

Classroom Games: A Market for Lemons

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I. Introduction

If product quality cannot be observed by buyers prior to purchase, then sellers will be tempted to skimp on it. Buyers then become reluctant to pay high prices as they learn to expect low-quality products -- or "lemons." The "lemons market" terminology is due to George Akerlof (1970), who explained how the pressure of competition may cause quality to deteriorate to such low levels that the market may fail to exist. This lemons outcome is discussed in some introductory and most intermediate microeconomics courses, and it is examined in some detail in a range of applied courses: industrial organization, regulation, antitrust, managerial economics, law and economics, game theory, and experimental economics.

The incentives that arise in markets with asymmetric information are illustrated in the classroom exercise presented here. Student sellers choose both a quality "grade" and a price for their products. Initially, both prices and grades for all sellers are posted, and buyers select from these offerings. In this full-information setup, the market prices and grades quickly reach efficient levels that maximize total surplus. Next, although sellers continue to choose grades and prices, only prices (not grades) are posted for buyers to see when they shop. The grades and prices then fall to inefficiently low levels. The observed market outcomes in this exercise can stimulate useful discussion of asymmetric information, market failure, and remedies such as quality standards and warranties.

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II. Procedures

Prepare for the exercise before the start of class by setting up a record table on the blackboard or overhead projector. There should be a column for each seller, with the seller number written at the top, and with enough rows for about six periods. Each cell of the table will be used to record the price, grade, and units sold for each seller in each period. Table 1 gives an example of such a table, fully filled out after six periods, although you would obviously begin with a blank table.

Table 1. Price and Grade Outcomes by Period

	seller 1	seller 2	seller 3
period 1 (full information)	\$11.50 grade 3 1 units	\$6.00 grade 2 2 units	\$12.00 grade 3 1 unit
period 2 (full information)	\$5.75 grade 2 2 units	\$5.50 grade 2 1 unit	\$1.90 grade 1 1 unit
period 3 (full information)	\$5.65 grade 2 1 unit	\$5.60 grade 2 2 units	\$5.60 grade 2 1 unit
period 4 (only price information)	\$2.40 grade 1 1 unit	\$5.60 grade 2 1 unit	\$2.40 grade 1 2 units
period 5 (only price information)	\$2.40 grade 1 1 unit	\$1.65 grade 1 1 unit	\$5.50 grade 1 2 units

This exercise begins by selecting sellers and buyers, and distributing to them copies of the instructions for each group contained in the appendix. The instructions and record sheets can conveniently fit on the same page if margins and fonts are adjusted. We have found that a market with three sellers and four buyers works well. We have also used six sellers and eight buyers.

A larger number of buyers makes a period last too long, because in this exercise buyers make purchase decisions in sequence. Rather than expand the numbers for larger classes, it is better to have buyers and sellers be represented by teams composed two or three students each. An added benefit is that discussion among members of a team may promote understanding and interest. For even larger classes, it is best to have some observe while others participate. To avoid communication between buyers and sellers, the buyers, sellers, and observers (if there are any) should be seated in separate rows or areas.

Begin by reading aloud the text of the instructions where it is the same for buyers and sellers. However, do not reveal the private information tables of sellers' costs and buyers' values, and there is no need to read through the record tables for keeping track of decisions and earnings. One purpose of keeping value and cost information private is to see whether the market can yield an optimal quality grade that could not be calculated on the basis of any one person's information.

It is useful at this stage to allow a few minutes for questions about the rules of the game. Sellers, for example, will often want to know if they are required to sell units of only one quality in a period (yes, and also at only one price, although the grade and price can be changed or left unchanged in later periods). Sellers may ask if they can refuse an offer to buy (yes), or whether they incur costs for units not sold (no). Of course, you should avoid any explanations to students that might tend to reveal the underlying conditions in the market. For example, if somebody asks about another's private value or cost information, or whether buyers' or sellers' values or costs are all the same, do not answer the question.

After procedural questions are settled, open the market by inviting the sellers to decide on the grade and price for the first period. Sellers earn money by selling at a price above the cost for the grade that they choose, although they are limited to selling no more than two units of the product in a period. Once all sellers have recorded their decisions on their instruction/record forms, collect the information and write grades and prices in the proper seller column on the blackboard or overhead projector. Then return forms to the sellers, and choose which buyer will begin the shopping. The easiest procedure is to draw lots: whoever received the marked lot draws first, and then move through the group in a preannounced manner, say, left to right or counterclockwise.

The first buyer in the sequence gets to choose whether to purchase, and if so, from which seller. Buyers can purchase only one item per period. They earn money by buying at a price below the money value of the unit that they purchase; this value can be thought of as the value for which the buyer could resell the unit. Presumably, the seller will wish to accept and sell a first unit, but the seller may not wish to sell a second unit if the price does not cover its cost. When a transaction is agreed upon, go on to the next buyer. As buyers make purchases, use the record table on the blackboard to keep track of the number of units sold by each seller, and draw a line through the price of a seller who has sold two units. After all buyers have finished, ask sellers to make grade and price choices for period two. Again, Table 1 gives an example of such a table, fully filled out after six periods.

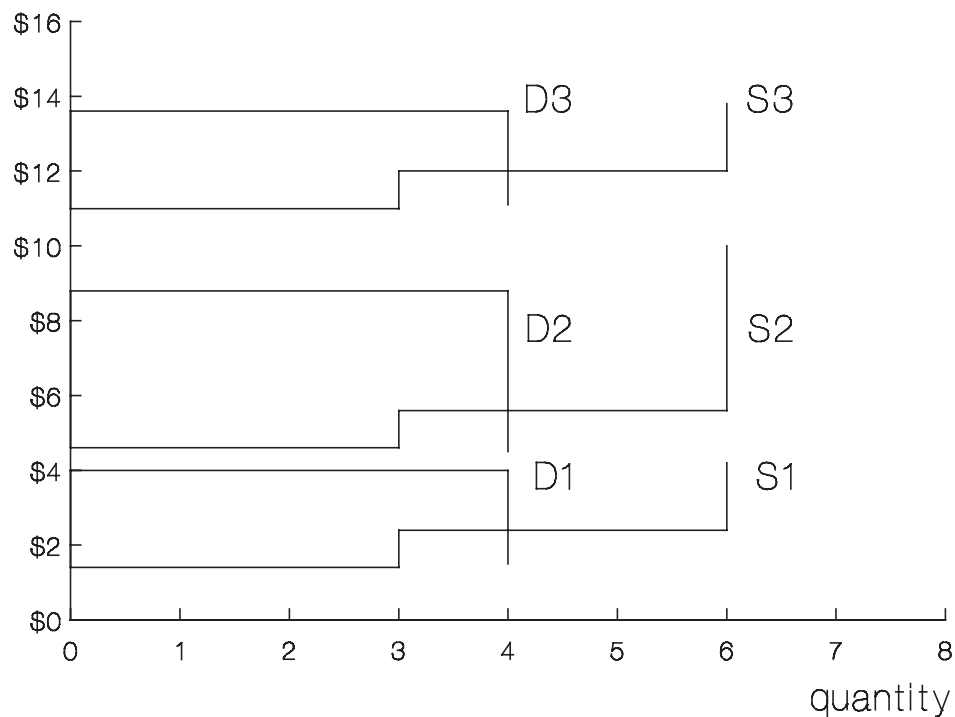


Figure 1. Demand and Supply Arrays by Grade

The structure of supply and demand for each period is determined by the information provided in the instruction sheets. Market demand is determined by the resale values known to buyers. Buyers have identical valuations. Each buyer can purchase at most a single unit of the

commodity in a period, and the value of that unit depends on the grade: \$4 for grade 1, \$8.80 for grade 2, and \$13.60 for grade 3. An individual buyer's demand for a grade 1 product is, therefore, perfectly inelastic at all prices below \$4. Thus, with four buyers and a grade of 1, for example, the market demand would be vertical at a quantity of 4 units for any price below \$4, as shown by the D1 curve in the lower part of Figure 1. Market supply is determined by the costs given to sellers. Each seller has a capacity of two units, with the cost of the second unit being \$1 higher than the cost of the first unit. For a grade of 1, the costs for the first and second units produced are \$1.40 and \$2.40 respectively, so the individual seller's supply curve would have two steps, before becoming perfectly inelastic at two units for prices above \$2.40. With three identical sellers, the market supply will also have two steps with three units on each step. The market supply for grade 1 is labeled S1 in the lower part of Figure 1, and it crosses the D1 curve at a price of \$2.40. The supply and demand curves for the other grades are shown above those for grade 1. Notice that in Figure 1, the sum of consumer and producer surplus is maximized at a grade of 2.¹ Sometimes the market will have settled at the optimal grade (of 2) by the second period, and it should do so by the fourth period.

When satisfied that the market is reasonably efficient in the sense of having settled on the correct grade, announce a change. Now, sellers are to choose grade and price, just as before, but now only price will be posted on the blackboard for buyers to see when they make their purchase decisions. Buyers do not find out the grade of their purchase until the instructor write all sellers' grades in the table after all buyers are finished shopping. This change must be announced before sellers make price and grade decisions for a period, and we try to do it with a straight face, so as not to hint that there are now new possibilities for taking advantage. Except for this informational difference, the procedures are the same as before. Two periods will usually establish an equilibrium at the lowest quality level 1, which of course is not the socially optimal outcome.

To summarize: 1) Before class, prepare separate buyer and seller instructions, with the

¹ The calculations can be simplified by using even dollar amounts for the costs and values. It is useful to keep the \$1 difference between the first and second unit costs, and to ensure that surplus is maximized at an intermediate grade of two. One possibility is to use more than three grades so that the optimal grade is not exactly in the middle. Some parameterizations with larger numbers of grades are used in Holt and Sherman (1990). We prefer to use only three grades in order to obtain quicker convergence in the full information periods.

appropriate information and record tables for each. 2) Based on the number of students expected, decide on the numbers of buyers and sellers and on the number of students to serve on each buyer or seller team. Minor adjustments can be made when the number of students attending class is known. Photocopy enough buyer and seller instruction/record sheets for participants and observers. 3) Prepare the record table on the blackboard, as in Table 1. 4) Distribute seller instructions to sellers and buyer instructions to buyers, keeping the two groups separate. Read the common text aloud, skipping over the private cost and value information, and answer procedural questions. 5) Begin the full information periods by asking sellers to make their grade and price decisions for period 1. 6) Collect seller decision sheets, post grades and prices for each seller, and return decision sheets to sellers. 7) Draw lots to determine the order of buyer shopping decisions, and make sure the seller agrees to each purchase request. 8) When an equilibrium grade develops, announce that in future periods only price (not grade) will be posted on the board, and continue with this revised procedure for several more periods. The exercise will take about an hour -- ten minutes for instructions and about seven minutes for each period - plus time for discussion.

III. Discussion

We begin by illustrating outcomes for an undergraduate "Economics of Regulation" class at the University of Virginia. The 21 students were assigned to teams corresponding to the three sellers and four buyers; thus, each team had from two to four students, and one student served as a recorder. (We have obtained similar results in a number of larger undergraduate classes with more buyers and sellers, but the data from a small class are easier to display.) Table 1, already presented, shows the pattern of results from this class. It took three periods before the full information market settled on the optimal grade of two. Notice that the prices in this period have converged to the sellers' cost of a second unit of grade two, which is \$5.60. This convergence to the optimal grade is expected, but the convergence the competitive price for that grade is not observed in all classes. In the final two periods when the grade information from sellers was not available to buyers, the grades fell to a suboptimal level. There is a clear rip-off in period five, where two low-quality units were purchased at a price of \$5.50 that is about at the previous going price for units of grade two.

Class discussion typically begins with the most salient result, the dramatic decline of price and grade in the asymmetric-information periods. Students are usually able to see that when buyers have less information, the sellers can take advantage of the situation and cut quality, and then buyers react to protect themselves. Follow up with questions investigating whether buyers or sellers benefit from the lower grade/price combinations: "Why is a low grade bad anyway, isn't it better for buyers to get the low prices that resulted?" The answer -- that the value to the buyers fell by more than price -- leads to the next question: "Sellers cut costs when they lowered the grade; will sellers be better off when the grade falls?" The answer depends on how low price falls, and some sellers may benefit from selling low grade units at a deceptively high price. If you have trouble eliciting discussion with these types of questions, try something more confrontational, like asking for a "sellers' representative" to offer an explanation of why prices had to fall, and for a response from a "buyers' representative." Some sellers might claim that they did not want to cut grade, but that buyers got burned by other sellers and seemed to prefer a low price at which it is only profitable to offer a low grade. Bans against price advertising, such as those employed by professional associations, were typically defended by the claim that price advertising would create pressure to lower quality to achieve lower costs. However, the Federal Trade Commission began to oppose such bans a little over ten years ago.

After everyone agrees that the low-grade outcome is bad for all concerned, consider the question of how much buyers and sellers as a group would benefit from a higher grade. To address this issue, students should be given complete value and cost information for both sides of the market, so that they can focus on the difference between buyer values and seller costs for the number of units sold. Instead of asking why grade 2 is optimal, it is better to ask whether a regulator would want to insist on the highest grade. The answer is no; in moving from grade 2 to 3, buyers' values go up by $\$13.60 - \$8.80 = \$4.80$, whereas sellers' costs go up by $\$12.00 - \$5.60 = \$6.40$. Be sure and make the point that grade can be too high as well as too low.

By this time, students can see that grade 2 is optimal, in the sense that it creates greater gains for sellers and buyers together. They might also notice that if valuations were different across buyers, then more than one grade might survive in equilibrium. For example, some sellers might cater to buyers who place a higher valuation on high quality, and other sellers may serve the more price-sensitive buyers. Students seldom can see how the second-unit cost for the

optimal grade will determine the full-information equilibrium price, but this can be established by questions that lead them to construct supply and demand curves in Figure 1; the type of questions that lead to the discovery of supply and demand curves are outlined in an earlier installment of this column concerning a "pit market" (Holt, 1996). Note that the prices in the full-information setup may not fall to the competitive level for the optimal grade, which could be due to the fact that sellers are price setters in a market without active counteroffers from buyers.

Next, the discussion should turn to factors that may remedy the inefficiencies caused by asymmetric information. It is pleasing when students figure out how warranties can overcome this problem, by protecting buyers and thus making their defensive behavior unnecessary. In markets with repeat purchases, sellers can establish and maintain reputations for the quality they provide, and an efficient outcome may evolve even when buyers cannot observe quality before the purchase.

It is also useful to push the discussion toward the problems faced by a potential regulator. Such a regulator is not likely to know value and cost information with precision; the values and costs can change; the regulator may be lobbied by seller and consumer groups that have unequal power; the lobbying itself uses up real resources; and so on. These observations suggest the merits of more flexible and less intrusive forms of regulation, like forcing disclosure of quality where that is possible, ensuring that seller warranties are clearly written and consistently honored, and allowing professional associations to set quality standards. In an antitrust class, you might want to ask under what conditions a quality standard might be anticompetitive; for example, the quality standard might be so high as to exclude new entry, or so rigid as to deter innovation.

IV. Further Reading

A number of experimental studies of markets with asymmetric quality information have been carried out. Lynch et al. (1986) document lemons outcomes in laboratory double auctions, and they investigate the effects of warranties, requirements for truthful advertising, and so on. Holt and Sherman (1990) also used laboratory experiments to evaluate factors that affect the degree to which quality deteriorates when it is not observed by buyers; the present classroom exercise is adapted from their setup. DeJong, Forsythe, and Lundholm (1985) allowed sellers to

make price and quality representations, but the quality representation did not have to be accurate, and the buyer had imperfect information about quality even after using the product. Finally, Miller and Plott (1985) report experiments in which sellers can make costly decisions that "signal" high quality, which might prevent quality deterioration. This literature is surveyed in Davis and Holt (1993, ch. 7) and Holt (1995).

Appendix: Instructions for Buyers and Sellers

Seller Instructions for Seller Number _____

This is a market with buyers and sellers. The sellers will begin by choosing a price and a quality "grade." We will collect these decisions and write them on the blackboard. Then we will give buyers the chance to purchase from one of the sellers at the grade and price listed. The grade can be any number from 1 to 3; a higher grade costs more to produce and is worth more to buyers. The table below shows your costs of different grades if you are a seller, and it shows your money values of different grades if you are a buyer.

	grade 1	grade 2	grade 3
seller cost of 1st unit	\$1.40	\$4.60	\$11.00
seller cost of 2nd unit	\$2.40	\$5.60	\$12.00

Each buyer can buy only 1 "unit" of the commodity during a period. Each seller can sell up to 2 units in a period, but the 2nd unit costs \$1 more to produce. If you are a seller, the top row of the table above shows the cost of the 1st unit that you actually sell in a period (for the grade you choose), the 2nd unit costs \$1 more than the 1st unit. Unsold units are not produced and hence incur no cost.

Buyers earn money by making a purchase at a price that is below the value, which depends on the quality grade. The value to the buyer depends only on the grade, not on whether it is the seller's 1st or 2nd unit in the period. A buyer's earnings are calculated as the difference between the value and the purchase price:

$$\text{buyer earnings} = \text{value for grade purchased} - \text{seller's price.}$$

If a buyer does not make a purchase, the buyer earns \$0.

Sellers earn money by making one or more sales at a price that is above the cost of the unit (determined from the table above). A seller's earnings are calculated as the sum of the earnings on the units actually sold:

$$\text{seller earnings} = \text{sale price} - \text{cost of grade produced.}$$

A seller who does not make a sale in a period will earn \$0.

When all sellers have finished choosing their prices and grades for the period, we will collect these sheets and write the prices and grades on the blackboard under the seller numbers. Then I will draw lots to determine a buyer number, and that buyer can purchase a unit from one of the sellers or from no seller. Buyers are then chosen in order; if buyer 2 goes first, then buyer 3 is second, ... and buyer 1 is last. Once a seller has sold a unit, the 2nd unit costs \$1 more, so the seller will be asked whether or not the seller wishes to sell a 2nd unit at the advertised price and grade. If a 2nd unit is sold, it must be at the same price and grade as the 1st unit. If a seller refuses to sell or sells both units in a period, I will draw a line through that seller's price.

You can use the table below to calculate (hypothetical) earnings. Any questions? We will begin by having each seller choose a price and grade for period 1, which you should write in the top two rows of your record table.

	pd.1	pd.2	pd.3	pd.4	pd.5
1) grade for current period	_____	_____	_____	_____	_____
2) price for current period	_____	_____	_____	_____	_____
3) sales price on 1st unit	_____	_____	_____	_____	_____
4) cost of 1st unit	_____	_____	_____	_____	_____
5) profit on 1st unit: (3) - (4)	_____	_____	_____	_____	_____
6) sales price on 2nd unit	_____	_____	_____	_____	_____
7) cost of 2nd unit	_____	_____	_____	_____	_____
8) profit on 2nd unit: (3) - (4)	_____	_____	_____	_____	_____
9) total profit: (5) + (8)	_____	_____	_____	_____	_____
10) cumulative profit	_____	_____	_____	_____	_____

Buyer Instructions for Buyer Number _____
 (Use the same initial paragraph as for sellers.)

	grade 1	grade 2	grade 3
buyer value	\$4.00	\$8.80	\$13.60

(Remaining instructions are the same as for sellers.)

	pd.1	pd.2	pd.3	pd.4	pd.5
1) ID of seller of product	_____	_____	_____	_____	_____
2) grade of product	_____	_____	_____	_____	_____
3) value to you (from table)	_____	_____	_____	_____	_____
4) purchase price	_____	_____	_____	_____	_____
5) earnings: (3) - (4)	_____	_____	_____	_____	_____
6) cumulative earnings	_____	_____	_____	_____	_____

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