Student's Manual: Theory and Discussion

The Apple Market

A Simple Trading Pit Experiment

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In Search of a Theory

We have a mystery on our hands. In each session of the Apple Market, prices seem to be closing in on certain values. But what determines the values to which prices seem to converge?

It would be really nice to have a *theory* that predicts outcomes, not only for the specific market that we observed experimentally, but for a variety of markets under widely varying conditions. We would like a theory that allows us to answer questions like:

- If everybody's cost of production increases by 10€, will the market price increase by 10€, by less than 10€, or by more than 10€?
- Suppose that the government decides to pay 10€ to every person who buys a bushel of apples. (Such a payment is called a **subsidy** to apple consumption.) Will suppliers absorb some or all of the subsidy by increasing their prices, or will demanders get all of the benefits from the 10€ subsidy?
- If bad weather reduces the quantity of apples that each producer could supply, what will be the effect on the price of apples and what will happen to total revenue of suppliers?

Economists have just such a theory. It is known as **supply and demand theory**, or more formally as **competitive equilibrium theory**. This theory offers answers for the above questions and for many others. These answers are often quite useful and surprising. Of course, a theory that predicts market outcomes will not be much good if these predictions are badly wrong. Therefore it is important and interesting to see whether supply and demand theory does a good job of predicting the outcomes of our experiments. If the theory does well in these experimental environments and continues to do well as we add more elements of realism, then we can put some credence in its predictions for actual markets. If this simple theory does not perform well, then we may have to look for a better theory.

Competitive Equilibrium

In the early rounds of experimental market sessions, some sellers were able to get higher prices for their apples than others. Some sellers were lucky enough to be offered a relatively high price by the first buyer they ran into. Every buyer would like to get apples as cheaply as possible, but different buyers may have different ideas of how cheaply they can get them. After seeing the outcomes of the early rounds, those buyers who paid the highest prices and those sellers who accepted the lowest prices are likely to seek better deals in the next round. To describe everybody's beliefs about the prices they can get and to describe everybody's luck in whom they encounter would be an overwhelmingly complicated task, even for this simple market.

Instead of trying to describe this complex reality in full detail, let's try to make a simplified *model* that would predict the outcomes to which trading converges in later rounds. The art of good modeling in economics, as in all of science, is to find the “right” simplifications. The model should remove enough complication from the actual situation to allow us to analyze and approximately predict outcomes, but should not remove so much reality that it distorts our picture of the way things really work. We are looking for a manageable model of markets that makes good predictions of the outcomes that we observe in experimental markets and in actual markets of the commercial world. Specifically, we would like to have a model that predicts the average price and the number of transactions in a market using the information that we have about the Buyer Values and Seller Costs of the market participants.

Let us try the following theory. Suppose that when everybody has experience with shopping around, all transactions takes place at the same price and everybody acts to maximize his or her profits at that price. If that is the case, we have to ask “and what would that price be?”

A supplier will surely want to sell if the price is greater and will surely not want to sell if the price is less than her Seller Cost. If the price is equal to her Seller Cost, she would have zero profits whether she sells or not and would thus be indifferent. A demander will want to buy if the price is lower than his Buyer Value and will not want to buy if the price is higher. If the price equals his Buyer value, he will be indifferent between buying and not buying.

There is no reason to expect that at an arbitrary price, the number of bushels of apples that demanders are willing to buy would equal the number of bushels that suppliers are willing to sell. But in general there will be *some* price at which the number of bushels of apples that suppliers are willing to sell is equal to the number of bushels of apples that demanders are willing to buy. This price, at which “supply equals demand,” is known as the **competitive equilibrium price** and the number of units bought and sold at this price is known as the **competitive equilibrium quantity**.

Supply curves and **demand curves** are the main tools that we use to study competitive equilibrium. The supply curve tells us the total amount of a good that suppliers are willing to sell at each possible price. We can draw a supply curve if we know each supplier’s Seller Cost. In this experiment, each supplier supplies at most one unit, so the number of units that will be supplied at any price equal to the number of suppliers whose Seller Costs are less than or equal to that price. The demand curve tells us the total amount of a good that buyers are willing to buy at each possible price. We can draw this curve if we know each demander’s Buyer Value. The number of units demanded at any price will be equal to the number of demanders who have Buyer Values at least as high as that price. At the point where the supply and demand curves cross, we have a price at which the number of suppliers equals the number of demanders. This is the price that we call a *competitive equilibrium price* with quantities being the *competitive equilibrium quantities*.

Some Implications of Competitive Theory

So far, we have explored the question of how well competitive equilibrium theory works to predict the outcome in trading environments like our classroom market. If competitive equilibrium turns out to be a good predictor of what happens, then it is interesting to know more about other implications of this theory.

Who Trades in Competitive Equilibrium?

In competitive equilibrium, every buyer and every seller chooses his or her most profitable action, given the price. Therefore suppliers will sell if their costs are less the competitive price and will not sell if their costs are more than that price. Those whose seller cost is exactly equal to the price will make zero profits whether or not they sell. Demanders will buy if their Buyer Values are greater than the price and will not buy if their Buyer Values are less than this price. If the price is equal to their Buyer Value, they are indifferent between buying and not buying.

From these facts, we an conclude that in a competitive equilibrium, the following are true:

- Every demander who buys a unit has a Buyer value at least as high as the competitive price and every demander who does not buy has a Buyer value no higher than the competitive price, it must be that the Buyer Value of every demander who buys a unit is at least as high as that of any demander who does not buy.
- Every supplier who sells a unit has a Seller Cost that is no higher than the competitive price and every supplier who does not sell has a Seller Cost at least as high as the no higher than the competitive price, it must be that the seller cost of every supplier who sells is no higher than that of any supplier who does not sell.
- Since every demander who buys a unit has a Buyer Value at least as high as the competitive price, and every supplier who sells a unit has Seller Cost that is no higher than the competitive price, it must be that all demanders who buy a unit have higher Buyer Values than any supplier who sells a unit.
- Since every supplier who does not sell has a Seller Cost that is at least as high as the price and every demander who does not buy has a Buyer Value that is no higher than the price, it must be that every supplier who does not sell has costs that are at least as high as the Buyer Value of any Seller any demander who does not buy.

Efficiency and Competitive Equilibrium

Economists are interested in the efficiency of market outcomes. A market outcome is said to be **efficient** if the sum of the profits made by all individuals in the market is as large as possible. A market outcome is said to be **inefficient** if some other possible arrangement of trades will result in higher total profits for all participants. If one set of market institutions leads to an inefficient outcome, then it may be possible to find alternative institutions that result in higher total profits. Higher total profits could, in principle, be redistributed in such a way that *everyone* is better off after the redistribution than they were before the reform.[1]

[profmax] In markets where the profits of buyers and sellers depend only on the trades that they make and not on the trades of others, competitive equilibrium is efficient.[2] That is, the sum of the profits of buyers and sellers in competitive equilibrium is at least as large as it would be with any other arrangement of trades.

We can prove this claim as follows:

The total amount of profits made by buyers and sellers is equal to the sum of the Buyer Values of those who buy a unit of the good *minus* the sum of the Seller Costs of those who sell a unit of the good. Recall from the warm-up exercises that (regardless of the price) the total profit made by the buyer and seller in any trade is equal to the buyer's Buyer Value minus the seller's Seller Cost. Therefore total profits made by any arrangement of trades is completely determined by who makes trades and who does not. We have seen that in competitive equilibrium, every demander who buys a unit of the good has a Buyer Value that is at least as high as as the Seller Cost of every supplier who sells. Moreover every demander who does not trade has a Buyer Value that is no larger than the competitive equilibrium price, and every supplier who does not trade has a Seller Cost that is no smaller than the competitive equilibrium price.

We can now show that no other trading outcome will lead to higher total profits than the competitive outcome. First of all, there can be no way to achieve higher profits with the same number of trades. If we were to have the same number of trades with different traders trading, we would have to swap some of the suppliers or demanders who are currently trading for suppliers or demanders who are not trading. But every demander who is trading has at least as high a Buyer Value as any demander who is not trading and every supplier who is not trading has at least as high a Seller Cost as any supplier who is trading. Therefore no such swap could increase the sum of Buyer Values or reduce the sum of Seller Costs. So there would be no way to increase total profits by changing who trades,

[1] It might be that although *total* profits with alternative institutions are higher than they were with the original institutions, the direct effect of the change makes some participants worse off than they were before the change. Even if there is enough total gain for the "winners" to compensate the "losers," it is not always possible to determine who the winners and losers will be.

[2] This is not necessarily the case in an economy with **externalities**, where trades between agents may affect the profits of others. We study such an economy in the Coal Market Experiment.

with the number of trades held constant.

There is also no way of increasing total profits by having more than the competitive equilibrium number of trades. In order to have more trades, we would have to add at least one demander who currently does not trade and at least one supplier who currently does not trade. But the Seller Cost of every supplier who is not trading is higher than the Buyer Value of every demander who is not trading. This means that adding a supplier and a demander who are not currently trading would reduce the difference between the sum of Buyer Values and the sum of Seller Costs and hence reduce total profits.

Finally, there is no way of increasing total profits by having fewer than the competitive equilibrium number of trades. In competitive equilibrium, the Buyer Value of every demander who trades is at least as high as the Seller Cost of every supplier who trades. Thus eliminating any buyer and seller from the set of those who trade could not increase the sum of profits.

Therefore it must be that total profits in a competitive equilibrium are maximized.