TEACHING WITH INTERACTIVE EXPERIMENTS IN ONLINE CLASSES

OSUN Connected Learning Contest Winner

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Course: Macroeconomics

Within the online lecture, students are asked to participate in interactive tasks with the platform classEx. I programmed this platform to allow for interactive interactions in big classes and in remote teaching. Students get certain roles and interact with their classmates. The instructor starts the task and students login in with a browser (no app or anything needed). They complete the task and the results are immediately shown on the instructor's screen to be shared and discussed with the class. They can conduct small surveys or to ask comprehension questions. The example uploaded below is just one example. It is about an apple market where students learn the role of supply and demand by selling and buying apples.

Use in different classes

I use the tool which is described below in almost all my classes to generate interactivity and engagement. One use was in the class Macroeconomics. In Macroeconomics, students learn to analyze aggregates of economic behavior and for this reason it is good to confront them with their own behavior as well. But the tool can be used in any type of class--from Psychology to Economics and Political Science. Teaching material can be found at econclassexperiments.com (market experiments) and in the companion book of CORE Econ (core-econ.org).

Practical and pedagogical value

The task is assigned on a regular basis within the seminars. It can be used to start a topic or to enhance the understanding after a theoretical introduction. With respect to the arc of the course, it provides a regular element in each chapter. The goal is to make them familiar with strategic interaction, to experience theoretical content and to provide an intuitive understanding of the material.

The advantage is to activate all students in class. During normal online seminars, the more quiet students tend to get to little attention and may lose focus. With this tool, each student provides an opinion or decision as the instructor gets a better understanding of the progress and the understanding of the overall class.

The Apple Market

A Simple Trading Pit Experiment

An experiment from the book

Experiments with Economic Principles

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Instructor's Manual

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> KEY CONCEPTS

> supply — demand — competitive equilibrium
> consumer surplus — seller profits — efficiency

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> The experiment is designed to be run using CLASSEX . For general instructions on CLASSEX go to https://classEx.de/documentation.

A   Objectives

In this section, we expect students to achieve the following:

- Become acquainted with the mechanics of a simple trading-pit environment.

- Learn to apply the concepts of competitive supply and demand to a very simple market.

- Learn to compare results in an experimental market with the theoretical predictions of the competitive model.

- Begin to understand the benefit of having an abstract *theory* for predicting the effects of changes in the environment.

- Learn to test a proposed theory by confronting it with experimental data.

- Learn to draw supply and demand curves corresponding to given market data, and to read market data from given supply and demand curves.

- Learn to calculate consumer surplus and seller profits.

B   Pre-Requisites

The experiment is self-contained and does not require any previous economic concepts. This is a simple trading-pit experiment and is commonly used as the first encounter of students with an experiment in the classroom.

C   Introduction

In this experiment, students act as suppliers and demanders of a single good, bushels of apples. We recommend running the experiment before students have studied the theory of supply and demand.[1] There are 2 sessions which differ in the distribution of types. This difference changes the market demand and supply curves, as well as the competitive equilibrium price and quantity. You can run 2 rounds in session 1 and (up to) 3 rounds in session 2.

In each session, there are two types of suppliers, high-cost (30€) and low-cost (10€), and two types of demanders, high-value (40€) and low-value (20€). Each supplier can sell and each demander can buy either 0 or 1 bushel of apples. Suppliers' personal information inform them of their Seller Costs for a bushel of apples and demanders' personal information inform them of their Buyer Values.

A seller with Seller Cost SC who sells a bushel of apples for price P will get profits of $P - SC$, and a buyer with Buyer Value BV who buys a bushel of apples at price P will get profits of $BV - P$. Those who do not trade obtain 0 profits.

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[1]But students who participated in this experiment *after* having studied supply and demand from a standard text, have told us that they understood the theory they learned earlier much better after they had taken part in the experiment.

Capsule Instructions: The Apple Market

- Have all students logged into CLASSEX before starting the experiment.

- Run the Warm-Up Quiz in CLASSEX (optional).

- Make sure that everyone understands the trading procedures and payoffs.

- Begin session 1 (Equilibrium price of 20€.)

    – Open trading in round 1. As transactions are submitted, the instructor screen shows the price, Seller Cost and Buyer Value.

    – When trading stops, send feedback.

    – Comment on the average price and the evolution of prices during the round.

    – Before starting round 2, remind students that they are still in session 1 and that the distribution of demanders and suppliers remains the same.

    – Proceed as with round 1.

- Begin session 2. (Equilibrium price of 30€.)

    – Remind students that they are now in session 2 and that they have moved to another market in a different country with possibly different distributions of demanders and suppliers.

    – Open trading in round 1. Prices tend to be below the equilibrium price, specially for the first transactions, since students tend to stick to prices from session 1.

    – Begin Round 2. Proceed as with Round 1.

    – If the price is not close to equilibrium and you have time, you can run round 3.

- You may want to skip rounds if prices converge quickly to equilibrium.

D Detailed Instructions

D.1 Time required

Within a 50-minute class meeting, it is easily possible to run two rounds of session 1, two or three rounds of sessions 2, and to have some discussion. CLASSEX is programmed to run two rounds for session 1 and three rounds for session 2, but you may want to skip some rounds if prices convergence quickly to equilibrium. In our experience, the average price tends to be close to the equilibrium price of 20€ already in the first round of session 1, with a reduction of price dispersion in the second round. We have typically found it satisfactory to run two rounds of each session, but session 2 may require a third round if students stick too much to prices observed in the first session.

D.2 First Step

Before starting the experiment, ask if there are any questions. Run the warm-up quiz in CLASSEX and work through those questions with a large percentage of incorrect answers. Ask again if there are any questions.

It is a good idea to remind students that they can not buy or sell *more than* one bushel of apples in this round. Also, emphasize the fact that they *do not have to* make a trade, and that they should therefore make a trade only if it doesn't cause them to lose money.

Make sure all students are logged in. Introduce the number of participants in the parameters of CLASSEX and start the experiment. Students can now move around the classroom and make deals. Suppliers should seek demanders, and demanders should seek suppliers, with whom to negotiate.

D.3 Trading in Session 1

In this session, the equilibrium price is 20€.

After trading stops, send feedback. Show the average price and ask students to think about whether, in the light of the information about trading prices, they could have found a better deal than they did. If the average price is much lower (higher) than 20€, you may want to point out those transactions where sellers sold too cheaply (buyers bought too expensively). This would speed up convergence to the equilibrium price.

There probably will be some "mistakes." Ask students to look at the list of transactions and see whether anyone lost money in trading. If they find such a transaction, point out that nobody needs to make a money-losing trade, since one can always get a zero profit by not trading.[2]

Before starting another round, tell students that they are still in the same session, that they are going back to the same market, and that everyone will play the same market role as they did in the first session, but that this time they will have some experience in the market, and therefore may have a better idea of what choices to make. Emphasize that this is a second round of the *first* session and *not a new session.* Emphasize that Buyer Values and Seller Costs in this second round remain the same as they were in the first round. Repeat this reminder at least one more time than you think is necessary. Most students hear you the first time. But you want to catch the ones who didn't.

D.4 Trading in Session 2

At the beginning of Session 2, remind students to carefully look at their Personal Information as their role may have changed. To reduce price stickiness, we tell them to think that they have joined an exchange abroad program, that they are moving to another country, and that what they knew about the prices of bushels of apples in session 1 is useless. This is also a good time to ask whether students have any more questions about the workings of this market experiment.

E   Predictions and Discussion

The theoretical equilibrium price is 20€ in the first session, and 30€ in the second session. The theoretical equilibrium quantity depends on the number of participants. Under the tab PREDICTION, CLASSEX provides graphs with the supply and demand curves and the competitive equilibrium predictions specific to your sessions. Figures 1 and 2 show a particular example for the distribution of demanders and suppliers specified in Table 1 below.

The results of this experiment are likely to correspond well to the theoretical predictions of the competitive model. But they will almost cer-

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[2]Since CLASSEX does not identify participants, you may discuss this transactions without embarrassing the person who made the loss.
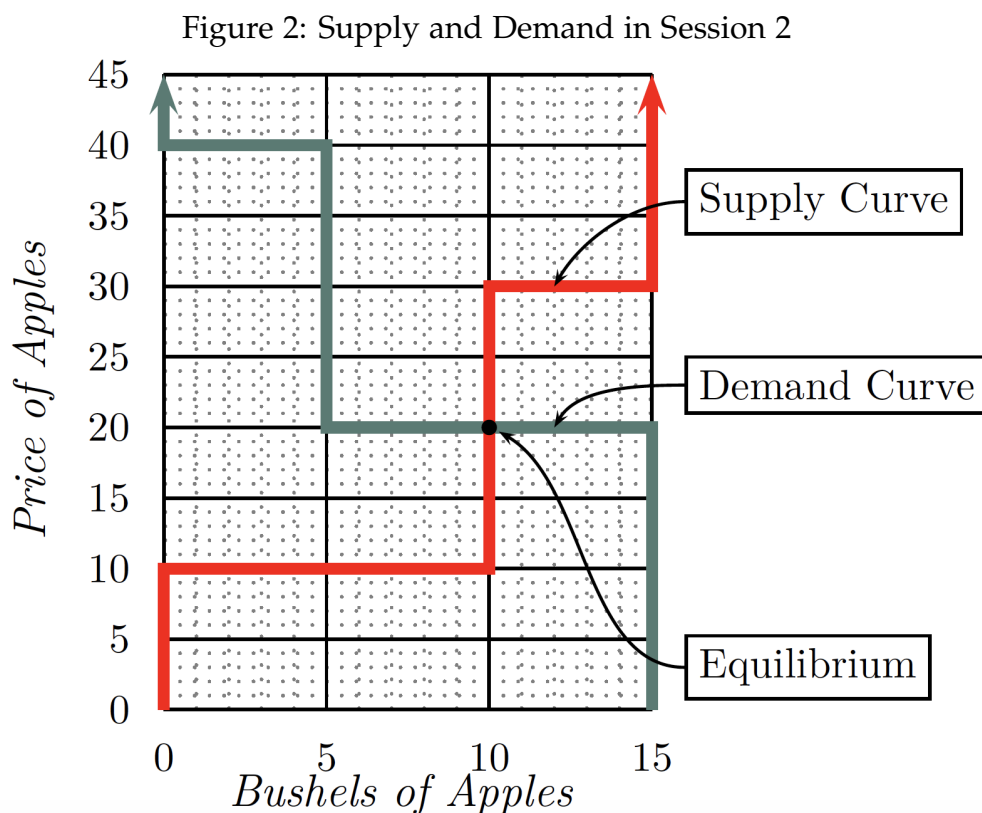
Table 1: Proportions of Supply and Demand Types

Type	Session 1	Session 2
Supplier with Seller Cost 10€	10	5
Supplier with Seller Cost 30€	5	10
Demander with Buyer Value 40€	5	10
Demander with Buyer Value 20€	10	5

Figure 1: Supply and Demand in Session 1
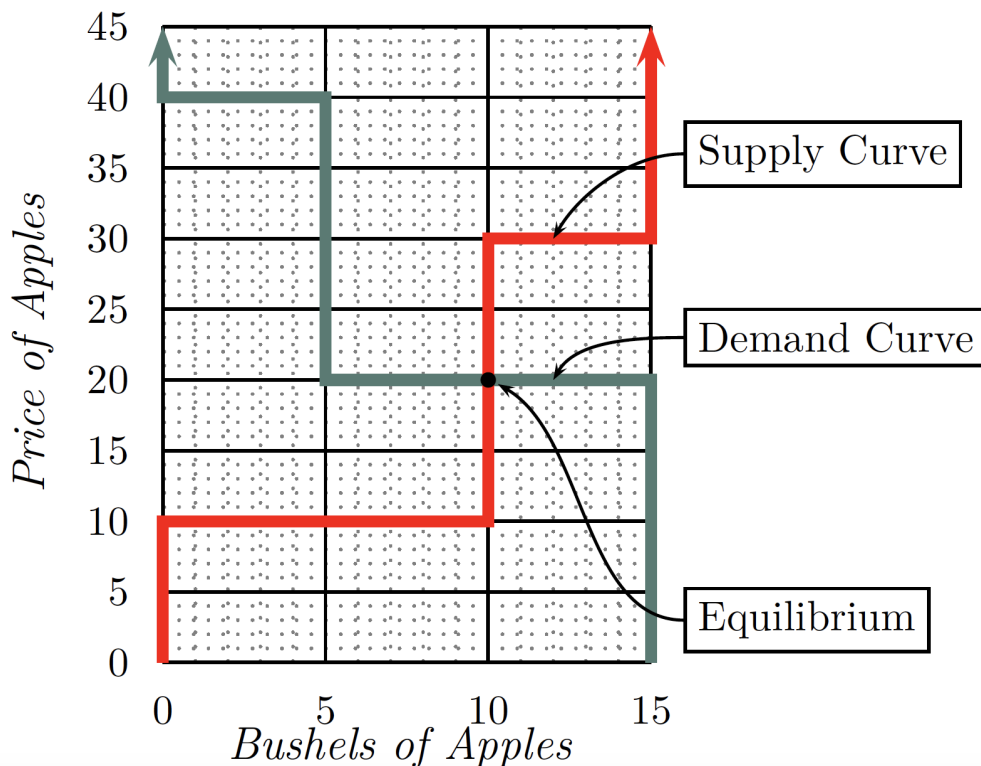
tainly not be *exactly* the same as competitive predictions. Especially in the first round of a session, you will probably observe some trades that would not occur in competitive equilibrium. This is to be expected, because participants in the experiment do not have access to a single market-clearing price as in competitive equilibrium models that enjoy the fiction of a Walrasian auctioneer. Although students (and instructors) may be impressed with how well the competitive model predicts the outcome, you should also encourage students to think about, and try to explain, *differences* be-

Figure 2: Supply and Demand in Session 2

tween the experimental outcomes and the predictions of the competitive model.

Since each student can make at most one transaction, the number of transactions in a trading round will be no larger than (and usually much smaller than) half of the number of students in the class. In our experience, trading proceeds briskly and few students are inclined to wait and watch the record of trades on the blackboard. (Students are concerned that if they don't act quickly, they will miss out on a profitable trading opportunity.) There is a short exploration time followed by an early flurry of trade and then trading activity comes to a halt, (usually within three or four minutes for classes of 40 students). In the first round of Session 1, there may be a few students who don't yet "get it" and who haven't been able to make a trade, even though opportunities for profitable trades are still available. When transactions seem to have halted, ask whether there are any high-value demanders who haven't traded. If there are, then you can ask the unsatisfied demander to make an offer and see whether any

sellers will sell him a bushel of apples at that price. If there are no high-value demanders left who have not traded, ask if there are any low-cost suppliers who have not traded. If there are, ask them to make an offer to sell at some price and see if they find any takers. Occasionally, after all other transactions have been recorded, two persons may be "deadlocked" in argument about the price. If this seems to be taking too much time, you may want to call the attention of other students to this impasse. Someone will probably make a competing offer, leading to a quick conclusion of trading. When trading has stopped, the market manager declares that this round of trading is over.

E.1   Optional Additional Activities

If there is time left after the first experimental session, we suggest leading a classroom discussion in which you encourage the class to speculate on what they have observed in the market and on what would happen if the market fundamentals were changed.

For example, you might ask the students to guess what would happen to the price of apples and the number of bushel of apples sold if the original conditions were as in Session 1, except that an increase in the costs of apple-pickers resulted in an increase of 10€ a bushel in every producer's costs. Ask the same question about Session 2.

Check the Fish Market experiment if you are interested in the theory of shifts in supply and demand.

F   Companion Material

You may want to skip this section if you have already run one of the other experiments.

Warm-Up Quiz in CLASSEX

There is a four-question quiz in CLASSEX based on the warm-up exercises in the Student's Manual. This is a very simple test to check students' understanding of the instructions. We also use the test as an incentive for students to carefully read the instructions before attending the experimental session. For that, we reward attendance points based on the number of correct answers. Statements and answers are provided in section G.2.

Lab Notes, Profits and Solutions

The spreadsheet **AppleMarket.xlsx** automatically generates the information for the Lab Notes, the answers to the exercises in the Student's Manual, and the profits that each student obtained in every round. It feeds from the data file generated by CLASSEX . The data file must be renamed as **DataAppleMarket.xlsx**.[3]

As an example, we provide the file `DataAppleMarketEx.xlsx` with data from a previous run of the experiment. If you want to use it, rename it as `DataAppleMarket.xlsx`, place it in the same folder as the `AppleMarket.xlsx` file, and choose update links when opening the latter.[4]

G   Technical Details

This section is not necessary for running the experiment nor for its discussion in the classroom. It provides technical information on how CLASSEX assigns types and on the warm-up quiz.

G.1   Roles and Types

Let P be the number of participants. Let N and R be the quotient and the reminder of the division $P/6$, so that $P = 6 \times N + R$. Tables 2 and 3 provide information on the distribution of Seller Costs and Buyer Values for Sessions 1 and 2, respectively. Table 4 shows the correspondence between the type displayed by CLASSEX in the student's screen and her role in each session of the experiment.

Example. For a sessions with $P = 34$ students, $34 = 5 \times 6 + 4$, and hence $N = 5$ and $R = 4$. It follows from Table 2 that in session 1 there are 6 suppliers with Seller Cost of 30€, 11 suppliers with Seller Cost of 10€, 11 demanders with Buyer Value of 40€, and 7 demanders with Buyer Value of 30€.

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[3] Although not recommended, data can also be introduced manually. Detailed instructions are provided in the first tab of the excel file.

[4] If you receive the error message "We can't update some of the links in your workbook right now," close the AppleMarket.xlsx file, open the DataAppleMarket.xlsx file, save it, close it, and reopen the AppleMarket.xlsx.

Table 2: Distribution of Types in Session 1

Reminder (R)	0	1	2	3	4	5
Seller Cost 30€	2N	2N	2N	2N	2N+1	2N+1
Seller Cost 10€	N	N	N	N	N	N+1
Buyer Value 40€	N	N+1	N+1	N+1	N+1	N+1
Buyer Value 20€	2N	2N	2N+1	2N+2	2N+2	2N+2

Table 3: Distribution of Types in Session 2

Reminder (R)	0	1	2	3	4	5
Seller Cost 30€	N	N	N+1	N+1	N+1	N+1
Seller Cost 10€	2N	2N+1	N+1	2N+1	2N+1	2N+1
Buyer Value 40€	2N	2N	2N	2N+1	2N+1	2N+2
Buyer Value 20€	N	N	N	N	N+2	N+1

Table 4: Distribution of Types in CLASSEX

Type	Role in Session 1	Role in Session 2
A	Demander with Buyer Value 40€	Supplier with Seller Cost 30€
B	Demander with Buyer Value 20€	Supplier with Seller Cost 10€
C	Demander with Buyer Value 20€	Demander with Buyer Value 40€
D	Supplier with Seller Cost 10€	Demander with Buyer Value 20€
E	Supplier with Seller Cost 30€	Demander with Buyer Value 40€
F	Supplier with Seller Cost 10€	Supplier with Seller Cost 30€

10

G.2 Warm-Up program in CLASSEX

The Warm-Up program in CLASSEX consists on a four-question quiz based on the warm-up exercises in the Student's Manual. Figure 3 shows the student screen. The following list provides for each question the statement, the seed (if there are student-specific information), and the answer.

"Suppose that a supplier with a seller cost of SC meets a demander with a buyer value of BV."

▷ Student-specific seeds: $SC \in [15, 25] \subset \mathbb{N}$; $BV \in [35, 55] \subset \mathbb{N}$; $P \in [SC + 1, BV - 1] \subset \mathbb{N}$.

Question 1 'If the supplier sells a bushel of apples to the demander for a price of P, how much profit will the supplier make?"
▷ Answer: Profits = $P - SC$

Question 2 "At the price of P, how much profit will the demander make?"
▷ Answer: Profits = $BV - P$

Question 3 "What is the highest price of a bushel of apples that would permit both the seller and the buyer to make the profit of 1€ or more?"
▷ Answer: $BV - 1$.

Question 4 "What is the lowest price of apples that would permit both the seller and the buyer to make the profit of 1€ or more?"
▷ Answer: $SC + 1$.

After collecting all answers, CLASSEX provides individualized feedback to students in their personal screens and shows the fraction of correct and incorrect responses as well as the statement for each question that can be used to resolve doubts. See Figure 4 and Figure 5 for a representative example.

Figure 3: **Warm-Up Questions** in CLASSEX as they show up in students' screens. The text underlined in red varies among students.

Suppose that a supplier with a seller cost of € 22 meets a demander with a buyer value of € 52.

Q1
If the supplier sells a bushel of apples to the demander for a price of € 30, how much profit will the supplier make?

€

Q2
At the price of € 30, how much profit will the demander make?

€

Q3
What is the <u>highest</u> price of apples that would permit both the seller and the buyer to make the profit of € 1 or more?

€

Q4
What is the <u>lowest</u> price of apples that would permit both the seller and the buyer to make the profit of € 1 or more?

€

Submit

Figure 4: **Personalized feedback** in a student's screen.

Q1) You answered 5, the correct answer is 5. ✓
Q2) You answered 25, the correct answer is 25. ✓
Q3) You answered 45, the correct answer is 45. ✓
Q4) You answered 17, the correct answer is 17. ✓

4 (out of 4) correct.

Figure 5: **Example of the outcome from the Warm-Up quiz**. Statements and distribution of correct and incorrect answers.

Supón que un oferente con coste de venta de € 20 encuentra un demandante con valor de compra de € 45

Q1) Si el oferente vende un quintal de manzanas al demandante a un precio de € 30, ¿cuántos beneficios tendrá el oferente?

correctas	82.6%
incorrectas	17.4%

¿Q2) Y cuántos beneficios obtendrá el demandante?

correctas	82.6%
incorrectas	17.4%

¿Q3) Cuál es el precio más bajo que permitiría tanto al vendedor como al comprador de manzanas obtener unos beneficios de € 1 o más?

correctas	78.3%
incorrectas	21.7%

¿Q4) Cuál es el precio más alto que permitiría tanto al vendedor como al comprador de manzanas obtener unos beneficios de € 1 o más?

correctas	73.9%
incorrectas	26.1%