Wesleyan Economics Working Papers

http://repec.wesleyan.edu/
N°: 2005-013

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April 5, 2005

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Abstract

We introduce a simple web-based classroom experiment in which students learn the Ricardian model of international trade. Students are assigned to countries and then make individual production, trade and consumption decisions. The analysis of experimental data introduces students to the concepts of absolute and comparative advantage, relative prices, production possibility frontier, specialization, gains from trade, utility maximization and general equilibrium. Students learn about the relationship between individual decision-making and aggregate economic activity. The associated software, Ricardian Explorer, is easy to setup and requires minimal preparation time for instructors. The game is developed as a tool to complement courses in international trade, but it can be used in introductory and intermediate microeconomics courses as well. The analysis of teaching effectiveness has demonstrated that integration of this experiment in the curriculum enhances student learning.

Keywords: *Absolute advantage, comparative advantage, specialization, production possibility frontier, gains from trade, utility maximization, general equilibrium, classroom experiments*

First version: January 2005
This version: April 2005

We thank Wesleyan University for financial support; Mike Lovell and poster session participants at the 2005 meetings of the American Economic Association for suggestions; Manolis Kaparakis, Mike Roy, Henk Meij, and Anne Loyer for their participation in different stages of this project; John Hammond for technical assistance; and our students of the last three years for their encouragement and constructive criticism.

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I. Introduction

David Ricardo's principle of comparative advantage, which states that a country gains from trade by specializing in the production of goods that it is relatively better at producing, is familiar to economics students. The Ricardian model of trade lays the foundation of the modern theory of international trade and is usually taught in introductory economics courses. Comparative advantage, however, is not an easy concept (Krugman, 1996). Paul Samuelson named it "the most counterintuitive yet compelling" proposition in the social sciences (Bhagwati, 2003, p. 5), and Paul Krugman (1993) emphasized its relevance in the undergraduate economics curriculum.

To facilitate the intuition, the Ricardian model is taught in introductory courses with the aid of graphs depicting the production possibilities frontier in the two countries engaged in trade. In International Trade courses, equations and further graphical analysis are added. For example, the Krugman and Obstfeld (2003) textbook introduces a relative demand-relative supply graph to illustrate the determination of equilibrium in the goods markets and a labor market graph to illustrate equilibrium in the Ricardian model with more than two goods. While the graphical analysis is a very useful pedagogical tool, some deeper elements of the model, such as the concept of general equilibrium and the inter-relation between micro decisions and aggregate market outcomes, are often overlooked in standard textbook treatments. We believe that a pedagogical tool in which students experience the decision problem of economic agents and observe the results of their interactions with other agents can help them appreciate more fully these deeper elements.

In this paper we describe how to use web-based classroom experiments to facilitate and enhance learning of the Ricardian model. Students are assigned to countries and are endowed with labor which they can use for the production of goods. Students make individual decisions on what goods to produce, whether to engage in trade and what goods to offer for trade. Trade is implemented using a posted offer institution in which sellers enter their offers and buyers have an opportunity to accept desirable trades. After production and trade, students make their consumption decisions. Analysis of the resulting data makes students think carefully about the relationship between their individual decisions and resulting aggregate economic outcomes. They grow to appreciate the role of prices in coordinating economic activity.

The game is played using Ricardian Explorer, a software package designed at Wesleyan University and available for use at other institutions free of charge[1]. It allows for a larger number of participants in a given experiment than traditional paper and pencil experiments.[2] Therefore it is attractive both for instructors who already use paper and pencil experiments and for those who are considering adoption of classroom experiments in their curriculum.[3] The program was originally designed for an International Trade course, but is applicable more broadly for teaching key economic concepts like opportunity costs, relative prices, production possibility frontier, absolute and comparative advantage, specialization, gains from trade, utility maximization, and general equilibrium at various levels of microeconomics. Since all transactions are conducted as barter exchange, the program can be also used in a monetary economics course to study the origins of commodity money. Finally, the program can be adopted in courses in experimental economics to study posted offer markets. We have successfully used the software at Wesleyan as part of an introductory curriculum and also in field courses in international trade.

Finally, we encourage conducting the experiment prior to assigning textbook readings or doing formal analysis in class. This allows students to learn the concepts experientially. Playing the game (with different parameters) for the second time after class discussion and related homework reinforces the acquisition of the key concepts and also increases student satisfaction because they feel more in command of the material.

The remainder of the paper proceeds as follows: In section II, we summarize the underlying theoretical model. In section III, we explain the procedures for conducting the experiment in a classroom setting. Section IV presents a discussion of the results of a version of this experiment implemented at Wesleyan in the Fall of 2004. In this context, we highlight some of the key pedagogical points that the experiment can be used to address. Section V provides evidence of teaching effectiveness using a controlled evaluation, and section VI concludes.

II. Ricardian model

The following description of the Ricardian model emphasizes the inter-relation between micro decisions and aggregate market outcomes.

Each country *c* is populated by I^c production and consumption units indexed by *i*. Think of them as family farms endowed with a fixed amount of labor L_i^c to use during each production period. All farms within a country have access to the same production technologies, which are linear in labor, the only factor of production. Assuming for simplicity that there are only two goods, *x* and *y*, country *c*'s production functions are $x = \left(1/a_{LX}^c\right)L$ and $y = \left(1/a_{LY}^c\right)L$, where a_{LX}^c and a_{LY}^c are the unit labor requirements parameters. The production possibilities frontier (PPF) describes the maximum levels of production of *x* and *y* available to the farm when it utilizes its labor endowment fully:

$$L_i^c = a_{LX}^c x + a_{LY}^c y . \tag{1}$$

Each farm can produce for its self consumption or for the market. In this simple economy there is no monetary unit: all market transactions are done through barter. Using *y* as numeraire, the market value of a farm's production basket $\left(x^p, y^p\right)$ is defined as

$$V_i^c\left(x^p, y^p\right)/p_Y \equiv \left(p_X / p_Y\right)x^P + y^P . \tag{2}$$

The consumption possibilities frontier (CPF),

$$y = V_i^c\left(x^p, y^p\right)/p_Y - \left(p_X / p_Y\right)x \tag{3}$$

describes the maximum levels of consumption of *x* and *y* available to the farm when it trades its production basket $\left(x^p, y^p\right)$ in the market.

In deciding whether or not to engage in a market transaction, the farm must compare its PPF with its CPF. In the example in Figure 1, the relative market price of *x* exceeds the farm's opportunity cost of producing *x*, a_{LX}^c / a_{LY}^c, making it profitable for the farm to sell *x* in exchange for *y*.

Because all farms in a country have the same opportunity costs, the autarky equilibrium price is $p_X / p_Y = a_{LX}^c / a_{LY}^c$. Therefore, in autarky farms have no incentive to produce for the market. Under free trade, farms will have an incentive to trade with farms in other country provided that opportunity costs differ across countries. Suppose that there are only two countries c = 1, 2 and that country 1 has a comparative advantage in good *x*: $a_{LX}^1 / a_{LY}^1 < a_{LX}^2 / a_{LY}^2$. Farms in country 1 will have an incentive to sell *x* in exchange for *y* if $a_{LX}^1 / a_{LY}^1 < p_X / p_Y$, and farms in country 2 will have an incentive to sell *y* in exchange for *x* if $a_{LY}^2 / a_{LX}^2 < p_Y / p_X$. Therefore, the free trade equilibrium price should lie in the $\left[a_{LX}^1 / a_{LY}^1, a_{LX}^2 / a_{LY}^2\right]$ interval. Any transaction at a price outside this interval will be prejudicial to one of the parties involved.

To recap, the model described so far has predictions at both the microeconomic and the aggregate level. At the microeconomic level it predicts that farms will not sell at a relative price below their opportunity cost, nor will they buy at a price above their opportunity cost. It also predicts that farms will have an incentive to specialize in the production of the good whose relative price exceeds its opportunity cost, and to sell that good in the market in exchange for the other good. At the aggregate level it predicts the direction of trade flows and a range of prices within which the equilibrium price will lie. Given the linearity of the production technologies, the model also predicts that at least one of the countries will be fully specialized in the production of the good in which it has a comparative advantage. Finally, when only one country fully specializes, the model predicts that the equilibrium price will equal the opportunity cost of the country that does not fully specialize.

The remaining ambiguity about this model is what exactly will be the free trade equilibrium price. If one wants that price to be unique, the model can be augmented with assumptions about preferences and consumption choices. The discussion so far has implicitly assumed that farms don't want to lose from trade. To be more precise we can assume that each family farm chooses a collective consumption basket to distribute among its members by maximizing a utility function. The usual assumption is that the utility function is quasi-concave, homothetic, and identical across all farms in all the countries. An example of such utility function, which we use in the Ricardian Explorer game is the CES utility function

$$U(x,y) = \left(x^{\rho} + y^{\rho}\right)^{\frac{1}{\rho}}, \quad \rho < 1. \tag{4}$$

This function includes the logarithmic and the Leontief utility functions as special limiting cases, when ρ approaches 0 and $-\infty$, respectively.

III. Procedures

In this section, we briefly describe the procedures for setting up an experiment, review sample game screens and outline the sequence of user actions.

1. Software Requirements

The software is a Java application that was developed by Information Technology Services (ITS) at Wesleyan and runs on a Wesleyan server. All users, including the instructor only need to have internet access through a web-browser (such as Internet Explorer). The browser needs to be Java enabled running Java 2 v. 1.43.x. or later. Users who do not have Java enabled browsers can download Java plugin for free from http://www.java.com

Instructors can set up their own game or use pre-programmed games. There is no limit on the number of users; therefore the software can be used even in very large classes. Users from outside of Wesleyan need to set up an account for authentication prior to using the software. The instructor can do this by contacting ITS and supplying a spreadsheet with student names and emails. The contact information is available at the game web site, http://www.wesleyan.edu/re.

The instructor can view the game using the experimenter control screen. After the game is over, the data can be downloaded in a comma-delimitted file and then opened using a spreadsheet program such as Excel. The software also generates basic summary statistics and graphs that can be viewed on the screen, printed out or projected during lecture using multimedia equipment.

2. Setting up a game

As we mentioned, instructors can choose among the existing games or create a new one. A game is defined by choosing country names, good names, and parameter values for total available labor, unit labor requirements and ρ, the utility function parameter.[4] While the software has no limit on the total number of countries and goods, we suggest using a simple example with two countries and two goods in introductory courses. This provides a natural parallel to the textbook discussion and also does not overwhelm students with complexity. If students have not been exposed to utility maximization, we suggest using Leontief preferences because they are more transparent to explain.[5] In addition, the game allows the option of carrying forward goods not consumed in a round to the next round, subject to a good-specific storage cost set by the instructor.

Besides choosing theoretical parameters, instructors also set up when the game will be played, its duration, and the number of trading rounds.[6] During each round students make production decisions, offer goods for trade, accept offers from other students, and decide how much to consume. The game can be set up such that there is time between each round for students to review the outcomes of the previous rounds and design a strategy for the next round. When deciding on the length of the experiment, the instructor has to decide on the length of each round and the time between rounds. For a 50 minute class, we suggest setting up a game with 4 rounds of 8 minutes in length with 4 minutes in between to review results. Instructors can also set up a game to run outside of class. There are two options for doing this. One is to require all students to play at a specified time from their own computers. The other is to set up a game lasting for several days. We prefer the first option because the markets can be very thin if students do not login at the same time.

Students are assigned to a country as they login. In the current version, the number of students assigned to each country is similar. However, it is possible to make countries different in size by choosing different values of the labor endowment parameter across countries. The instructor does not need to worry about assigning students to a country as it is done automatically by the program.

3. Procedures for users

Students are asked to login into the game using a Java-enabled browser. Upon login they are automatically assigned to a country and immediately see the game screen (Figure 2). The game screen used in the Ricardian Explorer web site is programmed as a Flash application such that students can see a description of the function of each particular area of the screen when they bring their mouse to that area. This provides an easy way for students to get quickly acquainted with the interface. Instructors can choose to show the game screen to students in advance and answer any questions they might have in order to minimize confusion during the first round of play.

The game information portion of the screen tells a player which country she was assigned to, her initial labor endowment and also tracks her utility in the current round and throughout the game. The top left-hand corner of the screen tracks the time remaining in a round and available labor. Next to it is information on each good including unit labor requirements for production, the number of goods produced in the current round, the number of goods bought/sold in the current round, the number of goods consumed and the number of goods available for consumption or trade. The middle portion of the screen is reserved for student actions. On the left, they choose how much of each good to produce, consume and offer for trade. All trades are presented as barter exchanges (good 1 in terms of good 2). Offers currently available on the market are displayed on the right side of the screen. On the top student sees her own offers, which she can choose to retract. Below are all offers on the market that she can choose to accept. The offers are sorted first by the good offered and then by the relative price.

Each student begins a round by making production and trade decisions. At the end of the round, students choose to retract outstanding offers and make their consumption decisions. There is a shortcut button that allows them to consume everything they are holding. Their utility score is computed. After the round is over, students spend several minutes reviewing the results and choosing a strategy for the next round. In each round they get a new allocation of labor. There is an option (chosen by instructor) to allow students to carry over goods from one period to the next. This can be especially attractive if one chooses to use the program to study the origins of commodity money. Students can learn how storage cost properties of different goods encourage their development as a medium of exchange. Notice that when this option is not chosen, all the goods in stock not consumed before the end of the round is lost.

Currently the score is computed with utility at autarky normalized to one, with any numbers above indicating gains from trade. We are also in the process of developing an alternative game score based solely on gains from trade. This will allow instructors to choose whether or not to include utility maximization as a teaching objective for this experiment.

The game screen is automatically refreshed every ten seconds and reflects all production, trade and consumption decisions. Students can rejoin the game at any time by opening the browser and typing in their login information. This is convenient in case they experience computer problems or close their browsers by accident. Another attractive feature of the software is its messaging capability. Students can send short text messages to each other, and the instructor can send messages to individual players or to all participants. Messages can be used by the instructor to make comments about the development of the game and by students to build trade relationships. Students find this feature very valuable.

IV. Classroom Discussion and Analysis of Sample Data

In this section we show data for a sample game to illustrate the pedagogical possibilities of the Ricardian Explorer game. This game, called Ricardos, was played by international trade students at Wesleyan University in the Fall of 2004. The game is characterized by the following parameters:

Country	Unit labor requirements		Labor Endowment	Rho
	Wine	Cloth		
England	2	3	10,000	-2
Portugal	1	6	10,000	

Notice that Portugal has comparative advantage in wine and England in cloth. Of course, players who log in to the game do not know this a priori; they only know the parameters corresponding to their respective country. Ideally, as the game progresses and players observe prices of trades in the market, they realize in which good they have a comparative advantage and start to take production decisions accordingly.

Figure 3 shows production choices at the end of the 2nd and 4th rounds of play for players located in Portugal. The vertical axis represents wine and the horizontal axis represents cloth. It is clear that between the 2nd and 4th rounds students learned to produce at the PPF. Moreover, in the 4th round 6 six out of twelve students fully specialized in wine, as the theoretical model predicts, compared to three out of thirteen in the 2nd round.

Figure 4 shows consumption choices of the same Portugal players at the end of the 2nd and 4th rounds of play. It is clear that more players managed to gain from trade and consume above their PPF, as the model predicts. But it is also clear that many players consumed even less than what they produced. Moreover, the graph does not show that four players in the 4th round and five players in the 2nd round did not consume at all.

When we asked students about zero consumption choices, some told us that they were so involved in the trading that forgot to click the "consume" button before the end of the round. Because this particular game does not allow carrying forward goods to the next round, they lost all the goods they produced or acquired through trade. Nevertheless, when looking at the data generated by the game, we could verify from the students' unconsumed inventory at the end of the 4th round that three out of the four with zero consumption could in fact have consumed outside the PPF if they had clicked the "consume all" button. This problem suggested to us the need to improve the feedback to players during the game. We believe that the new graphical interface under development depicting the PPF, the indifference curves, and the consumption and production points of the player at each point in time will be helpful both as a pedagogical tool, and to improve students' experience playing the game.

An important prediction of the Ricardian model, as we have mentioned in Section II is that market prices should lie on the interval determined by the two countries' opportunity costs. This means that the price of wine should be in the [1/6, 2/3] interval and the price of cloth should be in the [1.5, 6] interval. A more precise prediction can be obtained if each player chooses wine and cloth to maximize his or her utility function. Given the parameters of this game, the theoretical equilibrium price of wine in terms of cloth is 1/6, which equals Portugal's opportunity cost of wine in terms of cloth. That is, in this game, only players located in England should fully specialize and gain from trade.

What does the data say about these predictions? Figure 5 below shows the prices of transactions in the wine and cloth markets, respectively. In the Ricardian Explorer game a player can participate in a market by posting an offer or by accepting a posted offer. For example, in the wine market players post or accept offers of wine in exchange for cloth.

The data shows a reasonable degree of convergence of prices to the theoretical range in the wine market. Moreover, towards the end of the game, there is a greater concentration of observations around the lower bound, 1/6, as predicted by the model when it includes utility maximizing behavior. The cloth market, instead, shows more observations outside the expected range. However, towards the end of the game there also seems to be a concentration of observations around the theoretical value, which in this case is the upper bound of 6.

To further investigate players' choices in the game, Table 1 computes transaction errors in the two markets during the four rounds of play. One type of error is sellers selling at a relative price below their opportunity cost. Another type of error is buyers buying at a price above their opportunity cost. The column labeled "either or both" computes the percentage of transactions in which at least one of the parties, seller or buyer, made an error. Finally, as explained in Section II, the Ricardian model makes clear predictions about the direction of trade. Because all players in the same country have the same opportunity cost, they can't make gains from trade by trading with each other. Also, the model predicts that countries will sell the good in which the country has a comparative advantage; trade between two countries in the opposite direction will also entails losses for at least one of the parties. The column labeled "wrong country" computes percentages of transactions in a direction other than predicted by the theory.

The data shows a relatively large percentage of errors in transactions: 44% in the wine market and 51% in the cloth market. Most of these errors are associated with transactions in a direction other than predicted by the theory. Interestingly, in the wine market, which is the one where we found a greater degree of price convergence, the percentage of errors ("either or both" column) declines from round to round, showing an evidence of learning. However, in the cloth market, errors remain at about 50% of the transactions in all the rounds.

To better understand the large percentage of errors, we compiled data on trade errors for each individual player, where we found that most of the errors were concentrated in a relatively small number of players. Of 23 players, the 3 players with most trading errors accounted for 68% of all the selling errors and 49% of all the buying errors. On the other extreme, 48% of players made no selling errors and 26% of players made no buying errors. The rest of the players, while making an occasional error, gained from the majority of their trades.

The presence of errors may be due in part to the fast pace of the game and the difficulty in analyzing numerical data under time pressure. We expect that the new graphical interface under development will give players a much more intuitive way to evaluate how they are doing and make their decision-making easier. In any case, students' trading errors gives instructors a golden opportunity to motivate students to improve their understanding of the Ricardian model. A class discussion based on game results on production and consumption decisions, market prices, and trading errors could be very insightful. Although we have not discussed results in class this time, we believe that that doing so could greatly enhance the pedagogical potential of the game. The discussion can certainly go beyond comparative advantage and the Ricardian model of trade. Issues of functioning of markets, noise traders, and trading strategies could naturally arise when discussing the results of a Ricardian Explorer game, motivating students to learn more economics.

V. Evaluation of Teaching Effectiveness

In this section, we provide the results of teaching effectiveness evaluation conducted in the Fall 2004 semester using 2 sections of Introduction to Economic Theory (principles) course at Wesleyan taught by the same instructor. This course is a gateway course to the economics major at Wesleyan and is a calculus-based one semester introduction to micro- and macro-economics. One section (Section 2) of the course (selected using a flip of a coin) played the game prior to attending a lecture on international trade. Both sections were exposed to the same lecture, homework assignment and additional readings. The control section (Section 1) participated in an unrelated experiment that studied gender differences in performance. Both sections took the same final exam. There were 53 students in Section 1 and 50 students in Section 2, out of whom 33 played the game. There was one multiple choice question on the final that dealt with the Ricardian model.

We evaluate teaching effectiveness by looking at how likely students were to answer this question correctly. The question provided unit labor requirements and total available labor for a 2-country 2-good Ricardian model[7]. In the correct solution, students had to realize that due to parameter choice while one country had an absolute advantage in the production of both goods, Ricardian model predicted full specialization by one country only, while the other country produced both goods. Simply applying comparative advantage formula to decide on the pattern of specialization did not produce a correct answer. 76% of students in the control section blindly applied the comparative advantage formula and only 14% of students got the question right. In contrast, 51% of students in the treated section used comparative advantage formula and 31% answered the question correctly. It is worthwhile to mention that section 1 was overall a stronger section with students consistently getting higher scores on all exams. For further support, we ran several specifications of a linear probability regression to see how likely students were to answer the final question correctly depending on whether they participated in the game. Results of this analysis are reported in Table 2. Similar results can be obtained by running probit and are available upon request.

In all specifications, the dependent variable is 1 if a student answered the final exam question correctly and 0 otherwise. Specification (1) only uses participation in the Ricardian game as an explanatory variable. Column (2) in addition controls for individual scores on the first and second midterm exams as a proxy for student ability. Columns (3) and (4) add scores on trade homework assignments to specifications (1) and (2), respectively. This decreases the sample size as the problem sets did not count for students' grades and therefore not everybody completed them carefully, if at all. The second problem set had harder questions. None of the questions on the problem set were similar to the final exam question.

First we look at the pooled regressions, combining both sections of the course. As expected, performance on prior exams strongly predicts the likelihood of answering the trade question on the final correctly. Depending on the specification, the probability of answering the question correctly is between 32% and 43% higher for students who played the game. These results are statistically significant at the 1% level.

Similar results can be obtained by looking only at the treated section and controlling for the fact that not every student participated. These results are meaningful because non-participation (except in one case) was not a result of choosing not to come to class but rather due to an already fixed computer glitch that did not allow some students to login. While sample size decreases substantially if we look at section 2 only, students who played the game are 31% to 46% more likely to answer the final question correctly.

This evidence is very strong and in the future we would like to provide similar evaluations for using Ricardian Explorer at other levels of instruction and also with longer and more rigorous tests. In the meantime, we were very encouraged to see these preliminary results.

In addition, we conducted surveys at the end of the Fall 2004 and at the beginning of the Spring 2005 semesters to ask students about their experience with the software. Notice that while we ran the Fall 2004 survey during the exam week, between 1 and 2 months after the students played the game, students answered the Spring 2005 survey right after playing the game. Some interesting evidence from this survey is reported in Table 3. Students answered questions presented on a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree). Survey results show that students got better at understanding the game environment after repetition. Therefore it is advisable to play the game more than once during the course. Most of them agreed with the educational merits and objectives of the software. International trade students overwhelmingly commented on the benefits of playing the game more than once.

VI. Conclusion

Experiments are becoming a prominent teaching tool in economics. The interactive nature of classroom experiments allows students experience economic concepts as active participants. Furthermore, instructors can facilitate discussion using the Socratic method after the experiment complementing the traditional, lecture-based delivery of the material. Our software provides an easy way to adopt experiments to teach the Ricardian model of trade. By facilitating student understanding of the fundamental concept of comparative advantage and providing glimpses on deeper economic issues, such as the role of prices in coordinating individual decisions and general equilibrium, the Ricardian Explorer is a useful and pedagogically effective tool in international trade and microeconomics courses.

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Figure 1: Consumption Possibility Frontier for Production Choice (x^p, y^p)

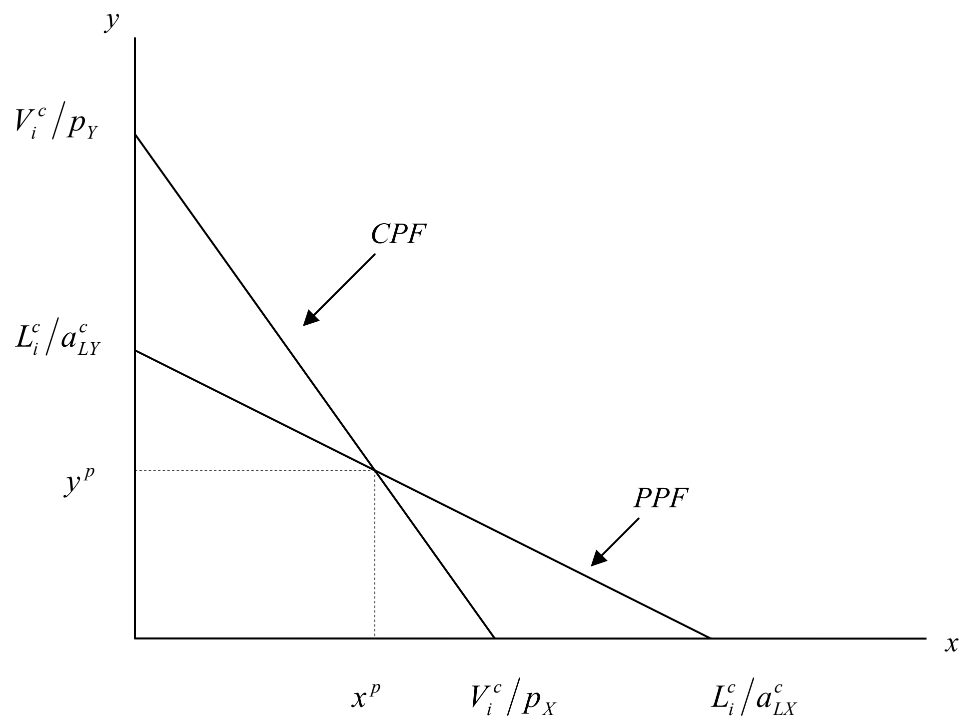

Figure 2: Game Screen

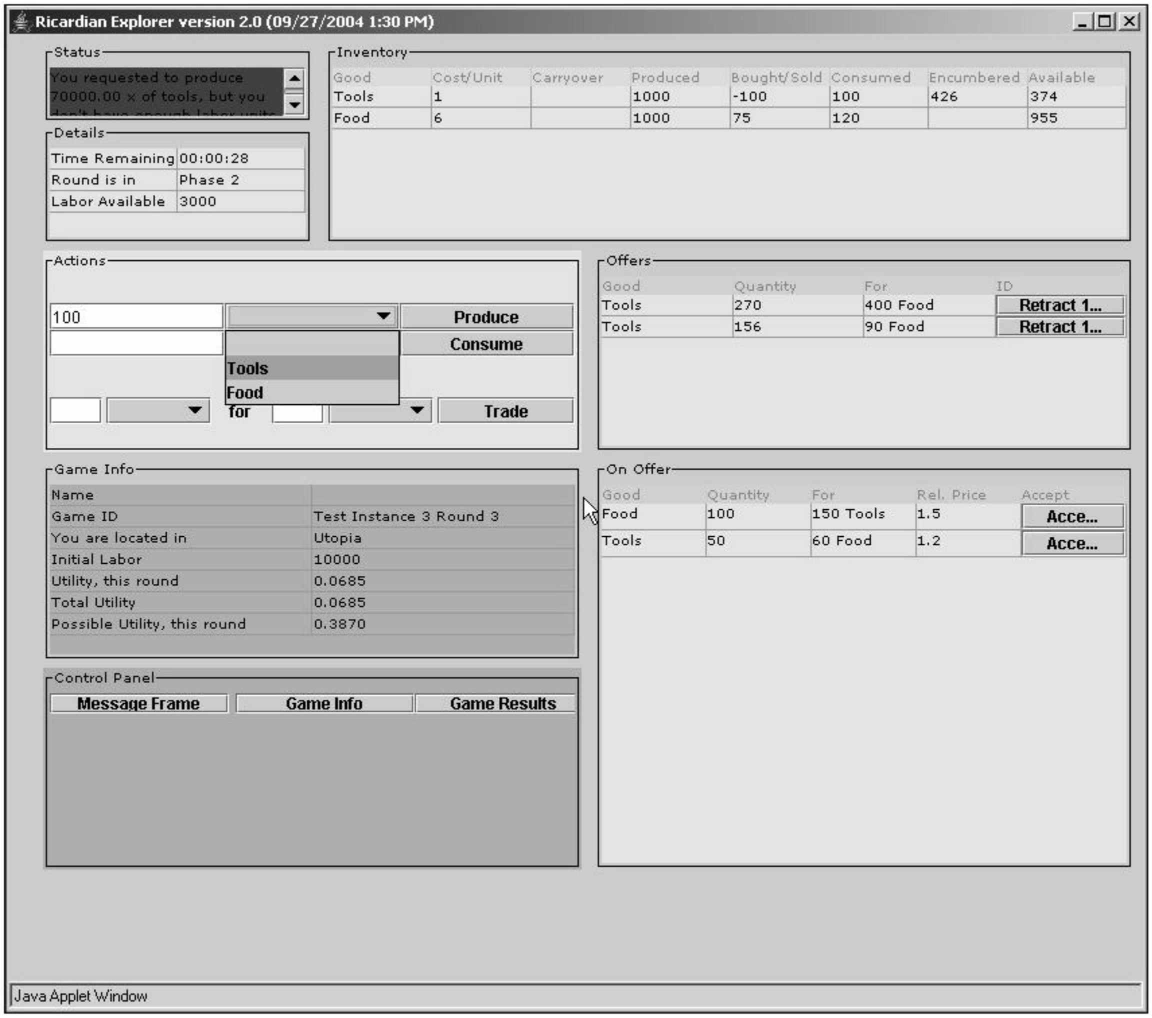

Figure 3: Reaching the PPF in Portugal (Ricardos game, Fall 2004, rounds 2 & 4)

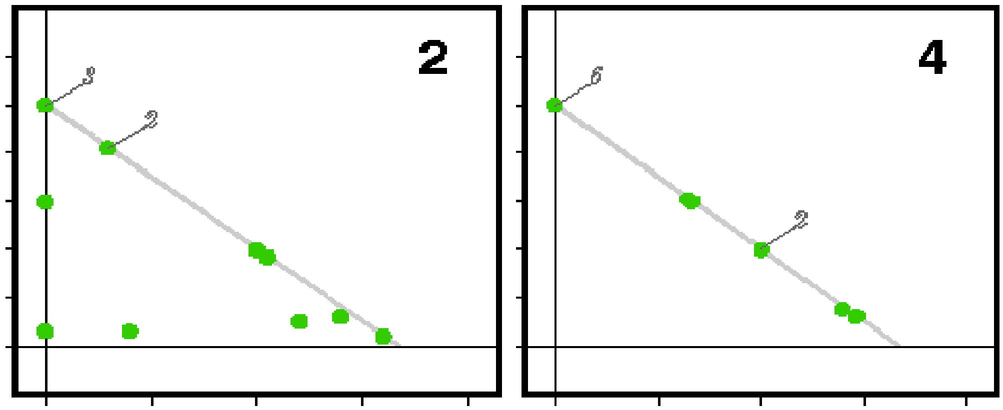

Figure 4: Gains from trade in Portugal (Ricardos game, Fall 2004, rounds 2 & 4)

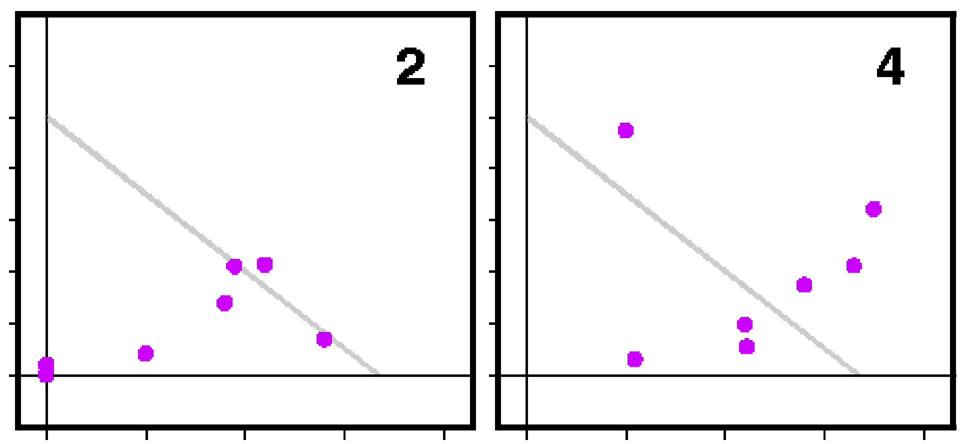

Figure 5: Relative prices (Ricardos game, Fall 2004)

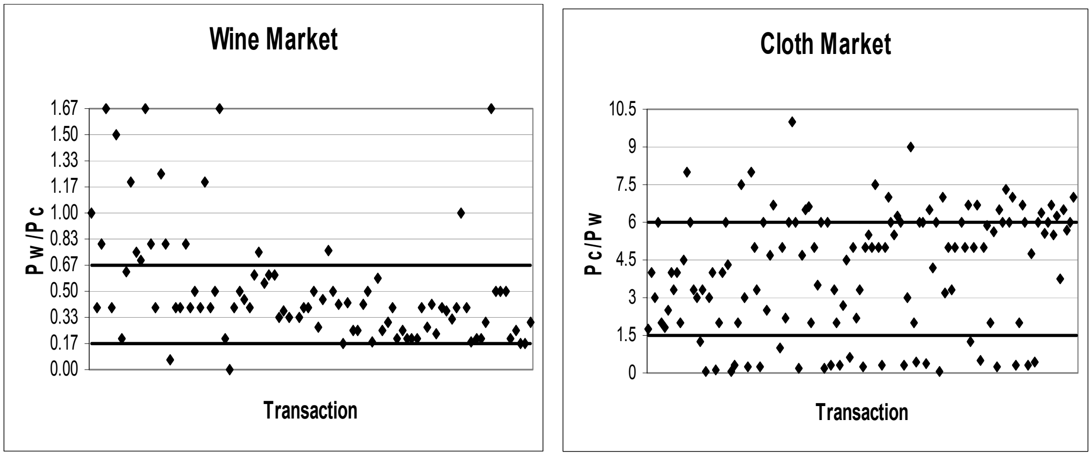

Table 1: Trading Errors (Ricardos game, Fall 2004)

	Wine Market				Cloth Market			
Round	Sellers sell too low	Buyers buy too high	Either or both	Wrong country	Sellers sell too low	Buyers buy too high	Either or both	Wrong country
1	6%	61%	67%	50%	44%	17%	52%	48%
2	29%	17%	46%	42%	23%	28%	50%	50%
3	25%	21%	38%	38%	26%	26%	53%	50%
4	13%	22%	30%	26%	21%	33%	51%	39%
Mean	19%	28%	44%	38%	27%	27%	51%	46%

Table 2: Teaching Effectiveness of the Ricardian Explorer game

A. Sections 1 and 2 Pooled

	(1)	(2)	(3)	(4)
Played Ricardian Explorer? (1=yes)	0.323***	0.355***	0.373***	0.432***
	(0.094)	(0.082)	(0.110)	(0.098)
Score in First Midterm Test		0.945***		0.789**
		(0.262)		(0.310)
Score in Second Midterm Test		0.358*		0.670**
		(0.185)		(0.308)
Score in First Trade Problem Set			-0.127	-0.146
			(0.190)	(0.214)
Score in Second Trade Problem Set			0.584**	0.463**
			(0.237)	(0.214)
Constant	0.101***	- 0.655***	-0.237	- 1.046***
	(0.036)	(0.143)	(0.224)	(0.312)
N. Observations	103	103	79	79
R-squared	0.14	0.34	0.23	0.41

B. Section 2 Only

	(1)	(2)	(3)	(4)
Played Ricardian Explorer? (1=yes)	0.424***	0.316***	0.461***	0.433***
	(0.088)	(0.087)	(0.115)	(0.148)
Score in First Midterm Test		0.916**		0.606
		(0.354)		(0.720)
Score in Second Midterm Test		0.392		0.866
		(0.247)		(0.661)
Score in First Trade Problem Set			-0.207	-0.210
			(0.325)	(0.278)
Score in Second Trade Problem Set			0.284	0.252
			(0.427)	(0.401)
Constant	0.000***	- 0.623***	-0.035	-0.864*
	(0.000)	(0.172)	(0.224)	(0.489)
N. Observations	50	50	32	32
R-squared	0.20	0.36	0.19	0.37

Notes: Robust standard errors in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% confidence levels, respectively.

Table 3: Surveys of Participants

	International Trade Fall 04	Introductory Economics Fall 04	Introductory Economics Spring 05	Experimental Economics Spring 05
In the **first round** of the game my production and trading decisions were almost random.	**0.43** (0.36)	**0.47** (0.47)	**0.50** (0.29)	**0.52** (0.36)
In the **last round** of the game my production and trading decisions were almost random.	**0.00** (0.93)***	**0.00** (0.94)***	**0.13** (0.75)***	**0.04** (0.84)***
The game helped me understand opportunity costs.	**0.64** (0.07)***	**0.39** (0.11)*	**0.77** (0.09)***	**0.44** (0.28)
The game helped me understand comparative advantage.	**0.77** (0.00)***	**0.58** (0.11)***	**0.79** (0.08)***	**0.48** (0.20)**
The game helped me appreciate even more the role prices play in coordinating economic activity.	**0.92** (0.00)***	**0.72** (0.11)***	**0.70** (0.09)***	**0.64** (0.20)***
It would be more useful to play the game more than once	**0.93** (0.00)***	-	-	
Number of responses	14	19	24	25
Participation rate	61%	59%	100%	100%

Notes: Bold numbers are the proportions of "agree" (4) and "strongly agree" (5) responses (p_A). Number in parentheses are the proportions of "disagree" (2) or "strongly disagree" (1) responses (p_D) . We tested for the equality of the proportions of agreements and disagreements (H_0: $p_A = p_D$, H_1: $p_A \neq p_D$). ***, ** and * indicate that the test is significant, respectively, at the 1%, 5% or 10% confidence levels.

Endnotes

1 The software is available at http://www.wesleyan.edu/re.

2 Paper-and-pencil classroom experiments to teach comparative advantage can be found in Anderson et al. (2001) and in Bergstrom and Miller (1997). A research experiment on the subject using a more complicated environment is in Noissair, Plott, and Riezman (1995).

3 Holt (1999, 2005) provides a comprehensive analysis of the history and practice of employing experiments for instructional purposes. See also recent reviews by Porter, Riley, and Ruffer (2004) and Ball and Eckel (2004). Recent applications include Santos (2002), Schmidt (2003), and Woltjer (2005).

4 Refer to Section II for details on the model on which the game is based.

5 In our experience, using a ρ = -60 provides a very good approximation to the Leontieff utility.

6 We have usually set up games of 4 rounds.

7 Consider 2 Island economies: Crete and Rhodes. Inhabitants produce 2 goods, fish and bread. Unit labor requirements for production of each good are in the table below. Inhabitants of Crete and Rhodes like to consume both goods in fixed proportions. Available labor: Crete 600, Rhodes 400.

	Crete	Rhodes
Fish	2	6
Bread	3	4

(a) Rhodes has an absolute advantage in the production of Bread.

(b) Crete has a comparative advantage in the production of Bread.

(c) According to the Ricardian model, when islands trade, Crete will specialize in Fish and Rhodes will specialize in Bread.

(d) According to the Ricardian model, when islands trade, Crete will produce both Fish and Bread, but Rhodes will produce Bread only.

(e) According to the Ricardian model, when countries trade, Crete will produce only Fish, but Rhodes will produce both Fish and Bread.