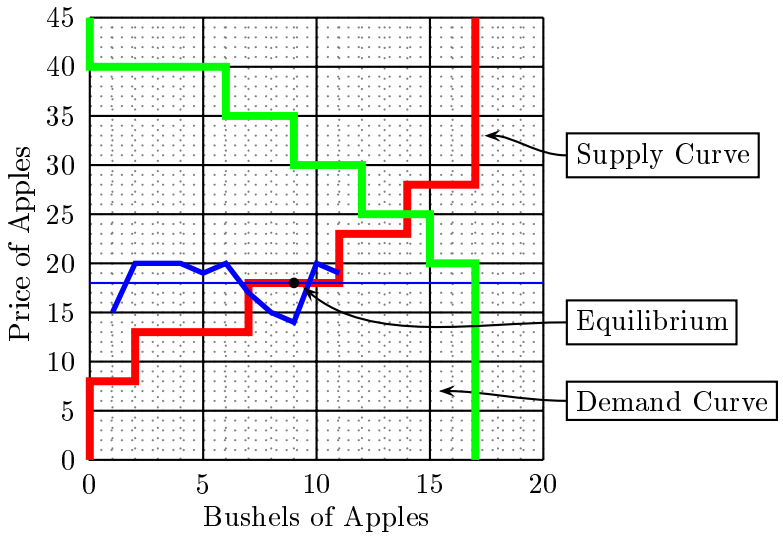


Figure R.3.6: Buyers Pay Sales Tax, Round 2

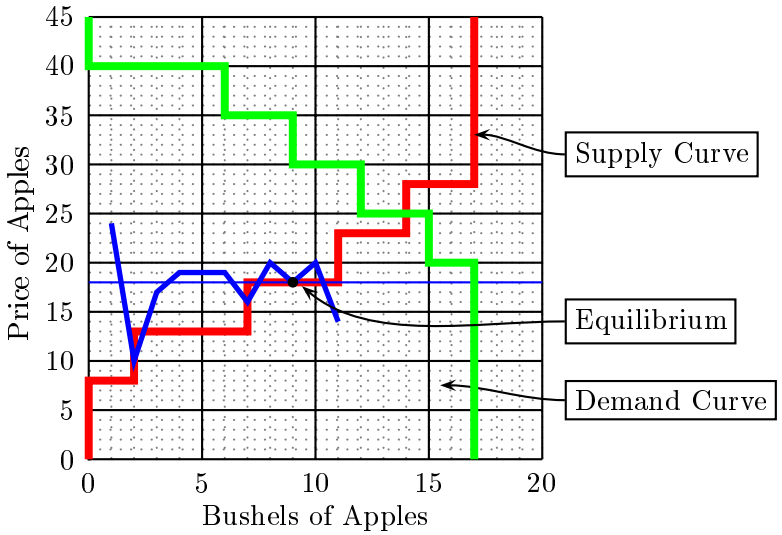
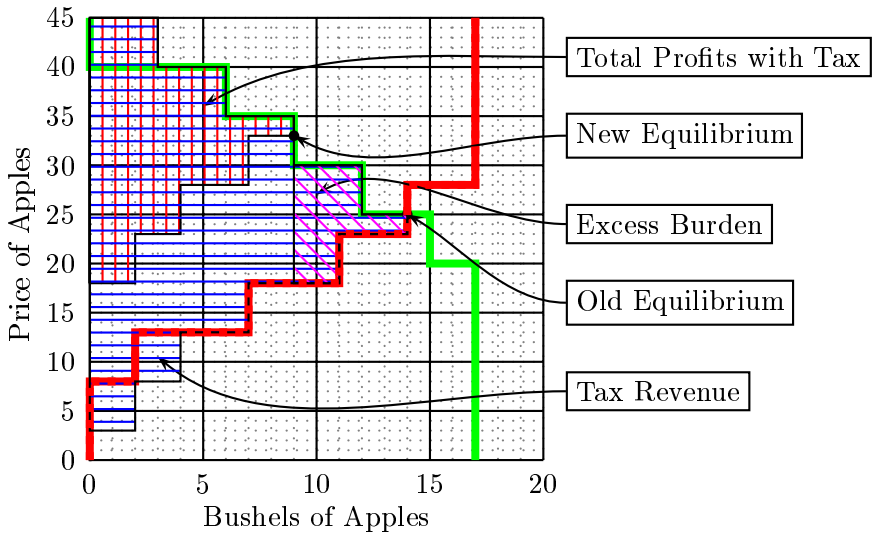


Figure R.3.7: Revenue and Excess Burden, Session 2



Related Experimental Literature

Surprisingly, we have not been able to find published reports of experiments on the incidence of a sales tax or the equivalence of sales taxes paid by buyers and by sellers. We would be grateful to hear of such work from readers.

Experiment 4

Prohibition

This experiment was conducted with a class of 32 students at the University of Michigan in Winter 1996. The demand and supply curves for the three sessions were as in Figures 4.1, 4.2, and 4.3. We ran three rounds of Session 1 and a single round in each of Sessions 2 and 3. The experiment took about 65 minutes. We ran it in a leisurely way, with time for discussion between sessions.

Distribution of Types of Agents

The participants in this session were 10 addicts, 10 recreational drug users and 12 suppliers.

Addicts had Buyer Balues of \$30, and if they got no drugs would get a payoff of $-\$20$. Recreational users had Buyer Values of \$15 and if they got no drugs would get a payoff of 0. Each supplier could supply 0, 1, or 2 units.

The supply and demand curves in Sessions 1-3, respectively are the same as those shown in Figures 4.1, 4.2, and 4.3, above. Looking at the intersection of supply and demand in these figures, we can find the competitive equilibrium for each session. In Session 1, the competitive equilibrium price is \$10 and every addict and every recreational users consumes a unit of drugs. In Session 2, the competitive price is \$25, and the 10 addicts each consume a unit of drugs, but the recreational users do not consume drugs. In Session 3, the competitive price is again \$25 and again only the addicts consume drugs.

Experimental Results and Competitive Predictions

We ran 3 rounds of Session 1. Prices started out considerably above equilibrium but appeared to be converging slowly toward equilibrium. In the second and third session, prices were close to competitive as early as the first round. In every round of every session, quantities were exactly as predicted by competitive theory, with all demanders buying drugs in Session 1 and with only addicts buying drugs in Sessions 2 and 3.

In Round 1 of Session 1, the mean price paid for drugs was \$15.4, the highest price that anyone paid was \$20, and the lowest price that anyone paid was \$13.

At the close of Round 1, we asked whether there were any demanders left who had not obtained drugs, but would have liked to. There were none. We asked if there were any suppliers left who would have liked to sell at the average price of transactions in this round. There were 4 such persons, each of whom had sold one unit of drugs but not a second unit.

In the second round of Session 1, the average price fell to \$14.25. In this session, the highest price paid was \$15, and the lowest price paid was \$11.75.

We ran a third round of Session 1 to see whether the price would converge closer to the competitive equilibrium of \$10. The mean price in this round was \$13.34. The highest price was \$14 and the lowest price was \$12.

The actual outcome of Round 1 of Session 2 was very close to the competitive outcome. Seven of the 10 transactions occurred at a price of \$25 or \$26. Two suppliers misunderstood the payoff functions and sold at prices of \$18 and \$15 respectively. The last transaction took place at a price of \$44, which, given the peculiar rules of confiscation in this market, was quite close to the equilibrium value.

Because of the way that confiscation works in Session 2, the last sale takes place at a different price from earlier sales. So long as there are at least two addicts who have not made a purchase, a supplier can sell to each of these addicts at a price of \$25 or higher and make a profit after one of the two sales is confiscated and a fine is paid. However, when there is only one addict left, whose demand is unsatisfied, the only way a seller can bring two contracts to the market manager is to sell one unit of drugs to the addict and one unit of drugs to one of the remaining recreational users. When this problem became apparent, class members discussed possible ways to deal with it. I was prepared to suggest a solution to this problem, but after a little bit of discussion, one of the students saw and proposed a solution. The recreational user will buy only if the price is \$15 or lower. In order for the

seller to make an expected profit, he will have to charge a price to the addict such that the sum of the addict's price and the recreational user's price is $50 or greater. In our experiment, a supplier made a contract with the last remaining addict for $44 and one with a recreational user for $14. Since one of these two contracts chosen at random would be confiscated, the seller's expected revenue was $(44+14)/2=$29. As it happened, the contract with the recreational user was confiscated and the supplier realized a profit of $19.

In the final session, in which confiscated drugs are resold by the police, all transactions except two took place at prices ranging between $25 and $26. The two exceptions involved a student who miscalculated the payoffs.

Remarks

The results of the experiment were largely as predicted by competitive theory. In the absence of government controls, as predicted by the theory, all consumers bought a unit of drugs. The prices in all transactions of the final round were below $15 (but not as low as the competitive prediction of $10). In the second and third sessions, as predicted by the theory, the only purchasers were addicts. The prices in almost all transactions were between $25 and $26. The theoretical prediction is $25.

We were surprised to find that the prices in the first rounds of Sessions 2 and 3, with confiscation and fines, were closer to the competitive equilibrium prices than the prices in the last round of trading in Session 1, with no government interference.

Our experience with slow convergence of prices to equilibrium in this experiment was similar to our experience in the fish market, where we also had producers with constant marginal cost and fixed capacities. In competitive equilibrium for these markets, suppliers made zero profits. It is understandable that in actual trading, suppliers will insist on positive profits, however small. We had expected that profits of $1 might be focal. But competition seemed slow to erode the profits this far. In our classroom experiments, we have noticed that a few of the suppliers who failed to sell their goods easily at the going price gave up without trying to sell at lower prices.

Two suppliers were confused about the payoff functions in Session 2 and one was confused in Session 3. If we had run another round, these students, having seen that their previous choices led to losses, would most likely have acted more rationally. Even with these mistakes, it appeared to us that the results were close enough to the eventual equilibrium that

we thought the lessons of the experiment had been taught. In running these experiments, the market manager must occasionally make decisions like this that trade repetitions which are likely to lead to more rational behavior against time and the students' patience. Because of the importance of keeping the students engaged and enthusiastic, we are willing to settle for fewer rounds of repetition in each experiment than would an experimental researcher with paid subjects.

Experiment 5

A Minimum Wage

This is a report on the results of a classroom experiment at the University of Michigan in Winter 1996. There were 36 participating students. The class was scheduled for 80 minutes. The total amount of time consumed by the experiment, preliminary discussion, and post session surveys was about 45 minutes.

We spent 10 minutes at the beginning of the class period discussing profit maximizing strategies for firms in this experiment. We worked through the warm-up exercise in the text at the beginning of the experiment, and discussed optimal choices for firms that can hire 0, 1, or 2 workers. We talked a bit about the difference between average and marginal product of labor, working with numerical examples. One student proposed an "average cost rule" for deciding how many workers to hire and another suggested a "marginal cost rule." We showed with the numerical examples that the marginal cost rule gave greater profits.

Distribution of Types of Agents

In Sessions 1 and 3, there were 13 workers with a reservation wage of \$5 and 14 workers with a reservation wage of \$12. In Session 2, there were 14 workers with a reservation wage of \$5 and 13 workers who received unemployment benefits of \$12.

In all sessions, there were 9 firms. Recall that in Sessions 1 and 2 firms could hire up to 2 workers. A firms' revenue was \$20 if it hired one worker and \$30 if it hired two workers. In Session 3, a firm could hire up to 4 workers. Its revenue was \$30 if it hired 1 worker, \$55 if it hired 2 workers, \$75 if it hired 3 workers and \$95 if it hired 4 workers.

The competitive supply and demand curves for the three sessions are given in Figures R.5.1, R.5.2, and R.5.3.

Figure R.5.1: Labor Market with No Minimum Wage, Session 1

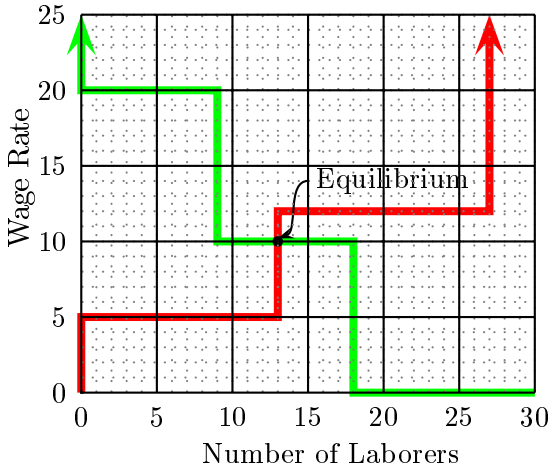
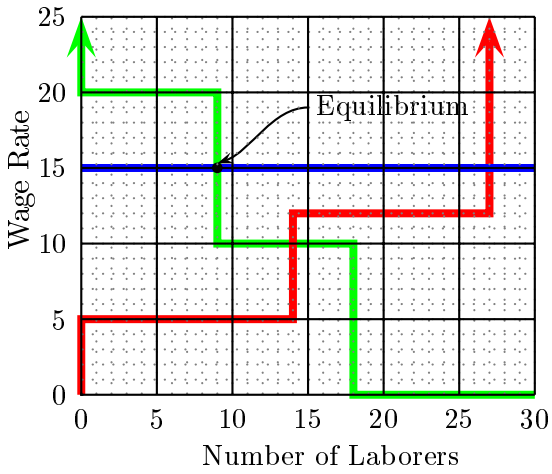


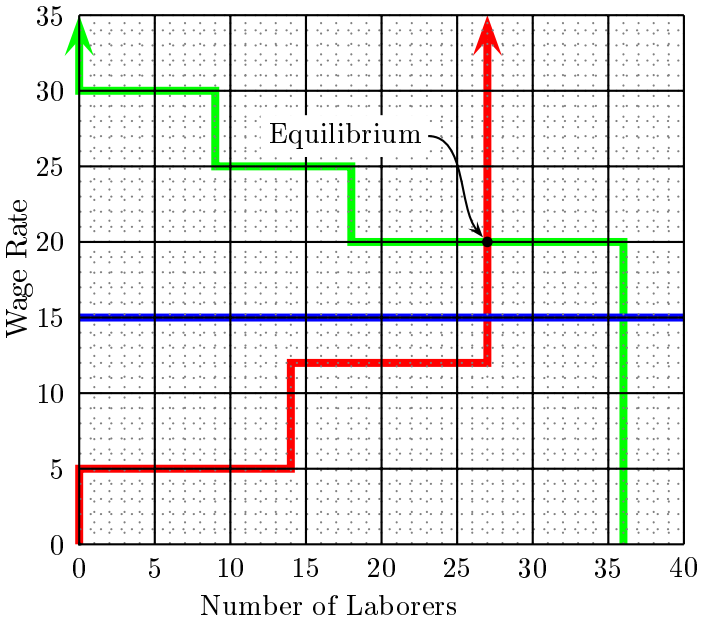
Figure R.5.2: Labor Market with Minimum Wage, Session 2



Experimental Results and Competitive Predictions

In Session 1 of the experiment, prices and quantities came out so close to the competitive equilibrium on the first round of trading that we decided

Figure R.5.3: Nonbinding Minimum Wage, Session 3



not to hold a second round. In Session 2, the outcome was again extremely close to the theoretical prediction and we did not run a second round of this session. In Session 3, where the legal minimum wage was *below*, the competitive equilibrium wage, convergence to equilibrium was less rapid. In the first round of this experiment, the average wage paid was closer to the minimum wage of \$15 than to the competitive equilibrium wage of \$20 in the first round. After a brief discussion[1], we ran a second round. This time wages were considerably higher, and near the end of the session, the wage seemed to be converging on the equilibrium wage of \$20. We stopped after two rounds, but in retrospect, we think it would have been interesting to run a third round of this session.

The employment statistics from the last round of each session are given in Table R.5.1.

Table R.5.2 shows the average wages and employment levels in each round of each session, and the corresponding competitive equilibrium wages and employment levels.

[1] We asked if there were any unemployed workers willing to work at the average wage paid in that round. There were none. We asked if there were any employers who would like to hire more labor at the average wage paid in this session. There were several, some

Table R.5.1: Employment Statistics–Experimental Results

Session and Round	Employed	Involuntarily Unemployed	Voluntarily Unemployed
Session 1	14	0	13
Session 2	9	18	0
Session 3	27	0	0

Table R.5.2: Wages and Employment in Theory and Experiment

	Equilibrium Wage	Average Wage in Experiment	Equilibrium Number Employed	Actual Number Employed in Experiment
Session 1	10	11.3	13	14
Session 2	15	15.3	9	9
Session 3, Round 1	20	15.7	27	27
Session 3, Round 2	20	17.7	27	27

Tables R.5.3, R.5.4, and R.5.5 report the activities of each firm in each session. Table R.5.6 compares total profits and total wages that would be paid in competitive equilibrium with total profits and wages in the last round of each session.

of whom would like to hire more than one more worker.

Table R.5.3: Firms' Profits in Session 1

Firm Number	Number of Employees	Firm's Total Revenue	Firm's Total Wage Costs	Firm's Profit
1	2	30	22	8
2	1	20	12	8
3	2	30	20	10
4	1	20	11	9
5	2	30	25	5
6	1	20	13	7
7	2	30	20	10
8	2	30	20	10
9	1	20	15	5
Total	14	230	158	72

Table R.5.4: Firms' Profits in Session 2

Firm Number	Number of Employees	Firm's Total Revenue	Firm's Total Wage Costs	Firm's Profit
1	1	20	15	5
2	1	20	15	5
3	1	20	15	5
4	1	20	15	5
5	1	20	15	5
6	1	20	15	5
7	1	20	15	5
8	1	20	15	5
9	1	20	17.5	2.5
Total	9	180	137.5	42.5

Table R.5.5: Firms' Profits in Session 3, Rd 2

Firm Number	Number of Employees	Firm's Total Revenue	Firm's Total Wage Costs	Firm's Profit
1	4	95	68	27
2	2	55	36	19
3	2	55	34	21
4	3	75	52	23
5	4	95	74	21
6	3	75	55	20
7	1	30	17	13
8	4	95	68	27
9	4	95	74	21
Total	27	670	478	192

Table R.5.6: Total Profits and Wages in Theory and Experiment

	Equilibrium Total Profits for Firms	Tot. Profits of Firms in Experiment	Equilibrium Tot. Wages & Unempl. Payments	Tot. Wages & Unempl. Pymts in Experiment
Session 1	180	135	298	314
Session 2	45	42.5	**	290.5
Sess 3, Rd 2	135	192	540	478

Class Discussion

After each session, we surveyed the class to determine the number of involuntarily unemployed. In Session 1, with no minimum wage, there was no involuntary unemployment. In Session 2, with a binding minimum wage, 18 persons were involuntarily unemployed, but only 5 fewer laborers were employed than in Session 1. Students were asked to speculate about how this could happen. They correctly explained that the minimum wage not only reduced total employment, but also increased the number of persons wanting employment at the average wage.

We had a brief discussion of who gained and who lost from the minimimum wage law. We asked for a show of hands of those students who made more money with the minimum wage than without it and then for a show of hands of those who made less money with the minimum wage. In our experiment, 9 laborers made more money with the minimum wage than without it, while 5 laborers and 8 firms made less money with the minimum wage than without it.

It is interesting to notice that in Session 1 there was "more-than-full" employment. In a competitive equilibrium, the wage is \$10 and the only laborers willing to take jobs are the 13 laborers who are entitled to unemployment benefits of \$5. The remaining laborers have unemployment benefits of \$12 and will not work for \$10. But in this session, total employment was 14. The way in which this happened is instructive. In the first 13 transactions, all 13 of the students with \$5 reservation wages had been hired, but one of the firms had not yet hired any labor. In the last transaction of the session, one of the students who had a reservation wage of \$12 was able to extract a wage of \$13 from a firm which had not yet hired anyone. This transaction was profitable to both parties, since the marginal contribution of a laborer to the firm's profits was \$20. In general, so long as the equilibrium price is not known to everyone, we can expect some trades at "false prices," where agents who would not be able to trade in competitive equilibrium make profitable transactions in the experimental market.

Related Experimental Literature

Mark Isaac and Charles Plott [4] explored the effects of price ceilings and price floors in a laboratory market conducted as a double oral auction. Among other things, they tested the competitive prediction that "nonbinding" price ceilings would have no effect, as predicted by competitive theory.

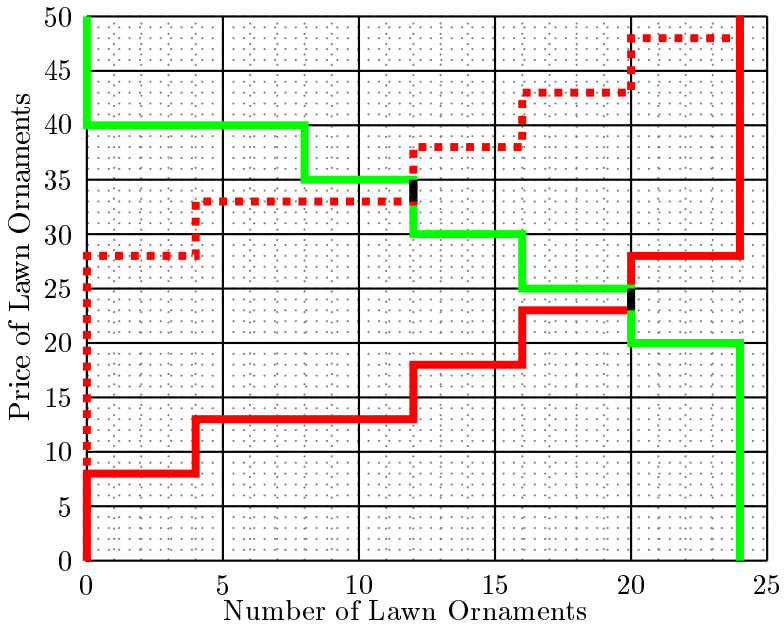
They found that non-binding price controls had little effect on the result reached after several rounds of trade, but they also found that non-binding controls affected the path of convergence to equilibrium. They also found that if non-binding controls are imposed, prices tend to converge to competitive prices while the controls are in place, but if these controls are then removed, prices move temporarily away from equilibrium values.

Experiment 6

Externalities

This experiment was conducted in 10 section meetings for a class of 500 students at the University of California Santa Barbara. Each section had approximately 48 students in attendance.

Figure R.6.1: Externalities and a Sales Tax



In Figure R.6.1, the solid lines show the supply and demand curves in the absence of a tax (as in Session 1) for a class of 48 students. The dotted line is the supply curve when suppliers must pay a $20 pollution tax (as in

Session 2). Since some sections had slightly different numbers of students, the demand and supply curves differ from section to section, but they are qualitatitively similar.[1]

Experimental Results

In Session 1, for all sections the competitive equilibrium price range was \$23-\$25. Some of the sections conducted two rounds of Session 1 and some conducted one round. In all sessions, the mean price in the first round was either in this range or very close to it. About half of the sections conducted a second round. Mean prices in the last round of Session 1 ranged from \$20.80 in the section with the lowest mean to \$24 in the section with the highest mean.

The equilibrium number of sales for Session 1 varied from section to section with the number of persons who attended. In most sections, there were two or three fewer trades than there would be in competitive equilibrium. If you look at Figure R.6.1, you will notice that for the last four units sold, the demand and supply curves are very close together. The amount of gains from trade are small. Perhaps some students with Buyer Values and Seller Costs close to the equilibrium price simply did not find anyone with whom to make a mutually profitable deal. Another possibility is that some students misunderstood the effects of externalities and thought that their own sales would have a stronger effect on the pollution damages that they suffer than is actually the case. A third possibility is that some students chose to sacrifice their own profits to reduce pollution. We suggest that near the end of each round, you make some effort to encourage students who haven't traded to look once more for a trading partner. For example, when trading appears to have stopped, you could estimate the average price in this round and ask if there is anyone else who wants to sell and anyone who wants to buy at this price. If there are buyers and sellers who answer in the affirmative, you can then give them a chance to trade.[2]

In Session 2, the competitive equilibrium price range was \$30-\$35 for some sections and exactly \$35 for others. All sections ran two rounds of this session. Mean prices in the last round of this session ranged from \$30.7 in the lowest section to \$32.8 in the highest.

[1] The demand and supply curves used are slightly different from the ones that you will be using, but the prices and quantities in equilibrium are similar.

[2] If you want to pursue this further, you may want to ask whether there are any students with Seller Costs lower than \$23 who did not sell. You can then ask these students why they chose not to sell.

Quantities sold in Session 2 tended to be closer to the equilibrium quantities than in Session 1, but frequently one or two fewer units were sold than the equilibrium quantity.

In Session 3, for almost all sections, the number of pollution permits issued was such as to make the competitive equilibrium price \$35. (For example, in the section where the demand and supply curve are drawn in Figure R.6.1, 11 pollution tickets were issued. Since the competitive supply of lawn ornaments must be equal to the number of tickets issued, the competitive price of lawn ornaments must be \$35.) If the pollution tickets are all acquired by the suppliers with the lowest Seller Cost, then those who sell lawn ornaments will all have Seller Costs of \$10 or less. In equilibrium the willingness-to-pay of a supplier with Seller Costs of \$10 for a pollution permit would be \$35 − \$10 = \$25. Since permits are in fixed supply, there is a vertical supply curve for permits and the competitive equilibrium price of a permit would be \$25.

In Session 3, the observed price of lawn ornaments ranged from \$26.5 to \$30.1. The median observed price for pollution tickets in different sections ranged from \$9 to \$15. It is interesting to notice that the price of lawn ornaments is lower than predicted and that the price of pollution tickets is well below their competitive equilibrium price, even conditional on the lower-than-equilibrium price of lawn ornaments.

Related Experimental Literature

The closest experiment that we have found to this in the literature was run by Charles Plott [6], who created a trading environment with externalities similar to those found here. Plott created a parallel market in which a fixed supply of pollution permits was traded among the participants. Both of these markets were conducted by means of double oral auctions rather than the pit-trading environment that we use. Plott's contribution and related literature are discussed by Davis and Holt [3].

Experiment 7

Monopoly and Cartels

This experiment was conducted with a class of 31 students at the University of Michigan in Winter, 1996. The class met for 80 minutes. The first three sessions were completed within 50 minutes.

As you can see from Table R.7.1, the distribution of demanders' Buyer Values in the experiment conducted at Michigan was different from that in the current design.

Distribution of Types of Agents

In each session, six students were designated as firms and 25 students were demanders. The distribution of demanders by buyer value and student status is described in Table R.7.1

Table R.7.1: Distribution of Buyer Values by Student Status

Status	Buyer Value $16	Buyer Value $21
Student	10	5
Non-student	0	10
Total Population	10	15

Experimental Results

Session 1

The profit-maximizing action for the cartel was to recommend a price of $15 and to give firms quotas that add to 25. In the experiment, the cartel agreed in to give each of the 6 firms a quota of 4 units and to recommend a price of $15. (The cartel could have done slightly better by assigning a quota of 5 units to a randomly chosen member and a quota of 4 to each of the others.)

When the time came to sell, two cartel members deviated from the recommended price. One deviant charged a price of $13 and one deviant charged a price of $19. The $13 firm sold its quota of 4 units and made a profit of $32, the $19 firm sold only one unit and made a profit of $14 . The other three firms charged $15 and sold 4 units, as they had agreed to do, and each made profits of $40.

After the session closed, we pointed out to students that the two deviants both got lower profits than the three firms that stuck to the agreement. We then discussed why this happened. We also asked one of the cartel members to explain the reasoning that led the cartel to conclude that its profits would be maximized at a price of $15 with total sales of 25 units. We asked what students thought would happen if we ran another round of the same session. Students were convinced that if this session were run again, the same quotas and recommended price would be set but that this time everybody would abide by the quota.

We decided not to run a second round of Session 1, thinking that the lesson was clear to almost everybody.

Session 2

Session 2, the cartel agreed to the same price and quotas set in Session 1, but the agreement broke down quickly. All sales took place in the price range from $6 to $8.

Session 3

In Session 3, the cartel correctly calculated that total profits would be maximized if students were charged a price of $15 and non-students were charged a price of $21. Two cartel members were given quotas of 1 student and 3 non-student customers, three members were given quotas of 2 students and

2 non-students, and one member got a a quota of 2 students and 3 non-students. All cartel members adopted the recommended prices and made sales exactly equal to their quotas. Thus the cartel succeeded perfectly in maximizing its total profits.

Session 4

In Session 4, the cartel members realized that they could not gain anything by charging different prices to students and non-students. They agreed to quotas of 4 sales for each firm and recommended a price of $15. They all acted as agreed and each sold 4 units.

Related Experimental Literature

There is a large experimental literature on the behavior of monopoly under alternative market institutions and on explicit or implicit collusion in markets with a small number of buyers and sellers. This literature is surveyed by Charles Holt in a chapter of the *Handbook of Experimental Economics* [5].

Experiment 8

Entry and Exit

Setting Up the Experiment

This is a report on the results of a classroom experiment at the University of Michigan in Winter, 1996 with a class of 34 participating students. The class was scheduled for 80 minutes. We used about 70 minutes of class time to conduct two rounds of each of the two sessions and to hold an extended discussion of economics principles after each session. After the first 50 minutes of class, we had conducted and discussed two rounds of Session 1 and one round of Session 2.

Before beginning the experiment, we discussed the way that restaurants calculate their profits. Students were reminded that anyone who chose to open a restaurant would have to pay a fixed cost (or overhead cost) of $20, no matter how many meals were sold and would also have variable costs of $5 per meal sold. We talked through a few numerical examples to make sure that everybody understood the cost structure. If a restaurant were able to sell out its full capacity of 4 meals at $15 per meal, its revenue would be $60, its total costs would be $40, and its profit would be $20. We emphasized the "sunk cost" principle by considering a restaurant that sold 4 meals at $9. Its revenue would be be $36, its total costs would be $40 and it would lose $4. Students saw that even though $9 is less than average total costs, this restaurant would *not* do better by selling fewer meals. For example, if it sold 3 meals at $9, its revenue would be $27, its total costs would be $35, and it would lose $8.

We then handed out personal information sheets. The distribution of Buyer Values was as in Table R.8.1

After distributing the personal information sheets, we told the students

Table R.8.1: Distribution of Buyer Values

Buyer Value	Number of Buyers
24	8
18	8
12	8
8	10

that we were going to do a crude market survey, to give everybody an idea of the amount of demand. We asked students successively to raise their hands if their Buyer Values were \$24, \$18, \$12, and \$8. We did not, at this point, write anything on the board. Therefore at the time that students made their first decisions about whether to open a restaurant, they had a rough idea of the nature of demand, but they did not know enough about the demand curve to be certain of the number of restaurants that the market could profitably sustain.

Students were asked if they had any questions: One student asked whether, if she opened a restaurant, she would make profits both in her role as a restaurant owner and as a consumer. The answer is "Yes." One student asked whether a restaurant-owner could eat at his own restaurant. The answer is "Yes." Another student asked whether somebody who chose to open a restaurant in the first round of the first session was committed to opening a restaurant in the second round of the same session. The answer is "No."

Experimental Results and Competitive Theory

Session 1, Round 1

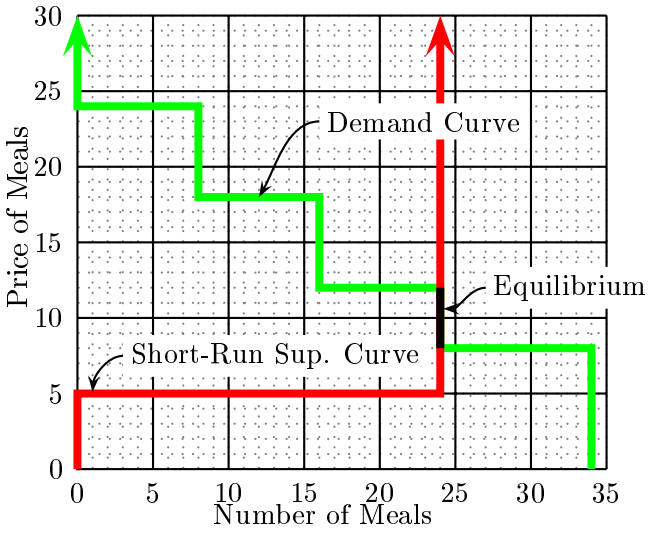
In the first round, we asked students in succession whether they wanted to open a restaurant, starting with students who had Type D (low value for meals) Personal Information Sheets. After each new entrant, we announced the number of restaurants now open and asked whether anyone else wanted to open a restaurant. In the first round of Session 1, 6 students chose to open restaurants.

The short-run supply and demand curve for this round are drawn in Figure R.8.1. In short-run competitive equilibrium, quantity is 24 and all 6 restaurants produce to full capacity, each selling 4 meals. The equilibrium price range is from \$8 to \$12. In short-run competitive equilibrium, restau-

rants make a profit if the price is above $10, a loss if the price is below $10, and they break even at a price of $10.

The *long-run* equilibrium number for this market turns out also to be 6, with a long-run equilibrium price of $10.

Figure R.8.1: Short-Run Supply and Demand Session 1, R1



In the actual experiment, average price was $10, and the total profits of the six restaurants were 0. Two of the restaurants lost money and four made profits. One of the money-losers posted the low price of $7 at the beginning of trading and sold out his capacity immediately. The other money-loser posted a high price at first and then when he failed to attract customers, lowered his price to $8. The sales and profits of each restaurant are reported in Table R.8.2.

After this round was completed, we announced the profits or losses of each restaurant. We also reported the exact distribution of Buyer Values in the class and drew the corresponding demand curve. We drew the short-run supply curve and found the short-run equilibrium price range. Then we held a brief discussion of short-run equilibrium.

We deliberately did not discuss the question of whether the number of entrants to the industry was the long-run equilibrium number and we started a second round of Session 1.

Table R.8.2: Restaurant Profits Session 1, Round 1

Restaurant	Prices of Meals				Revenue	Costs	Profit
1	14	10	10	10	44	40	4
2	11	11	11	11	44	40	4
3	12	12	12	12	48	40	8
4	7	7	7	7	28	40	-12
5	11	11	11	11	44	40	4
6	8	8	8	8	32	40	-8

Session 1, Round 2

For Round 2 of Session 1, restaurant costs and Buyer Values were the same as in Round 1, but we allowed students to reconsider their decisions about whether to enter the industry. Again we surveyed students in succession, asking whether they wished to open restaurants and announcing the number of current entrants before asking whether others wanted to enter. This time, (to the surprise and dismay of some earlier entrants) a seventh person chose to enter the industry.

The short-run supply and demand curves for this round are given in Figure R.8.2. The competitive equilibrium price is \$8 and the competitive equilibrium quantity is 28, with each of the 7 restaurants operating at full capacity. In short-run competitive equilibrium, each of the 7 restaurants loses \$8.

In the actual experiment, the average price was \$9. Five of the firms lost money and two broke even. At the beginning of the round, a few meals sold for \$11, but many customers waited for restaurant owners to reduce their posted prices. Posted prices fell to \$10, then \$9, \$8, and finally to \$7, before all restaurants were sold out to capacity. The prices received for meals and the profits of each firm are reported in Table R.8.3.

At the end of this round, we reported the profits of each firm. We then drew the short-run supply curve on the graph with the demand curve, and we showed that competitive theory predicts losses for restaurants when there are as many as 7 restaurants.

After this round, there was a lively discussion about success and failure of small businesses. Students were well aware of the frequency of failures of restaurants, bars, and coffee houses, and of hopeful new entries.

In our discussion, we agreed that after Round 1, it was not silly for someone to think that a 7th restaurant could make a profit. Students had

Figure R.8.2: Short-Run Supply and Demand Session 1, R2

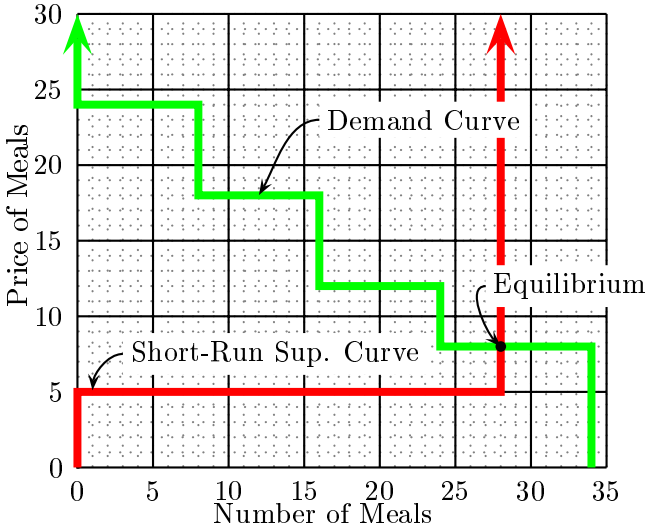


Table R.8.3: Restaurant Profits Session 1, Round 2

Restaurant	Prices of Meals				Revenue	Costs	Profit
1	11	7	7	7	32	40	-8
2	11	11	8	7	37	40	-3
3	11	9	9	8	37	40	-3
4	8	8	8	8	32	40	-8
5	11	11	9	9	40	40	0
6	11	11	9	9	40	40	0
7	11	10	7	7	35	40	-5

seen that in Round 1, four firms made profits and only two made losses. In our discussion, we observed that in the real world, it might similarly be unclear whether the market had room for a new entrant.

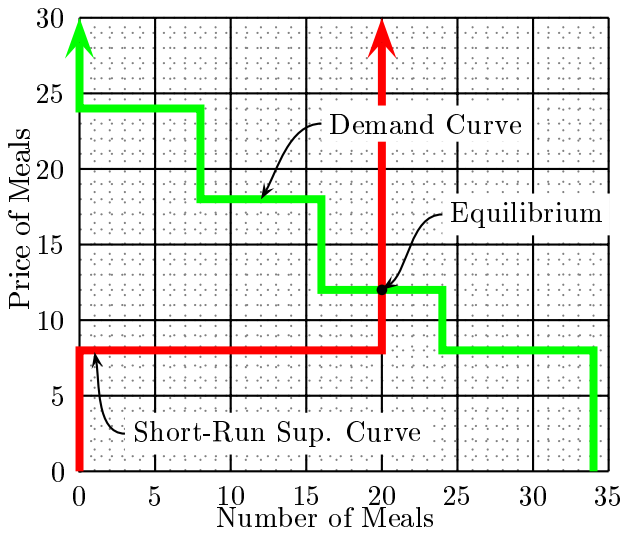
Rather than run another round of this session, we discussed what we thought would be likely to happen in a third round. Students were quite certain that after this lesson, nobody would try to open a 7th restaurant.

Session 2, Round 1

In Session 2, the Buyer Values are the same as in Session 1, but firms now have to pay a sales tax of \$3 per meal, so their variable costs are \$8 rather than \$5 per meal.

In the first round of this session, 5 students chose to open restaurants. The short-run supply and demand curves are as in Figure R.8.3. In the short-run competitive equilibrium with 5 restaurants, the equilibrium price is \$12. At equilibrium, each restaurant would sell 4 meals for a total revenue of \$48, but each has total costs of \$52, which implies that all would lose money.

Figure R.8.3: Short-Run Supply and Demand Session 2, R1



In the experimental market, three of the five firms lost money, one made a profit, and one broke even. The outcomes are as reported in Table R.8.4

After the round was over, we reported the profits of each restaurant to the

Table R.8.4: Restaurant Profits Session 2, Round 1

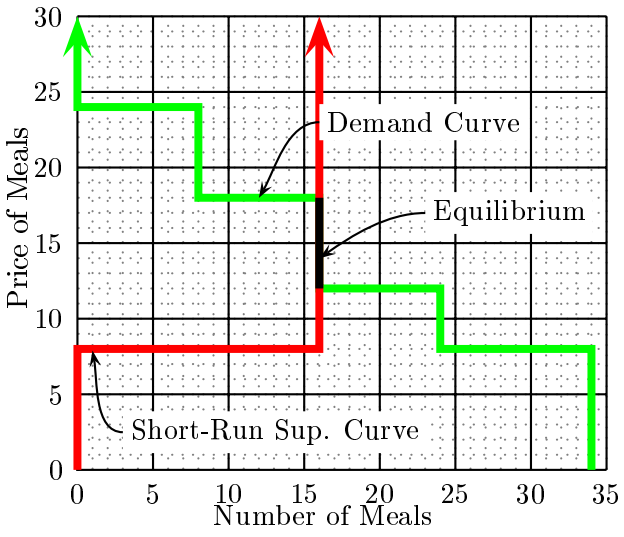
Restaurant	Prices of Meals				Revenue	Costs	Profit
1	13	13	13	13	52	52	0
2	14	14	14	14	56	52	4
3	11	11	11	11	44	52	-8
4	13	11	11	11	46	52	-6
5	10	10	10	10	40	52	-12

class. We drew the short-run supply and demand curves on the blackboard and found the short-run competitive equilibrium price with 5 restaurants.

Session 2, Round 2

In the second round of Session 2, students were again allowed to decide sequentially whether to open a restaurant. This time, only 4 students chose to open restaurants. The short-run supply and demand curves are as drawn in Figure R.8.4. As the figure shows, there is a range of possible competitive equilibrium prices, ranging from \$12 to \$18; a range which includes the break-even price of \$13 per meal.

Figure R.8.4: Short-Run Supply and Demand Session 2, R2



In the experimental market session, the average price paid for a meal was $13.87. As can be seen from Table R.8.5 all four restaurants made positive profits.

Table R.8.5: Restaurant Profits Session 2, Round 2

Restaurant	Prices of Meals				Revenue	Costs	Profit
1	14	14	14	14	56	52	4
2	14	14	14	14	56	52	4
3	14	14	14	14	56	52	4
4	16	14	12	12	54	52	2

All transactions took place within the short-run competitive equilibrium price range. The first posted prices were all $16 or higher, but buyers were resistant. At this price, only one buyer made a purchase. When there was no further trading at $16, we asked sellers if they wished to post new prices. At first, none of them would lower prices below $16. One seller said, "It's the principle of the thing." When no customers appeared, the market manager said, "I will close the market on the count of 3." When the count reached 2, one owner lowered his price to $14 and sold all of his capacity. Shortly thereafter, the others lowered their prices to $14, and two more sold out their capacity. An interesting thing happened with the last restaurant to sell out its capacity. After it had sold 2 meals, it could not get anyone else to buy at $14. It lowered its price to $13 and still was unable to sell. At this time, there were two buyers with Buyer Values of $18 who had not yet made a purchase. They did not budge. One student called out, "You don't have to cut your price. Just count who must be left." Another student said, "Raise your price." Restaurant Number 4, however, lowered its price to $12 and then was able to sell its last 2 meals. At the end of the market, Seller Number 4 was in a relation of bilateral monopoly with each of the two remaining $18 buyers. One might have expected that Number 4 could have bargained for a price approximately half way between the $18 that these two buyers would have been willing to pay and the $12 price at which the buyers with the next lower buyer values would be willing to enter the market. But Restaurant Number 4 finally dropped its price to $12, at which time the two remaining buyers with $18 Buyer Values materialized. The last buyer declared, with his best poker face, that he would have held out for a lower price, but he wanted to finish the session, so he could go home.

Experiment 9

Network Externalities

This experiment run was run at the University of California Santa Barbara in the Winter Quarter of 1999, in a Principles of Economics class of 500 students. The experiments were run by graduate teaching assistants in 10 sections, each of which had about 50 students.

Students liked this experiment a lot. Many went out of their way to tell us that this was their favorite of all the experiments they did during the quarter. Students were intrigued to see that economics has interesting things to tell us about a hot, new industry like information technology. They were especially engaged in the dramatic events of the market with competing standards, with its parallels to real-world market events.

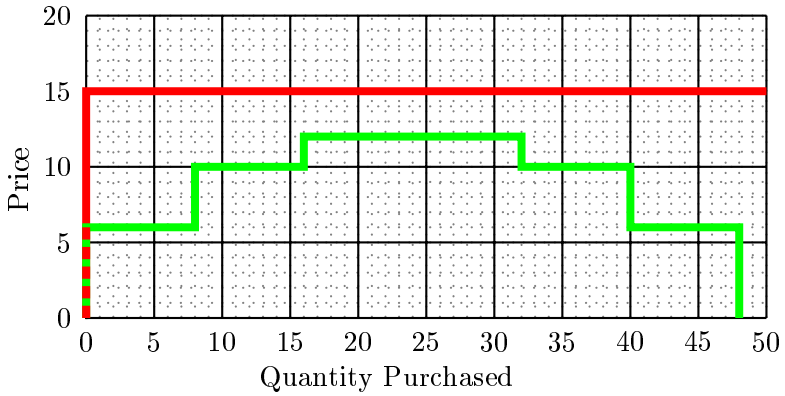
The length of each section meeting was 70 minutes. In this time we were able to run two or three rounds of Session 1, three or four rounds of Session 2, and one round of Session 3. In a 50 minute session, you should be able to run two rounds of Session 1 as well as two or three rounds of Session 2.

Predicted Results for Session 1

In Round 1, the market manager is willing to supply as many Picture Phones as students chose to buy at a price of \$15 and nothing at prices below \$15. Figure R.9.1 shows the "no-regrets demand curve" for a class of 48 students. The supply curve has a horizontal segment at a height of \$15 and a vertical segment that follows the vertical axis from the origin to the point $(0, \$15)$. The supply curve meets the demand curve only at a quantity of 0. Thus the only equilibrium is one in which no units are sold.

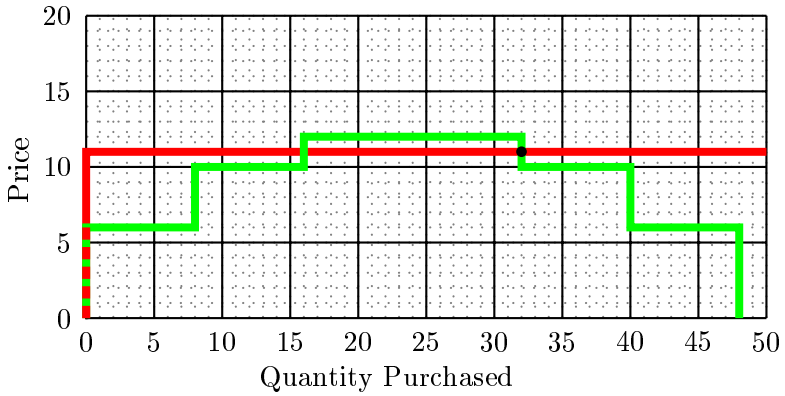
In Round 2, the market manager supplies Picture Phones at a price of \$11. Figure R.9.2 shows the "no-regrets demand curve" along with a

Figure R.9.1: Demand and Supply with Costs of $15



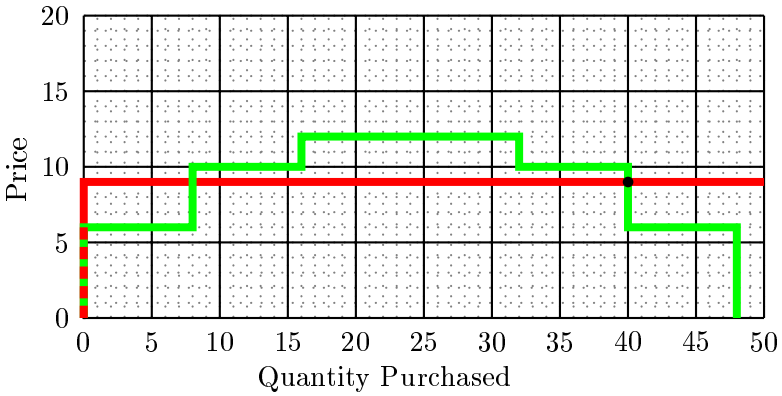
horizontal segment at a height of $11. The supply curve meets the demand curve at two stable equilibria, one with a quantity of 0 and one with a quantity of 32 units. Thus the theory predicts that the equilibrium quantity could be either 0 or 32.

Figure R.9.2: Demand and Supply with Costs of $11



In Round 3, the market manager supplies Picture Phones at a price of $9. Figure R.9.3 shows the "no-regrets demand curve" along with a horizontal segment at a height of $9. The supply curve meets the demand curve at two stable equilibria, quantities of 0 and 40 units. Thus the theory predicts that the equilibrium quantity could be either 0 or 40.

Figure R.9.3: Demand and Supply with Costs of $9



Results from Session 1

Round 1

In round 1, in most sections, about 4 or 5 optimists (not always people with the highest Initial Values) would sign up for Picture Phones. Despite the urgings of these bold pioneers, nobody else would sign up. The Net Externality Factor therefore remained at 1, and all of the individuals who signed up lost money. (With a N.E.F. of 1, the highest Buyer Value would be only $1 \times 6 = \$6$, which is less than the cost of a phone.) We surveyed the students about whether anyone would want to buy a phone if we ran this round again at a price of $15. Nobody wanted to do so.

In one section there was a large failed boomlet. In this case 17 students signed up. The number of complete six-packs distributed was 8, so that the N.E.F. was 3. With a N.E.F. of 3, those buyers with Initial Values of 6 made a profit and those with Initial Values of 5 broke even. But some of those who bought phones had Buyer Values of 4 or less and they lost money.[1]

The most intriguing outcome in the first round of Session 1 was the result of a mistake on our part. In one of the sections we had the following distribution of Initial Values. There were 7 students with Initial Values of 6, 7 with Initial Values of 5, and 6 each with Initial Values of 4, 3, 2, and 1. We were very surprised to see that 26 students bought Picture Phones at $15. We were even more surprised when we realized that none of them lost money. We had distributed 6 complete six-packs as well as additional

[1] It would have been interesting if we had run this round over again with a price of $15, but this wasn't done.

sheets with I.V.'s 6 and 5. With 26 students, the N.E.F. is 5. With a N.E.F. of 5, students with I.V. 's of 3 break even by buying a phone and those with I.V. 's greater than 4 make a profit. Our mistake in this instance was to distribute high I.V. sheets rather than low I.V. sheets to the leftover students. We found it quite remarkable that this class was able to achieve this very delicate task of coordination.

Round 2

We tried a price of $11 in 3 of the 10 sections. In two of these sessions, the students coordinated on the high-level equilibrium in which students with Initial Values of 6, 5, 4, and 3 bought phones. When this happens, the N.E.F. is 4. Therefore students with Initial Values of 3 or higher had Buyer Values of $12 or higher and all made a profit. Students with Initial Values of 1 or 2 would all lose money if they bought phones.

Round 3

We tried a price of $9 in 8 of the 10 sessions that we ran. In all 8 of these sessions, students found the high-level equilibrium in which students with Buyer Values of 6, 5, 4, 3, and 2 bought phones. When this is the case, the the N.E.F. is 5. Students with I.V.'s of 2 or higher will have Buyer Values of $10 or higher. Students with I.V.'s of 1 will have Buyer Values of only $5.

We had not expected to see such universal convergence to the high-level equilibrium. It was interesting to watch it happen. Typically there would be a few optimists at the beginning, and a lot of hesitators. In one section, an eager student shouted out "Look. I've done the math! It will work!" He then proceeded to explain his reasoning to everyone who would listen. There were dramatic tipping points as the N.E.F. reached 2, bringing in all of the stragglers with I.V.'s of 5 and 6, and again when the N.E.F. reached 3, bringing in the most cautious of the 4s and 3s, and again when it reached 4 and 5.

Session 2

Theory does not provide us with detailed guidance about what to expect in three or four rounds of Session 2. In fact, there were quite diverse outcomes across the 10 sections that ran this experiment. In all sections, students participated with raucous enthusiasm.

In three sections, the leader after the first round had either gone out of business or was operating unprofitably by the end of the last round. In four sections, the leader after the first round had either a monopoly or a dominant market share by the end of the last round. In three of the sessions, two or more firms continued to hold significant market shares at the end of the last round.

An interesting story could be told about events in each of the section meetings. We will confine our account to two sections in which the sequence of events was fairly different. We will call these Section A and Section B.

Shades of Apple? A Hint of Linux?

In Section A there were 42 participants. In Round 1 of Session 2, the three firms began by posting prices of $6 or $7. During this round, none of them lowered their prices below the marginal cost of $5. One seller sold 15 units and thus had a Network Externality Factor of 3. The other two sellers sold 14 and 11 units respectively, and so had Network Externality Factors of 2. At the beginning of Round 2 of Session 2, the seller who had the early lead attempted to take advantage of her higher N.E.F. by raising her price to $13. One of the other firms started to sell a lot of units at $5, at which point the early leader cut her price back to $7 and then $5. The early leader thus maintained her market share. In the third round of this session, the supplier who had been in third place wrote FREE SOFTWARE! on the blackboard. The demanders started to chatter about this new development, and one of them made a little speech about how if everyone got the free Software, all demanders would get Buyer Values of $60. This would make it worthwhile for everyone to switch operating systems, even after paying the learning cost. About 80% of the demanders went to the seller whose price was zero. The remaining 20% of the demanders stayed with the original leader. In the fourth round of this session, the original leader stayed in the market. The supplier who had offered free software and now had the largest customer base posted a price of $10. The original leader tried a price of $7 and then $3. The original leader got only two customers and the insurgent got all of the rest.

In this section, as in two other sections that we observed, when the early leader attempted to capitalize on her larger market share and resultant higher Buyer Values, she lost out to a challenger who initially charged lower prices. This resonates with the experiences of several early leaders in the computer software industry, such as WordStar in word processing, Lotus in spreadsheets, and Apple in operating systems. The effort to gain market

share by offering "free software" is reminiscent of the strategy pursued by NetScape for Web browsers. There is also an intriguing parallel to linux and the "free software movement." Currently, Linux can be downloaded for free or can be purchased at a relatively low price from commercial vendors with some support materials.

An Emergent Bill Gates?

In Section B there were 45 participants. In Round 1 of Session 2, one of the Sellers priced more aggressively than her two competitors. While the others posted prices of \$5 or \$6, she set a price of \$1, and later \$0. She attracted almost all of the buyers in the first round, so that the other two firms went out of business at the end of the first round. Therefore, when the second round began, she was a monopolist. At the beginning of the second round, she carefully explained to all of the students that if everyone bought from her, each would have a Buyer Value of \$60. She then said: "I am not going to be a pig about this. I know that my product is worth \$60, but I am going to sell it for \$35." There was a great deal of grumbling from demanders, and nobody went up to buy from her initially. Some demanders loudly pointed out that her marginal costs were only \$5, and that if they waited long enough she would have to cut her price. The seller looked at the demanders and thought for a minute. Then she said. "OK, OK. Here's the deal. The FIRST TEN BUYERS will get it for \$30. After that I will raise the price to \$40." Three or four demanders raced up to buy. Then the gates opened. There was a rush to join the first ten, and after that all but two or three demanders bought at \$40.

Session 3

In nine of the ten sections, the new firm with the superior technology had the dominant market share by the end of the first round. There was one close call. In the section described above as Section B, the monopolist who operated so successfully in Session 2 cut her price back to her marginal cost of \$5. She got several early buyers and for a while it appeared that the insurgent wouldn't get a foothold. Finally, the insurgent cut her price and by the end of the first round, the insurgent got more than half of the market.

Experiment 10

Measuring Productivity

This experiment was conducted at the University of Michigan with a class of 33 students. The entire experiment took about 70 minutes. The experiment was followed by a 5-10 minute discussion. The session was more boisterous than most experiments, but enjoyable, and we think instructive.

Because of an organizational snafu, students had not seen the airplane-making instructions before class, and so we spent 10-15 minutes at the beginning of class, practicing airplane-making. Each student in the class was allowed to make and fly a practice airplane. We also decided to run one session with 1-person firms.

In the first session, each individual was given three minutes to make as many airplanes as possible. Airplane specifications were modified so that individual students didn't need staplers or scissors. Students were allowed to simply tell how many airplanes they had made. We did not verify that these planes were up to standard. The productivities claimed by the one-person firms were as follows: 8 people made 1 airplane, 12 people made 2, 10 people made 3, and 1 person made 6. The mean output per worker was 2.19 airplanes.

We then organized five five-person firms. Each firm was assigned a quality-control inspector; a student who was not a member of the firm. The outputs of these five firms were 7, 8, 9, 10, and 10 airplanes, so that average output per worker was 1.7.

We next organized three ten-person firms, whose outputs were respectively, 7, 15, and 17. Average output per worker was 1.3. (The firm that produced only 7 had a large inventory of partially-completed planes when time was up.)

We organized two fifteen-person firms whose outputs were 8 and 25. The

firm that produced only 8 units included the 10 workers who had previously produced only 7. Members of this firm complained that their quality-control inspector was too harsh. This quality control inspector maintained that he was using the same standards he had applied in the previous session, when he had monitored the output of a firm that produced 17 planes.

In the final session, we had a firm with 25 members. Its total output was 22. Average output was .88. Because of the lack of space and the bottlenecks caused by the requirement that the firm use a single stapler, scissors and pen, several members of this firm simply stood around during the production process.

Experiment 11

Comparative Advantage

This experiment was run with a class of 33 students at the University of Michigan in Winter, 1996. Of these students, 11 were assigned to be Richlanders and 22 to be Poorlanders.

In Session 1, students were asked to submit slips of paper on which they were supposed to select a profit-maximizing output, given that they were not able to trade. The correct answer for Richlanders was to produce 8 units of each good and the correct answer for Poorlanders was to produce 4 units of each good. All Poorlanders, and 8 of the 11 Richlanders got the answer right.

In Session 2, trade was allowed. The competitive equilibrium has Richlanders specializing in fish, Poorlanders specializing in bread, and people trading fish for bread at a price of about 1.

In the first round of Session 2, only 4 of the 11 Richlanders and only 7 of the 22 Poorlanders specialized. When profits were calculated, it was found (and reported) that in each country, those who specialized made higher profits. In Round 2 of Session 2, 8 of the 11 Richlanders specialized in bread and 21 of the 22 Poorlanders specialized in fish. Trading proceeded rapidly, with almost everybody trading at the rate of one unit of fish per unit of bread. Of those who specialized, all Richlanders and all but one Poorlander were able to trade to a point where they consumed equal amounts of each of the two goods.

Experiment 12

Adverse Selection

This experiment was conducted at the University of Michigan, in Winter, 1996, with a class of 36 students.

Experimental Results

Session 1

In Session 1, each student was asked to write down a price that he or she would offer for used cars if he or she were the only car dealer in town, given two situations. In Situation (i), there are 6 lemons and 6 good cars in town. In Situation (ii), there are 8 lemons and 4 good cars in town. The profit-maximizing answer is $1601 in Situation (i) and $1 in Situation (ii).

Of the 36 students in class, 31 correctly answered $1601 in Situation (i). Two students answered $1200, and one answered $800. These students made big losses, because the prices that they offered were higher than the value of lemons, but not high enough to attract the good used cars, so each of them would buy 6 lemons. One of the remaining students offered a price of $5, and one offered a price of $1700. These two students each made positive profits less than the maximum possible.

Of the 36 students in class, 29 correctly answered $1 in Situation (ii). Three students answered $1601, which is greater than the average value of a used car in this town, and hence results in a loss. Three students offered prices in the range from $600 to $1000. These offers would attract only the lemons and would lose money for the buyer. One student offered $5, which is close to a profit-maximizing offer.

When Session 1 was completed, we discussed the correct answer, in hopes of getting everyone to understand the principle of adverse selection.

Session 2

In Session 2, there were 5 used-car dealers. Everyone was informed that 14 lemons and 13 good used cars were available in the market. The average value of used cars, if all came to market, would be $1944. There is a competitive equilibrium with self-confirming beliefs, in which cars sell for just under $1944, and all used cars come to market.

At the beginning of trade, 4 of the 5 dealers posted prices just over $1600 and one posted a price of $1900. The dealer who posted a price of $1900 was able to buy 19 of the 27 cars. Eventually the other dealers realized that they would have to raise their prices to get any purchases. One dealer was able to buy 5 cars at $1800. (This dealer may have been able to get some purchases at $1800, because of congestion at the $1900 dealer's spot.) Near the end of trading, one other dealer raised his price to $2550 and bought two cars (for a loss of about $600 per car), one bought a used car for $1950 and one bought a used car for $2000.

Session 3

In Session 3, there were again 5 used-car dealers. Everyone was informed that 20 lemons and 7 good used cars were available in the market. The average value of used cars, if all come to market, would be $1278. This price is lower than the price of $1601 needed to induce the owners of good used cars to sell their cars. There is a competitive equilibrium with self-confirming beliefs, in which cars sell for just under $500, and only the lemons are brought to market.

In the first round of this session, 26 of the 27 cars sold for prices between $1601 and $1703, and one sold for a price of $450. All cars came to market. Since the average used car was worth only $1278, all buyers lost money.

In light of this result in the first round, we conducted another round, with the same, poorer but wiser, car dealers. In this session, 25 of the 27 used cars sold for prices between $450 and $490, one car sold for $200, and one sold for $100. This result seems a good approximation to the prediction of the model of competitive equilibrium with self-confirming beliefs.

Session 4

In Session 4, with certification, the competitive solution is for lemons to sell for just under $500 and for good cars to sell for just under $3500. There

were 16 lemons and 15 good cars. [1]

Dealers posted separate prices for lemons and for good cars. Of the lemons, 13 sold for prices between \$450 and \$495. One lemon sold for \$300 and two for \$400. (The last two lemons to be sold went for \$490 and \$495.) Of the good cars, 10 sold for prices between \$3300 and \$3400, and 13 sold for prices above \$3000. The lowest price paid for a good used car was \$2500.

Related Experimental Literature

Several interesting experiments involving asymmetric information can be found in the literature. A survey of such experiments can be found in Davis and Holt [3].

[1] This differs from the proportions used in the current experimental design where, for this session, 2/3 of the used cars are lemons.

Experiment 13

Auctions

Experimental Results

This is a report on an experiment conducted at the University of Michigan in Winter, 1996, with a class of 36 students, during a class period of 80 minutes. The class was divided into four groups of nine students each.

Four Types of Auctions

The results of the English Auction are found in Table R.13.1.

Table R.13.1: Results of English Auction

Group	A	B	C	D
High Bid	97	85	85	85
Second-high Bid	96	80	80	83
High Bidder's B.V.	99	95	91	91
Highest Other B.V.	96	83	80	80
High Bidder's Profit	2	10	6	6

Results of the Dutch Auction are found in Table R.13.2.
Results of the first-price, sealed-bid Auction are found in Table R.13.3.
Results of the second-price, sealed-bid Auction are found in Table R.13.4.

Results of Discussion Session Auctions

In the pennies-in-a-jar auction, the jar contained 240 pennies. The highest bid was $10. The high bidder lost $7.60.

Table R.13.2: Results of Dutch Auction

Group	A	B	C	D
High Bid	97	75	77	62
High Bidder's B.V.	98	86	83	65
Highest Other B.V.	99	67	70	68
High Bidder's Profit	1	11	6	3

Table R.13.3: Results: First-Price Sealed Bid Auction

Group	A	B	C	D
High Bid	92	77	80	90
Second-high Bid	65	76	60	82
High Bidder's B.V.	97	79	84	98
Highest Other B.V.	70	98	67	87
High Bidder's Profit	5	2	4	8

Table R.13.4: Results: Second-Price Sealed Bid Auction

Group	A	B	C	D
High Bid	96	90	97	10 bil.
Second-high Bid	87	82	90	95
High Bidder's B.V.	96	89	97	96
Highest Other B.V.	92	82	89	95
High Bidder's Profit	9	7	7	1

In the unreliable accountants experiment, in each group, the object sold for more than its actual value of $120. The sales price ranged from $130 to $160.

In the escalation auction, the dollar bill sold for $2.25. The second-highest bid was $2.20. The high bidder lost $1.25. The second-highest bidder lost $2.25.

Comments on Auction Results

In the English auction, the object always went to the person with the highest Buyer Value at a price slightly above the second-highest Buyer Value.

In the Dutch auction, for groups B,C, and D, the object went to the person with the highest Buyer Value at a price below the highest Buyer Value. In group A, the result was more interesting. The person with the highest Buyer Value had a social security number ending in 99. Since he had won the English auction, his number became known to the class when we posted the results of the English auction. There was a student in group A who had a Buyer Value of 98. She realized that she would have to bid early to beat the person with Buyer Value 99, so she said "Mine!" at a price of 97 and won the object.

In the first-price, sealed-bid auction, the object went to the person with the highest Buyer Value in three of the four cases.

In the second-price, sealed-bid auctions held in the four groups, three of the four high bidders and three of the four second-highest bidders, made bids within $1 of their Buyer Values. One of the high bidders bid $10 billion. He was lucky, and nobody bid more than his Buyer Value, which was $96, so he got the object for $95, which was the second-highest Buyer Value. If someone had known that there was a bid of $10 billion, they could, of course, have punished this bidder severely by bidding $9 billion, in which case $10-billion bidder would have gotten the object, but would have had to pay $9 billion.

Related Experimental Literature

There is a fascinating body of experimental literature on auctions. Experiments have been run with several alternative auction mechanisms and with private-values and common-values informational environments. This literature is well summarized in a survey article by John Kagel in a chapter of the *Handbook of Experimental Economics* [5].

Experiment 14

Bargaining

This is a report on a bargaining experiment run at the University of Michigan in a class of 34 students in Winter, 1996.

That experiment was conducted with a slightly different story, in which the seller had a reservation price of $100. In the current version, the seller's reservation price is 0. We made this change to simplify computation and avoid confusion. We expect that the results with our current design would be similar to the ones found here where offers and counter-offers are $100 lower than those found here.

Experimental Results

Session 1, The Ultimatum Game

In Session 1, if the players all played subgame perfect strategies, buyers would offer $101 and sellers would accept. In the actual experiment, the mean offer was $114.5. Of the 10 students who offered $115 or less, 6 had their offers rejected. The offers of all 7 students who offered more than $115 were accepted.

Session 2, Two-Stage Bargaining

For Session 2, the subgame perfect outcome is that the buyer makes an initial offer of $130, and the buyer accepts the offer. Sellers should reject any offer lower than $129. The actual results of the two-stage bargaining experiment are reported in Table R.14.2. As the table indicates, five buyers offered $125 and all five of these offers were accepted. The mean offer was $117.

The results of the first session are reported in Table R.14.1.

Table R.14.1: Offers and Responses in the Ultimatum Game

Buyer's Offer	Accept or Reject
101*	Accept
101	Reject
101	Reject
105	Reject
110	Accept
110	Accept
110	Reject
112	Accept
115	Reject
115	Reject
120	Accept
120	Accept
122	Accept
125	Accept
127	Accept
145	Accept

* With the current experimental design, a pay-off equivalent bid would be $100 lower than those reported here.

Table R.14.2: Outcomes of Two-Stage Bargaining

Initial Offer	Accept or Counteroffer	Counteroffer Accepted?
110*	120	Yes
115	125	No
115	Accept	[redacted]
120	121	No
120	121	No
120	124	Yes
125	Accept	[redacted]
125	Accept	[redacted]
125	Accept	[redacted]
125	Accept	[redacted]
125	Accept	[redacted]
129	Accept	[redacted]
129	Accept	[redacted]
130	Accept	[redacted]
132	Accept	[redacted]
135	Accept	[redacted]

* With the current experimental design, a pay-off equivalent bid would be $100 lower than those reported here.

Session 3, Three-Stage Bargaining

The subgame perfect outcome for Session 3 is that the buyer makes an initial offer of \$113, and the buyer accepts this offer. The actual results of the three-stage bargaining experiment are reported in Table R.14.3. Only one buyer made the subgame perfect offer, and this offer was accepted. In all other cases, the buyer offered more than \$113. The average first offer was \$126. The buyer's offer was accepted in every instance but one. In the one case where agreement was not reached, the buyer's offer of \$119 was rejected. The seller then made a counteroffer that was larger than the subgame perfect counteroffer. The buyer made a second offer of \$101, which the seller did not accept, so buyer and seller both got profits of 0.

Table R.14.3: Outcomes of Three-Stage Bargaining

Initial Offer	Accept or Counteroffer	Counteroffer Accepted?	Second Offer	Second Offer Accepted?
113*	Accept			
118	Accept			
119	125	No	101	No
120	Accept			
125	Accept			
125	Accept			
125	Accept			
125	Accept			
125	Accept			
130	Accept			
130	Accept			
130	Accept			
130	Accept			
130	Accept			
130	Accept			
130	Accept			
133	Accept			

* With the current experimental design, a pay-off equivalent bid would be \$100 lower than those reported here.

Remarks

This was a lively experiment. Some students got fairly angry at their classmates, lamenting their greed, stubbornness, or stupidity. Although, in the two-stage procedure, most students did not behave as the model of subgame perfection predicts, a handful of them were able to "solve" for the subgame perfect outcomes by working backwards. Some of these students eagerly explained their insights to others during the course of bargaining.

Related Experimental Literature

The subject of sequential bargaining has attracted the attention of many of the most capable experimental economists, who have been exploring such questions as: Do bargainers eventually learn to behave according to the rules of subgame perfection? Is their behavior determined by notions of fairness rather than self-interest? How are notions of fairness formed in the case of asymmetric games? Fine introductions to this intriguing literature can be found in the survey article on bargaining experiments by Alvin Roth in the *Handbook of Experimental Economics* [5] and in the discussion of bargaining games in *Experimental Economics* by Davis and Holt. [3]

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