Economic Instruction

In this section, the *Journal of Economic Education* publishes articles, notes, and communications describing innovations in pedagogy, hardware, materials, and methods for treating traditional subject matter. Issues involving the way economics is taught are emphasized.

MICHAEL WATTS, Section Editor

An Experiment in Comparative Advantage

Michael J. Haupert

Comparative advantage is one of the basic concepts principles level students are expected to master. Indeed, it is one of the fundamental concepts of economic theory, underlying the principles of specialization, division of labor, and exchange. I have found that an experiment illustrating these concepts is useful in demonstrating both comparative advantage and opportunity cost.

Although practical examples of the comparative advantage principle are abundant, many students still have difficulty with the basic premise and wide-ranging applicability of the concept. Personal experience has shown that no matter how often I repeat the story of Robinson Crusoe or have my students work out homework problems calculating comparative advantage, the reality of the concept never quite sinks in for all of them. My pronouncement that without trade, one is restricted to consuming only what one can produce does not seem to go far beyond the immediate examples that I give in class. In addition, the extant literature on interactive learning leans toward favoring such pedagogical techniques in order to promote comprehension and retention. Students tend to benefit more from interactive learning styles than from traditional, impersonal lecture formats (Andrews 1981; Byrne and Johnstone 1983; and Hilligoss 1992).

For these reasons, I designed an experiment that I now implement in both the micro and macroeconomics principles courses. I run this experiment during the first week of the semester immediately following the lecture on opportunity cost and comparative advantage. Although I use an entire one-hour period for this

Michael J. Haupert *is an associate professor of economics at the University of Wisconsin-La Crosse.*
The author would like to thank Noelwah Netusil, Donald Wells, and three anonymous referees for helpful comments and the University of Wisconsin Teaching Improvement Council for financial support in the development of this experiment.

experiment, I lose very little class time because I substitute this experiment for a number of examples of comparative advantage and opportunity cost. I have found that a single example of each topic, coupled with the experiment, is much more effective.

THE EXPERIMENT

In this experiment, students have a choice of goods to produce given a fixed allocation of inputs and a production function. They are given a consumption goal and an opportunity to trade their output over a number of trials of the experiment. The experiment is designed so that students can achieve their consumption goals only by specializing in the production of the good in which they have a comparative advantage and then trading with other players.

The concept of opportunity cost is straightforward in this experiment, because each student has the capacity to produce only two goods with one given type of input. The opportunity cost of producing one good is the quantity of the other good that could be produced. The idea of comparative advantage is also straightforward, because all participants in the experiment produce the same two goods using the same input. This makes it easy to compare production possibilities among players, to determine comparative advantages.

In this experiment, the class is divided into four types of producers, although a greater variety of producer types or production goods could easily be used to increase the sophistication of the trading. I have found that two goods and four player types works sufficiently well, however, especially since the goal of the experiment is to illustrate the concepts of opportunity cost and comparative advantage and not necessarily to mirror a complex trading market.

Each player is identified as either type A1, A2, B1, or B2. Each of the four player types is allocated a number of hours of labor and a production function telling them how many hours of labor it takes to produce one unit of steel or one unit of wheat. The number of labor hours allocated and the number of hours it takes to produce each good remain constant through all five rounds. The type 1 players are each allocated 80 hours of labor, and type 2 players are each allocated 150 hours of labor. Type A players require one labor hour to produce wheat, and type B players require one labor hour to produce steel. A1 players require two hours to produce steel, and A2 players require three hours. B1 players require two hours to produce wheat, and B2 players require three hours (Table 1). Players must decide how many units of wheat and steel they will produce given the limited amount of labor hours each has. Players may not produce any fractional units of a good, nor may they use fractional hours of labor. Neither labor nor production goods may be carried over from one period to the next.

In each round of the experiment, the rules change slightly. In the first round, individual players may choose to produce whatever combination of wheat and steel they would like. No trading is allowed in the first round, so whatever is produced will also be consumed. In the second round, players once again determine their production combination. This time, however, after they have made their production decisions they may go into the market and trade with anyone they wish.

TABLE 1
Player Types and Allocations

Allocations	Player type			
	A1	B1	A2	B2
Allocation of labor hours per round	80	80	150	150
Hours required to produce one unit of wheat	1	2	1	3
Hours required to produce one unit of steel	2	1	3	1
Opportunity cost of steel (units of wheat)	2	1/2	3	1/3
Opportunity cost of wheat (units of steel)	1/2	2	1/3	3
Maximum possible production of wheat per round	80	40	50	150
Maximum possible production of steel per round	40	80	50	150
Five-round consumption goal: Wheat	200	150	450	200
Five-round consumption goal: Steel	150	200	200	450

Wheat and steel may be traded in whole units, but labor may not be traded. Once a player receives a good in trade, it cannot be traded again—it must be consumed.

In the third and fourth rounds, players may again trade, but this time they may consult with other players before they produce in order to make binding production and trading agreements. If they wish, they may reveal their labor allocation and production functions to other players as part of their negotiating process. For example, player A1 might get together with player B1 and agree to produce 80 units of wheat and trade all of them for 80 units of steel produced by B1. In this way, players can base their production plans on their comparative advantage with other players.

The fifth round is a repeat of the fourth round. An option for varying the fifth round is to use the same production and trading rules as round four but establish a tariff on wheat. In this case anyone receiving wheat in trade must pay a tariff equal to 10 percent of all the wheat received. The purpose of the tariff is to add another dimension to the comparative advantage lesson by discussing the effect on trade and efficiency when markets are not allowed to operate freely. The disadvantage of instituting a tariff is that it does complicate the experiment and add to its length. Depending on the level of the class and the amount of time available for the experiment, the time may be better spent by leaving round five as a repeat of round four and devoting more time to a follow-up discussion on the experiment and its illustration of comparative advantage.

Choice of Parameters

The choice of production functions sets up reciprocal comparative advantage relationships between A1 and B1 in the one instance and A2 and B2 in the other. Players can meet their consumption goals by trading with their reciprocal match at a ratio of one for one. If a type 1 player trades with a type 2 player, the prices could fluctuate and players could consume more than their goal by enough to earn the additional extra credit points available for exceeding their consumption goals.

In addition, these numbers allow players to make a mistake in the first round and still recover. For example, if player A1 decides in the first round to produce 20 units of steel and 40 units of wheat, he or she can still recover by focusing solely on wheat production in each of the next four rounds, producing 80 units per round for a total of 320, keeping half of them for consumption (along with the 40 produced and consumed in the first round) in order to achieve his wheat consumption goal and still have 160 units to trade at a ratio of one for one, which will allow A1 to make a consumption goal of 150 units of steel.

If player A1 makes the same production mistake in each of the first two rounds, but in the second round trades all of his or her wheat for 40 units of steel, at the end of round two A1 will have 60 units of steel and 40 units of wheat. Over the last three rounds, the best possible outcome will be to produce only wheat, for a total of 240 units (160 of which will have to be kept to meet the wheat consumption goal). The other 80 units can be traded, but trading them with B1 for steel will still leave A1 short of the consumption goal of 150 units of steel. Instead, A1 will have to search for a better deal, most likely with B2, and trade his or her wheat at a ratio of better than one for one. Because B2 has an opportunity cost of producing wheat equal to 3 units of steel, B2 will be better off trading even 2 units of steel for a unit of wheat, so such a trade is certainly possible. Making such a trade, however, will require that A1 gets to B2 before B2 makes a better deal, with A2, for example, with whom B2 would likely be able to find a deal at the ratio of one for one.

PRIOR RUNS OF THE EXPERIMENT

I have run this experiment in classes ranging in size from 24 to 80 students. In all cases, the exchanges went smoothly. I pass out the instructions with a sample record sheet one class period in advance of actually running the experiment. At the beginning of the period, I allow 5 to 10 minutes to answer questions and briefly review the instructions before beginning. I find that with an assistant or two in the class, the experiment goes much more quickly, because the most time-consuming part is answering questions students have about filling in their record sheets. In addition, in order to discourage any ex-post trading from occurring, I require all record sheets to be filled out in pen and all corrections to be initialed by me or my assistants. (See Appendix A for the instructions and record sheet.)

On occasion, a trade is made between two players after one of them made a mistake in production. These trades must be disallowed because a player cannot produce more wheat and steel than his labor allocation will allow. To minimize such problems, I require the students to write down the name of each player they trade with as well as that person's player type (A1, A2, etc.). This increases the probability of undoing an illegal trade and also helps the students to get to know one another early in the semester.

In a typical class, I have found that most students will try to produce both goods in the first and second rounds. Once they get into the trading market after their round two production, they begin to see what others are capable of producing, and those that have not already caught on to the comparative advantage principle

begin to see the advantages of specializing in production and trading with others. Of course, not everyone "sees the light." Despite my previous lectures centering on comparative advantage, about half of the students will not resort to complete specialization in the third round and, as a result, will not be able to reach their consumption goals. Those who have recognized the problem search out a potential trading partner, specialize their production over the last three rounds, and trade for the good at which they have a comparative disadvantage of production.

CONCLUDING REMARKS

In addition to granting bonus points to players who achieve their consumption goals, I also grant additional bonus points to the players who exceed their goals by the greatest amount. This keeps players in the game after they have made their original goals and reduces the possibility that players will simply give their production to someone else just because they have no reason to keep it. I typically award bonus points in an amount equal to 1 percent of their semester grade for those students who meet their consumption goal. I award an additional half percent to the 10 students who exceed their consumption goals by the greatest amount.

The students who earn the additional extra-credit points as top earners are those who recognize the optimal strategy in the first round and begin specializing immediately. These tend to be the better students in the class, although occasionally a shrewd trader who is able to find a partner with whom to trade at a ratio better than one to one will also be in this group.

Even those students who fail to meet their consumption goals (about half in each class) learn from this lesson, as failure can be a motivating teacher. I concentrate the follow-up discussion on various trading strategies used by students, highlighting both successful and unsuccessful strategies and allowing the students to discuss why they worked or failed to do so. My experience with this experiment is that more students come away with a better understanding of the concept of comparative advantage after having experienced it in practice than when I simply explained it to them and worked out some examples for them.

APPENDIX A
Production and Trade Experiment Instructions

This is an experiment in the economics of market decisionmaking. The instructions are quite simple; however, if you have any questions, please ask.

For this particular experiment, there are four types of players. In the upper left-hand corner of your record sheet you will find an A1, A2, B1, or a B2 to designate which one of the four you are.

At the beginning of the game, each player will be allocated a certain number of labor hours, which are needed to produce two separate goods: wheat and steel. What you must decide is how many units of wheat and how many units of steel you are going to produce given the limited amount of labor hours that you have. You may produce any combination of wheat and steel that you like; you may choose to produce all of one good and zero units of the other. There are only two basic restrictions. You may not produce any fractional units of wheat or steel; you must produce whole units. In addition, you may not use fractional hours of labor; you must use whole hours to produce wheat and steel.

Your record sheet must be completed using a pen. If you make a mistake in one of your entries, your correction must be initialed by the instructor. Failure to do this will invalidate the entry.

ADDITIONAL TRIALS

Trial Two

After you have chosen the particular combination of wheat and steel to be produced, you may trade what you have produced for what another player has produced. Trading is limited to whole units.

Trials Three and Four

You may consult with other players about their production capabilities and make binding trade agreements based on the production each of you will undertake for the upcoming period (that is, contract to make trades before you produce. Do not agree to trade unless you can produce that quantity.) You may not trade labor hours, only wheat and steel.

Trial Five

You still have the option to trade wheat and steel with other players, but now a tariff has been imposed. Anyone receiving wheat in trade must pay 10 percent of all the wheat they receive to the government as a tariff.

EXAMPLE OF RECORD-SHEET ENTRY

(See next page of instructions for sample record sheet)

In this example, you are a type A1 player, and your consumption goal is 40 units of wheat and 15 units of steel. You are expected to meet this consumption goal after all five rounds are completed. You are not expected to meet this goal each round.

Row A indicates that you have 160 hours of labor available for production in each round. Row C indicates that you require 20 hours of labor to produce one unit of wheat. Row F indicates that you require 40 hours of labor to produce one unit of steel. Now you must decide how many units of each good to produce.

If you decide to produce two units of wheat, then enter a 2 in row D. In row B, enter the total hours of labor you used to produce those two units of wheat. Since you produced two units of wheat, and each one required 20 hours of labor, then you used 40 hours of labor to produce wheat. Enter the number 40 in row B.

You started out with 160 hours of labor and used 40 to produce wheat, so now you have 120 remaining. If you decide to use those 120 hours to produce steel, then enter the number of units of steel you wish to produce in row G. If you decide to produce two units of steel, then enter a 2 in row G. Since you produced two units of steel, and each one required 40 hours of labor, then you used 80 hours of labor to produce your steel. Enter the number 80 in row E.

In the first period, there is no trading, so you are finished. In row P enter the number of units of wheat you consumed. In row Q, enter the number of units of steel you consumed. Since there is no trading, you consume what you produce. Enter a 2 in row P and a 2 in row Q. You have now consumed two units of wheat and two units of steel. Since your consumption goals are 40 wheat and 15 steel, you must consume another 38 wheat and 13 steel in the next four periods to meet those goals.

If you decide to produce the same number of each good in period two, then your entries for rows A through G will be the same. In round two, however, you now have the opportunity to trade what you produced for what others have produced, giving you an opportunity to consume a different bundle of goods from the one you produced.

Player Type A1: Production and Trade Experiment Record Sheet

Allocation	Period 1	2	3	4	5	Total
A. Total labor hours available	160	160	160	160	160	
B. Hours used to produce wheat	40	40				
C. Hours required to produce one unit for wheat	20	20	20	20	20	
D. Units of wheat produced (B/C)	2	2				
E. Hours used to produce steel	80	80				
F. Hours required to produce one unit of steel	40	40	40	40	40	
G. Units of steel produced (E/F)	2	2				
H. Units of wheat traded		1				
J. Units of steel received		3				
K. Units of steel traded		0				
L. Units of wheat received		0				
M. Player traded with (name and type)						
N. Tariff paid (.1 x L) 0						
P. Total units of wheat consumed (D – H + L)	2	1				
Q. Total units of steel consumed (G + J – K)	2	5				

If you trade one of your units of wheat to another player for three units of steel, then enter a 1 in row H, which is labeled "units of wheat traded." Then enter the number of units of steel you received in the trade in row J. Since you received three units of steel, enter a 3 in row J. Since you did not trade any steel, nor did you receive any wheat in trade from other players, enter zeros in rows K and L.

Now calculate your total consumption for round two. Your consumption consists of all goods that you produced but did not trade away, plus all goods you obtained in trade. Row P asks you to calculate the total units of wheat consumed. Since you produced two units of wheat, traded away one, and received none in trade, you consumed one unit of wheat. Enter a 1 in row P. Since you produced two units of steel, traded none away, and received three in trade from another player, you consumed five units of steel. Enter a 5 in row Q. Note also that you are asked to record the name and player type of the player with whom you traded. Enter this information in row M.

Notice now that after two rounds you have consumed a total of three units of wheat

(two in period one and one in period two) and seven units of steel (two in period one and five in period two). Your goal is to consume 40 wheat and 15 steel; therefore, in the remaining three rounds you must consume 37 units of wheat and 8 units of steel.

REFERENCES

Andrews, J. 1981. Teaching format and student style: Their interactive effects on learning. *Research in Higher Education* 14 (2): 161–78.

Byrne, M., and A. Johnstone. 1983. Interactive units for the development of critical attitudes. *Simulation Games for Learning* 13 (3): 95–103.

Hilligoss, T. 1992. Demystifying "classroom chemistry": The role of the interactive learning model. *Teaching Sociology* 20 (1): 12–17.