Student Learning on a Multistage Market Simulation

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Simulations are widely used to teach economic principles and to provide students experience in decision making. This paper describes and evaluates a simulation exercise that helps students understand public policy impacts in a multistage market. Student teams of producers, marketers, and processors use information on costs and demand in negotiations to determine prices and quantities. Selected public policies such as marketing orders with price discrimination are implemented and analyzed. The simulation exercise improved student understanding of marketing orders and policy impacts on prices, quantities, and profits in a multistage market. Financial outcomes in the simulation were related to student learning as evidenced by exam scores.

Developing effective instructional techniques to help students clearly understand public policy issues is both important and challenging. Techniques that place the responsibility for learning on students and engage them in the learning process can produce an enjoyable learning experience and enhance learning (Velenchik 1995). One such technique is economic simulation: student understanding of public policy issues can be improved by actively involving learners in simulated markets with regulations.

The objective of this article is to report the development, implementation, and evaluation of a multistage market simulation exercise that is used to teach economic analysis of public policies. Student teams managing hypothetical firms make choices on technologies, prices, and quantities in a market that involves producers, marketers, and processors. Prices and quantities are determined through negotiations. Marketing orders with price discrimination and other government policies are simulated, and their impacts analyzed.

The multistage market simulation involves several economic principles related to quantity and price determination, profit determination, price discrimination, and government policies. This study addresses several aspects of student learning related to these economic principles. Student survey questionnaires are used to describe perceived understanding of the concepts. Exam scores are related to the survey responses in order to compare actual and perceived understanding. Simulated profits, which measure financial performance in the simulation exercises, are used as regressors in an analysis of exam scores in order to compare different measures of student learning.

Evaluation of student learning from the simulation addresses three areas. First, student learning related to selected economic principles is addressed. Second, perceived and actual understanding of economic principles is examined. Third, financial performance on the simulation and understanding of economic principles are analyzed through regression analysis.

Related Literature

Some early writers thought that student performance on economic simulations was due almost entirely to random effects (Greenlaw and Wyman 1973). However, a large body of literature has developed to help explain performance. The factors that influence performance on simulations are numerous, and the relationships among these factors are complex (Gosenpud and Miesing 1992). Interactions among major, grade point average, and gender have been considered in explaining performance (Hornaday and Wheatley 1986; Norris and Neibuhr 1980). Motivation, background, and cohesion variables have been used to help explain performance (Gosenpud 1989). Motivation and interest influence performance (Gosenpud and Miesing 1992). A major conclusion from this body of literature is that students who are interested and skilled in decision-making processes will generally outperform others on economic simulations.

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Few studies have examined the relationship between performance on simulations and other measures of student learning. Whitely and Faria (1989) analyzed the effects of a simulation exercise on understanding marketing concepts. Participation in the simulation did not improve student understanding. Oltmans (1995) reported that participation in a financial management simulation improved students' exam scores on the leverage and risk unit 5 percentage points. Neither of the above studies examined the relationship between financial performance and improved understanding of theoretical concepts. Anderson and Lawton (1992) analyzed the relationship between financial performance on a simulation exercise and other measures of student learning. A composite score for net income, return on investment, and return on assets was used as the measure of financial performance. No significant relationship was found between financial performance and other measures of student learning such as quizzes, exams, and assignments. With the widespread use of financial performance in student assessment, further research on its ability to reflect learning is needed.

Economic Simulation

A vertically related multistage market is simulated with primary supply firms, marketing firms, and processing firms. Student teams with three to five members operate the hypothetical firms through economic simulation. The simulation involves role playing by the students as they make management decisions, negotiate with other firms, and evaluate their own results. Students are able to experience the consequences of their decisions in terms of simulated profits.

The basic simulation model is simple enough that students in any level of undergraduate economics can follow the process. However, the model is flexible enough to include forward contracting, government programs, and price discrimination.

A set of rules is developed to capture the more salient aspects of the economic simulation. Rules may vary depending on course objectives and student backgrounds. A simple set of rules will be described to illustrate the simulation. Producers determine production levels through negotiations with marketing firms as middlemen. In turn, the marketing firms negotiate with processing firms as consumers. Producers can choose from among alternative technologies as reflected by supply curves S_1 and S_2 (figure 1). The processing firms can choose from alternative technologies as reflected by derived demand curves D_1 and D_2 (figure 1). The demand is the processor's derived demand for raw inputs, not consumer demand for the processed product.

Producers cannot trade directly with processors. Producers and processors can trade with more than

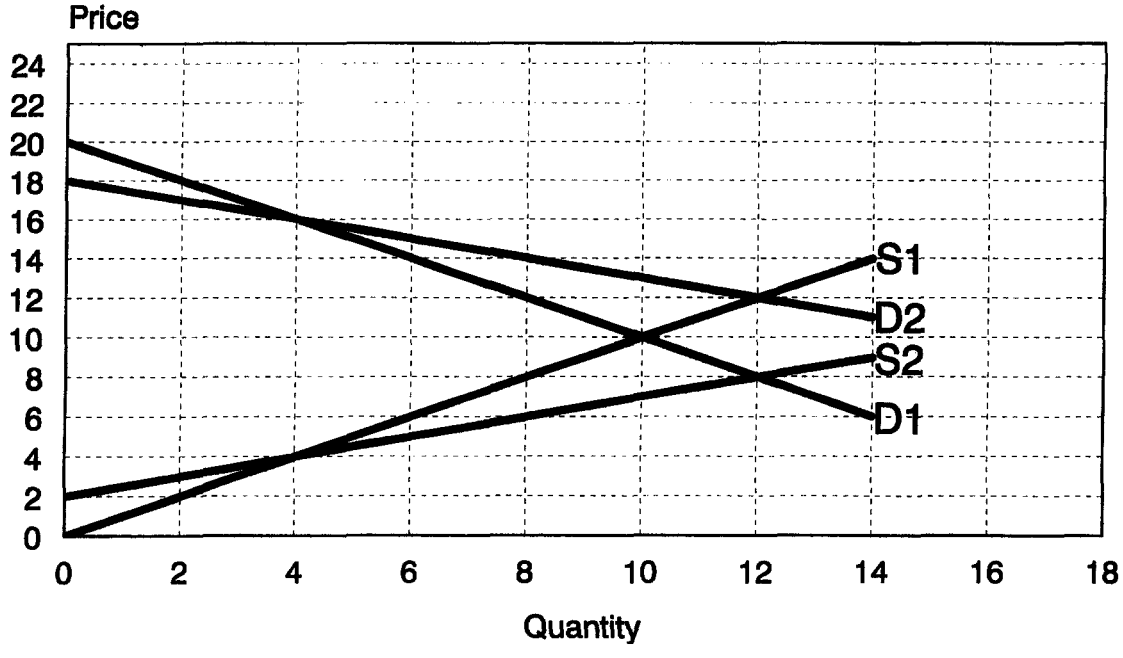

Figure 1. Multistage Market

one team of marketers. Multiple trades by a firm are added together, and only its total quantity is used in calculating economic surplus. Marketers can trade with more than one team of producers and/or more than one team of processors.

The goal for each firm is to maximize profit. With no fixed costs, profit is the same as economic surplus. Prices and quantities are to be determined through negotiations with other firms, with each firm attempting to maximize profit. Profits for the marketing firms are dependent on the wedges they are able to negotiate between processor and producer prices.

Added realism can be achieved by introducing fixed costs, forward contracting, storage, etc. With forward contracting each round or production/marketing period is divided into three subperiods. In the preproduction subperiod, processing firms are allowed to forward contract a limited quantity. Producers select the technology to be used and the quantity to be produced in the production subperiod. Production in excess of forward contracts is traded in the postproduction subperiod. Processing firms determine their technology in the postproduction subperiod. With storage, any firm can carry over stocks to a subsequent period. Storage costs should be accounted for.

The rules and objectives of the simulation are introduced and explained. Student teams are given basic model parameters. If full information on the market is given, some form of collusion may result. Hence, producers are given only the two supply curves and processors are given only the two demand curves. Marketers may not be given any market information initially. If appropriate, marketers could be given full information after one round.

The first round generally has no government policy, allowing students to become familiar with the instructional simulation in its simplest form. Subsequent simulations introduce alternative government policies and measure their impacts. Taxes and/or subsidies can be applied to processors, marketers, and/or producers to measure their impacts on the various stages of a multistage market. Policy impacts are measured by comparing prices, quantities, and profits under a new policy with the perfectly competitive situation, i.e., the results of the first round of the simulation.

Price Discrimination

The buyers face two alternative demand curves, based on different technologies. One price to all buyers would tend to prevail under competition. However, the buyers can be separated into two groups under a marketing order program, and different prices charged to the two groups. This approach controls the disposition of production and enhances prices and incomes of producers through price discrimination.

Multiple Factors

An extension of the model for more advanced study involves multiple factors. The first input is still supplied by the producers. The second input is supplied exogenously to the marketers with a fixed price and unlimited quantity. Quantity available for sale by the marketers is determined from a Cobb-Douglas production function:

$$Q_m = \alpha X_1^{\beta} X_2^{1-\beta}$$

where Q_m is quantity available for sale by marketers, X_i are input quantities, and α and β are parameters. Price for X_2 should be set at a level that results in a combination of both factors being used. Government policies considered with this alternative involve changing the price and/or quantity of the second factor, which is supplied exogenously to the market.

Implementation

The multistage market simulation has been used five years in a junior-level economic policy course that emphasizes the economic analysis of public policies. Both microeconomic and macroeconomic principles are required as prerequisites for the course. Economic concepts are introduced in lecture and reinforced through reading, problem sets, and the simulation.

The simulation exercise is a role-playing game and not a computer program. Simulation of a production period may take fifteen to twenty minutes. As students become familiar with the process, they are able to handle more complex problems in the same length of time used initially with simple problems.

Class size ranges from twenty-five to sixty students, with the simulation working equally well throughout this range. As the class size varies, only the number of teams needs to be adjusted. Teams of students move freely around the classroom, negotiating with other teams. Sometimes one team may enter preliminary negotiations with two or three teams before making a final trade. The students expend a lot of energy in the exercise, which is usually staged during the last fifteen to twenty minutes of a class period.

The simulation exercise does not require any

special resources such as teaching assistants. While the students are engaged in trading, the instructor is available to answer questions and clarify instructions. I have never had any difficulty in administering the simulation.

After students have completed a production period, a computer program is used to summarize results for the class. I usually spend thirty to forty-five minutes outside of class for each production period to go over the students' work, run the computer program, and analyze the results for the next period. Results are reported to the class preceding the next simulated production period. Reviewing previous results helps students learn from the process and prepare for the next production period.

Profits generated from trading in the competitive simulation exercise are used to measure performance. A team's relative financial performance based on its ranking in the class is used in assigning a grade for performance. Students may also be graded for a paper analyzing the team's performance. Also, students are tested on applications of economic principles used in the simulation.

Evaluation

Student Surveys

The multistage market simulation was evaluated with student surveys. The students were asked whether they agreed or disagreed with several statements related to their understanding of specific economic concepts used in the simulations and to their overall evaluations of the simulations. A response of 5 would be *strongly agree* and a response of 1 would be *strongly disagree.* Mean responses to the survey for two classes are discussed below.

Students were asked to rate their understanding of three economic concepts before and after participating in the multistage market simulations. They rated their understanding of (a) price discrimination, (b) the impact of policies on prices and quantities, and (c) the impact of policies on economic surpluses.

Mean responses reported in table 1 indicated that statistically significant learning occurred in each area. Responses for the three concepts averaged 2.85 before participating in the simulations and 4.05 afterward. The mean difference in understanding, which is indicative of learning, was 1.20 over all concepts. The mean differences were statistically significant for all concepts and indicated similar levels of learning related to the three concepts: 1.25 for price discrimination, 1.20 for policy impacts on prices and quantities, and 1.16 for policy impacts on economic surpluses. The ending responses indicated students felt that they had a good understanding of these economic concepts after participating in the simulations.

Table 1. Mean Survey Responses for Understanding of Economic Concepts

	Understanding		
Economic Concepts	Prior to the Simulation	After the Simulation	Difference
Price discrimination	2.74	3.99	1.25*
Policy impacts on prices and quantities	2.88	4.08	1.20*
Policy impacts on economic surpluses	2.94	4.10	1.16*
Average	2.85	4.05	1.20*

*Statistically significant at the 0.10 level.

Survey results showed that the multistage market simulation was an enjoyable and worthwhile exercise. The mean response for the simulation being enjoyable was 4.3. The statement relating to being worthwhile was: "I learned more from the simulation than I would have learned from just lectures." The mean response for this statement was 4.0, indicating agreement with the statement.

Surveys and Examinations

The multistage market simulation is used in a three-week unit on factor markets. At the end of the unit, students complete a regularly scheduled hour exam, which contains multiple choice questions and problems. Scores on the exam are counted toward the course grade. Some of the questions on the exam are directly related to the economic concepts covered in the simulation and addressed in the surveys. Student performance on exam questions covering a particular economic concept can be characterized as their *actual* understanding of the concepts, whereas their responses to the surveys described in the earlier section can be characterized as their *perceived* understanding. This section compares actual and perceived understanding.

Students who said they understood a particular economic concept well at the end of the simulation correctly answered 78% of the questions related to that concept. All other students correctly answered 67% of the questions related to the economic concepts of the simulation. By considering several questions for each student, a total of 308 cases were analyzed. With a computed χ^2 statistic of 3.5, the scores for the two groups were significantly different at the 0.10 level. These results indicate a statistically significant positive relationship between actual and perceived understanding.

Exams and Financial Performance

This section addresses the relationship between exam scores and financial performance on the simulation exercises. Regression analysis was used to determine the effect of financial performance on exam scores, as a conventional measure of student learning.

Data on eighty-nine students from two years (1996 and 1997) with complete information were used in the analysis. Students took an hour exam after completing the multistage simulation exercises. The percentages of correct answers relating to the simulation are the exam scores used as the dependent variable in the regression analysis. Exam scores were regressed on the average of two previous exams, a dummy variable for the year, and dummy variables for financial performance.

Mean financial performance on the multistage simulation exercises was 120, with a standard deviation of 60. Students were categorized into four groups: (1) very low financial performance (more than one standard deviation below the mean, or less than 60), (2) low financial performance (within one standard deviation below the mean, or 60–120), (3) high financial performance (within one standard deviation above the mean, or 121–80), and (4) very high financial performance (greater than one standard deviation above the mean, or greater than 180). Dummy variables were used for the latter three groups.

A Goldfeld-Quandt test for heteroscedasticity was applied to the regression model. The thirty students with the lowest average test scores were compared with the thirty students with the highest average test scores. The F statistic was 1.45, which was not statistically significant at the 5% level, indicating that homoscedasticity could not be rejected. The condition number was 337, which indicates no serious problem with multicolinearity.

Regression results are reported in table 2. The regression analysis controlled for the average score for previous exams. Each percentage point on previous exams raised the exam under consideration by 0.56 percentage points. The regression analysis also controlled for differences in exams between years. The coefficient for 1997 reflects a more difficult exam.

In comparison with the group with very low financial performance, the other three groups had positive coefficients. The group with high financial performance had a coefficient of 8.68, indicating this group's exam scores were 8.68 percentage points higher than the group with very low financial performance. Exam scores for students with low financial performance and very high financial performance were not significantly different from students with very low financial performance. The results indicate a statistically significant relationship between financial performance and exam scores, but the relationship is not linear over all ranges of financial performance.

Table 2. Regression Explaining Exam Performance

Variable	Economic Surplus	Coefficient	Student's t statistic
Constant		30.66	2.35
Low financial performance	60–120	1.60	0.37
High financial performance	121–80	8.68	1.85*
Very high financial performance	>180	1.05	0.21
Average on previous exams		0.56	3.56*
Dummy for 1997		−16.90	−5.36*
R^2		0.35	
F statistic		9.01*	

*Statistically significant at the 0.10 level.

Conclusions

The multistage market simulation is an innovative approach to teaching problem-solving skills. Student teams operate hypothetical production, marketing, and processing firms and make decisions on technologies, prices, and quantities under various government policy scenarios. Students are actively involved in the decision-making process and in analyzing the consequences of their decisions.

Several economic concepts are addressed in the simulation exercise. Student surveys were utilized to assess the consequences of participating in the simulation on understanding these economic concepts. Survey results indicated the simulation exercise had improved students' understanding of price discrimination and government program impacts on price and quantity determination and economic surpluses in a multistage market. A comparison of surveys and examinations indicated a statistically significant, positive relationship between perceived and actual understanding, which helps validate these survey results. The regression results indicate a statistically significant relationship between financial performance and exam scores. Students with high financial performance scored 8.68 percentage points higher on average than others on an exam covering the economic principles of the simulation.

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Appendix: Directions for Students

The class is divided into student teams of three to five members each. The teams make economic decisions on prices and quantities traded in the context of a simulated market. The market consists of three types of hypothetical firms: producers, marketers, and processors. Each student team can choose whether it wants to be a producer, a marketer, or a processor. In order to maintain a balanced market, there should be an equal number of producers, marketers, and processors.

Supply and demand curves for the firms are shown in figure 1. Producers choose from two possible supply curves, representing different technologies. Processors are agribusinesses that process the product. They have two possible derived demand curves for raw inputs. Demand curves represent different technologies. Marketers, which are market intermediaries, buy the product from producers and sell it to processors without changing its form.

Processors cannot trade directly with producers. Producers and processors can trade with more than one team of marketers. Likewise, marketers can trade with more than one team of producers and/or processors. Firms with multiple trades add up quantities and average prices to determine profits.

The objective for each firm is to attempt to maximize profit. Prices and quantities are to be determined through negotiations. With no fixed costs, profit for producers is the same as producer surplus—the area between the supply curve and the price line. Likewise, profit for processors is the same as consumer surplus—the area between the demand curve and the price line. Profit for marketers is the price wedge between average prices for purchases and sales multiplied by the quantity traded by the marketing firm.

There will be three rounds of the simulation exercise: (1) no government programs, (2) a subsidy on consumption, and (3) a marketing agreement. The impacts of the government programs will be analyzed by comparing the results with a subsidy and a marketing agreement with the results with no government program in the first round.

Under the marketing agreement, marketers segment the market with price discrimination. Small quantities are sold to some processors at high prices, and larger quantities are sold to other processors at lower prices. With price discrimination, producers and marketers are expected to earn higher profits than under a free market with a single price.

Trading results on the first round (free market) in a recent policy class are reported in appendix table 1. Teams for which only selling activities are reported as producers, while those with only buying activities are processors. Marketers report both buying and selling activities. Teams 1 and 9 earned \$65 of profit by selling 10 units at \$11 each. Team 5 earned \$22 of profit by buying 10 units at \$11 each and selling them for \$13.20 each. This information is provided to help students formulate successful trading strategies.

Appendix Table 1. Results from Round 1 Trading on Multistage Market Simulation

		Selling		Buying	
Team No.[a]	Profit ($)	Quantity	Price ($)	Quantity	Price ($)
1	65.00	10.00	11.00	0.00	0.00
9	65.00	10.00	11.00	0.00	0.00
8	55.00	0.00	0.00	10.00	10.00
6	40.00	8.00	9.00	0.00	0.00
2	32.00	6.00	8.33	0.00	0.00
10	32.00	0.00	0.00	8.00	12.00
4	27.00	0.00	0.00	14.00	12.57
5	22.00	10.00	13.20	10.00	11.00
3	20.00	0.00	0.00	2.00	9.00
7	10.00	10.00	12.00	10.00	11.00
12	10.00	2.00	10.00	2.00	5.00
11	6.00	8.00	9.75	8.00	9.00

[a]Teams are ranked by amount of profit.