

Price Discovery and Auctions
v. 2.0

Version 2.0 update supported by TRBF and the Take Charge America Institute

Original Lesson Prepared for The Freedom and Prosperity Academy

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1. Title

Price Discovery and Auctions

2. Overview (why this lesson is important)

Resources are scarce (neither our resources nor our lives are infinite), so as a society we want to do the most we can with what we have. We also want to create more opportunities for future generations. Markets are one of many methods societies have devised for allocating scarce resources.

In this lesson, students will have an opportunity to participate in a “labor” market, either as a buyer of labor units or a seller of labor units. They will have access only to their information (value or cost), and they will be able to observe others’ transactions. From this activity they will learn that when buyers and sellers have private (and accurate) information and where prices are free to move, markets allocate resources in a way that maximizes value. We call this value the gains from trade. *We are better off because we trade.*

Once they understand the value of trade, the students will have an opportunity to learn why the theory of supply and demand is a good predictor of the level of market participation and the prevailing price.

The software that accompanies this lesson allows the teacher to walk the student through nine separate market manipulations. These modules are designed to allow the teacher to introduce or reinforce other lessons on market manipulations—e.g., minimum wage, maximum wage, tax on the buyer or seller (or both), or even a third party payer system.

Once the students understand the conditions under which markets function, they will be able to make connections between market manipulations and the overall welfare of a people.

3. Description

Students interact in multiple markets in one classroom setting, half of them acting as buyers and half acting as sellers. The instructor is free to set up multiple market periods depending on the objective of the lesson. If the lesson is intended to teach the basics of gains from trade, and supply and demand, 3-4 market periods may be appropriate. If the objective is to teach one of the market manipulations in addition a refresher on the basics of supply and demand, 4-5 market periods will be in order. The instructor may choose from nine market manipulations.

In the course of their participation, the students are able to see transactions as they occur. The auction program prevents students from making irrational trades. (Irrational trading, not allowed here, can provide an opportunity for learning.) The debriefing can start immediately following the market interactions. The program includes an option to save the auction at a point in time or just the data for use in later class meetings. The debriefing is designed to cover the following:

- A. a sequential overview of what the students actually did in the market session (Bids & Asks by transaction and session);
- B. a chance to observe regularities in the prices from market session to market session;
- C. a close examination of incentives and rationality through the surplus gained per transaction (Surplus by Trade);
- D. using buyer values and seller costs to calculate maximal surplus to be gained through trade (before theory of supply and demand are introduced);
- E. an exploration of theoretical predictions of behavior;
- F. the theory of supply and demand, predicted market quantity and price;

- G. a calculation of market surplus (from theory);
- H. a calculation of efficiency of each of the market interactions (= Surplus by Trade / theoretical maximum surplus)

4. Time

Minimum: One 50-minute class period

This lesson can be used for one class period or many times with different applications of market interventions. I recommend that the first use of this lesson framework with students be the baseline market with at least three trading periods.

5. Background

Students might be familiar with modern double oral auctions such as the Chicago Mercantile Exchange and New York Stock Exchange. These markets exist to match buyers and sellers. The classic double oral auction shows how a price mechanism orders the buying and selling decisions individuals with dispersed and private knowledge of their personal circumstances (see Smith 1962).

The oral double auction has been shown to converge consistently to the market clearing price and quantity, across many replications and under a variety of market conditions. It is not unusual for student interactions to approach 100 percent efficiency.

6. Big Idea

The first big idea is that there are gains from trade. We are better off for trading with our neighbors. The second big idea is that we know very little about each market participant's willingness to buy or sell. We know our private information and perhaps the prevailing market price of the goods or services in question. Perhaps the biggest marvel for the students will be in experiencing firsthand a series of trade interactions in which "the most significant fact about this [price] system is the economy of knowledge with which it operates, or how little the individual participants need to know in order to be able to take the right action" (Hayek, 1945, p. 526).

7. Essential Questions

- How does the price system coordinate private, individual circumstances?
- How is surplus generated from trade?
- How do market restrictions affect the surplus from trade in a competitive market?

8. Objectives

- A. The students will be able to explain why voluntary exchange occurs only when all participating parties expect to gain from the exchange.
- B. The students will acquire some of the tools needed to understand the role of information in market transactions.
- C. The student will be able to graph a supply and demand curve, given the sellers' costs and the buyers' values
- D. The student will explain how the underlying efficiency of competitive markets stems from the participation of sellers with low costs and buyers with high values.
- E. The student will understand that equilibrium price is a prediction from a very powerful theory of behavior: The theory of supply and demand.
- F. Depending on the manipulations chosen by the instructor, the student will be able to recognize that shifts in supply, demand, or market constraints will affect market participation and the market price—e.g.,
 1. how price ceilings and floors cause shortages or surpluses;

2. How a tax on buyers has the same effect on market participation (surplus) as a tax on sellers or a tax split between buyers and sellers;
3. How a subsidy provided to buyers has the same effect on market participation (surplus) as a subsidy provided to sellers or a subsidy split between buyers and sellers;
4. How subsidies extend markets beyond the maximal surplus, encouraging low-valued buyers and high-cost sellers;
5. How third-party-payer systems (for example, insurance contracts that pay 80 percent of the negotiated price between the buyer and seller distort market participation);
6. When trade does not happen because there is no market clearing price.

9. Materials

The instructor will need Internet access to set up the classroom market sessions.

econteachinglab.org

The instructor can use a PC, a Mac or an Ipad. Once the website is activated, the instructor can disconnect from the Internet and run the entire session *without* an Internet connection. To get the most out of the graphical interface of the market software, I suggest using a digital project or document camera to project the images of the market sessions and debriefing. The most recent version of these notes can be viewed and printed from the Lesson button found under the Print menu on the right side setup screen of the auction site.

All materials for this lesson can be printed directly from the auction site setup tab:
econteachinglab/da/:

- Print screen of each market setup (Full Information on Buyer Values and Seller Costs) – *optional (these screens can be displayed during debriefing)*
- Under the Print Menu on the Setup Screen
 - Handouts: Buyer/Seller record sheets for private information and recording profits – *not optional*
 - Buyer/Seller Labels (to be printed on standard Avery labels and affixed to either the back of buyer/seller recording sheets or index cards (one color for buyers, one color for sellers) – *optional*
 - Instructions - *optional*

If the instructor would prefer to have students construct their own demand and supply curves, he or she should provide graph paper and straight edges.

For an implementation with less paper, the instructor need only print the Buyer/Seller record sheets and then read the instructions aloud.

10. Procedures

Before Class

- A. To begin, before class, teachers select
 - i. the Hand-run Auction Interface from econteachinglab.org;
 - ii. the number of students;
 - iii. the number of market periods (recommended for first-time use: 3, 4 or 5);

- iv. the market conditions for each market period. (The default is “baseline.” For first-time use in a classroom, I recommend at least two baseline conditions before moving on to a market manipulation.)

Number of Students: 20 Number of Buyers: 10 Number of Sellers: 10 Number of Market Periods: 1

Market 1
Market Condition: Baseline

Buyer	Value 1	Value 2	Value 3	Value 4	Seller	Cost 1	Cost 2	Cost 3	Cost 4
1	13.55	5.55			11	2.00	16.35		
2	12.75	5.95			12	2.05	15.55		
3	12.35	6.35			13	2.75	14.75		
4	11.95	6.75			14	3.55	13.95		
5	11.55	7.15			15	4.35	13.15		
6	11.15	7.55			16	5.15	12.35		
7	10.75	7.95			17	5.95	11.55		
8	10.35	8.35			18	6.75	10.75		
9	9.95	8.75			19	7.55	9.95		
10	9.55	9.15			20	8.35	9.15		

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Figure 1: The Setup Tab for the Double-Oral Auction Experiment

The software automatically starts on the **Setup** tab. The software generates Buyer/Seller record sheets that need to be printed. These will be generated once the instructor prints “Handouts” under the Print menu in the upper-right hand corner of the **Setup** tab. Be careful not to refresh or close the browser. You will reset the experiment.

- B. The instructors need to prepare any other materials they want to distribute:
- i. Buyer/Seller identity cards: “Print Labels” on the **Setup** tab displays for printing 20 labels (10 Buyers, 10 Sellers) on one sheets of Avery Standard 5260 (Standard 30 address labels per sheet). These 20 labels can either be affixed to the back of the Buyer/Seller record sheets for one use only, or they can be affixed to index cards—one color for buyers and one color for sellers. Cards make it easy for students to hold up their card and identify themselves as a buyer or seller.
 - ii. Buyer/Seller record sheets: Print “Handouts” on Print menu on **Setup** tab creates a new browser window for printing individual record sheet for each buyer and seller in class. These can be paired with the Buyer/Seller identity cards for easy distribution.
 - iii. Instructions: At least one copy of the instructions to be read aloud.
 - iv. Market setups: A listing of Buyer Values or Seller Costs can be printed from each **Market #** tab on the **Setup** tab.
 - v. Graph paper.

Instructions

A. Display the **Demo** tab on your computer.

Buyers			
Unit	Value	Price Paid	Profit on Unit <small>Value - Price Paid</small>
1st	10.20		
2nd	8.20		
3rd	6.20		
4th	4.20		
Total Profit:			0.00

Sellers			
Unit	Price Received	Cost	Profit on Unit <small>Price Received - Cost</small>
1st		3.90	
2nd		5.90	
3rd		7.90	
4th		9.90	
Total Profit:			0.00

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Figure 2: The Demo Tab for the Double-Oral Auction Experiment

- Connect the computer to the display device.
- Divide the class in half, making half the students buyers of labor and half of them sellers of labor.
- Distribute the Buyer/Seller information.
- Read the instructions aloud (Instructions attached).
- Use the **Demo** tab to demonstrate how a buyer would fill in his or her record sheet while you read through the Buyer Section of the instructions
- Use the **Demo** tab to demonstrate how a seller would fill in his or her record sheet while you read through the Seller Section of the instructions
- This is the time to answer any questions the students might have. This is also the right time to motivate them to earn a profit. These experiments ALWAYS work when the payoffs are salient. The experiment is designed so that everyone can trade at least one unit. No one should be left out. However, some students might be in better trading positions than others. It is important that they do the best they can with what they are dealt. No one should make a negative profit. Some will make more than others. If you run more market experiments and randomly distribute values and costs, the students are likely to experience many market positions. If the incentive to do well is tied to extra credit points, for instance (or student supply dollars), there might be increased attendance on market days!

Market Participation

- Click to the **Market** tab and take the students on a tour of this page. They will see something like **Figure 3** throughout the market sessions you have set up.

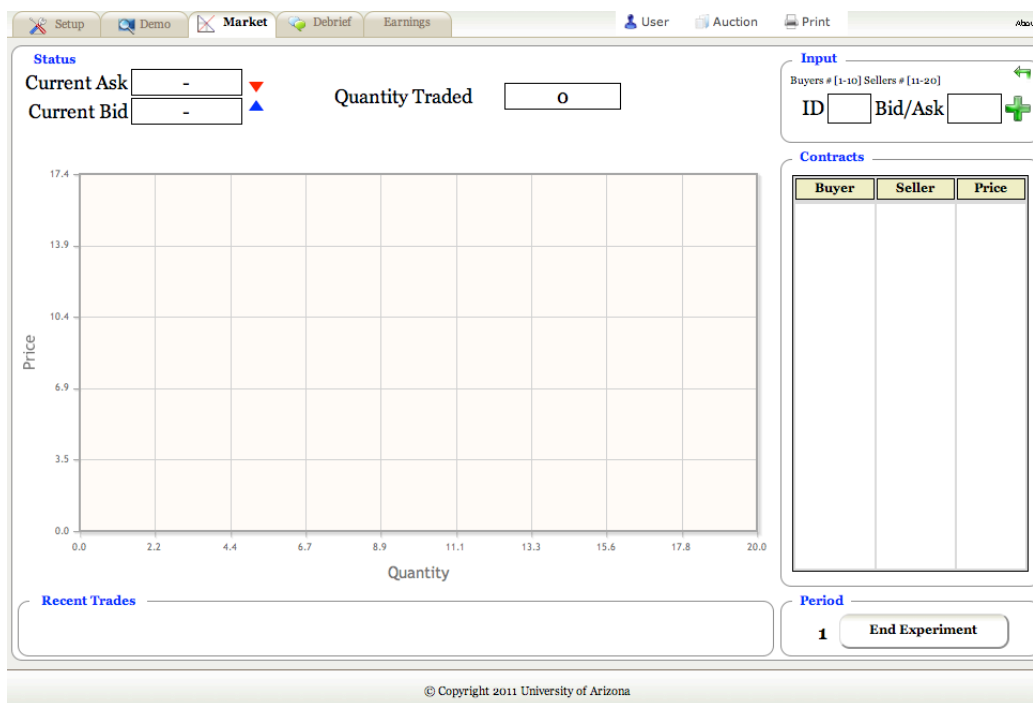


Figure 3: The Market Tab for the Double-Oral Auction Experiment

- In the upper right corner of the **Market** tab is the “Input” area. This is where the auctioneer or the auctioneer’s helper will enter the Buyer and Seller IDs and the Bid or Ask. Buyers will always be low-numbered IDs (1 - 10) and sellers high-numbered IDs (11 - 20), so there is no need to input a “b” or “s” in the ID field—just the ID number. The cursor’s home is the ID field. Tab to the Bid/Ask field; then tab to the green plus sign. This is the “add this bid or ask to the market” icon. Use the “Enter” key or “Space Bar” or click on this icon to activate the bid or ask. There is a small undo arrow for misinterpreted bids and asks.
 - To the left of the Input area, the Current Asks and Bids are indicated. They are also indicated on the graph below. The most current are the highest bid and lowest ask. These can be seen on the graph as the “inside” bid and ask.
 - Across the bottom of this page is the “Recent Trades” area. The last five trades are listed here so students can see the details of their transactions. The most recent transaction is on the far left. This allows the auctioneer to keep going to the next bid or ask and the students can catch up writing down their exact transaction.
 - The right side of the screen is a complete list of all the deals made, including the most recent five.
 - When bids and asks trail off, the auctioneer can start the next market period. Once a market period is started, there is no “undo.” The market is over, and no more trades can be made in that market period.
- B. For the first session: Start slowly with bids and asks. The first market session can be used as a learning experience. The students will be uncomfortable, given how little information they have and given the structure of bidding and asking. This is one reason for running more than one baseline session.
- C. Run as many programmed market session as you have time for. It can take up to five minutes to run each market session, but up to 20 minutes for the first market session. You can restrict bids to 10-, 25- or 50-cent increments to speed things up.

Debriefing the Baseline Markets

- A. Once all market sessions are completed (or not), you can display the **Debrief** tab.

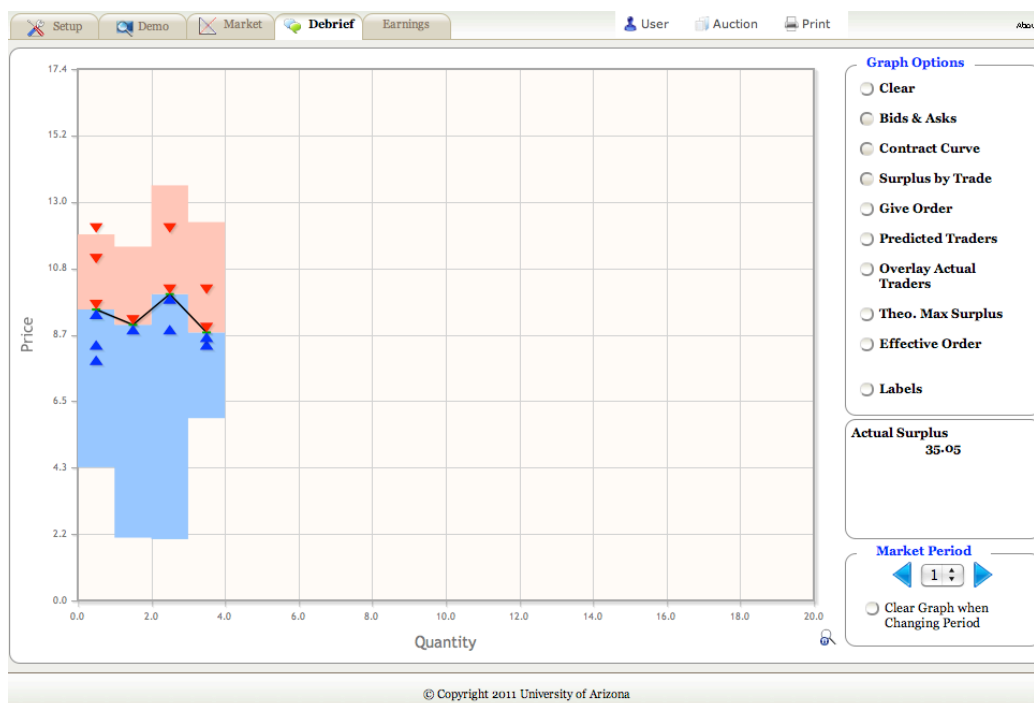


Figure 4: The Debrief Tab for the Double-Oral Auction Experiment

- B. This tab is designed to help the instructor lead the students through a session in which they gain insight into what they have just done. The display default is blank. The image in Figure 4 above has three radial dials activated: **Bids & Asks**, **Contract Curve**, and **Surplus by Trade**. Eventually, students will see how the buyers' values are connected to a demand schedule and how the sellers' costs are connected to a supply schedule. There are ten graphing options. The first eight can be used in the order in which they are listed. I find that it helps to spend a lot of time in the early part of the list: **Bids & Asks**, **Contract Curve** and **Surplus by Trade** to connect the students' actions, in the order they did it (*not yet* to the order of the eventual supply and demand curves), to the graphical depiction of transactions. You can flip between Market Periods in the lower right-hand corner. There is a **Labels** indicator at the bottom of the list of Graph Options. This will display the actual buyer and seller numbers from the sheets to the graph. This Label indicator can be toggled with any of the other Graph Options. In addition, there is a magnifying glass icon in the Graph Options section. You can activate this and expand a section of the graph so that market details can be illustrated more effectively.

Here is a series of suggested debriefing techniques (instructors will surely want to do different things with these options as they gain experience):

- i. Provide a sequential overview of what the students actually did in the baseline market session. The market data generated from the experiment will have little meaning if the students don't have the opportunity to understand how their individual actions create the overall market data. These steps are designed to help them make that connection.
- ii. Click on **Bids & Asks** and click through the baseline Market periods. Labels can be applied and students can find where they fit in the series of transactions.
- iii. Give the students another option to observe regularities in the prices from market session to market session by activating the **Contract Curve** option. This is a line that connects all the prices at which deals were made. When we move from one session to the next with the deals strung together, it is much easier for the students to observe that prices became more

- stable and perhaps more or fewer trades were made. What is different between session 1 and session 3? Why would prices seem more stable? Did Session 3 feel different to you? The students might understand right away that they had more experience and more information in later sessions. By then they knew how the market operated. They knew more about prices from early sessions in later sessions. Both will create more stability in the pricing.
- iv. Use the **Surplus by Trade** option to provide a close examination of the surplus gained per transaction (incentives and rationality). This can lead to a discussion of what negotiated price between a buyer and a seller creates the most surplus between that buyer and seller. (Answer: Any price that allows a trade. The important thing is that a trade is made!) Note the different prices and the surplus that is created. Allow the students to calculate this. Note that to calculate surplus they need information that they didn't have access to as market participants. They need other people's values and costs. (The value of the surplus is calculated for you in the lower right corner. You can note this or you can come back to this option when you want to calculate the students' demonstrated market efficiency.)
 - v. Pass out or display Market 1 under the **Setup** tab. Use buyer values and seller costs to calculate maximal surplus to be gained through trade. It is important to do this before the theory of supply and demand is introduced (in this context). Should everyone trade if what we care about is creating value?
 - vi. Creating value for market participants is what markets are about. If we didn't care about creating value, we wouldn't need markets. Since surplus is important, we would like to have a story to tell about how much of a good will be traded and at what price when buyers and sellers are allowed to come together in a market. What amount was traded in our markets (roughly)? What was the price (roughly)? What stories can we tell to predict that outcome? Do we need to know all the values and costs to make that prediction? Which ones are important? (Answer: The last buyer and the last seller willing to buy and sell at the prevailing price. We really don't need to know the values and costs of the others, just that they are voluntary trades.)
 - vii. To get the ball rolling, the instructor can give a series of prices (\$2.00, \$3.00, \$4.00) and ask how many people would be willing to buy and how many would be willing to sell at those prices. It doesn't matter whether you start high or low: there will be more buyers or more sellers depending on which side of the equilibrium price you start on. It turns out you don't need to know everyone's willingness to pay or cost; you just need to know how many are in on each side. When a price is discovered where there is the same number of units wanted for purchase as wanting to be sold we call this the equilibrium price. At the equilibrium price there will be no pressure on the market to push the price up or pull the price down.
 - viii. We can see how we can find the equilibrium price by taking a survey. That is pretty much what a market does. But we have all the information. We can let the buyers' values and sellers' cost "talk" to us by ordering those values and cost. It makes sense that given a price, all the buyers with a higher value would be willing to buy. Suggest ordering those buyers from highest value to lowest value. Similar logic holds for the suppliers. Those with a cost less than the price offered are willing to sell. So order them from lowest cost to highest cost. The **Give Order** option displays the buyers and sellers in these orders. This is their supply and demand curve. Use the **Labels** option here and ask a couple of students to find out where they reside on their respective curves. Use the **Overlay Actual Traders** to help them out.
 - ix. It is an easy step from here to use the **Predicted Traders** option to illustrate what the students already knew: the equilibrium price and quantity.
 - x. **Theoretical Maximum Surplus** shows the theoretically maximal surplus created in this particular market. You can challenge the students to come up with an allocation of buyers and sellers that create more surplus. (With confidence!)
 - xi. Calculate the efficiency of each of their market interactions ($= \text{actual surplus} / \text{theoretical maximum surplus}$). It is not surprising to have high levels of surplus in these experiments.

The traders not likely to trade are the ones near the equilibrium. Non-participation from these traders will have a small impact on the efficiency of the market. It is important to point out that the original supply and demand curves represent the cost and values to the buyers and the sellers. The **Effective Order** option reminds us that these are the curves used to calculate true market surplus.

Debriefing the Market Manipulations

As a general rule, it is good for students to have gone through a thorough treatment of the Baseline Markets. There are four markets in which there is a shift in one of the sides of the market. Those choices can be found under Market Shifters in the Market Conditions Tab (where the default market is Baseline). The applications below can be quite succinct and to the point.

- A. **Maximum Allowable Price/Wage (Price Ceiling):** Buyers of labor are not allowed to ask more than a certain published rate, and sellers cannot bid higher than that published rate. (Think restrictions on CEO pay.) Here the important lesson is the loss of efficiency due to lower market participation. There are fewer sellers in this market than when the price was free to move as high as equilibrium price. A finer point to make is that the Theoretical Maximum Surplus option actually shows the maximal efficiency possible. In reality, there is no force that keeps low-valued buyers out of the market, as the graph indicates. Lesson: The lower the value of the service, the less surplus actually generated.
- B. **Minimum Wage (Price Floor):** Buyers of labor are not allowed to ask less than a certain published rate, and sellers cannot bid lower than that published rate. Here the important lesson to teach is the loss of efficiency due to lower market participation. There are fewer buyers in this market than when the price was free to move as low as equilibrium price. A finer point to make is that the Theoretical Maximum Surplus option actually shows the maximal efficiency possible. In reality, there is no force that keeps high-cost sellers out of the market, as the graph indicates. Lesson: The higher the cost, the less surplus actually generated.
- C. **Tax on Wage Earner (\$2):** Indicated as a \$2 increase in cost for each seller. This market condition can be used to show the impact on market price and market participation as a **decrease in supply**. Here the important lesson is the loss of efficiency due to lower market participation.
- D. **Tax on Wage Payer (\$2) –** Indicated as a \$2 decrease in value for each buyer. This market condition can be used to show the impact on market price and market participation as a **decrease in demand**. Here there are two important lessons: (1.) the loss of efficiency due to lower market participation; (2.) when used in tandem with Tax on Wage Earner, the impact on surplus and equilibrium quantity are the same. Question: Why aren't the price outcomes the same? What is the difference?
- E. **Tax on both Wage Earner and Wage Payer (\$1 each):** Indicated as an increase in cost of \$1 for each seller cost and as a decrease in value of \$1 for each buyer. This market condition can be used to show the impact on market price and market participation as a **decrease in both supply and demand**. Here again there are two important lessons: (1.) the loss of efficiency due to lower market participation; (2.) when used in tandem with Tax on Wage Earner or Wage Payer, the impact on surplus and equilibrium quantity are the same. Question: Why aren't the price outcomes the same? What is the difference?
- F. **Subsidy on Wage Earner (\$2):** Indicated as a decrease in cost of \$2 to each seller. This market condition can be used to show the impact on market price and market participation as an **increase in supply**. Here the important lesson is the loss of efficiency due to HIGH market participation.
- G. **Subsidy for Wage Payer (\$2):** Indicated as a decrease in cost of \$2 for each seller. This market condition can be used to show the impact on market price and market participation as an **increase in demand**. Here the important lesson to teach is the loss of efficiency due to HIGH market participation.
- H. **Third-Party Payer:** Indicated as huge increase in demand. Basically, a third party (say an

insurance company or the government) has announced that it is willing to pay 80 percent of all negotiated prices (e.g., for medical care). This lesson can be done with a baseline treatment and an announcement. The instructor will want to use the Third-Party-Payer **Predicted Traders** to show what that announcement does to the market.

11. Assessment

At the conclusion of the basic lesson with no market manipulations, given a supply schedule and a demand schedule, a student should be able to predict the market price and quantity traded, and calculate the market surplus from the market participation.

12. Enhancement

Iowa Electronic Markets (Prediction Markets)

If the information or the lack of information used in markets has your students interested, take a look at the Iowa Electron Markets webpage: <http://tippie.uiowa.edu/iem/index.cfm>.

These markets are small-scale, real-money futures markets where contract payoffs depend on economic and political events such as elections.

From the Iowa Electronic Markets web site:

I and many of my colleagues have used [the markets in classes](#) as a pedagogical tool. We have found them to provide an excellent way to focus attention and give hands-on experience with real-world markets. We have developed [several modules](#) to help you integrate the IEM into your course. The modules are organized by topic (e.g. Supply and Demand). Each unit module contains the following:

PowerPoint slide lecture	Lecture Notes
Learning Objectives	Assignments
Lecture Outlines	Quizzes/Tests

Please e-mail us at iem@uiowa.edu if you need assistance.

Veconlab is a wonderful site set up by University of Virginia economics professor Charlie Holt. The setup is for use in a computer lab or with laptops. Students can share logins. We recommend early pretesting of the experiments so instructors can be familiar with the graphics, but they are open to anyone for use in the classroom. See <http://veconlab.econ.virginia.edu/admin.htm>.

Acknowledgments:

The software that accompanies this lesson was developed and programmed by Richard Kiser, Tucson, Arizona. The setup of running a handheld Auction with a computer visual aid for the classroom was originally implemented by James Murphy (University of Alaska) and further improved upon by Bart Wilson (Chapman University).

Cathleen Johnson is an economist and serves as the Director of the Office of Economic Education in the University of Arizona's Norton School of Family and Consumer Sciences. The Office of Economic Education offers workshops and university graduate courses to K-12 teachers so that they may become more effective teachers of economics. She develops experimental protocols for teaching economic concepts at several levels: to her students, the teachers in the graduate program and often with policy and program officers. Johnson also serves on the board of the University of Arizona's Take Charge America Institute for Consumer Financial Education and Research. She received her PhD in economics from Virginia Tech (2000). Cathleen@email.arizona.edu.