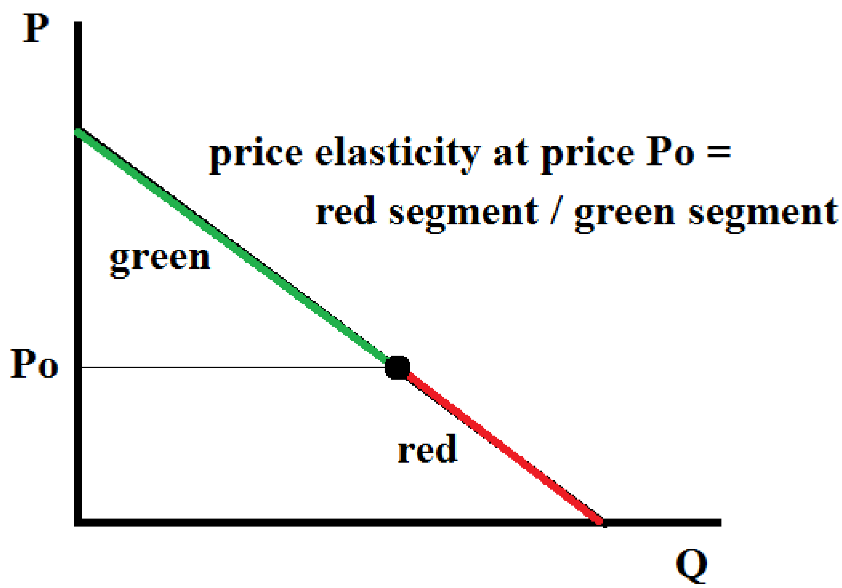
Chapter 3

Elasticity and Its Uses

This chapter is concerned with quantifying the responsiveness of demand or supply to changes in prices and income. For example, with price elasticity, we ask how that an x% change in the price of a good will cause a y% change in the quantity demanded of the good. The elasticity is then defined as y/x. Thus, if a 10% change in the price of a particular good causes a 5% reduction in the quantity demanded for that good, we say that the **point price elasticity** is 5/10 = 1/2. A price elasticity less than 1 is said to be inelastic.

For linear demands, it is relatively easy to determine the price elasticity of the demand at a particular price. The figure below shows how we can calculate the price elasticity at any point on the demand curve. The elasticity is just equal to the red divided by green segments of demand.

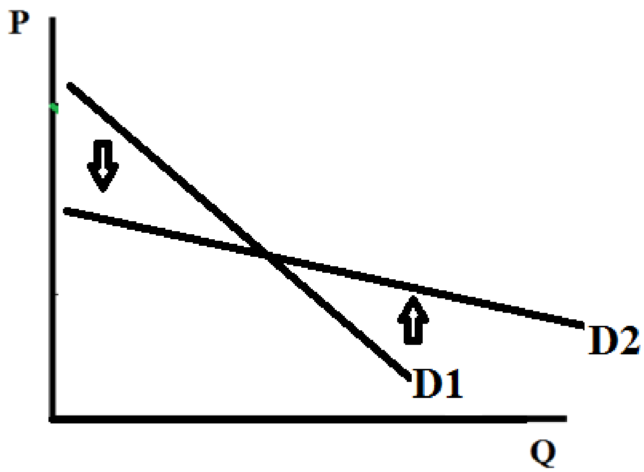



In the figure above, the price elasticity is clearly less than 1 and we can say that at $P_o$ the demand is inelastic. There is not much response of the quantity demanded to changes in the price. Unitary elasticity occurs at the midpoint of the demand. At that price, the red segment and the green segment have equal lengths. It will be useful for you to spend some time thinking about elasticity along the demand curve. So, it should be clear that as one moves from the lower right corner of the demand up to the upper left corner of demand the elasticity changes from 0 to positive infinity. In short, elasticity increases monotonically up along the demand curve.

Some students may wonder how elasticity can be calculated if the demand curve is not linear. This is a rather easy question to answer. One merely draws a straight line *tangent* to the curvy demand at the chosen price and then use the tangent line to calculate the elasticity at that price using the method described in the previous paragraph.

The point price elasticity changes when a demand shifts right or left. Once again, using a linear demand it is not difficult to see that the price elasticity falls at all positive prices when the demand curve shifts right (increases) and rises at all positive prices when the demand curve shifts left (decreases).

An interesting case occurs when the demand curve tilts as is shown in the following diagram




This is what we might expect if there was sudden increased competition in the market for this good since even as small change in price now generates a very large change in the quantity demanded. Can we say anything about the point price elasticity at every price for this good? To answer this, let's begin with a demand function

$$Q = \alpha - \beta P \text{ (demand)} \quad \text{or} \quad P = \frac{\alpha}{\beta} - \frac{Q}{\beta} \text{ (inverse demand)}$$

The definition of the point price elasticity is

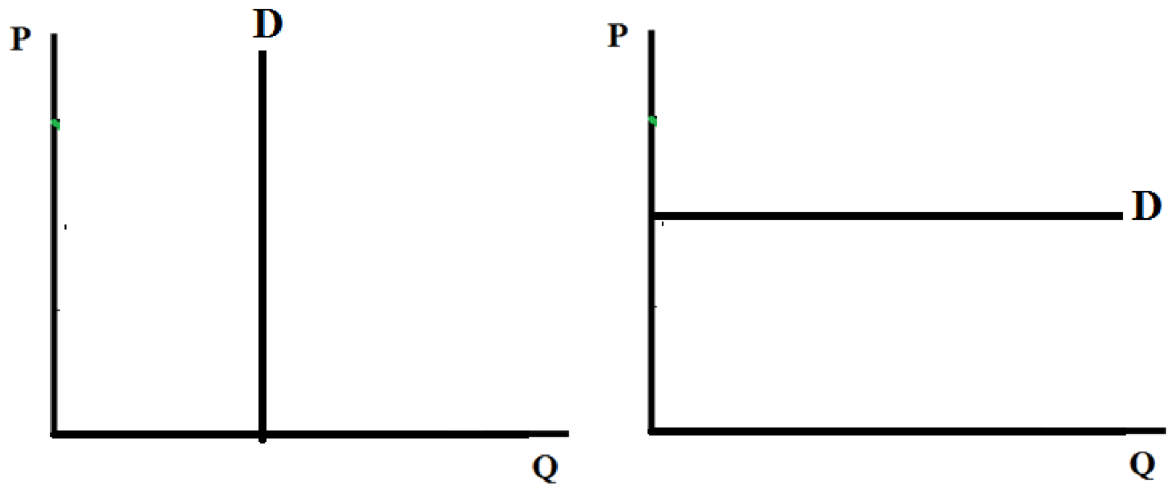
$$\varepsilon \equiv -\frac{\Delta Q}{\Delta P}\frac{P}{Q}$$

And, this can be computed very quickly as

$$\varepsilon \equiv \frac{P}{\frac{\alpha}{\beta} - P}$$

Now to get the tilt required we need $\alpha$ to increase, but $\beta$ to increase even more. This reduces the denominator of elasticity for any given price, and thus elasticity increases at all prices. This is important because it says that increased competition will generate a higher point price elasticity of demand.

There are two extreme cases of demand price elasticity. These are shown in the figure below

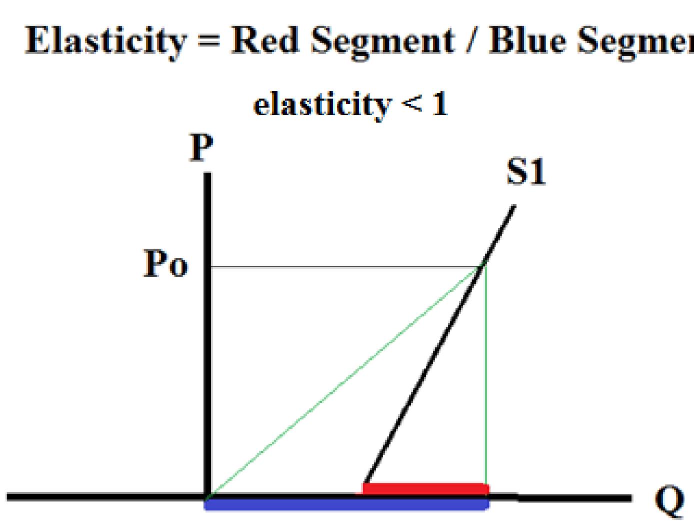



One of these demand curves has an infinite elasticity while the other has a zero elasticity. See if you can explain which is which.

Price elasticity extends to supply also. The interpretation is the same. Elasticity of supply measures the responsiveness of the quantity of supply to changes in the price. Like the elasticity of demand it is somewhat easy to see how to calculate supply elasticity using linear supply. The supply elasticity is also defined as

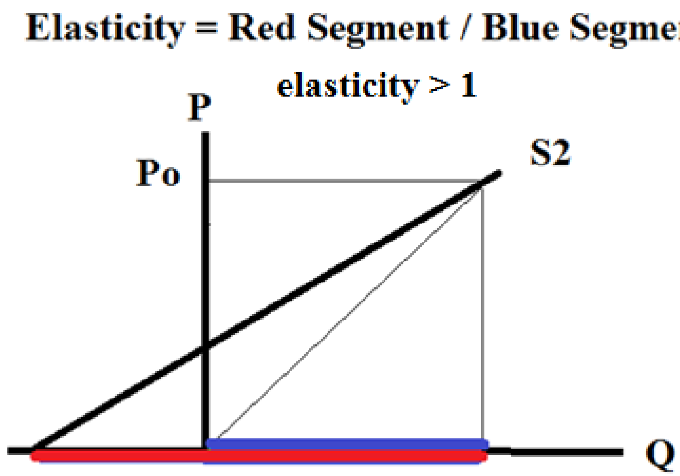
$$\varepsilon \equiv \frac{\Delta Q}{\Delta P}\frac{P}{Q}$$

where the Q refers to the quantity supplied. Note there is no minus sign in front.



The elasticity of the supply at $P_o$ is the ratio of the red segment to the blue segment. In the above figure, at what price would the elasticity become zero?

$$\varepsilon \equiv \frac{\Delta Q}{\Delta P}\frac{P}{Q}$$




The elasticity of the supply at $P_o$ is the ratio of the red to the blue segment. It is obviously greater than one in the figure. In the above figure, at what price would the supply elasticity become infinite?

From the above two figures it should be easy to construct the case where the supply curve has unit elasticity at every price.

How can we *use* elasticity? One of the most common ways it is used is to discuss who bears the burden of a sales tax (i.e. who pays more of the tax the sellers together or the buyers together). To discuss this, we need a market. We will see that the burden affects consumers more in some markets and producers or sellers more in other markets. The key determinant is the size of the demand and supply price elasticities. You can see a very fine analysis here.

(P1) Calculate the price elasticities at P = 20 and P = 80, given the demand $Q = 100 - 30P$

(P2) See if you can create an **Income Elasticity** of demand formula.

(P3) See if you can create a **Cross Price Elasticity of Demand** using $Q_1$ = quantity of good 1 and $P_2$ = Price of good 2.

(P4) You can define elasticity for any two sets of positive numbers. How would you define the elasticity of X with respect to percentage changes in Y, where both X and Y are positive?

(P5) If you have observations on only two points of demand or supply (price, quantity) = (P,Q) then you can calculate the arc-elasticity defined as

$$\bar{\varepsilon} \equiv -\frac{\Delta Q / \bar{Q}}{\Delta P / \bar{P}}$$

Do this now for the points (10, 200) and (12, 180) -- be approximate.

(P6) Consider the two good indifference curve-budget constraint description of equilibrium. Now let income change from one level to another. Let income increase again, and yet again. Draw a picture of the set of equilibrium points in ($X_1$ , $X_2$) space that the changes in income generate. This curve is called an **Engel Curve**. Show that the income elasticities of demand for $X_1$ and $X_2$ can be calculated using this curve.

(P7) Why is it important that income and other *ceteris paribus* variables do not change when we compute the price elasticity of demand?

(P8) What factors would tend to affect the price elasticity of demand?

(P9) Explain the relevance of the price elasticity of demand to changes in total revenue, PQ.

(P10) What factors would tend to affect the price elasticity of supply?