

## Experiment 2

# Adverse Selection

### A “Lemons” Market

If you have ever purchased a used car from a stranger, you probably have worried about whether she was telling you the whole truth about the car. Perhaps you thought: “The seller knows a lot more about her car than I do. If the car is any good, why does she want to sell it?”

Today’s experiment simulates a used-car market. There are two kinds of used cars in the market, bad used cars (commonly known as “lemons”) and good used cars. Used-car owners sell their cars to car dealers.<sup>1</sup> Dealers are unable to tell the difference between good cars and lemons.<sup>2</sup> Sellers, on the other hand, have lived with their cars and know very well whether their car is a lemon or not.

### Instructions

#### Used Car Owners (Suppliers)

An owner’s **reservation price** for an object is the smallest price that the owner would accept for the object. Thus if you are a used-car owner, you will want to keep your car unless you are offered at least your reservation price. You should be willing to sell to the person who makes you the highest offer that is greater than your reservation price.

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<sup>1</sup>Although people usually associate car dealers with the role of sellers, in this experiment they function as buyers purchasing cars for resale.

<sup>2</sup>Some macho buyers may kick the tires and lift up the hood; they may even talk about fuel pumps and suspension systems, but this is all for show.

In this experiment, some used-car owners will have lemons and some will have good used cars. Understandably, owners of good used cars will have higher reservation prices for their cars than lemon owners. The owner of a good used car has a reservation price of \$1600 for her car, and a lemon owner has a reservation price of \$0. A used-car owner's profit from selling her car will be the price she receives for it minus her reservation price. If she doesn't sell her car, her profits are zero.

### Used-Car Dealers (Buyers)

Some people are willing to pay more for used cars than these cars are worth to their current owners. In fact, there are a large number of people who are willing to pay \$500 for a car that is known to be a lemon and \$3500 for a car that is known to be good. These consumers are not directly represented by participants in the experiment, but their willingness-to-pay determines the Buyer Values of the dealers. Dealers will discover the quality of each car that they buy shortly after they buy it, and they are required by law to reveal this quality to consumers. Dealers can resell good used cars for \$3500 and lemons for \$500 each.

### Session 1—Monopolistic Used-Car Dealers

This session consists of a thought experiment, in which you decide what price to offer for used cars. Before you come to class, read through these instructions and work the warm-up exercises. These will help you to decide on the most profitable actions to take in this session.

Imagine that you are the only used-car dealer in town. All used-car owners in your town must either sell their used cars to you or keep them. At the time you buy a used car, you cannot tell whether it is a good used car or a lemon. However, between the time you buy the car and the time you resell it, you will find out whether the car is a lemon or a good car. You will resell all of the cars that you buy. You can resell lemons for \$500 and good cars for \$3500.<sup>3</sup> Your profits are equal to the revenue you get from reselling cars minus the total amount of money you pay for cars. You must post a single price at which you are willing to purchase all used cars that are brought to you. Buyers will bring their cars to you if the price you post is higher than their reservation prices.

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<sup>3</sup>In your town, used-car dealers (unlike the initial owners) are required by law to reveal the actual quality of their cars to their customers.

We consider two alternative situations. In Situation A, there are six good used cars and six lemons in your town. In Situation B, there are four good cars and eight lemons in your town. In this session you will be asked to submit your name or identification number, the price that you would offer for used cars in Situation A, and the price that you would offer for used cars in Situation B.

### Session 2—A Competitive Used-Car Market

In this session, the used-car market is competitive and car buyers interact with sellers. Most class members are used-car owners (sellers). Half of the car owners have good used cars and half of them have lemons. Some class members are used-car dealers. If you are a dealer, you will be given some blackboard space on which you can post the price that you are willing to pay for used cars. You can change your posted price at any time. You can buy as many used cars as people are willing to sell to you. When you buy a car, you should record the seller's identification number on your Record of Purchases. At the time of the purchase, you will not know which cars are good and which are lemons.

At the end of trading, dealers will bring their Records of Purchases to the market manager. The market manager will calculate the average value of *all* used cars purchased by *all* dealers. If you are a dealer, the value to you of each used car that you buy will be equal to the average value of used cars purchased by *all* dealers. For example, suppose that all dealers combined purchased a total of 10 good used cars and 5 lemons. The average value of these cars is

$$\frac{(\$3500 \times 10) + (\$500 \times 5)}{15} = \$2500.$$

A dealer who bought 3 used cars will receive a total revenue of  $\$2500 \times 3 = \$7500$ . The dealer's profits are then  $\$7500$  *minus* the total amount she paid for the 3 cars that she bought.

### Session 3—A Used-Car Market with More Bad Cars

Session 3 is conducted exactly like Session 2, except that in this session, only 1/3 of the used cars are good and 2/3 of the used cars are lemons.

### Session 4—Quality Certification (Optional)

In this session, as in Session 3, 1/3 of the used cars are good and 2/3 are lemons. In this session, used-car owners who have good used cars are allowed

to show their Personal Information Sheets to dealers to prove that they have good used cars. Used-car dealers can ask to see an owner's Personal Information Sheet before buying a used car and can offer different prices to a seller depending on whether or not she can prove that she has a good car. When a used-car owner sells a used car to the dealer, the dealer should record the price and the seller's identification number on the dealer's Record of Purchases. If the seller proves that her car is a good used car, the dealer should mark an asterisk next to the price.

In Session 4 (unlike in Session 3), a dealer's revenue is equal to the total value of the cars *that he actually purchased* rather than the average value of all cars purchased by all dealers.

### Warm-up Exercise

**W 2.1**<sup>4</sup> Suppose that in Session 1, you are a monopoly car dealer in a town where six used-car owners have good cars and six have lemons. What is the lowest price at which lemon-owners would sell their cars? \_\_\_\_\_ Would the owners of good cars sell their cars at this price? \_\_\_\_\_ What is your profit if you offer this price? \_\_\_\_\_

**W 2.2** In Session 1, the lowest price at which *all* used-car owners will sell their cars is \_\_\_\_\_. What is your profit if you offer this price? \_\_\_\_\_

**W 2.3** In Session 1, if there are six good used cars and six lemons in town, what price should you offer for used cars in order to maximize your profits?  
\_\_\_\_\_

**W 2.4** In Session 1, suppose that the used-car owners in your town have four good cars and eight lemons. What is the lowest price at which lemon-owners will sell their cars? \_\_\_\_\_ If you offer this price, your profit is \_\_\_\_\_ . What is the lowest price at which *all* used-car owners will sell their cars? \_\_\_\_\_ If you offer this price your profit is \_\_\_\_\_ .

**W 2.5** In Session 1, if there are four good used cars and eight lemons in town, what price should you offer in order to maximize your profits? \_\_\_\_\_

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<sup>4</sup>Answers to these exercises can be found on page 17.

# Discussion of Experiment 2

## Markets with Asymmetric Information

Our experimental used-car market is an example of a market with **asymmetric information**. Asymmetric information occurs when traders on one side of the market know things that traders on the other side of the market do not. At first blush, asymmetric information might not seem to be a serious problem for markets. Usually it would be cheap and easy for traders who know things that others don't know to pass this information on. The problem, as you may have guessed, given your experiences in real-world markets and in the experiment, is that traders who have detailed information may benefit from concealing or misrepresenting this information. Talk is cheap. If a buyer offers a higher price to those who say they have good cars than to those who say they have lemons, lemon owners will want to say they have good cars. In the design of all sessions except Session 4, there is nothing to prevent them from doing so.<sup>5</sup>

### Adverse Selection

Asymmetric information often leads to a market problem that is known as **adverse selection**. Adverse selection occurs in a market when buyers or sellers would, on average, be better off trading with someone selected at random from the population than with those who volunteer to trade. A classic example of adverse selection occurs in used-car markets. As we saw in our experiment, it can happen that in equilibrium the used cars that come onto the market are not a random selection from the population of used cars but just the worst ones. When this happens, a used-car buyer who thinks that the used cars that are for sale are of average quality will be sadly mistaken.

The problem of adverse selection also applies to insurance markets. The customers that are most likely to want insurance are the people who face the highest risks, but these are the people that insurance companies would

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<sup>5</sup>In real life, even if you don't value the truth for its own sake, lying to those you deal with regularly will hurt you. If your acquaintances catch you in a lie, they are likely to mistrust you in the future. In an arm's length business encounter with someone whom you are not likely to meet again (like a stranger to whom you sell a used car) this constraint on behavior is missing.

least like to have as customers. For example:

- The people who most want to buy collision insurance for their cars are those who drive a lot and are most likely to have accidents.
- The people who are most eager to buy health insurance are those who have reason to think that they are going to have an expensive illness.
- The people who are most likely to buy life insurance are those who have reason to believe that they are likely to die soon.
- The people who are most eager to buy annuities are those who have reason to believe that they will live for a long time. (An **annuity** is a promise to pay somebody a fixed amount every year until he or she dies.)

Insurance companies are well aware that their customers will, on average, be worse insurance risks than a randomly-selected member of the population. Accordingly, instead of basing their estimates of the risks they face on statistics for the population as a whole, they base them on statistics for *insured* people in previous years.

### Moral Hazard

Another problem of asymmetric information, similar to adverse selection, is known in the insurance industry as **moral hazard**. Adverse selection occurs when your trading partners have less favorable *characteristics* than the population at large. Moral hazard occurs when the *actions* taken by your trading partners are less favorable for you than the actions of the average member of the population.

Examples of moral hazard include the following. People who have fire insurance will be less interested in preventing fires than those without fire insurance. People who have insurance against auto theft are likely to take fewer precautions against having their car stolen than people who do not have insurance. People with unemployment insurance may search less intensely for jobs. Workers whose performance is not monitored may shirk. Construction contractors whose work is not closely inspected may do shoddy work, the flaws of which do not become apparent until after they are paid.

With moral hazard, as with adverse selection, the problem is that people on one side of the market know something that the people on the other side do not. Moral hazard is sometimes called the case of **hidden action**. With

moral hazard, one side of the market is not able to observe the actions taken by the people they deal with.

Where moral hazard is a problem, the market participant without information tries to monitor performance of the participant with information, and to make this performance part of the terms of the contract. Fire insurance companies have inspectors who observe precautions taken by their large industrial customers. Auto theft insurers may give discounts to customers who have anti-theft devices on their cars. Unemployment insurance runs out after a few weeks of unemployment. Firms try to monitor their workers' performance. People that hire contractors often hire inspectors to observe that construction proceeds according to specifications. Because monitoring is expensive, and usually imperfect, even with monitoring the problem of moral hazard remains a serious one.

## Demand and Supply in a Lemons Market

Demand and supply analysis can help us to predict the outcome in a market where, as in our used-car experiment, there is adverse selection. Since suppliers know the quality of their own used cars, we can construct the supply curve in the same way that we drew supply curves for previous experiments. But drawing a demand curve requires more care.

At first glance, it may seem impossible to draw an appropriate demand curve for a lemons market. Demanders cannot observe the quality of a car before they buy it. The amount that a demander is willing to pay for a used car depends on the average quality of the used cars that are for sale. But, as we discovered in the experiment, the average quality of the used cars that owners are willing to sell depends on the price. So how can we draw a demand curve?

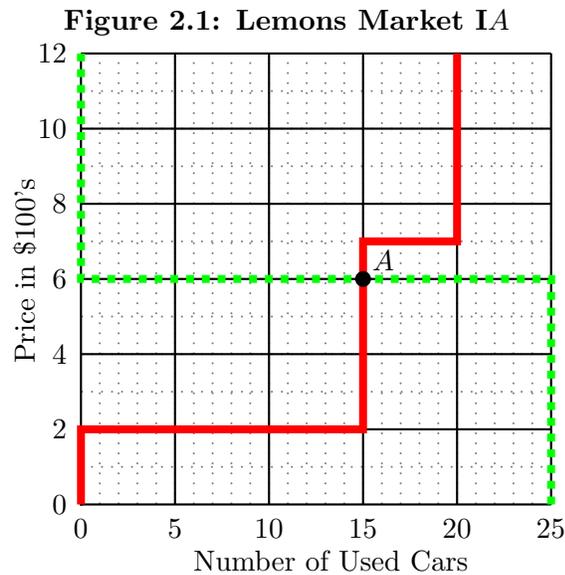
In order to determine equilibrium in a lemons market, we need to introduce a new idea, the idea of **self-confirming beliefs**. Self-confirming beliefs have the property that if people hold these beliefs and act on them, the consequences of their actions will be consistent with these beliefs. We illustrate the idea of self-confirming beliefs by considering two examples of lemons markets that are similar to the markets in our experiment.

### Example 1

There are 25 potential used-car buyers, each of whom is willing to pay \$1200 for a good used car and \$400 for a lemon. Potential buyers want to buy at

most one car. Before they purchase a used car, buyers are not able to tell whether it is a good used car or a lemon.

The current owners of good used cars have a reservation price of \$700 for their cars, and the current owners of lemons have a reservation price of \$200. In this market, there are 5 good used cars and 15 lemons. At prices below \$200, all current used-car owners would want to keep their cars, so no used cars would be offered for sale. At prices between \$200 and \$700, the lemon owners would all want to sell their cars, but the good car owners would want to keep their cars. Therefore at prices in this range, 15 used cars would be offered for sale, all of which would be lemons. At prices above \$700, all used-car owners would want to sell their used cars, and so all 20 used cars would be offered. We can draw the resulting supply curve for used cars on Figure 2.1.



### Mistaken Optimism in Example 1

Suppose that all of the potential buyers believe that all 20 used cars, the 5 good cars as well as the 15 lemons, will be offered for sale. If this is the case,  $1/4$  of the used cars for sale will be good and  $3/4$  will be lemons. Therefore buying a used car is like buying a lottery ticket where you have a probability of  $1/4$  of winning \$1200 (the Buyer Value of a good used car)

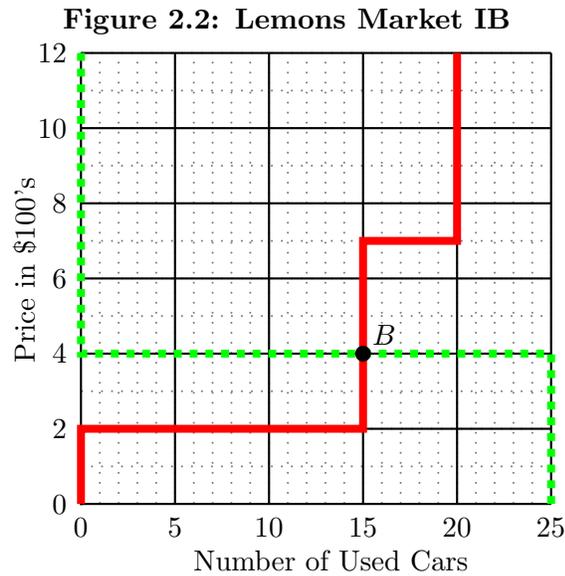
and a probability of  $3/4$  of winning \$400 (the Buyer Value of a lemon). We will assume that a buyer's willingness to pay for a lottery is the "expected value" of the lottery. The **expected value** of a lottery is equal to a weighted average of the possible amounts of payoff, where the weight placed on each possible payoff is the probability of receiving that payoff. In this example, the expected value of a used car is  $\left(\frac{1}{4} \times \$1200\right) + \left(\frac{3}{4} \times \$400\right) = \$600$ . This expected value is equal to the *average* value of used cars to buyers, if all used cars reach the market.

Now we can draw the demand curve for used cars, *given that buyers believe that all used cars will come onto the market*. At prices above \$600, no demanders would want to buy a used car; at prices below \$600, all 25 demanders would want to buy a used car; and at a price of exactly \$600, all demanders would be indifferent between buying a used car or not. This means that the demand curve looks like the dashed line in Figure 2.1, with a horizontal segment at a height of \$600. With these beliefs, the supply curve intersects the demand curve at the point *A*, where the price is \$600 and the number of used cars supplied is 15. All of the used cars that are supplied will be lemons. (Since owners of good used cars have reservation prices of \$700, they will not make their cars available for \$600.)

But now we see that the optimistic belief that all 20 used cars would come to the market is *not* self-confirming. When demanders act on this belief, they discover that they are mistaken, since the only cars that came to market are the lemons. This mistaken belief is costly to the buyers since, although they paid \$600 for used cars, they are sure to get only lemons, which are worth just \$400. Demanders who started trading with the belief that all used cars would come to market would want to revise their views after this experience.

### Pessimistic Self-confirming Beliefs in Example 1

Suppose that all demanders believe that the only used cars that will reach the market are lemons. Since a lemon is worth \$400 to a buyer, when demanders believe this, the demand curve will look like the dashed line in Figure 2.2. When demanders hold these beliefs, the supply curve intersects the demand curve at the point *B*, where the price is \$400 and the number of used cars supplied is 15. The 15 used cars that are supplied are all lemons, which confirms the pessimistic belief of demanders that all used cars that reach the market are lemons. Therefore, the belief that all used cars on the market are lemons is self-confirming. When demanders act on this belief, the market result is consistent with what they believe.



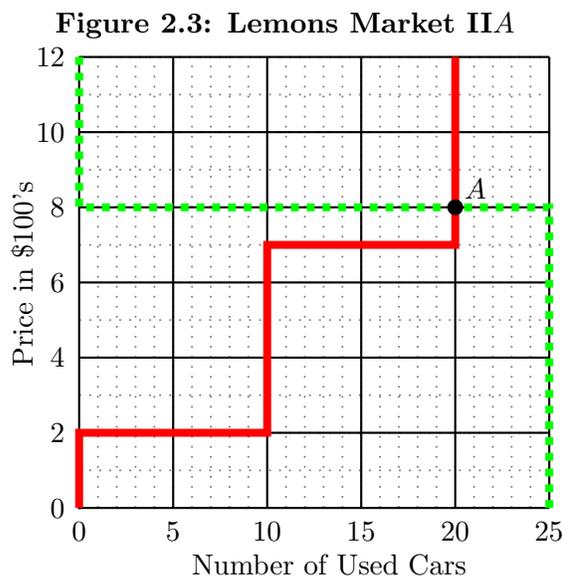
In Example 1, we discovered that the only self-confirming belief for demanders turns out to be that only lemons will reach the market.<sup>6</sup> In Example 2, a higher proportion of the used cars in the market are good, and consequently the optimistic belief that all used cars, including the good ones, will reach the market will be self-confirming.

### Example 2

As in Example 1, there are 25 potential used-car buyers, each of whom is willing to pay \$1200 for a good used car and \$400 for a lemon. Also, as in Example 1, current owners of good used cars have a reservation price of \$700 for their cars, and current owners of lemons have a reservation price of \$200. Now, however, there are 10 good used cars and 10 lemons.

The supply curve for used cars is drawn on Figure 2.3. Using similar reasoning to that used in Example 1, we see that at prices between \$200 and \$700, only 10 used cars are supplied, all of which are lemons; while at prices above \$700, 20 used cars will be supplied, 10 of which are good and 10 of which are lemons.

<sup>6</sup>As an exercise, you may want to show that the belief that the good car owners *and not the lemon owners* will sell their used cars is also not self-confirming.



### Optimistic, Self-confirming Beliefs in Example 2

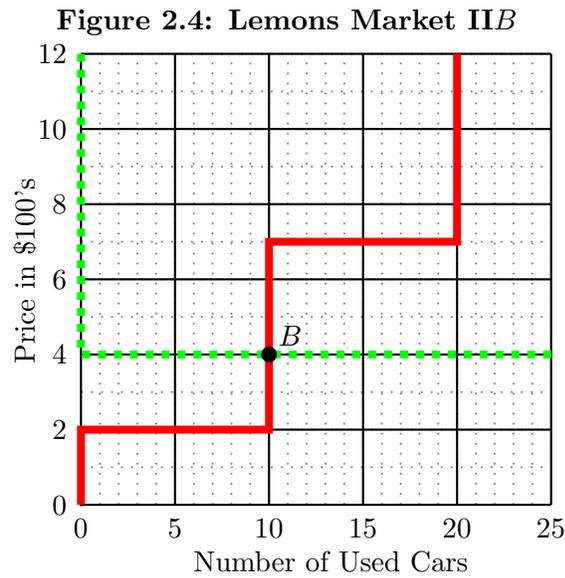
As in the previous example, there are 25 used-car buyers, each of whom is willing to pay \$1200 for a good used car and \$400 for a lemon. Suppose that all buyers believe that all used cars, including the good ones, will be offered for sale. If this is the case, half of the used cars for sale will be good and half will be lemons. In this case, the expected value of a used car is  $\left(\frac{1}{2} \times \$1200\right) + \left(\frac{1}{2} \times \$400\right) = \$800$ . Therefore, if demanders believe that all used cars will come onto the market, each demander is willing to pay up to \$800 for a used car. In this case, the demand curve is given by the dashed line in Figure 2.3, which includes a horizontal line segment at a height of \$800.

Given these optimistic beliefs, the competitive equilibrium price is \$800. Since \$800 is greater than the \$700 reservation price of good-car owners, all 20 used-car owners want to sell. Since when demanders act on this belief, their belief is confirmed by the market outcome, we say that the demanders' belief that all used cars will reach the market is self-confirming.

But this is not quite the end of the story. Remarkably, when half of the used cars are good and half are lemons, there are *two different* sets of self-confirming beliefs. The pessimistic belief that all used cars that reach the market are lemons also turns out to be self-confirming.

### Pessimistic, Self-confirming Beliefs in Example 2

Suppose that all demanders believe that the only used cars that reach the market are lemons. Since a lemon is worth \$400 to a buyer, the demand curve for demanders with this belief would look like the dashed line in Figure 2.4. With these beliefs, the supply curve intersects the demand curve at the point  $B$ , where the price is \$400 and the number of used cars supplied is 10. At a price of \$400, the 10 used cars that are supplied are all lemons, Thus the demanders' pessimistic belief that all used cars that reach the market are lemons is self-confirming.



In Example 2, we found that in a used car market, there can be two very different outcomes, each of which is an equilibrium with self-confirming beliefs. In the next exercise, we explore a similar effect in the labor market.

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### Exercise: Capable Workers and Klutzes<sup>7</sup>

In some industries it is very difficult to monitor the performance of individual workers. In others it is quite easy. Let us consider an industry in which monitoring is difficult. There are two kinds of workers:

<sup>7</sup>Answers to this exercise can be found on page 17.

some are “capables” and some are “klutzes.” Half of all workers in the labor force are capables and half are klutzes. A capable will produce \$1200 of output per week for his employer. A klutz will produce only \$400 of output per week. Capables and klutzes look and talk just the same. Capables know they are capable and klutzes know that they are klutzes. But if you ask, everybody will claim to be capable. Both capables and klutzes have the option of taking a job in another industry where performance can be closely monitored. In the other industry, capable workers could earn \$700 per week and klutzes could earn only \$200 per week.

**Exercise 2.1** In the industry where monitoring is difficult, suppose that a firm has the pessimistic belief that the only workers it can hire are klutzes. What is the highest wage that this firm would be willing

to pay per week to hire a worker? \$ \_\_\_\_\_

**Exercise 2.2** If the firm offers this wage, what kind of workers will it attract? Explain your answer.

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**Exercise 2.3** In the industry where monitoring is difficult, suppose that another firm believes that half of its workers will be capables and half will be klutzes. Given this belief, what is the highest wage that

this firm would be willing to pay per week to hire a worker? \$ \_\_\_\_\_

**Exercise 2.4** If the firm offers this wage, are its beliefs about the quality of its workers likely to be confirmed? Explain your answer.

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## Lessons from Lemons

### The Private and Social Value of Certification

When there is asymmetric information about product quality, it is often possible, at some cost, to get a credible expert to certify the quality of an item. Typically, the initial owners of high-quality items will be willing to pay to have their quality certified. The “social gain” from certification, however,

is not always the same as the private gain. The certification of high-quality items will not only increase the price that sellers of high-quality items receive, but it will also reduce the price that sellers of lower quality items receive. Thus total profits may either increase or decrease with the introduction of costly certification. We illustrate these two possible outcomes by revisiting Examples 1 and 2 from pages 7 and 10.

In Example 1 we found that in the only equilibrium with self-confirming beliefs, the price of used cars was \$400 and the only used cars that were offered for sale were lemons. This happens even though buyers would be willing to pay up to \$1200 for used cars that they knew to be good and current owners of good used cars would be willing to sell them for \$700. The problem is that the current owners of good cars have no way to convince the buyers that their cars are good. Suppose that a new mechanic arrives in town. This mechanic places a high value on his reputation and is known to be scrupulously honest. For a cost of \$100, the mechanic will check a car thoroughly and will certify good cars as good and lemons as lemons. A good-car owner who has her car certified could sell it for \$1200. Since the inspection costs \$100 and her reservation price is \$700, she would make a profit of \$400 by doing so. With the arrival of the mechanic, there is a new equilibrium. All good-car owners have their cars certified and sell them for \$1200. They each make \$400 more in profits than before the mechanic arrived. Lemon owners will not spend \$100 to get their cars certified as lemons. They continue to sell their cars without certification, for a price of \$400, to buyers who know that they are getting lemons. In this example, the introduction of the certification process increased the profits of good-car owners and had no effect on the profits of lemon owners. Total profits of all car owners are increased by the arrival of the mechanic.

Now consider the equilibrium with optimistic self-confirming beliefs that we found in Example 2. There are equal numbers of good cars and lemons in the hands of the original owners. There is an equilibrium in which the price of cars is \$800 and all of the used cars are offered for sale. Now suppose that the mechanic moves to this town and offers to certify cars for \$100. If the owner of a good car takes it to the mechanic and pays \$100, the car will be certified as good and sell for \$1200. Since uncertified cars are worth \$800, she will increase her profits by \$300 if she takes her car to the mechanic. There will be a new equilibrium in which all good car owners take their cars to the mechanic, have them certified, and sell them for \$1200. Lemon owners will not have their cars certified. Buyers know that uncertified cars are lemons and will buy them for \$400. Lemon owners are unhappy about the new situation, since before the mechanic arrived they were able to sell

their cars for \$800. What about total profits of lemon owners and good car owners? Before the mechanic arrived, everyone was getting \$800 for a used car. After the mechanic arrived, the 10 good car owners each got an extra \$400 for their cars, but the 10 lemon owners each got \$400 less for their cars. Thus the total revenue received by car owners did not change. But the owners of good cars each had to pay \$100 for certification, so the profits of each good-car owner increased by only \$300 while the profit of each lemon owner decreased by \$400. Total profits of all car owners are lower after the mechanic arrives.

### Remarks on Multiple Equilibria

In Example 2 and in the story of “klutzes and capables,” we found that two very different sets of beliefs about the nature of the economic environment can each be self-confirming if people act on these beliefs. The possibility of multiple, self-confirming equilibria is fairly common in economic models, and especially in models with asymmetric information.

The possibility of multiple equilibria is frustrating to economists, because it means that we cannot always make sharp predictions with the theory. On the other hand, these examples teach us an important lesson. Once we see that different sets of beliefs can lead to dramatically different outcomes, each of which is self-confirming, we begin to understand how it is that strikingly different economic outcomes, accompanied by different systems of beliefs about economic and social matters, can survive over long periods of time in different parts of the world.

When President Franklin Delano Roosevelt took office in 1933, in the depths of the Great Depression and in the midst of a banking crisis, he gave eloquent expression to this view in his Inaugural Address:

“So first of all, let me assert my firm belief that the only thing we have to fear is fear itself—nameless, unreasoning, unjustified terror which paralyzes needed effort to convert retreat into advance.”

In the more pedestrian language of this chapter, we could paraphrase Roosevelt’s remarks as follows: “The economic ills of the Great Depression are the result of the economy falling into an equilibrium of pessimistic, self-confirming beliefs. If people regain confidence in the economy, it can reach a different equilibrium in which optimistic beliefs are self-confirming.”

## Food for Thought

■ Suppose that a company offers “grade insurance” that works as follows. For each course in which you get a grade below a C, the company pays you \$500. Before offering the insurance policy for sale, the company looks over the transcripts of university students and finds that, on average, 10% of all grades given are below a C. Explain why the insurance company would be incorrect in assuming that it would only have to pay claims on about 10% of its policies. Explain how adverse selection and moral hazard would each affect this market.

■ It is common practice for a buyer who is thinking of buying a used car from a stranger to take the car to a mechanic and have it evaluated. If more than one potential buyer considers the car, these buyers don’t share the information, but each of them takes it to a mechanic and each pays for a new evaluation. It appears that money could be saved if the *seller* would have the car evaluated and then make this evaluation available to all potential buyers. Why do you think this doesn’t happen more often?

■ Many firms pay for insurance coverage for all of their employees. Typically, this coverage is compulsory. That is, the firm will not let you opt out of the coverage. Insurance companies often sell group rate insurance at a lower price to firms that have compulsory coverage than either to individuals or to firms where coverage is voluntary. How do you explain this?

■ Suppose that researchers discover a new medical test such that persons who fail this test are far more likely to have an expensive illness over the course of the next year than those who pass the test. An insurance company discovers that it would cost only half as much to insure those who have passed the test as to insure those who have failed it. This company plans to sell health insurance to persons who have taken and passed the test at half the price that it charges to others. Can you make a case for why a government might choose to make it illegal for insurance companies to do this? Suppose that insurance companies begin to offer insurance at one rate to those who have passed the test and at twice this rate to those who have failed it. If you had the choice of either (a) taking the test and then buying insurance at the rate that applies to you given the result of the test or (b) never taking the test and being insured at the rates that applied before the test was invented, which option would you choose?

## Answers to Warm-up Exercises

**W 2.1:** \$1, No,  $(6 \times \$500) - (6 \times \$1) = \$2994$ ; **W 2.2:** \$1601,  $(6 \times \$500) + (6 \times \$3500) - (12 \times \$1601) = \$4788$ ; **W 2.3:** \$1601; **W 2.4:** \$1,  $(8 \times \$500) - (8 \times \$1) = \$3992$ , \$1601,  $(4 \times \$3500) + (8 \times \$500) - (12 \times \$1601) = -\$1212$ ; **W 2.5:** \$1.

## Answers to Exercise

**Ex. 2.1:** \$400; **Ex. 2.2:** Klutzes only. Capables can earn \$700 elsewhere. Klutzes can earn only \$200 elsewhere; **Ex. 2.3:** \$800; **Ex. 2.4:** At a wage of \$800, capables and klutzes will all want to work for the firm. Since half of the workforce is capable, if it picks applicants at random, the firm can expect on average to get about equal numbers of each. So its beliefs will be, at least approximately, confirmed.

# Lab Notes for Experiment 2

## Recording Sales Information

In Table 2.1, record the number of good cars and lemons that were in the hands of the original owners at the beginning of Sessions 2–4.

**Table 2.1: Distribution of Car Types**

	Session 2	Session 3	Session 4
Number of Good Car Owners			
Number of Lemon Owners			

In Table 2.2, record the number of good cars and of lemons that were *sold* by their original owners in Sessions 2–4. In the last row, calculate the average value *to buyers* of the used cars that were sold in each session.

**Table 2.2: Types of Cars Sold**

	Session 2	Session 3	Session 4
Number of Good Cars Sold			
Number of Lemons Sold			
Average Value of All Cars Sold			

Complete Tables 2.3 and 2.4. In the first two columns record each dealer's ID number and the number of cars that he purchased. The Dealer's Total Cost is equal to the total amount that he paid for the cars he purchased. The Dealer's Total Revenue is the number of cars that he purchased times the Average Value of Cars Sold in the Session, which can be found in the last row of Table 2.2. A Dealer's Profits are equal to his Total Revenue minus his Total Cost.

**Table 2.3: Purchases and Profits: Session 2**

Dealer's ID	Number of Cars Bought by Dealer	Dealer's Total Cost	Dealer's Total Revenue	Dealer's Profits

**Table 2.4: Purchases and Profits: Session 3**

Dealer's ID	Number of Cars Bought by Dealer	Dealer's Total Cost	Dealer's Total Revenue	Dealer's Profits



NAME \_\_\_\_\_ SECTION \_\_\_\_\_

## Homework for Experiment 2

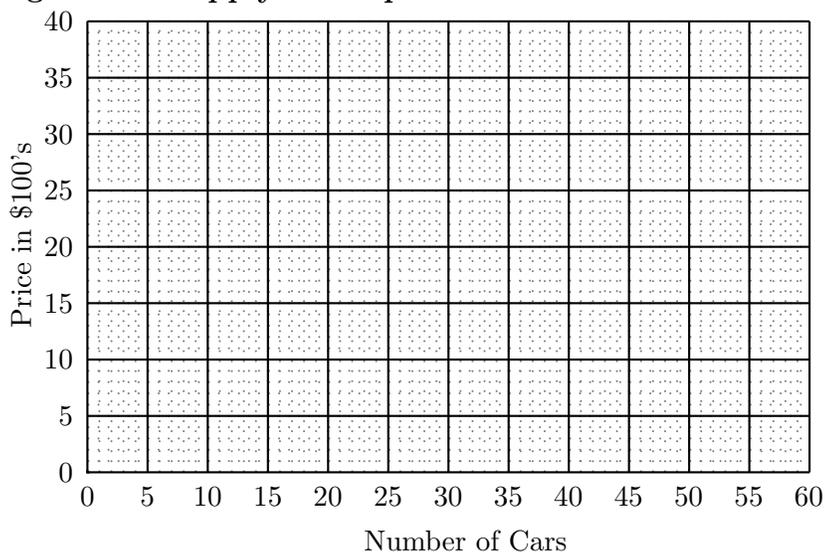
### Problem 2.1

**Part a)** In Session 2, the original owners have \_\_\_\_\_ good used cars and \_\_\_\_\_ lemons.

**Part b)** Owners of lemons are willing to sell their cars at any price above \$0. Owners of good used cars are willing to sell their cars at any price above \$1600. The number of used cars that will be offered for sale at prices between \$0 and \$1600 is \_\_\_\_\_, and at prices above \$1600 is \_\_\_\_\_

**Part c)** In Figure 2.5, draw the supply curve for used cars in Session 2.

**Figure 2.5: Supply and Optimistic Demand: Session 2**



**Problem 2.2** In Session 2:

**Part a)** What fraction of the used cars held by original owners are good and what fraction are lemons? \_\_\_\_\_

**Part b)** What is the average value to dealers of the used cars that are in the hands of the original owners? \$ \_\_\_\_\_

**Hint:** Since a good used car is worth \$3500 and a lemon is worth \$500 to dealers, the average value is the fraction of used cars that are good times \$3500 plus the fraction of used cars that are lemons times \$500.

**Problem 2.3** Suppose that there are several potential buyers for used cars and that there is no limit to the number of cars that any of them can buy. If all buyers believe that used cars on average are worth  $\$V$ , then the demand curve for used cars will include a horizontal line running all the way across the graph at a height of  $\$V$ . Suppose that car buyers have the *optimistic* belief that all of the original owners of used cars will sell their cars.

**Part a)** With this optimistic belief, what is the value to a dealer of the average used car that is offered for sale? \$ \_\_\_\_\_

**Part b)** On Figure 2.5, draw the demand curve for used cars, assuming that all buyers have this optimistic belief.

**Part c)** Given this optimistic belief, at what price does the number of used cars supplied equal the number demanded? \$ \_\_\_\_\_

**Part d)** At this price, which types of used cars are sold? \_\_\_\_\_

**Part e)** Is this outcome consistent with the demanders' belief that all owners of used cars will sell them? \_\_\_\_\_

**Part f)** Is the belief that all used-car owners will sell their used cars a self-confirming belief? \_\_\_\_\_

**Problem 2.4** Suppose that in Session 2, car dealers have the *pessimistic* belief that only the lemon owners will sell their cars.

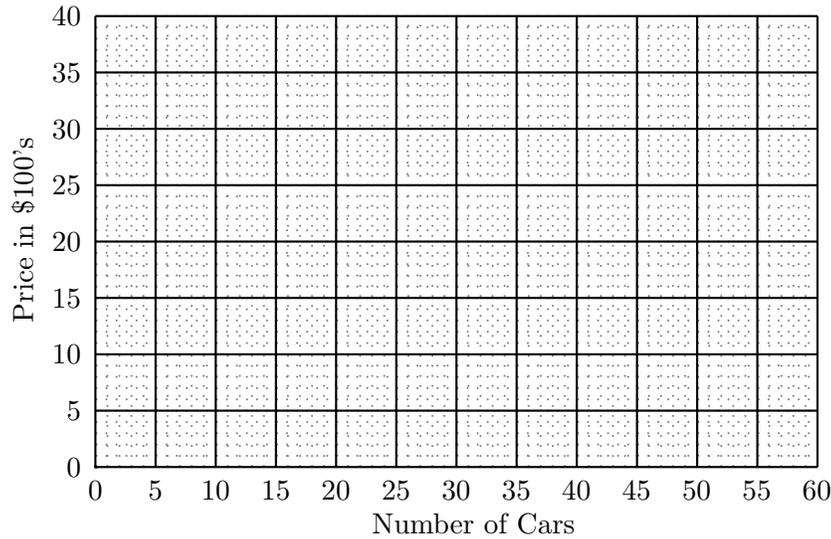
**Part a)** Then the expected value of a used car to a dealer is the price he can get for a lemon, which is \$ \_\_\_\_\_

**Part b)** On Figure 2.6, draw the supply and demand curves that apply if used-car dealers all believe that original owners will sell only lemons.

**Part c)** Given these pessimistic beliefs, at what price does the number of used cars supplied equal the number demanded? \$ \_\_\_\_\_

**Part d)** At this price, which types of used cars are sold? \_\_\_\_\_

Figure 2.6: Supply and Pessimistic Demand: Session 2



**Part e)** Is this consistent with the demanders' belief that only the lemon owners will sell their cars? \_\_\_\_\_

**Part f)** Is the belief that only the lemon owners will sell their used cars a self-confirming belief? \_\_\_\_\_

**Problem 2.5** In the last round of Session 2, the average price at which cars actually sold was \$ \_\_\_\_\_

Was this price closer to the competitive equilibrium price with optimistic self-confirming beliefs or pessimistic self-confirming beliefs? \_\_\_\_\_

**Hint** To calculate the average price, sum the dealers' total costs in Table 2.3 and divide by the total number of cars purchased.

**Problem 2.6** In Session 3:

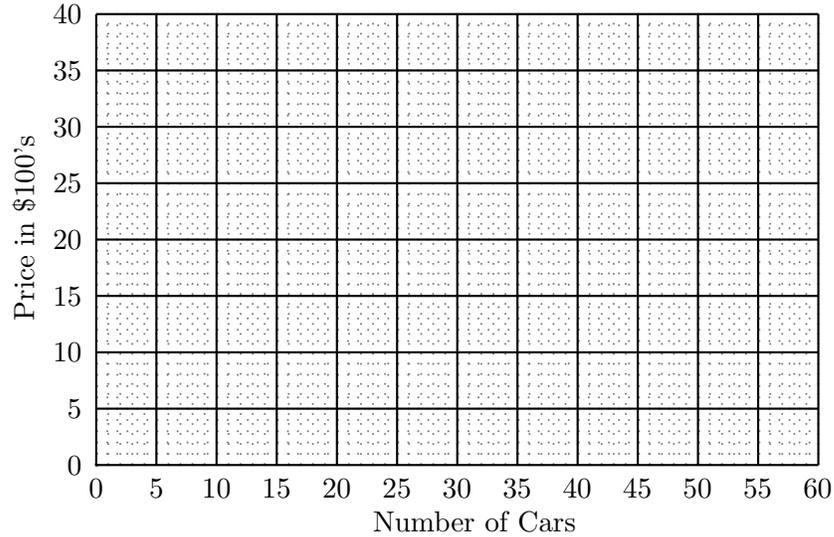
**Part a)** The original owners have \_\_\_\_\_ good used cars and \_\_\_\_\_ lemons.

**Part b)** The number of used cars that will be offered for sale at prices between \$0 and \$1600 is \_\_\_\_\_, and at prices above \$1600 is \_\_\_\_\_

**Part c)** In Figure 2.7, draw the supply curve for used cars in Session 3.

**Problem 2.7** In Session 3:

Figure 2.7: Supply and Optimistic Demand: Session 3



**Part a)** What fraction of the used cars held by original owners are good and what fraction are lemons? \_\_\_\_\_

**Part b)** What is the average value to dealers of the used cars that are in the hands of the original owners? \$ \_\_\_\_\_

**Problem 2.8** In Session 3, suppose that car buyers have the *optimistic* belief that all of the original owners of used cars will sell their cars.

**Part a)** How much is the average used car worth to dealers? \$ \_\_\_\_\_

**Part b)** On Figure 2.7, draw the demand curve for used cars, assuming that all buyers have this optimistic belief.

**Part c)** Given these optimistic beliefs, at what price does the number of used cars supplied equal the number demanded? \$ \_\_\_\_\_

**Part d)** At this price, which types of used cars are sold? \_\_\_\_\_

**Part e)** Is this outcome consistent with the demanders' belief that all owners of used cars will sell them? \_\_\_\_\_

**Part f)** Is the belief that all used-car owners will sell their cars a self-confirming belief? \_\_\_\_\_

**Problem 2.9** In Session 3, suppose that car dealers have the *pessimistic* belief that the only cars that suppliers will sell are lemons.

**Part a)** The expected value of a used car to a dealer is the price he can get for a lemon, which is \$ \_\_\_\_\_

**Part b)** On Figure 2.8, draw the supply and demand curves that apply if used-car dealers all believe that original owners will only sell lemons.

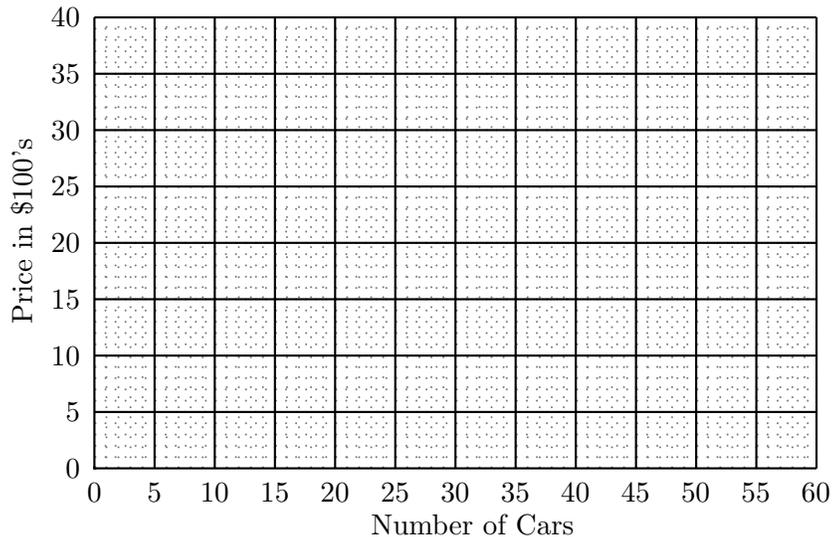
**Part c)** Given these beliefs, at what price does the number of used cars supplied equal the number demanded? \$ \_\_\_\_\_

**Part d)** At this price, which types of used cars are sold? \_\_\_\_\_

**Part e)** Is this consistent with the demanders' belief that only the lemon-owners will sell their cars? \_\_\_\_\_

**Part f)** Is the belief that only lemon-owners will sell their used cars a self-confirming belief? \_\_\_\_\_

**Figure 2.8: Supply and Pessimistic Demand: Session 3**



**Problem 2.10** In the last round of Session 3, the average price at which cars actually sold was \$ \_\_\_\_\_  
 Was this price closer to the competitive prediction for optimistic self-confirming beliefs, pessimistic self-confirming beliefs, or to neither? \_\_\_\_\_

**Problem 2.11** In Session 4, every used-car owner has a certificate stating whether the car is a good used car or a lemon. What is the most a dealer would be willing to pay for a car from somebody who showed a good car certificate? \$ \_\_\_\_\_  
 What is the most a dealer would be willing to pay for a car from somebody who showed a lemon certificate? \$ \_\_\_\_\_  
 If you were a dealer, what is the most you would be willing to pay to a seller who refused to show you a certificate? \$ \_\_\_\_\_

**Problem 2.12**

**Part a)** In Figure 2.9, draw the demand and supply curves for used cars that are certified to be good in Session 4, and in Figure 2.10 draw the demand and supply curves for used cars that are certified to be lemons.

**Figure 2.9: Certified Good Cars: Session 4**

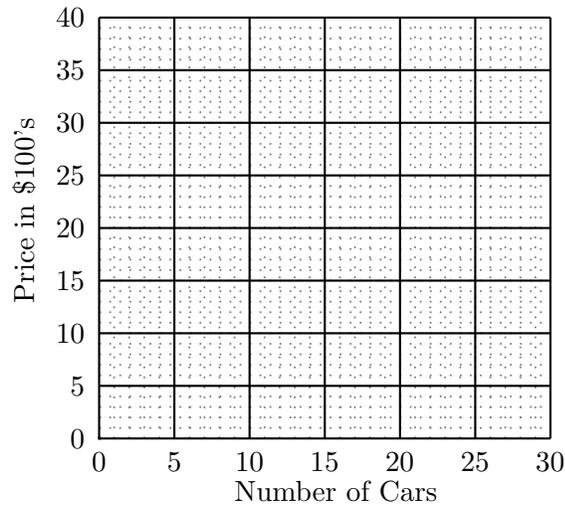
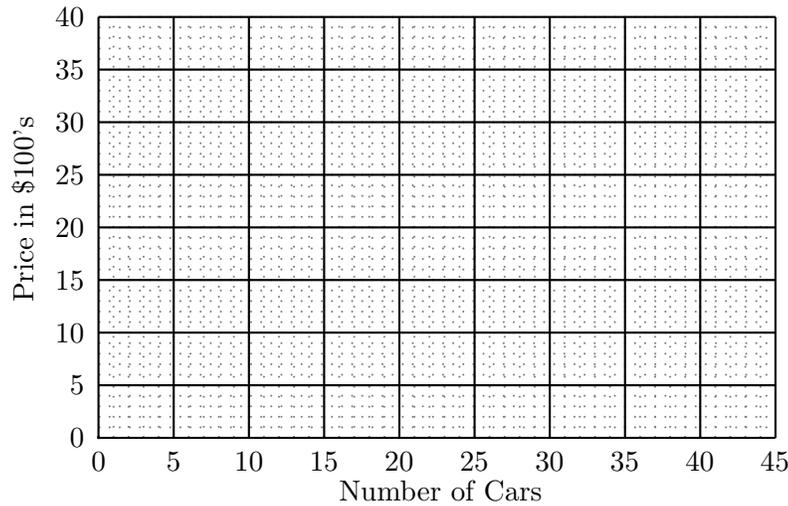


Figure 2.10: Certified Lemons: Session 4



**Problem 2.13** In Session 4:

**Part a)** What is the competitive equilibrium price for used cars that are certified to be good? \$ \_\_\_\_\_

**Part b)** What was the average price actually paid in the experimental market for used cars that were certified to be good? \$ \_\_\_\_\_

**Part c)** What is the competitive equilibrium price for used cars that are certified to be lemons? \$ \_\_\_\_\_

**Part d)** What was the average price actually paid in the experimental market for used cars that were certified to be lemons? \$ \_\_\_\_\_

**Problem 2.14** The only difference between Sessions 3 and 4 was that in Session 4, owners of good used cars could prove to buyers that their cars were good.

**Part a)** Complete Table 2.6 to show how total profits of used-car sellers and buyers were affected by this difference.

**Hints:** The total amount of profits made by all market participants is equal to the total value to the buyers of the cars they purchased minus the total of the reservation prices of the car owners who sold their cars. You can find the numbers of lemons and good cars sold in Table 2.2. Since good-car owners have a reservation price of \$1600 and lemon owners have a reservation price

of \$0, you can use this information to calculate the Sum of Reservation Prices of Sellers. You can also calculate the total Value to Buyers of Cars Purchased since a good used car is worth \$3500 to a buyer and a lemon is worth \$500 to a buyer.

**Table 2.6: Profits in Sessions 3 and 4**

	Session 3	Session 4
Number of Lemons Sold		
Number of Good Cars Sold		
Sum of Reservation Prices of Sellers		
Value to Buyers of Cars Purchased		
Total Profits of All Market Participants		

**Part b)** Allowing good-car owners to prove that they had good cars caused total profits of all market participants to (increase? decrease?) \_\_\_\_\_ from Session 3 to Session 4 by \$\_\_\_\_\_