CHAPTER 2 LECTURE – DEMAND AND SUPPLY ANALYSIS

In a market-oriented economy, the majority of price and output decisions are determined in the market through the forces of Demand and Supply.

A. DEMAND

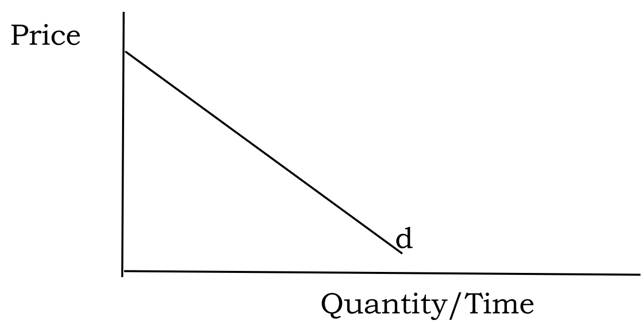
QUANTITY DEMANDED is the amount of a good that consumers are willing to purchase at each price per unit of time. The number of bottles of soda, for example, that an individual will buy per month is Q_d, or the quantity demanded of bottles of soda.

The amount of a good that consumers are willing to buy will depend on factors such as price of the good itself, the income level of the consumer, tastes or preferences for the good, price of substitute good (ex. coffee versus tea) or price of complements (cameras and film), number of buyers, etc.

The demand function is generally expressed as:

$Q_d = Q_d$ (Price, Income, Tastes or Preferences, Price of Substitutes and Complements, Number of Consumers)

Demand Curve for Bottles of Soda



The demand curve above shows the different quantities of bottles of soda that will be purchased at various prices per time period, holding the other factors that effect demand constant (ceteris paribus).

Notice that as the price of the good falls, more of the good will be purchased (ceteris paribus).

SUMMARIZING:

LAW OF DEMAND: As the price of the good rises ($P\Uparrow$), the quantity demanded of the good falls ($Q_d \Downarrow$) and as the price of the good falls ($P\Downarrow$), the quantity demanded of the good rises($Q_d \Uparrow$), holding all other factors constant or ceteris paribus.

An easy way of writing the law of demand is:

As $P \Uparrow \Rightarrow Q_d \Downarrow$ and as $P\Downarrow \Rightarrow Q_d\Uparrow$, ceteris paribus

We have specifically noted that various factors other than the price of the good itself will also determine the amount of a good demanded. For a given demand curve the movement along a demand results from a change in the price of the good and assumes other factor remain constant. However, if one of the other factors change, more or less of the quantity of a good will be demanded at a given price. Thus, a change in one of these factors will cause a shift of the demand curse either left or right, rather than a movement along the demand curve.

CHANGE IN QUANTITY DEMANDED - The movement along the demand curve resulting from a change in the price of the good. This holds all other factors constant.

CHANGE IN DEMAND - A shift in the demand curve resulting from a change in a factor other than the price of the good itself.

Major factors that shift the demand curve or cause a **Change in Demand** include:

1). Change in Income

a). Normal Good - I $\Uparrow \Rightarrow$ D$\Uparrow$ b). Inferior Good - I $\Uparrow \Rightarrow$ D $\Downarrow$

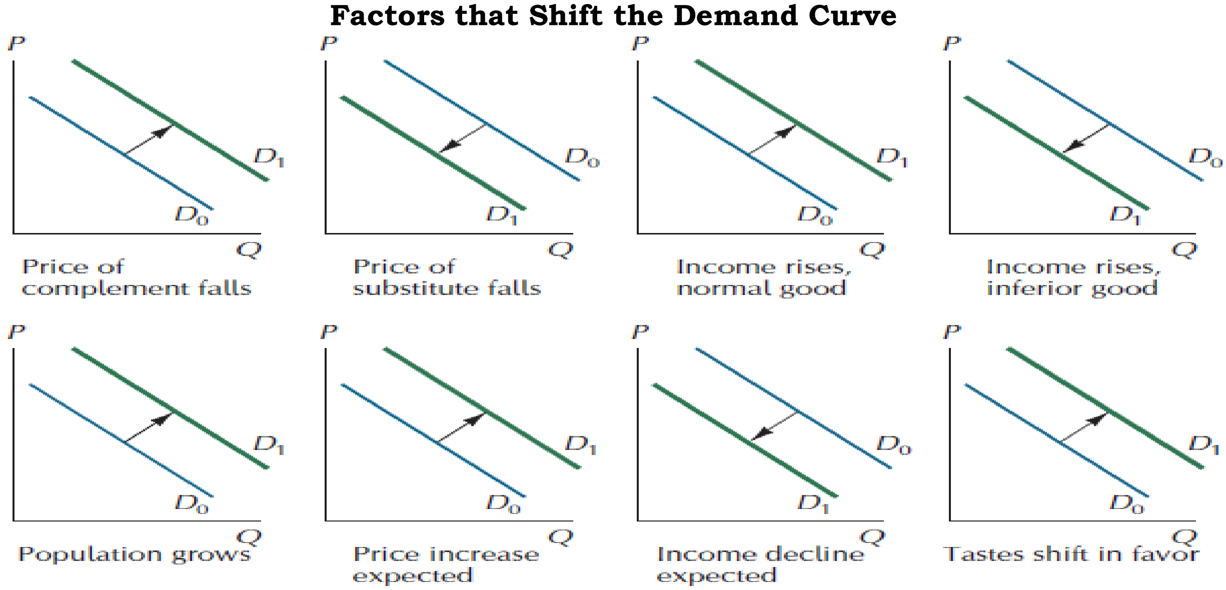
2). Changes in Tastes or preferences

T $\Uparrow \Rightarrow$ D $\Uparrow$ and T $\Downarrow$ $\Rightarrow$ D $\Downarrow$

3). Substitutes - Price of substitute good rises - Demand for good rises.
Price of substitute good falls - Demand for good falls

4). Complements - Price of complementary good rises - Demand for good falls.
Price of complementary falls - Demand for good rises.

Factors that Shift the Demand Curve

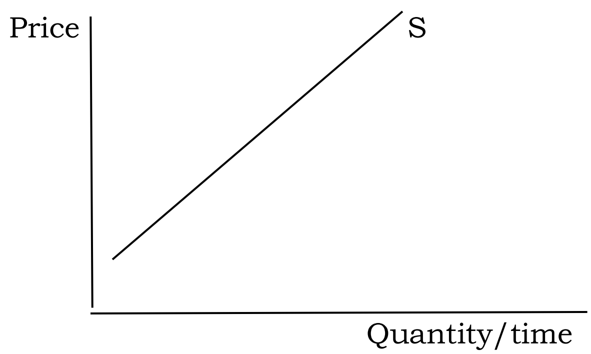


B. SUPPLY

QUANTITY SUPPLIED is the amount of a good that firms want to produce at each price per unit of time. The number of bottles of soda, for example, that the beverage manufacturer will produce per month is Q_s, or the quantity supplied of bottles of soda.
The amount of a good that firms will produce will depend on such factors as the price of the good itself, the price of inputs used to produce the good, the level of technology, and the number of firms.

The supply function is generally expressed as: Q_s = Qs (Price, Price of Inputs, Technology, Number of firms)

Supply Curve for Bottles of Soda



The supply curve above shows the different quantities of bottles of soda that will be produced or made available for sale at various prices per time period, holding the other factors that effect supply constant (ceteris paribus).

Notice that as the price of the good rises, more of the good will be produced (ceteris paribus).

SUMMARIZING:

LAW OF SUPPLY: As the price of the good rises ($P\Uparrow$), the quantity supplied of the good rises ($Q_s\Uparrow$) and as the price of the good falls ($P\Downarrow$), the quantity supplied of the good falls ($Q_s \Downarrow$), holding all other factors constant or ceteris paribus.

An easy way of writing the law of supply is:

As $P \Uparrow \Rightarrow Q_S \Uparrow$ and as $P \Downarrow \Rightarrow Q_S \Downarrow$, ceteris paribus

Just as there was a difference between a change in quantity demanded and a change in demand, we can distinguish between a change in quantity supplied and a change in supply.

CHANGE IN QUANTITY SUPPLIED - The movement along the supply curve resulting from a change in the price of the good. This holds all other factors constant.

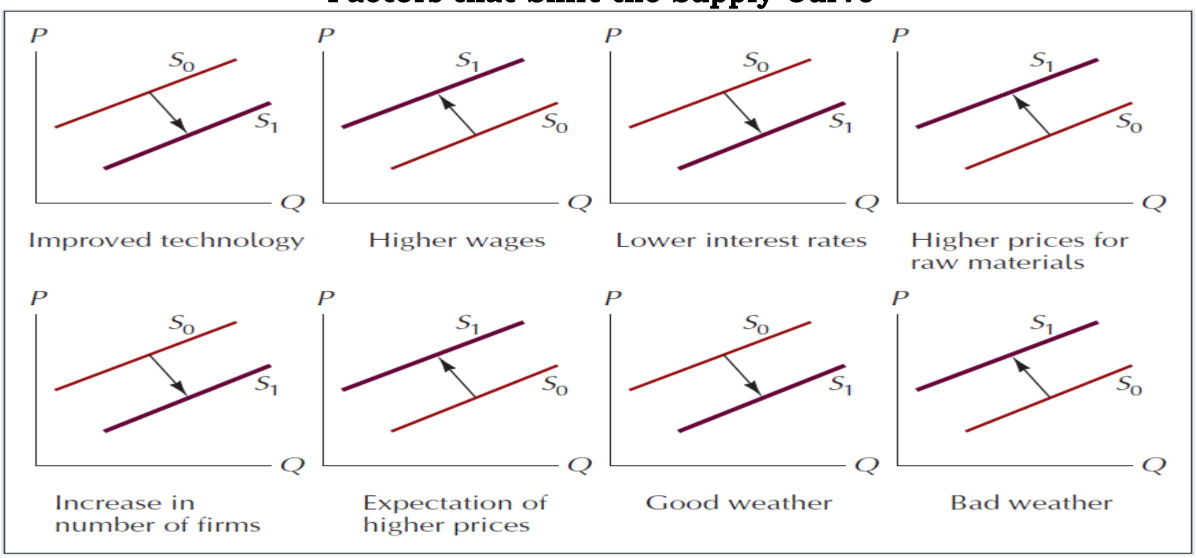
CHANGE IN SUPPLY - A shift in the supply curve resulting from a change in a factor other than the price of the good itself.
Major factors that shift the supply curve or cause a **Change in Supply** include:

1). Price of Inputs
Price of Inputs $\Uparrow \Rightarrow S \Downarrow$ Price of Inputs $\Downarrow \Rightarrow S\Uparrow$

2). Technology
Tech $\Uparrow \Rightarrow S\Uparrow$ Tech $\Downarrow \Rightarrow S\Downarrow$

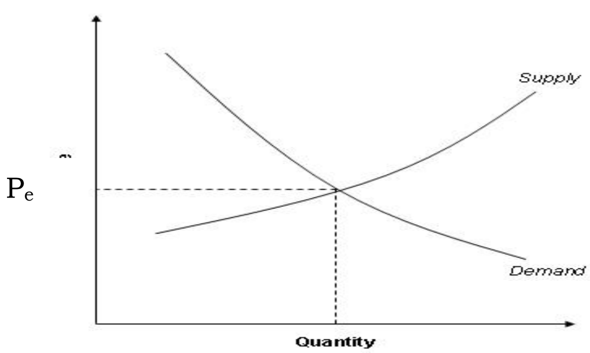
3). Number of Firms Number of Firms $\Uparrow \Rightarrow S\Uparrow$ Number of Firms $\Downarrow \Rightarrow S\Downarrow$

Factors that Shift the Supply Curve



C. SYNTHESIS OF DEMAND AND SUPPLY

The two forces of supply and demand determine equilibrium price and quantity.



At P_e $Q_d = Q_s$

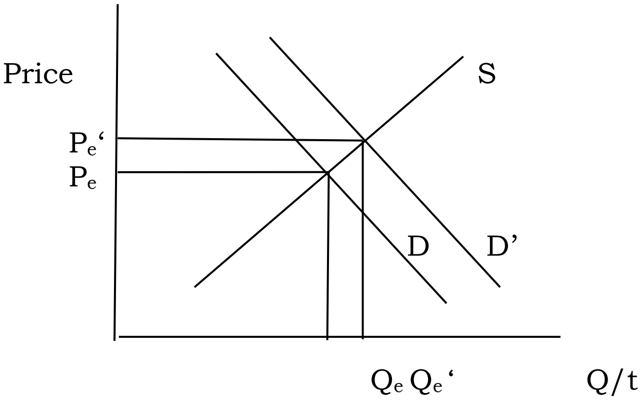
If $P < P_e$ $Q_d > Q_s$ Shortage
If $P > P_e$ $Q_s > Q_d$ Surplus

There is no guarantee that market prices will always be at equilibrium level. Actual or markets prices may differ.

Once the market is in equilibrium, there is no tendency for prices to change, unless a factor affecting the demand or supply curve changes. Should such a change occur, the market moves to a new equilibrium price and quantity.

Looking at Changes in Demand and Supply

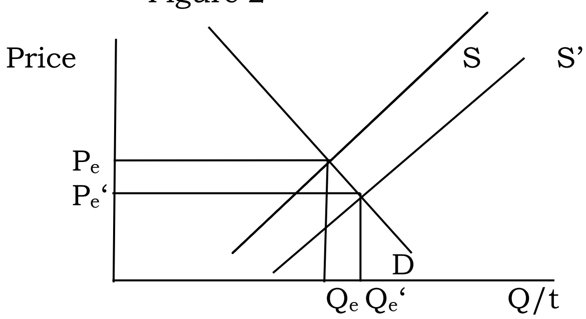
Figure 1



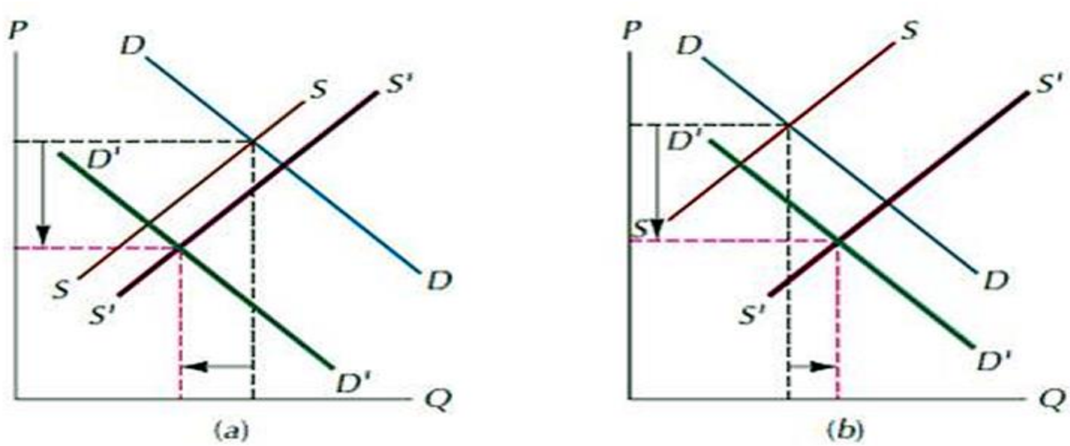
SUMMARIZING:

Increase in demand: D $\Uparrow$ $\Rightarrow$ $P_e \Uparrow$ and $Q_e \Uparrow$
Decrease in demand: D $\Downarrow$ $\Rightarrow$ $P_e \Downarrow$ and $Q_e \Downarrow$
Increase in supply: S $\Uparrow$ $\Rightarrow$ $P_e \Downarrow$ and $Q_e \Uparrow$
Decrease in supply: S $\Downarrow$ $\Rightarrow$ $P_e \Uparrow$ and $Q_e \Downarrow$

Figure 2



You can give examples of changes in both Supply and Demand at the same time.



Rationing function of price: the process whereby price directs existing supplies of a product to the users who value it most highly.

Allocative function of price: the process whereby price acts as a signal that guides resources away from the production of goods whose prices lie below cost toward the production of goods whose prices exceed cost.

Supply and Demand - A Mathematical Approach (We can use Q or q)

Supply-Demand Equilibrium Example:

$Q_d = 1000 – 100P$ $Q_S = -125 + 125P$

Equilibrium ⇒ $Q_d = Q_S$ $1000 – 100P = -125 + 125P$ or $225P = 1125$

$P^* = 5$ $Q^* = 500$

Shifts in Supply-Demand Equilibrium Example

What happens to the equilibrium price if either demand or supply shift?

A shift in demand will lead to a new equilibrium:

Original Supply and Demand

$Q_d = 1000 – 100P$ $Q_S = -125 + 125P$

New Demand

$Q'_d = 1450 - 100P$ $Q'_d = 1450 - 100P = Q_S = -125 + 125P$

or $225P = 1575$ $P^* = 7$ $Q^* = 750$

Sometimes we use the inverse demand and supply functions. That is, Price= f(Q).

Suppose we have the demand curve $Q_d = 20 - P$

The inverse demand function is $P= 20 - Q_d$

Suppose we have the supply curve $Q_s = -8 + P$

The inverse supply function is $P= 8 + Q_s$

If we solve original equations, in equilibrium we know that $Q_d = Q_s$, we arrive at:

$20 - P = -8 + P$ or $2P = 28$ or $P^* = 14$

Substituting this back into either the supply or demand equation gives the equilibrium quantity of $Q^* = 6$

Solving using the inverse functions: $20 - Q_d = 8 + Q_s$ Since $Q_d = Q_s$

$2Q = 12$ or $Q^* = 6$ and solving for P, $P^* = 14$.

A more general model of Demand and Supply is:

Demand: $q_D = a - bp$ Supply: $q_S = c + dp$

Equilibrium ⇒ $q_D = q_S$

$$a - bp = c + dp$$

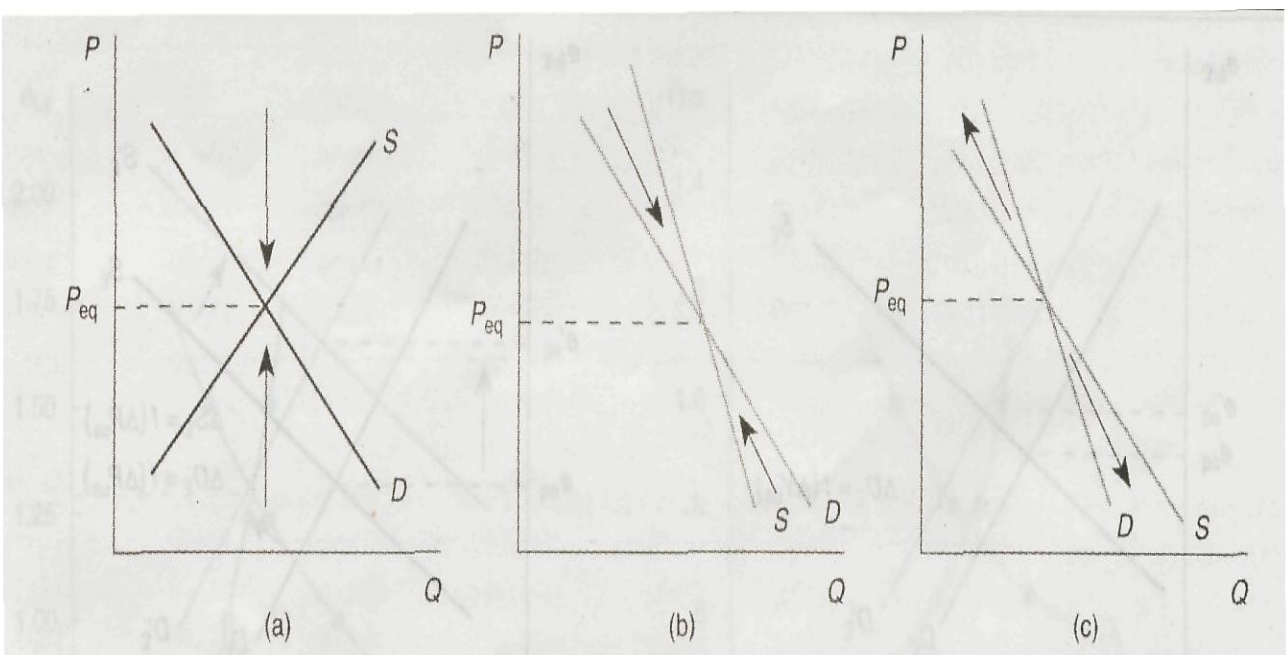
$$p^* = \frac{a-c}{d+b}$$ You can solve for q.

What happens to the equilibrium price if either demand or supply shift?

- An increase in demand (an increase in *a*) increases equilibrium price
- An increase in supply (an increase in *c*) reduces price

$$\frac{dp^*}{da} = \frac{1}{d+b} > 0 \qquad \frac{dp^*}{dc} = \frac{-1}{d+b} < 0$$

We Can Look at Stable and Unstable Equilibrium



More on Demand Functions

A demand curve for X can be written as follows, $Q_d = f(P_x, P_{other\ goods}, I, T)$ where I is for income and T is other facts such as tastes. This simply states that the quantity demanded is a function of the variables in the brackets.

So for a typical demand curve, all these other variables are constant -- only P_x changes along the curve.

The following equation could be a demand curve:

$$Q_d = 800 - 6P_x - 5P_y + 10I$$

How do we interpret this? **What does the "negative sign" tell us?**

Well, it tells us the slope and that this is indeed a demand curve because the law of demand says there is an inverse relationship between quantity demanded and price.

What does the negative sign in front of P_y tell us?

It means that if the price of a related good goes up then the demand for X goes down. Therefore, this good must be a **complement** (like beer and peanuts. If it was a positive then the goods would be substitutes (like different kinds of beer).

What does the positive sign in front of income tell us?

It means that if income goes up, then demand for X goes up -- therefore it is a normal good. If it were negative, then it would be an inferior good.

We can also show supply functions in as similar way. ***Give some examples***.

ELASTICITY OF DEMAND AND SUPPLY

ELASTICITY can be defined as a measure of responsiveness. We want to examine how a change in one variable affects a change in another.

Price elasticity of demand is defined as the percentage change in quantity demanded with respect to a percentage change in the price of the good.

The symbol often used to denote price elasticity of demand is E_d even though the text uses € (epsilon). E_d is easier to write so we can us E_d. Other texts may different symbols – Economists are not consistent). We will use the following formula for price elasticity of demand: We keep in mind that $Q = Q_d$

$E_d = \frac{\%\Delta Q}{\%\Delta P} = \frac{\Delta Q}{\Delta P} x \frac{P}{Q}$ or if we use calculus we can define elasticity as

$E_d = \frac{dQ}{dP} x \frac{P}{Q} = \frac{\partial Q}{\partial P}\frac{P}{Q}$. We will look at using this formula a little later.

Some books put a negative sign in front of the equation or take the absolute value. Thus, the value of elasticity always becomes positive. Some books do not consider the absolute value and treat elasticity as negative. **BE AWARE OF HOW ELASTICITY IS DEFINED**.

Notice that the value of the price elasticity of demand includes the reciprocal of the slope of the demand function, $\Delta P/\Delta Q_d$. The value of the slope of the demand function is a factor affecting the value of the elasticity. However, the values are not the same.

Remember, in principles we generally looked at the arc elasticity, taking the average between to points. We defined arc elasticity as:

$$E_d = \frac{\Delta Q}{\Delta P} x \frac{P^*}{Q^*} \quad \text{where } P^* = \frac{P_1 + P_2}{2} \quad \text{and} \quad Q^* = \frac{Q_1 + Q_2}{2}$$

Using a little bit of algebra, the formula above reduces to:

$$E_d = \frac{\Delta Q}{\Delta P} x \frac{P_1 + P_2}{Q_1 + Q_2}$$

If we have a straight-line demand curve, we can use determine elasticity at a particular point.

Let Q = 10 – 2P   What is the value of the elasticity at P= 2?

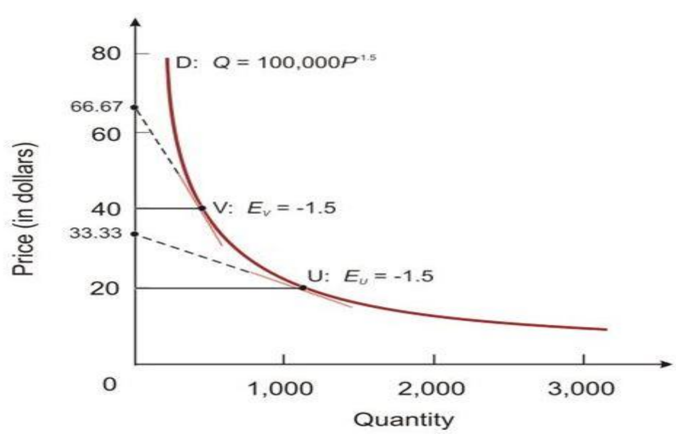
Solving for $\frac{dQ}{dP}$ we obtain $\frac{dQ}{dP}$ = -2, and at P= 2, Q = 10 – 2 (2) = 6.

Thus, $\frac{dQ}{dP} x \frac{P}{Q}$ = $(-2) x \frac{2}{6} = -0.67$

Special Case of a constant price elasticity demand curve

Let $Q = aP^{-b}$ or $Q = \frac{a}{P^b}$ a and b are constants

$\frac{dQ}{dP} = -baP^{-b-1}$ If P = P, $Q = \frac{a}{P^b}$ Thus, $E_d = (-baP^{-b-1})\frac{P}{aP^{-b}} = -b$



If the demand function is in logarithmic form, then the coefficient of the variable is the value of the elasticity.

Let Q = $2P^{-3}$ Taking the natural logs of both sides yields ln Q = ln2 – 3ln P

If y = lnx, we know that the derivative of a logarithm is

$$\frac{dy}{dx} = \frac{d\ln x}{dx} = \frac{1}{x} \quad \text{or} \quad d\ln x = \frac{dx}{x} \quad \text{so} \quad d\ln Q = \frac{dQ}{Q} \quad \text{and} \quad d\ln P = \frac{dP}{P}$$

Elasticity is defined as $E_d = \dfrac{\frac{dQ}{Q}}{\frac{dP}{P}} = \dfrac{d\ln Q}{d\ln P}$

From before: ln Q = ln2 – 3ln P $E_d = \dfrac{d\ln Q}{d\ln P} = (\dfrac{d\ln 2}{d\ln P} - 3\dfrac{d\ln P}{d\ln P} + \ln P\dfrac{d\ln -3}{d\ln P}) = (-3) = -3$

Knowing how to calculate the value of the price elasticity of demand is important. What is perhaps more important, however, is understanding what the value of elasticity means and its relationship to the concept of **TOTAL REVENUE**.

TOTAL REVENUE is defined as price times quantity.

We noted before that the value of elasticity indicates the percentage change in quantity with respect to the percentage change in price. Since elasticity is a fraction, the value calculated can be interpreted as the percentage change in quantity with respect to a one percent change in price.

If, for example, E_d = -1.14, a one percent increase in price would cause quantity to fall by 1.14 percent. This can also be interpreted as saying a ten percent increase in price would cause quantity to fall by 11.4 percent.

Elasticity and Total Revenue (TR)

When discussing the price elasticity of demand it is useful to distinguish different ranges of elasticity values.

If $|E_d| > 1$, demand is referred to a being elastic.

If $|E_d| < 1$, demand is referred to a being inelastic.

If $|E_d| = 1$, demand is referred to a being unit or unitary elastic.

Whether demand is elastic, inelastic or unit elastic will determine how a change in price (and the resultant change in quantity) will affect total revenue (PQ).

a) If $|E_d| > 1$, or demand is elastic, a decrease in price will increase the value of total revenue. An increase in price will decrease the value of total revenue.
b) If $|E_d| < 1$, or demand is inelastic, a decrease in price will decrease the value of total revenue. An increase in price will increase the value of total revenue.
c) If $|E_d| = 1$, demand is unit elastic, and any change in price will have no effect on total revenue. Thus, total revenue is constant. At the price and quantity in which demand is unit elastic, total revenue is also maximized.

Elasticity and Marginal Revenue (MR)

From above, it was shown that the value of elasticity determines the effect of a price (quantity) change on total revenue. A change in total revenue with respect to a change in quantity is called **Marginal Revenue (MR)**.

Marginal Revenue = $\frac{\Delta TR}{\Delta Q_d} = \frac{dTR}{dQ_d}$ (We will let $Q = Q_d$ so = $MR = \frac{\Delta TR}{\Delta Q} = \frac{dTR}{dQ}$
Deriving the relationship between MR and TR. We know TR = PQ

Look at changes: $\Delta TR = P\Delta Q + Q\Delta P$ $\quad MR = \frac{\Delta TR}{\Delta Q} = P\frac{\Delta Q}{\Delta Q} + Q\frac{\Delta P}{\Delta Q} = P + Q\frac{\Delta P}{\Delta Q}$

Look at the term $\frac{Q\Delta P}{\Delta Q}$. Multiplying by $\frac{P}{P}$ yields $\frac{PQ\Delta P}{P\Delta Q}$

Remembering that $E_d = \frac{\Delta Q}{\Delta P}\frac{P}{Q}$ $\quad MR = P + P(\frac{1}{E_d})$ $\quad MR = P(1 + \frac{1}{E_d})$

This can also be solved be taking the derivative of TR with respect to Q.

$$\frac{dTR}{dQ} = P\frac{dQ}{dQ} + Q\frac{dP}{dQ} \quad = MR = P + Q\frac{dP}{dQ} = P + \frac{Q}{P}\frac{dP}{dQ}P \quad MR = P(1 + \frac{1}{E_d}) \text{ or } MR = P(1 + \frac{1}{E_d})$$

NOW REMEMBER THAT E_d will be negative. Sometimes you will see the use of the absolute values of E_d or $|E_d|$

Substituting into the MR function yields:

If $|E_d| > 1$, $\{(1 + \frac{1}{E_d})\}$ > 0 or $(1 - \frac{1}{|E_d|})$ >0., and MR > 0. As P rises (Q falls), TR falls.

If $|E_d| < 1$, $\{(1 + \frac{1}{E_d})\}$ < 0, or $(1 - \frac{1}{|E_d|})$ <0 and MR < 0. As P rises (Q falls), TR rises.

If $|E_d| = 1$ $E_d = 1$, $\{(1 + \frac{1}{E_d})\}$ = 0, $(1 - \frac{1}{|E_d|})$ =0 and MR = 0. As P rises (Q falls), TR remains constant.

We can also look at the relationships of changes in Price, Price Elasticity and Total Revenue

$$TR = Q_x \bullet P_x.$$

Taking the derivative of the above total revenue equation with respect to price (dTR/dP_x), we obtain the following general functional relation (you can show):

$$dTR/dP_x = Q_x (1 + E_d)$$

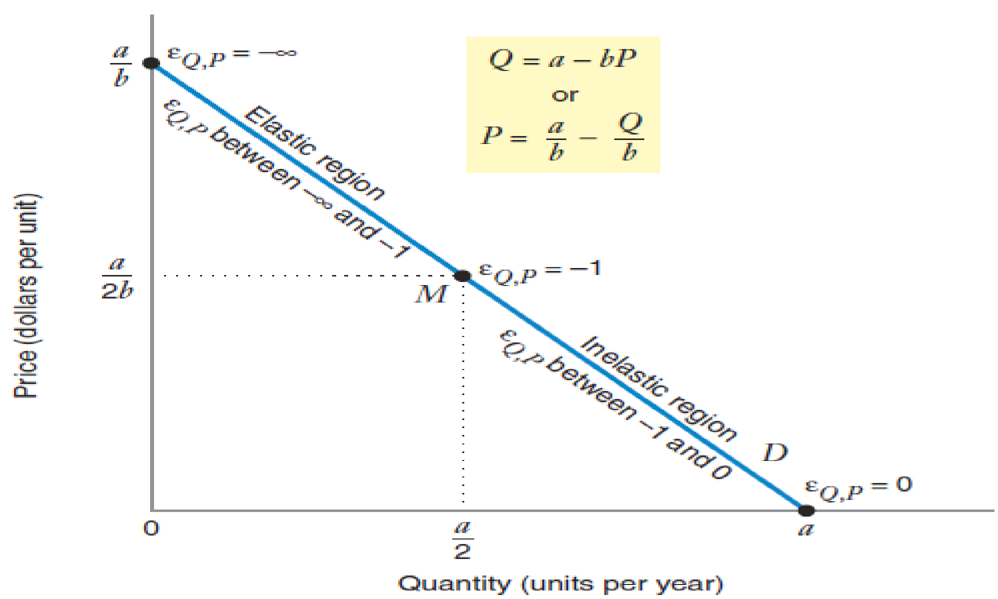
E_d represents the price elasticity of demand. Since E_d is always negative, we can take the absolute value.

$$\mathbf{dTR/dP_x = Q_x (1 - |E_d|)}$$

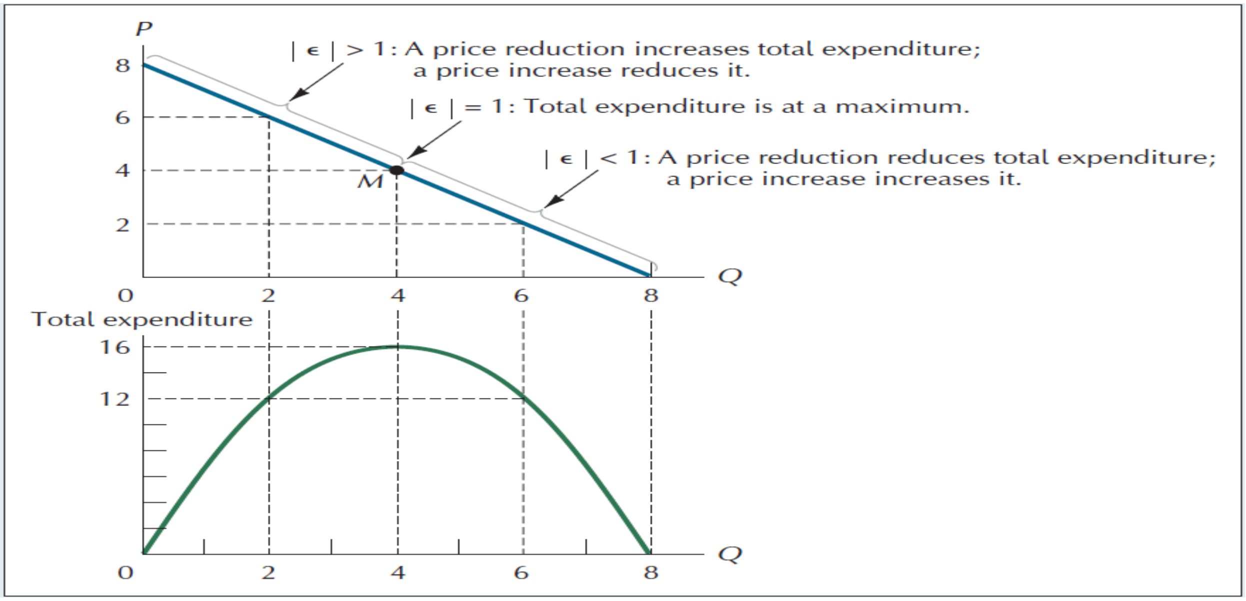
a) If $|E_d| > 1$, then $dTR/dP_x < 0$. In plain English, this says that when demand is price elastic, the relationship between price and total revenue is negative. That is, an increase in price will decrease total revenue and a decrease in price will have the opposite effect on total revenue.
b) If $|E_d| < 1$, then $dTR/dP_x > 0$. Again, in plain English, this says that when demand is price inelastic, the relationship between price and total revenue is positive.
c) If $|E_d| = 1.0$, then $dTR/dP_x = 0$. Thus, a change in price will have no effect on total revenue.

Linear demand curve

If we have a linear demand curve of the form Q = a -bP, then when we can solve for Q and P, we find



Elasticity and Total Revenue (TR) Diagram



Special Cases of Elasticity (You can show the shape of the demand function)

If E_d = - ∞, demand is referred to a being perfectly elastic.

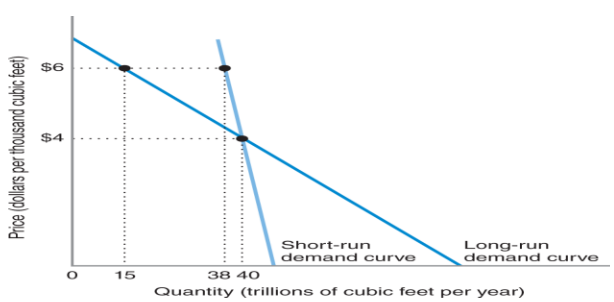
If E_d = 0, demand is referred to a being perfectly inelastic.

NOTE: Although we know that along a (straight line) demand curve the value of elasticity will change, a steep demand curve is often referred to as being relatively inelastic. A flat demand curve is referred to as being relatively elastic.

Factors that affect the price elasticity of demand.

- ***Substitution possibilities:*** the substitution effect of a price change tends to be small for goods with no close substitutes.
- ***Budget share:*** the larger the share of total expenditures accounted for by the product, the more important will be the income effect of a price change.
- ***Direction of income effect:*** a normal good will have a higher price elasticity than an inferior good.
- ***Time:*** demand for a good will be more responsive to price in the long-run than in the short-run.

Price Elasticity Is Greater in the Long Run than in the Short Run



FITTING LINEAR DEMAND CURVES USING QUANTITY, PRICE, AND ELASTICITY INFORMATION

Suppose demand is linear: $Q_d = a - bP$ Hence, elasticity is $\varepsilon_{Q,P} = {}^{-bP}/_{Q}$

If we have data on ε, Q, and P, we can calculate b from elasticity equation and then calculate a by substituting into demand.

Example:

Per capita consumption is 70 pounds – price 70¢ per pound

$$\varepsilon_{Q,P} = -0.55$$

$$\varepsilon = -{}^{bP}/_{Q} \Rightarrow b = -\varepsilon\left({}^{Q}/_{P}\right) = -\left(-.55\left({}^{70}/_{0.7}\right)\right) = 55$$

$$a = Q_d + bP = 70 + .(55 * 70) = 108.5$$
$$Q_d = 108.5 - 55P$$

Other Types of Elasticity

1. Cross price elasticity of demand is defined as the percentage change in quantity demanded of good two with respect to a percentage change in the price of good one.

$$E_{1,2} = \frac{\%\Delta Q_2}{\%\Delta P_1} = \frac{\Delta Q_2}{\Delta P_1} x \frac{P_1}{Q_2} \text{ or } \frac{dQ_2}{dP_1} x \frac{P_1}{Q_2} \text{ or } \frac{\partial Q_2}{\partial P_1} x \frac{P_1}{Q_2}$$

If $E_{1,2} > 0$, goods 1 and 2 are substitutes.

If $E_{1,2} < 0$, goods 1 and 2 are complements.

If $E_{1,2} = 0$, goods 1 and 2 are not related.

2. Income elasticity of demand is defined as the percentage change in the quantity of a good with respect to a percentage change in income.

The symbol commonly used to denote income elasticity of demand is μ, the Greek symbol mu. (Although η (eta) is used by the book). The book also uses Y to represent Income, but M or I are also used.

$$\eta = \frac{\%\Delta Q}{\%\Delta I} = \frac{\Delta Q}{\Delta I} x \frac{I}{Q} \text{ or } \frac{dQ}{dI} x \frac{I}{Q} \text{ or } \frac{\partial Q}{\partial I} x \frac{I}{Q}$$

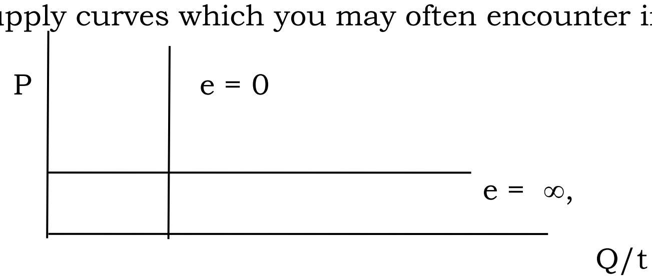
If $0 < \eta \leq 1$, the good is considered a normal good.
If $\eta < 0$, the good is considered an inferior good.
If $\eta > 1$, the good is considered superior

3. Elasticity of Supply is defined as the percentage change in quantity supplied with respect to a percentage change in the price of the good.

The symbol commonly used to denote the price elasticity of supply is the letter e. The formula for elasticity of supply is:

$$e = \frac{\%\Delta Q_s}{\%\Delta P} = \frac{\Delta Q_s}{\Delta P} x \frac{P}{Q_s} \quad \text{or} \quad \frac{dQ_s}{dP} x \frac{P}{Q_s} \quad \text{or} \quad \frac{\partial Q_s}{\partial P} x \frac{P}{Q_s}$$

Supply curves which you may often encounter in economics are:



An example of a good that has a perfectly inelastic supply curve is land. Land is a resource that is in fixed supply and no matter how high price rises output cannot increase.
An example of a resource that has a perfectly elastic supply curve is unskilled labor. Firms can hire all the labor necessary at the going wage rate. In this case, wage is the price of labor and quantity is the amount of labor available.

Range of the Coefficient of Elasticity of Supply: $0 \leq e \leq \infty$

If $e > 1$ then, elastic price elasticity of supply.
If $e = 1$ then, unitary elastic price elasticity of supply.
If $e > 1$ then, inelastic price elasticity of supply.

The elasticity of supply tends to be greater in the long run, when all adjustments to the higher or lower relative price have been made by producers (than in shorter periods of time).

Alternative Market Equilibrium Definitions based on the Price Elasticity of Supply

The definitions are based on the work of Alfred Marshal, who emphasized the time element in competitive price equilibrium.

1. Momentary Equilibrium (Market Period)

Producers are totally unresponsive to a price change. Why? There is no time for producers to adjust output levels in response to the change in price!

Supply is perfectly inelastic; therefore, demand determines price.

2. Short-Run Equilibrium

Firms can respond to the change in market price for the good by increasing the variable input in production. That is to say, produces produce more by using their equipment and/or plants more intensively.

Short-run production function:

$Q = F(K, L)$, where K (capital) is the fixed input and L is the variable input.

Hence, firms are able to increase output in the short-run if they increase their variable (labor) input.

3. Long-Run Equilibrium (or "**Normal Price**")

All inputs are variable; hence, firms can increase their capital stock, e.g., build new plants, and new firms can enter the industry or old ones leave. $Q = F(K, L)$.

4. **Very-Long Run Equilibrium**

Technology is improving, so that for a given amount of capital and labor input more output is forthcoming. The supply curve is becoming more elastic! $Q = T\{Q(K, L)\}$.