CLASSROOM GAMES:
TRADING IN A PIT MARKET

Charles A. Holt[*]

Abstract

This paper describes a classroom exercise that resembles trading in the "pit" of some financial and futures markets. Playing cards are used to induce supply and demand functions. Instructions and helpful hints are provided. The exercise facilitates an understanding and appreciation of the robustness and efficiency of the textbook model of perfect competition.

Setting Up a Pit Market

The supply and demand model is the centerpiece of any introductory microeconomics course. An effective way to introduce this model is to put students into a situation that resembles trading on the floor or "pit" of some commodities futures markets. After the negotiated prices have stabilized, the participants can be shown market parameters and asked to explain why the prices converged to the observed levels. The objective is to have students discover the supply and demand model themselves, and to realize that "large numbers" of traders are not necessary for obtaining efficient, competitive outcomes. The classroom market can also be used to illustrate a variety of other factors: the effects of price controls, shifts in demand or supply, and more.

Playing cards can be used to distribute value and cost information quickly and confidentially to the students. The trading exercise to be described requires only a deck of

---

[*] Department of Economics, Rouss Hall, University of Virginia, Charlottesville, VA 22903, USA. I wish to thank Sylvia Gomez and Jeff Prisbrey for helpful suggestions.

playing cards and copies of the instructions and record sheets given in the appendix. In particular, no money payments are needed; simply say that all earnings are hypothetical.[1] With 10-25 participants, it takes from 40 minutes to an hour read the instructions and go through several 5-minute trading periods.

Begin by dividing the class into equal numbers of buyers and sellers, leaving two or three people out to be assistants. Each buyer is given a "red" card (hearts or diamonds), and each seller is given a "black" card (clubs or spades). Buyers can earn money by purchasing at prices below the "value" numbers on their cards, and the sellers can earn money by selling at prices above the "cost" numbers on their cards. For example, if a buyer with a red 10 and a seller with a black 2 agree on a price of $5, then the buyer earns $5 and the seller earns $3. Sellers are not permitted to sell below cost, and buyers are not permitted to pay more than the value of a unit. Thus each buyer has a perfectly inelastic demand for one unit at any price below the buyer's card number, and each seller has a perfectly inelastic supply at any price above the seller's card number. All buyers and sellers receive a single card at the beginning of a trading period. The resulting market demand and supply curves will be step functions, as shown on the left side of figure 1. The cards used for the for the solid line D and S curves in this figure are:

Black (spades or clubs): 2, 2, 3, 4, 5, 6, 6, 7, 8
Red (hearts or diamonds): 10, 10, 9, 8, 7, 6, 6, 5, 4

The competitive price of 6, which is obvious from the graph, will not be at all obvious to the traders who have only their own value or cost information. The equilibrium quantity prediction in this example is a range from 5 to 7 units.

After the cards are distributed, the participants are called to a trading area in the front of the room to begin negotiations. When a buyer and a seller agree on a price, they proceed to the recording desk, where the price is checked, announced, and written on the blackboard. The right

---

[1] To increase interest, I occasionally announce in advance that one participant will be selected at random after the game is concluded and that person will be paid 50 percent of their cumulative earnings in cash.
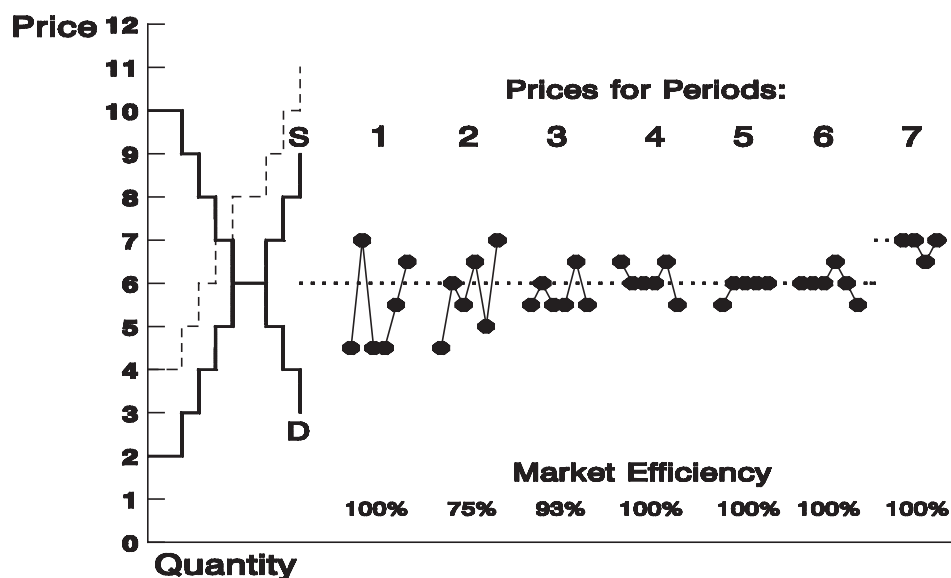
Figure 1. Data from a Classroom Pit Market (University of Virginia, Fall 1994)

side of Figure 1 shows a typical sequence of trading prices.[2] The six dots for period 1 show the first six transactions, in the order that they were announced. The cards were collected, shuffled, and redistributed at the start of each successive period. Prices are quite close to the equilibrium by period 4. Period 7 shows the effects of a supply shift that was announced:

> The government has decided to impose a $2 tax per unit, to be paid by sellers. A seller who does not sell a unit pays no tax. Therefore, the tax is like a cost increase of $2. When a trade is recorded, the assistants will ensure that the price is at least 2 above the number on the seller's card. Sellers, your cost will really be $2 above the number on the card that you get this period.

Here the supply shift had the immediate effect predicted by the intersection of the demand curve with the dashed-line supply curve in figure 1. Other possible treatments include price ceilings,

---

[2] These data are from a first-year (freshman) seminar in environmental economics at the University of Virginia, Fall 1995. I was covering for a colleague who had to be absent for personal reasons. This is another advantage of this classroom exercise: after doing it with several classes, one can have a colleague or teaching assistant run it in a class that you have to miss.

floors, and monopoly combinations of sellers.[3]

I have done this exercise in a variety of introductory, intermediate, and graduate classes, with 6 to 40 student traders. The design in figure 1 can be expanded by using additional decks of cards and inserting "vertically aligned" value and cost steps in a way that does not alter the equilibrium price. For the eighteen-card example above, you could accommodate 20 students by adding a black 3 and a red 9.[4] If the trading area is not too cramped, the trading periods will still be very short, say 5-7 minutes.

With larger classes it is better to use the students near the aisles and let the others watch.[5] One way to increase interest among non-traders in a large room is to give them photocopied handouts with a list of buyers' values and sellers' costs and with several leading questions (discussed below) that help them begin to figure out how price is determined. The traders should be separated so that they do not see the market information. To prevent watchers from getting bored, use a "heavy-handed" supply and demand design that converges quickly in two or three periods. One such design is obtained by changing the cards to get a range of equilibrium prices from 5 to 7:

Black (Spades or Clubs): 2,   2, 3, 4, 5, 5, 7, 7, 8
Red (Hearts or Diamonds): 10, 10, 9, 8, 7, 7, 5, 5, 4

This second design is quite stable, with high excess supply at above-competitive prices and high

---

[3] For example, a ceiling can be explained: "There is no tax on sellers this period, but there is a price ceiling in effect: no unit will be permitted to trade for a price above $4.50   The assistants will enforce this rule." A monopoly can be created by giving one seller control over all sellers' cards. Monopolists are sometimes not very effective in this environment (Holt, 1995). Monopoly outcomes are more likely when the seller can post a single price on a take-it-or-leave-it basis, which is the topic of a subsequent column.

[4] If you become confused, just use an equal number of red and black numbered cards, and you can construct the supply and demand functions *ex post* during the class discussion. Here you lose some of the advantages of a specific design with well thought out effects of a supply shift or a price ceiling, as discussed below.

[5] I have not actually done this with a small group of traders in a class of several hundred students. Several people who use this approach have told me that it is essential to be quick, with a small number of traders (10-12) and only one or two periods. Of course, the learning-from-experience aspect of this is much greater if it can be done in the smaller discussion sections that are often scheduled with large lecture classes. The alternative of letting new groups of traders rotate into the market is less satisfactory, since the convergence is sometimes retarded when new cohorts enter.

excess demand at below-competitive levels. I have used this design in situations where I was worried about noise in the trading, for example, when I conducted the auction with instructions translated into Spanish for a Business Spanish class.[6] I even used this "price tunnel" setup with as few as three buyers and three sellers (with costs of 3, 5, and 8, values of 9, 7, and 4): Trading lasted less than a minute, with 2 units traded and all prices in the $5-$7 competitive range in each period. A $3 tax on sellers reduced quantity to 1 unit and raised prices to about $7, as would be predicted. Then a $4.50 price ceiling (with no seller tax) resulted on only 1 transaction per period.

Unlike many classroom exercises, this one requires some advance attention to detail. Use inexpensive playing cards that do not have red or black background colors on the back, to avoid confusion about who is a buyer and who is a seller. The traders' instructions in Appendix A have been modified to anticipate many of the other confusions, mistakes, and questions that tend to arise. These instructions have the advantage of fitting onto a single page if printed with a 10 point font. Therefore, you need one instruction sheet per person, with the Earnings Record sheet in the form given in Table 1 copied on the reverse side. You also need instruction sheets for the 2-3 assistants, and record sheets in the form of Table 2 for recording and checking prices in each period. Arrange the card decks *before class* by selecting only the cards that you plan to use.

Finally, consider the classroom layout. When you face the class, the people on your right will be buyers, and the people on your left will be sellers. They will come to a central trading area to negotiate prices. It is best to have a table near the blackboard in the front, where buyers and sellers report their trades to the assistants. The trading area can be between the table and the students' seats, or (better) in an aisle that separates the buyer and seller sides of the room. When the buyers and sellers start out facing each other on opposite sides of the trading area, the initial calling out of prices is a little more public and urgent, which makes the situation more competitive.   The quick and loud announcement of transactions prices will also serve to disseminate good information about the terms of trade.

To summarize: 1) Organize the cards before class on the basis of the expected number of traders. Photocopy the instructions and earnings record sheets. 2) Pass out the traders'

---

[6]   A translation of the instructions into Spanish (done by Sylvia Gomez) is available on request.

instruction sheets while you count the students and decide on the exact cards to be used, given the number of students present. Shuffle the stacks of buyer and seller cards, keeping them separate. 3) Select the assistants, move them to the front, give them their special instructions that they can read on their own. 4) Read the first paragraph aloud before dealing the cards to buyers (on the right) and sellers (on the left). 5) Read the instructions up to the call for questions; avoid lengthy digressions. 6) Position the assistants, read the final paragraph of the instructions, note the starting time, and call the traders to the trading area. 7) During the trading, you should help the assistants, make sure that students in who have made a trade stay together in the waiting line, and send traders back to their seats to calculate their earnings after they report their prices. 8) After the period ends, ask traders to turn in untraded cards and return to their seats to calculate their (hypothetical) earnings. 9) Sort the cards by color and check the two stacks to make sure that none are missing. Shuffle and distribute the same cards, and note the starting time of the new period. I do not allow collusive discussions between periods.

Class Discussion

It is better to limit the number of trading periods so that about 15 minutes is saved for initial discussion of the main results, even if some of the more subtle issues are not settled until the following class. I usually begin the discussion by revealing buyers' values and sellers' costs (that is, listing the values of the black and red cards distributed), but without ranking them. Then I sketch the price series, without revealing the demand and supply curves. This is easier if you have a transparency with the price scale, but with supply and demand curves covered by a scrap of paper (a "post it" works well). I used to ask students what theory would explain why prices converged to the observed level, but even those with prior knowledge of supply and demand would not make the connection. Students often come up with theories based on averaging all values and costs. This says a lot about the ineffectiveness of the usual authoritarian, smooth-curve presentations of supply and demand.

A more effective approach is to present the data and begin with a series of leading questions. For the market parameters shown in figure 1, you could ask the students who would be willing to trade more units, buyers or sellers, at a price $5. Then ask them whether the excess of buyers would tend to raise or lower price from the initial level of $5. Next, ask them how

high the price would go before the excess of buyers is eliminated, and lead them toward the concept of equilibrium. If this is not enough, rephrase the same questions for the case of an initial price of $7. This approach is especially useful if the prices do not converge to the competitive equilibrium for some reason.[7]

The important thing in the discussion is to let students figure out that the price must be one that balances the quantities demanded and supplied. The step function demand and supply curves should only be drawn after students understand the equilibrium idea at an intuitive level. Otherwise, the drawing of step functions can be too confusing. However, the time it takes to explain the step-function market demand and supply curves is well spent, since this makes later explanations (for example, of consumer surplus) much easier and more intuitive.

The students are usually eager to discuss earnings. If asked about which traders are most likely to make the initial deals, students will recall that the most profitable trades often occur first. After the high-value buyers and low-cost sellers are out of the picture, the final haggling is typically among those with a smaller potential surplus and those who will find it impossible to trade at all.

Once students realize that the initial trades produce a lot of the possible surplus, they are ready to think about whether the market extracted all of the gains from trade. You can focus their attention on the results from a later period and ask if it would have been possible to increase the total earnings of all traders as a group by forcing additional trades. Then you can ask what would be (or what was) the effect on total earnings of a price ceiling below the competitive level. Here, I try to get them to discover the connection between the earnings-maximizing allocation and the competitive equilibrium. One way to buttress this connection is to point out that the extra-marginal units that do not trade in a competitive equilibrium can trade if there is enough price dispersion. In early periods, for example, a seller with a unit cost that is above the competitive price might be able to find a high-value buyer who is willing to pay a high price. Here the inefficiency results from the displacement of a seller with a lower cost. The point is that inefficiency can arise from price dispersion, which is reduced with experience and

---

[7] Prices will almost always converge with the heavy-handed "price-tunnel" design. Undetected collusive discussions and altruism among class participants can impede convergence in other designs.

good public information about past prices. Notice that the price dispersion in figure 1 falls after the initial periods. The actual earnings, expressed as a percentage of the maximum earnings, are shown as the "market efficiency" series in Figure 1. This learning can be applied to a discussion of trading institutions, the design of electronic stock exchanges, and similar topics. In particular, trading institutions that provide a lot of public information about current bids, asks, and transactions prices are likely to be more efficient.

The supply shift in Figure 1 had the predicted effect in a single period; otherwise I would have done a second period of this treatment. The discussion here focused on why the $2 tax only raised prices by $1, which gives students a chance to apply what they have learned.

My experience suggests that this exercise is very effective; it is ideal for a first meeting of a discussion section for a principals class, when there are no other assignments. Even doctoral students seem to enjoy and appreciate the experience of market trading, and I suspect it is especially useful for those who come from more mathematical backgrounds or from countries with more central planning. Indeed, the pit market trading exercise would be my clear first choice if I were limited to a single lecture in a microeconomics course at any level.

Further Reading

This type of market was first conducted by Chamberlin (1948), who let students wander around a classroom and negotiate in small groups. Ironically, Chamberlin's objective was to show that the received model of perfect competition does not predict well. For example, he observed trading quantities that were above the competitive prediction, and he speculated that this was due to the decentralized nature of negotiations in small groups. The pit market described in this paper creates more public information by putting traders in a common location, announcing prices, and letting the process be repeated. Smith (1962) showed that institutions with public information about bids, asks, and trading prices tend to produce efficient, competitive outcomes.[8]   The early work of Smith and others stimulated a large literature on market performance in the laboratory. This literature is reviewed in Davis and Holt's (1993)

---

[8]   Smith developed the "double auction" in which all bids, asks, and transactions prices were displayed publicly, as on a ticker tape. A classroom experiment using this institution will appear in a future installment of this column.

Experimental Economics, and in the Plott (1989) and Holt (1995) surveys of experiments with an industrial organization focus. The use of experiments in the classroom is also discussed in Wells (1991) and Williams and Walker (1992).

Appendix: Traders' Instructions

We are going to set up a market in which the people on my right will be buyers, and the people on my left will be sellers. Several assistants have been selected to help record prices. I will now give each buyer and seller a numbered playing card. Some cards have been removed from the deck(s), and all remaining cards have a number. Please hold your card so that others do not see the number. The buyers' cards are red (hearts or diamonds), and the sellers' cards are black (clubs or spades). Each card represents one "unit" of an unspecified commodity that can be bought by buyers or sold by sellers.

Trading: Buyers and sellers will meet in the center of the room (or other designated area) and negotiate during a 5-minute trading period. Prices must be multiples of 50 cents. When a buyer and a seller agree on a price, they will come together to the front of the room to report the price, which will be announced to all. Then the buyer and seller will turn in their cards, return to their original seats, and wait for the trading period to end. There will be several market periods.

Sellers: You can each sell a single unit of the commodity during a trading period. The number on your card is the dollar cost that you incur if you make a sale. You will be required to sell at a price that is no lower than the cost number on the card. Your earnings on the sale are calculated as the difference between the price that you negotiate and the cost number on the card. If you do not make a sale, you do not earn anything or incur any cost in that period. Suppose that your card is a 2 of Clubs and you negotiate a sale price of $3.50. Then you would earn: $3.50 - $2 = $1.50. You would not be allowed to sell at a price below $2 with this card (2 of Clubs). If you mistakenly agree to a price that is below your cost, then the trade will be invalidated when you come to the front desk; your card will be returned and you can resume negotiations. Think of it this way: it's as if you knew someone who would sell you the commodity for a price that equals your cost number, so you can keep the difference if you are able to resell the commodity for a price that is above the acquisition cost.

Buyers: You can each buy a single unit of the commodity during a trading period. The number on your card is the dollar value that the you receive if you make a purchase. You will be required to buy at a price that is no higher than the value number on the card. Your earnings on the purchase are calculated as the difference between the value number on the card and the price that you negotiate. If you do not make a purchase, you do not earn anything in the period. Suppose that your card is a 9 of Diamonds and you negotiate a purchase price of $4. Then you would earn: $9 - $4 = $5. You would not be allowed to buy at a price above $9 with this card (9 of Diamonds). If you mistakenly agree to a price that is above your value, then the trade will be invalidated when you come to the front desk; your card will be returned and you can resume negotiations. Think of it this way: it's as if you knew someone who would later buy the unit from you at a price that equals your value number, so you can keep the difference if you are able to buy the unit at a price that is below the resale value.

Recording Earnings: Some sellers with high costs and some buyers with low values may not be able to negotiate a trade, but do not be discouraged since new cards will be passed out at the beginning of the next period. Remember that earnings are zero for any unit not bought or sold (sellers incur no cost and buyers receive no value). When the period ends, I will collect cards for the units not traded, and you can calculate your earnings while I shuffle and redistribute the cards. Your total earnings equal the sum of earnings for units traded in all periods, and you can use the Earnings Record Form on the back of this sheet to keep track of your earnings. Sellers use the left side of the Earnings Record Form, and buyers use the right side. At this time, please draw a diagonal line through the side that you will *not* use. All earnings are hypothetical. Please do not talk with each other until the trading period begins. Are there any questions?

Final Observations: When a buyer and a seller agree on a price, both should immediately come to the front table to turn in their cards together, so that we can verify that the price is neither lower than the seller's cost nor higher than the buyer's value. If there is a line, wait together with your trading partner. After the price is verified, the assistant at the board will write the price and announce it loudly. Then those two traders can return to their seats to calculate their earnings. Buyers and sellers, please come to the central trading area NOW. Everyone ready? Begin calling out prices at which you are willing to buy or sell. You have 5 minutes remaining.

Table 1. Earnings Record Sheet (copy on the reverse of the instruction sheet)

name:_____

Seller Earnings				Buyer Earnings		
(sellers use this side)				(buyers use this side)		

_____	_____ = _____		first period	_____	— _____ =	_____
(price)	(cost) (earnings)			(value)	(price)	(earnings)
_____	— _____ = _____		second period	_____	— _____ =	_____
(price)	(cost) (earnings)			(value)	(price)	(earnings)
_____	— _____ = _____		third period	_____	— _____ =	_____
(price)	(cost) (earnings)			(value)	(price)	(earnings)
_____	— _____ = _____		fourth period	_____	— _____ =	_____
(price)	(cost) (earnings)			(value)	(price)	(earnings)
_____	— _____ = _____		fifth period	_____	— _____ =	_____
(price)	(cost) (earnings)			(value)	(price)	(earnings)
_____	— _____ = _____		sixth period	_____	— _____ =	_____
(price)	(cost) (earnings)			(value)	(price)	(earnings)
_____	— _____ = _____		seventh period	_____	— _____ =	_____
(price)	(cost) (earnings)			(value)	(price)	(earnings)

total earnings, $ total earnings, $
for all periods: _____   for all periods: _____

Instructions to Assistants

You will be positioned at the front of the room near a recording table. The traders will be "buyers" or "sellers". Each buyer will have a card with a red number (hearts or diamonds), and each seller will have a card with a black number (clubs or spades). When a buyer-seller pair agree on a price, they will come up to this table. Your job is to record the price after you have checked to be sure that the trade is legal; that is, that the price is not below the seller's cost (number on the black card) and the that the price is not above the buyer's value (number on the red card). Prices must be in 50-cent increments. Make the buyer-seller pairs form a line in front of the table. They should wait in pairs.

When a pair arrives at the front of the line, take their cards and ask for price that they negotiated. Then check to be sure that the price is no lower than the black card (clubs or spades) and no higher than the red card (hearts or diamonds). Equality is allowed. If the trade is not legal, then give the cards back to both the buyer and seller and send them back to the trading area. If trade is legal, write down the price in the next blank of the Record Sheet, which will be on the table. Then keep the cards, send the traders back to their seats, and write the seller's and buyers' card numbers in the columns to the left and right of the center price column. Remember to keep the cards for trades that are completed so that the traders cannot use the cards twice in the same period. Try to handle the cards and place them face down so that traders are less likely to see each other's card numbers.

One of you should be a blackboard recorder who announces the price loudly when it is confirmed and then writes it on the blackboard. The announcer will have to stand near the recording desk so that confirmed prices can be communicated to the announcer. Be sure to announce confirmed prices loudly for everyone to hear, even if the don't appear to be listening. These blackboard announcements should be quick and accurate so that traders on the floor have up-to-date information about the current state of the market. Please take your time and be careful in checking trades in the first period when most mistakes will occur. To summarize:

> PRICE MUST BE > OR = THE NUMBER ON THE BLACK CARD.
> PRICE MUST BE < OR = THE NUMBER ON THE RED CARD.
> RECORD PRICES VALUES AND COSTS IN ORDER AS YOU VERIFY THEM.
> ANNOUNCE PRICES LOUDLY AND WRITE THEM ON THE BLACKBOARD.
> KEEP CARDS FOR VALID TRADES.

Table 2. Sheet for Verifying and Recording Prices

Seller Cost (number on the black card, recorded here after traders walk away)	≤ Price ≤	Buyer Value (number on the red card, recorded here after traders walk away)

References

Chamberlin, Edward H., "An Experimental Imperfect Market," *Journal of Political Economy*, April 1948, *56*, 95-108.

Davis, Douglas D., and Charles A. Holt, *Experimental Economics*. Princeton: Princeton University Press, 1993.

Holt, Charles A., "Industrial Organization: A Survey of Laboratory Research." In Roth, Alvin, and John Kagel, eds., *Handbook of Experimental Economics*. Princeton: Princeton University Press, 1995, 349-443.

Plott, Charles R., "An Updated Review of Industrial Organization: Applications of Experimental Methods." In Schmalensee, Richard, and Robert D. Willig, eds., *Handbook of Industrial Organization*. Vol. II. Amsterdam: North-Holland, 1989, 1109-76.

Smith, Vernon L., "An Experimental Study of Competitive Market Behavior," *Journal of Political Economy*, April 1962, *70*, 111-37.

Wells, Donald A., "Laboratory Experiments for Undergraduate Instruction in Economics," *Journal of Economic Education*, Summer 1991, *22*, 293-300.

Williams, Arlington W., and James M. Walker, "Computerized Laboratory Exercises for Microeconomics Education: Three Applications Motivated by the Methodology of Experimental Economics," *Journal of Economic Education*, Fall 1993, *22*, 291-315.