# GEOG590-002/EVPP741-002 Fall 2003: Market Equilibrium and Market Efficiency*

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## 1 Market Demand Curves

In Week 2, we derived an individual demand curve. Of course in the real world, in almost any industry, there are many consumers, and those consumers are likely to differ in terms of preferences, income, and even the prices they face for other goods. As a consequence, their demand curves will differ. We can, however, combine a set of individual demand curves to obtain a *market demand curve* that tell us what quantity of a good will be sold if it is offered for sale at a given price. In order to derive this demand curve, we add up the quantity of the good demanded by each consumer at a given price, and we then plot the relationship between that price and the market quantity. In effect this implies a *horizontal* summation of demand curves.

Now, this can easily get confusing, but the source of the confusion is pretty clear. It comes from the fact that economists generally talk about (and even derive) quantity demanded as a function of price, but they plot price as a function of quantity. So, to obtain the solution to this problem, we need to start with the regular demand equations, work backward to express quantity as a function of price, sum these, then translate back into price as a function of quantity.[1] An example should help clarify things. Assume that we have a market with only two consumer, to make things simple. Their demand curves are given by:

$$P = 18 - 3Q_d^1 \quad (1)$$

$$P = 6 - \frac{3}{2}Q_d^2 \quad (2)$$

But what we want to know right now is what quantity will be demanded for a given price. So we solve each equation to express quantity in terms of price:



[1]When we study public goods, we will take the other approach, and sum prices for each individual quantity. But there is a strong theoretical rationale for this approach.

$$Q_d^1 = 6 - \frac{1}{3}P \quad (3)$$

$$Q_d^2 = 4 - \frac{2}{3}P \quad (4)$$

Now (assuming that $P$ on the right side represents the same value for each consumer) we sum both quantities to get the total market quantity demanded for a given price:

$$Q_d^M = Q_d^1 + Q_d^2 = (6 - \frac{1}{3}P) + (4 - \frac{2}{3}P) = 10 - P \quad (5)$$

Finally, we solve in terms of $P$ to get the form we are used to seeing:

$$P = 10 - Q_d^M \quad (6)$$

Now that we have the market demand curve, we can add it to our panel of graphs. Note that if you pick a given price, you can see that the total quantity demanded is the horizontal sum of the individual quantities. Note also how different the two individual demand curves are. *Question:* What could you say about the relative importance of the good to each consumer?

# 2 Market supply

In a very similar fashion, we can construct a market supply curve that is the sum of the individual supply curves, which we discussed in detail last week. Similarly to the demand curve, the *market supply curve* represents the total quantity that will be brought to market for any given price. It is the horizontal sum of the individual supply curves.

In our example we have only two firms supplying the good, again for simplicity. Their supply curves are:

$$P = 4Q_s^1 + 4 \quad (7)$$

$$P = \frac{4}{3}Q_s^2 + \frac{4}{3} \quad (8)$$

Before we go on, note that there is something different about these supply curves than the one we looked at last week. Last week the supply curve went through the origin. These don't–their intersection is above the origin. What does this mean? This means that the firm has some fixed costs that it must cover in order to supply anything at all to the market. For example for firm 1, to produce anything at all, the market price must be greater than \$4 a unit.

Once again, we want to know what quantity will be supplied for a given price. So we solve each equation to express quantity in terms of price:

$$Q_s^1 = \frac{1}{4}P - 1 \quad (9)$$

$$Q_s^2 = \frac{3}{4}P - 1 \quad (10)$$

Again, assuming that $P$ represents the same value for both firms, we sum the quantities supplied for a given price to get the market supply curve:

$$Q_s^M = Q_s^1 + Q_s^2 = (\frac{1}{4}P - 1) + (\frac{3}{4}P - 1) = P - 2 \quad (11)$$

Then we solve back into our usual form for graphing:

$$P = Q_s^M + 2 \quad (12)$$

Now we can graph the market supply curve, and also note that the total quantity supplied is the horizontal sum of the individual quantities.

By some tremendous coincidence, it turns out that the market supply and demand curves that we have derived are the same as those used by Nicholson for his example starting on page 264. What a surprise!

# 3 Market Equilibrium

Nicholson asserts that the market equilibrium will occur at the point defined by the intersection of supply and demand ($Q^*$,$P^*$). Why does this make sense? We can use a similar type of argument to that that we used last week to figure out why. Take point $Q'$. Note that at this point, there is at least one consumer who would pay up to $P_d'$ for an additional unit of the good. This is the consumer's *willingness to pay* (WTP). As well, at this point there is at least one supplier who would sell the good for as little as $P_s'$. This is the producer's *willingness to accept* (WTA). Note that the WTP is greater than the WTA by the amount $P_d'$- $P_s'$. (We can also identify this point on the graph.) This amount is called the *gains from trade*. In effect, we can argue that there is an incentive for market activity to continue until the gains from trade reach zero. Notice that where supply equals demand, the gains from trade are exactly zero. *Question:* Can you use a similar argument to convince yourself why a point to the right of $Q^*$,$P^*$ does not make sense as an equilibrium?

We can solve numerically for this market equilibrium by using the fact that the quantity supplied will equal the quantity demanded. Using equations 5 and 11:

$$10 - P = P - 2 \Rightarrow P = 6 \quad (13)$$

Now, we can plug that price ($P^*$) back into either the supply or demand curve to get the equilibrium quantity: $Q^* = 10 - 6 = 4$.

# 4 Gains from Trade and Market Efficiency

Remember, last week we talked about consumer and producer surplus. Both of these are easily visible on our graph. Consumer surplus is the area below the demand curve and above $P^*$, and producer surplus is the area above the supply curve and below $P^*$. From our example above, hopefully we can see how the combination of these two elements represent the gains from trade in this market–the benefits that accrue to consumers and producers from their market interactions. In fact, in this very simple and stylized example, it can be shown that the market equilibrium point $Q^*$,$P^*$ is the allocation of goods that maximizes the possible gains from trade. The implication is that (according to the model) the free market does as well as even the most benevolent dictator. Further, relative to any other quantity outcome, $Q^*$,$P^*$ is a Pareto improvement. *Question:* What does that mean, again? The logic of this argument carries over to much more complex models and forms the heart of many economist's opposition to government regulation. But, as we will review next week, this argument is based on some very restrictive assumptions about how well the market functions, and there are reasons to believe that this model may represent the exception rather than the rule. However, it gives us an excellent baseline from which to build models of what happens when the assumptions don't hold.

We can even use the information that we have to calculate the consumer and producer surplus in this market. Since we are using linear supply and demand curves, it's pretty easy, since the area of each triangle is just half the area of the corresponding rectangle. So, consumer surplus is:

$$CS = \frac{1}{2}(10 - P^*)Q^* = \frac{1}{2}(10 - 6)4 = 8 \tag{14}$$

And producer surplus is:

$$PS = \frac{1}{2}(P^* - 2)Q^* = \frac{1}{2}(6 - 2)4 = 8 \tag{15}$$

# 5 Shifts in Demand

Nicholson notes that the price signal serves two important functions. The first is to signal to producers how much to produce. The second is to ration demand. We can see how this rationing mechanism works through the example of an increase in demand. If for some reason consumers are willing to pay more for a good across the board, the demand curve will shift to the Northeast. Possible causes of the demand shift include increases in consumer incomes, increases in the prices of substitute goods, and a change in consumer preferences. *Question:* Can you think of products that have experienced a recent increase in demand? Why?

Notice that this increase in demand is accompanied by an increase in the equilibrium price of the good. (See Nicholson, figure 8.3). If the price had not risen the total quantity demanded under the new level of demand would have been quite high. This second point is quite important to us, because it implies that prices will accurately reflect the economic scarcity of resources in well-functioning markets. *Question:* What do you think would happen to resource use in the absence of a price signal?

Notice also that the effect of a shift in demand depends on the slopes of the supply curve (this is often referred to as *elasticity of supply*, but for our purposes looking at the slope is sufficient.) If the supply curve is relatively steep, the quantity sold won't change much, but price will go up quite a bit. If the supply curve is relatively shallow, the quantity sold will change a lot, but price won't change much. *Question:* What kind of conditions do you think might be represented by a relatively steep or shallow supply curve? This demonstrates that equilibrium price and quantity are jointly determined by supply and demand, something that took economists many years to figure out.

## 6 Shifts in supply

Similarly, the supply curve may shift outward (to the Southeast) as well, due to a fall in input prices or a technological improvement. This implies that at any given market price, more will be brought to market. *Question:* What impact will an outward shift in supply have on the equilibrium price and quantity? Why does this make sense?

The impact of an outward shift in supply will also depend on how steep the demand curve is (again, *elasticity* of demand). If the demand curve is relatively shallow, the quantity will increase a lot, and price will go down just a bit. If demand is relatively steep, quantity won't increase much, but price will fall a lot. *Question:* What kind of conditions might be represented by a relatively steep demand curve? Can you think of examples?

## 7 An exercise

Now I'll let all of you try an example. Assume that, as in Nicholson, the market demand curve shifts up to $Q^d = 12 - P$. Answer the following questions:

1. Graph the new demand curve along with the old supply curve
2. Label the old equilibrium price and quantity on your graph. Where will the new equilibrium lie in relation to this?
3. Find the new equilibrium price and quantity
4. Calculate the new consumer and producer surplus. How to they compare to the old numbers?