CHAPTER
02 Demand, Supply and Equilibrium

- Demand
- Determinants of Demand
- Market Demand
- Supply
- Equilibrium
- Movement in Equilibrium

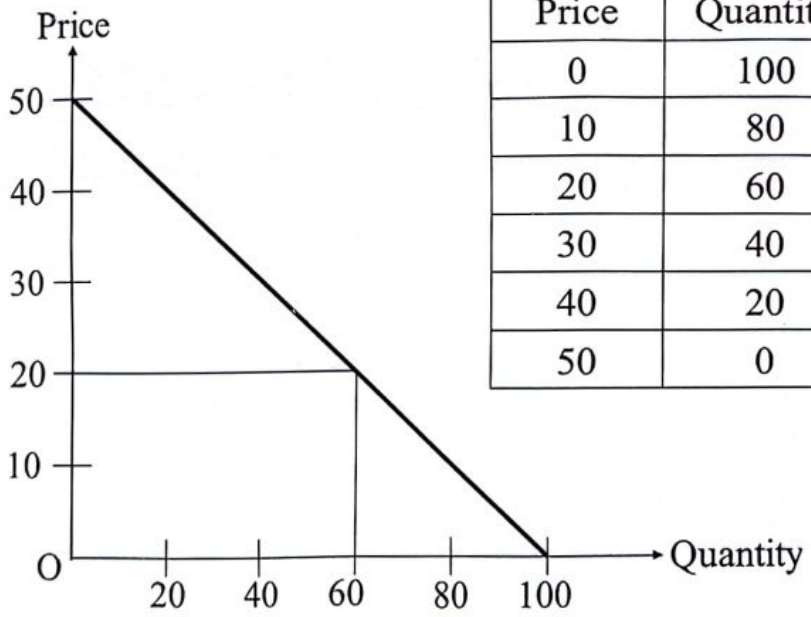
2.1 Demand

The quantity of a good or a service that is purchased by a consumer or the consumer desires to purchase at a certain price is demand. All other things remaining unchanged, a rise in price leads to a fall in quantity demanded and a fall in price leads to a rise in quantity demanded. Such inverse relationship between price and quantity demanded is known as the law of demand.

Demand Curve

Because of the inverse relationship between price and quantity demanded, demand curve slopes downward to the right. Assume a linear demand function $Q = 100 - 2P$, corresponding schedule and graph are sketched below.

Demand Curve



Price	Quantity
0	100
10	80
20	60
30	40
40	20
50	0

Figure- 2.1

2.2 Determinants of Demand

Demand for a good or a service depends on a variety of factors. Own price, other goods' prices and income are considered as the prime determinants of demand.

2.2.1 Own price

All other things remaining unchanged, a fall in own price of a good or a service leads to a rise in its quantity of demand. This inverse relation between price and quantity demanded gives rise to negatively sloping demand curve.

Change in Quantity Demanded

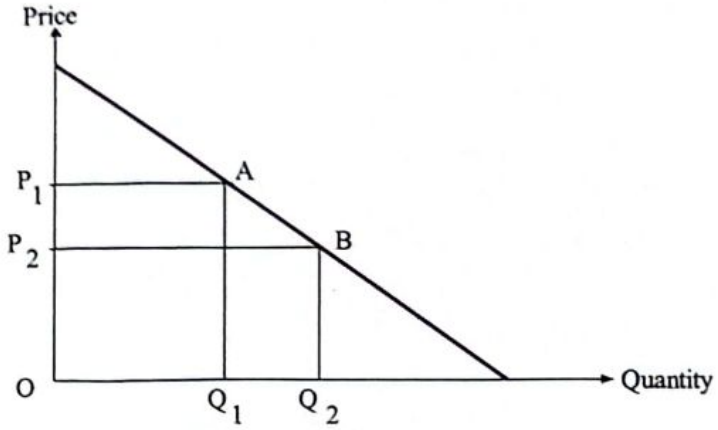


Figure- 2.2

In figure 2.2 a fall in price from OP_1 to OP_2 results in an increase in quantity demanded from OQ_1 to OQ_2. This movement, pertaining to change in own price, occurs along a demand curve- which is called change in quantity demanded.

2.2.2 Price of other goods

Two categories of related goods, e.g., substitutes and complementaries are taken into account. If X and Y are substitutes, a consumer will increase consumption of good X as a reaction to the increase in price of Y. In figure 2.3 quantity demanded for commodity Y drops from Q_{y1} to Q_{y2} following an increase in the price from P_{y1} to P_{y2}. Individual consumer now switches its preference from consumption of Y to X. Consequently, demand for X increases from OX_1 to OX_2. Price of X remaining unchanged at P_0, increase in demand for X is demonstrated through the shifting of demand curve of X from D_1 to D_2. Note that change in consumption of X now takes place through the shifting of entire demand curve.

Impact of Substitute's Price

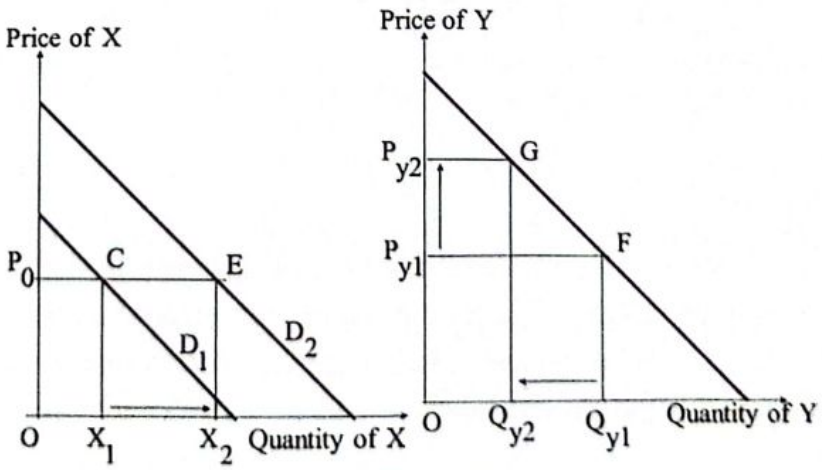


Figure- 2.3

Such change, attributable to the change in price of other goods, is called change in demand rather than change in quantity demanded. What we notice is that an increase in price of a substitute is likely to increase the demand for related good. In case of complementary goods, the reverse will happen.

If X and Z are complementary goods then increase in price of Z will cause a fall in demand for X. For example, fuel is complementarily used with car. Use of car turns out to be expensive if fuel price increases. In the result, demand for car falls following an increase in price of fuel.

Impact of Complement's Price

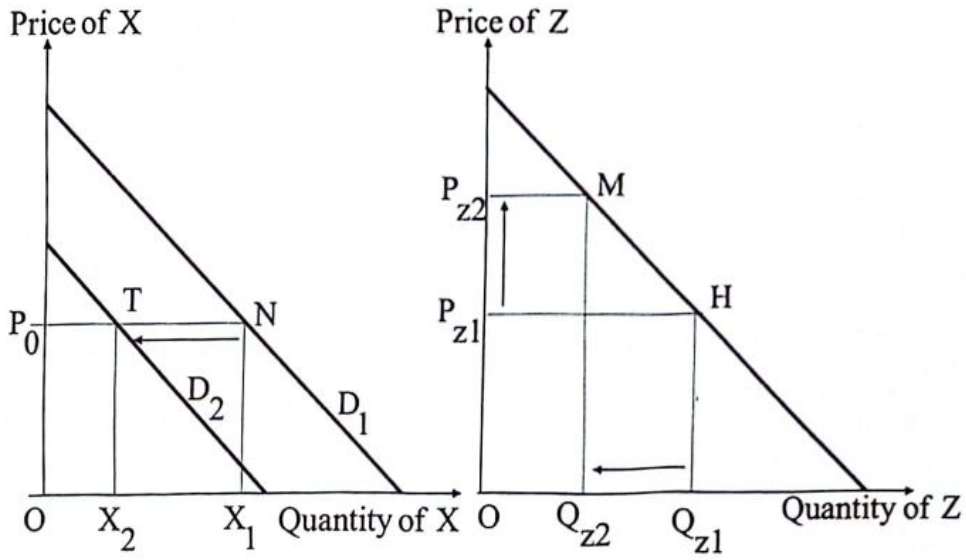


Figure- 2.4

Figure 2.4 illustrates the impact of a rise in price of complementary good Z on demand for X. Demand curve of X shifts leftward from D_1 to D_2 following a rise in price of Z.

2.2.3 Income

Increase in income may cause an increase or decrease in demand for a good depending on the nature of good. An increase in income causes an increase in demand for a normal good and a fall in demand for an inferior good. Demand for an income-neutral good remains unaltered with a change in income.

Impact of Increase in Income

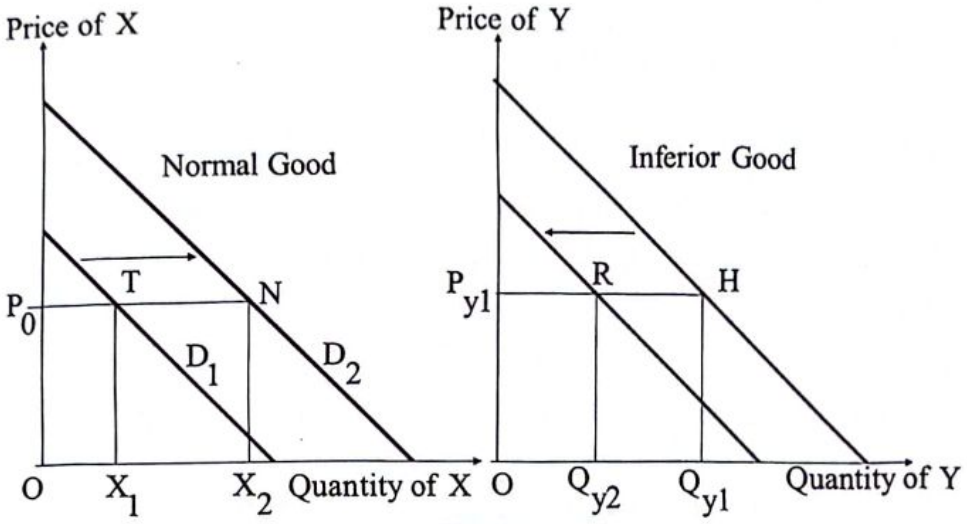


Figure- 2.5

Figure 2.5 describes the cases of normal good and inferior good under the circumstance of an increase in income. Assuming good X normal, demand for X increases from X_1 to X_2 following an increase in income, shifting the demand curve of X rightward from D_1 to D_2. Conversely, Y's demand decreases from Q_{y1} to Q_{y2} with an increase in income as Y is assumed inferior.

Apart from price and income, other factors like taste, weather, political situation etc may influence demand. Continuous rainfall during winter may be responsible for unanticipated increase in demand for umbrella. Cell phone's availability has changed people's taste quite significantly. Unlike early times, individuals are not very eager to have land phone connections. It is a lengthy task to identify all factors influencing demand. Following function may be useful to examine the movement of demand with its prime determinants.

$Q_x = f(P_x, P_y, P_z, M...)$, here M stands for income.

$\frac{\partial Q_x}{\partial P_x} < 0$, which means increase in price of X results in a decrease in the quantity demanded for the good. If X and Y are substitutes then $\frac{\partial Q_x}{\partial P_y} > 0$ because increase in price of Y will motivate the consumer to consume X instead of Y. Similarly, If Z is complementary to X then $\frac{\partial Q_x}{\partial P_z} < 0$ because increase in price of Z will result in a decreased consumption of X together with Z.

$\frac{\partial Q_X}{\partial M}$ may be positive, negative or zero depending on whether good X is normal, inferior or income-neutral.

Example 2.1

Demand for good A, $X_A = 100 - 2P_A + 3P_B - 4P_C + \sqrt{M}$

a) Compute demand assuming $P_A = 10, P_B = 20, P_c = 30$ & $M = 100$
b) Examine the relationship between goods A and C
c) Is good A normal? Why?

Solution

a) Demand for good A, $X_A = 100 - (2 \times 10) + (3 \times 20) - (4 \times 30) + \sqrt{100} = 30$

b) $\frac{\partial X_A}{\partial P_C} = -4 < 0$, i.e., increase in price of C reduces consumption of A, referring complementary relationship between A and C.

c) $\frac{\partial X_A}{\partial M} = \frac{1}{2} M^{-1/2} = \frac{1}{2} \frac{1}{\sqrt{M}} > 0$; This implies an increase in demand for A following an increase in income, hence good A is normal.

2.3 Individual Demand vs Market Demand

The demand for a good or a service created by a single individual is individual demand. Market demand is the sum of all individuals' demand at a certain price. Suppose, there are three individuals A, B and C whose demand curves are shown as D_A, D_B and D_C. Horizontal summation of these demand curves gives rise to the market demand D_M in figure 2.6 below.

Market Demand

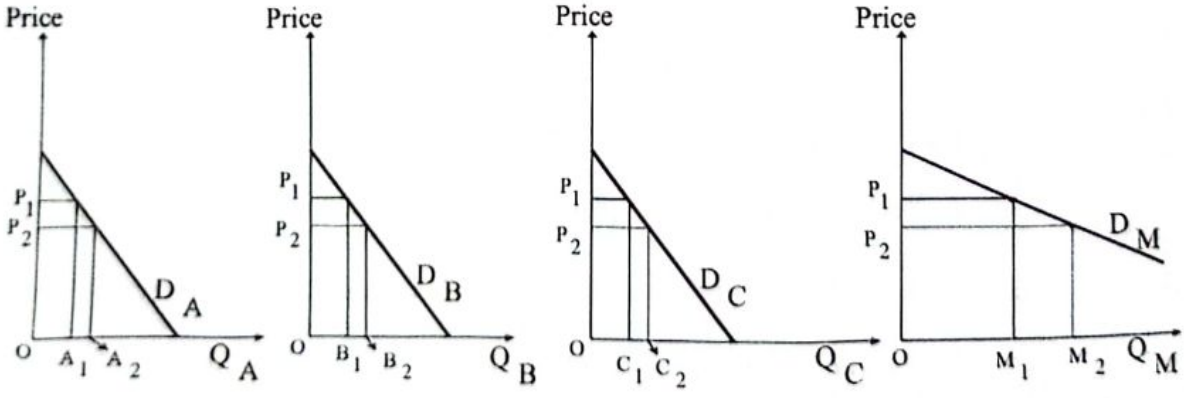


Figure- 2.6

At P_1 price individual A, B and C's quantities demanded are OA_1, OB_1 and OC_1 respectively. Quantity of market demand at this price is $OA_1+OB_1+OC_1= OM_1$. Analogously, quantity of market demand at OP_2 price is OM_2 which is the sum of OA_2, OB_2 and OC_2. Quantity of market demand at every price can be obtained through horizontal summation of individual quantities of demand.

Example 2.2

Individual A, B and C's demands are described by the following three demand functions.

$$Q_A = 20 - 2P$$

$$Q_B = 30 - 3P \text{ and } Q_C = 40 - 4P$$

i. Compute market demand.
ii. Determine the price at which market demand would be zero.

Solution

i. Market demand

$$Q_M = Q_A + Q_B + Q_C = 20 - 2P + 30 - 3P + 40 - 4P = 90 - 9P$$

$$\text{i.e, } Q_M = 90 - 9P$$

ii. Set $Q_M = 0$, which follows

$$0 = 90 - 9P$$

$$or, 9P = 90$$

$$\therefore P = \frac{90}{9} = 10$$

i.e., at 10 units of price market demand would be zero.

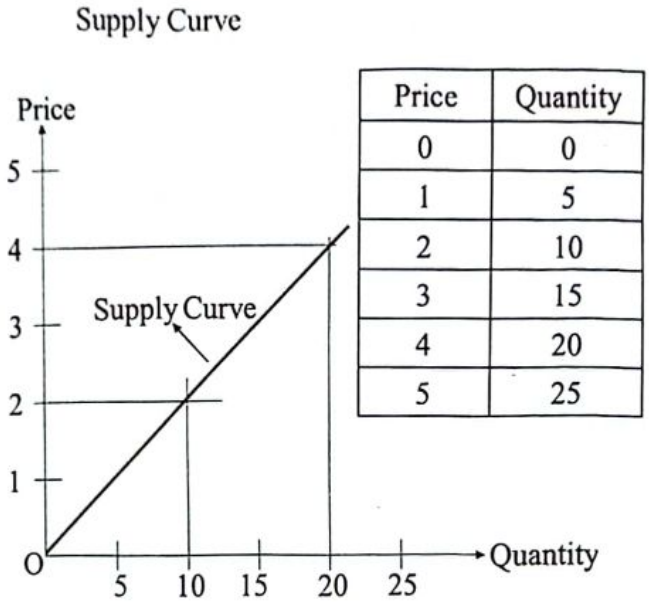
2.4 Supply

The quantity of a good or a service that is sold or ready for sale at a certain price is called supply. Other things remaining unchanged, a rise in price causes a rise in quantity of supply and vice versa, which is known as the law of supply. Because of direct relationship between price and quantity of supply, supply curve slopes upward. In addition to price of a good, input price, technology, weather and many other factors influence the supply of the good.

Example 2.3

Draw the supply curve assuming supply function $Q_S = 5P$

Solution



Price	Quantity
0	0
1	5
2	10
3	15
4	20
5	25

Figure- 2.7

2.5 Determinants of Supply

Among other factors, price of the good, prices of factors of production, technology and weather largely influence supply. Impact of own price is observed through the change in quantity of supply along the supply curve. This change is called change in quantity supplied. Own price remaining unchanged, if factor price changes then supply changes through the shifting of supply curve- which is called change in supply.

Change in Supply

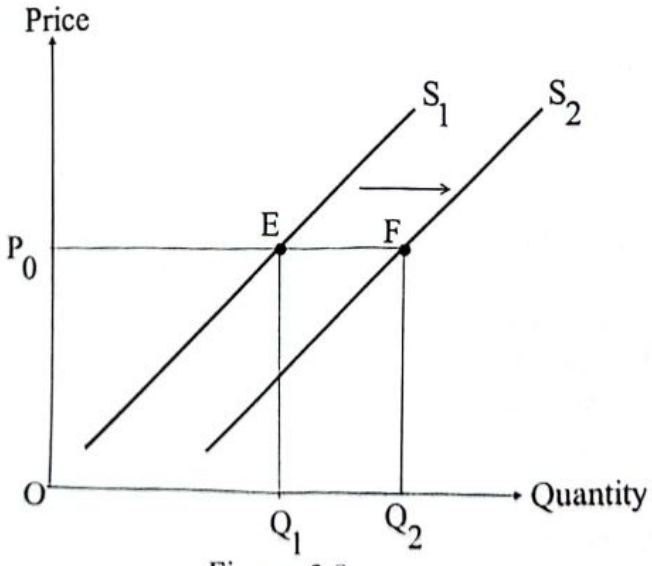


Figure- 2.8

In figure 2.8 amount of supply along S_1 supply curve at P_0 price is OQ_1. If factor price falls, cost of production also falls and business becomes profitable to the producers. As a consequence, supply increases to OQ_2. Supply curve shifts from S_1 to S_2. Such rightward shift in the supply curve may occur due to technological improvement or favourable weather. Conversely, supply curve shifts left due to increase in factor price, technological weakening or unfavourable weather.

2.6 Equilibrium

Equality between quantity demanded and quantity supplied is defined as equilibrium. If quantity demanded exceeds quantity supplied, excess demand will prevail that pushes price up. Excess supply, measured as the quantity of supply over demand, in contrast, drives price down.

Equilibrium

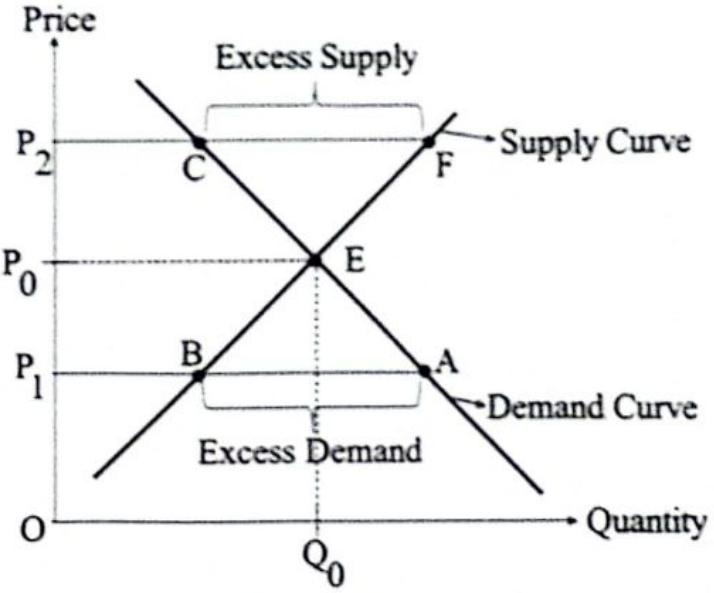


Figure- 2.9

In figure 2.9 demand curve and supply curve intersect at point E which is equilibrium point since quantities of demand and supply are equal at this point. Equilibrium price and quantity are OP_0 and OQ_0 respectively. Any price above P_0 will cause excess supply and below P_0 excess demand. In figure at OP_1 price quantity of demand is P_1A and quantity of supply P_1B. Amount of excess demand is AB. Because of excess demand, price will rise. At OP_2 price quantity of supply is larger than quantity of demand. Amount of excess supply is CF. Because of excess supply, price will fall.

Example 2.4

Assume demand and supply functions

$$Q_d = 20 - 5P$$

$$Q_s = 5P$$

i. Compute equilibrium price and quantity.
ii. Show your results in diagram.
iii. Explain the nature of disequilibrium assuming separate prices above and below equilibrium price.
iv. Compute the impact of a tax at the rate of 1 dollar per unit. What is the amount of tax burden on consumer?

Solution

i. Equilibrium condition

$$Q_d = Q_s$$

$$or,\ 20 - 5P = 5P$$

$$or,\ 10P = 20$$

$$\therefore \quad \overline{P} = 2 \quad \text{, which is equilibrium price.}$$

Setting P = 2 into demand and supply equation,

$$Q_d = 20 - 5P = 20 - 5 \times 2 = 10$$

$$Q_s = 5P = 5 \times 2 = 10$$

Thus $Q_d = Q_s = \overline{Q} = 10$, which is equilibrium quantity.

ii. Figure 2.10 describes market equilibrium

Market Equilibrium

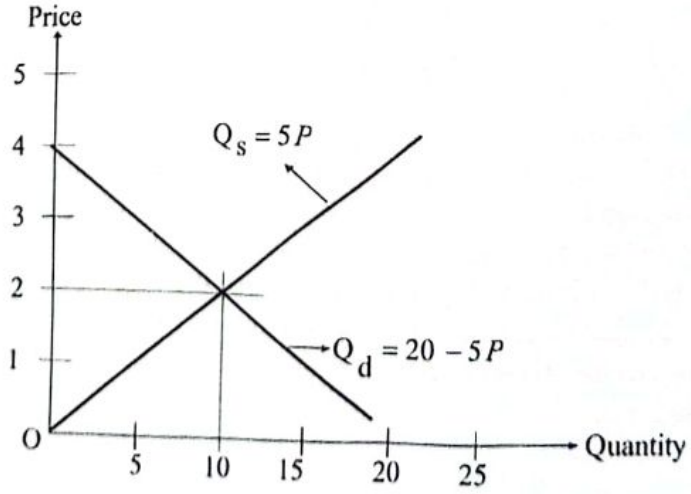


Figure- 2.10

iii. Assume a price above equilibrium

Let P=3, $Q_d = 20 - 5P = 20 - 5 \times 3 = 5$ and $Q_s = 5P = 5 \times 3 = 15$.

The quantity of supply is apparently greater than demand.
Amount of excess supply is 15-5=10 unit.

Assume another price P=1.5 which is below equilibrium price.

In this case $Q_d = 20 - 5P = 20 - 5 \times 1.5 = 12.5$ and $Q_s = 5P = 5 \times 1.5 = 7.5$.

Amount of excess demand equals to 12.5-7.5 = 5 unit.

iv. Imposition of tax alters supply function. Before tax, suppliers used to receive a price equal to P dollar. Upon imposition of tax at the rate of 1 dollar, they receive only (P-1) dollar.

After tax supply function would be: $Q_s^* = 5(P-1) = 5P - 5$.

Equilibrium condition

$$Q_d = Q_s^*$$

$or,\ 20 - 5P = 5P - 5$

$or,\ 10P = 25$

$\therefore \overline{P}^* = 2.5$

Setting this new price into demand and supply equations, equilibrium quantity is computed $\overline{Q}^* = 7.5$.

Imposition of tax increases equilibrium price and decreases quantity. Earlier, consumers had to pay 2 dollars for each unit of the good but now they have to pay 2.5 dollars.

Tax burden on consumer = 2.5 - 2 = 0.5 dollar, which is 50% of total tax per unit.

Example 2.5

i. Solve the following market model.
ii. Examine the impact of a subsidy at the rate of Tk. 1.00 per unit of output.

$D = 40 - P^2$
$S = 1 + 3P$

Solution

i. Equilibrium condition: D = S

or, $40 - P^2 = 1 + 3P$

or, $P^2 + 3P - 39 = 0$

Hints:

If $ax^2 + bx + c = 0$, then

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$\text{or, } P = \frac{-3 \pm \sqrt{3^2 - 4 \times 1 \times (-39)}}{2 \times 1}$$

$$\text{or, } P = \frac{-3 \pm \sqrt{9 + 156}}{2 \times 1} = \frac{-3 \pm \sqrt{165}}{2}$$

$$\text{or, } P = \frac{-3 \pm 12.84}{2} = \frac{-3 + 12.84}{2} \text{ and } \frac{-3 - 12.84}{2}$$

$$\text{or, } P = \frac{9.84}{2} \text{ and } \frac{-15.84}{2}$$

or, $P = 4.92$ (negative price is devoid of economic meaning)

When P = 4.92, D = S = 15.8
Therefore, equilibrium price $\overline{P} = 4.92$ and
equilibrium quantity $\overline{Q} = 15.8$

ii. Supply function after subsidy: $S^* = 1 + 3(P + 1) = 4 + 3P$

Equilibrium condition: D = S*

$$\text{or, } 40 - P^2 = 4 + 3P$$

$$\text{or, } P^2 + 3P - 36 = 0$$

$$\text{or, } P = \frac{-3 \pm \sqrt{3^2 - 4 \times 1 \times (-36)}}{2 \times 1}$$

$$\text{or, } P = \frac{-3 \pm \sqrt{9 + 144}}{2 \times 1} = \frac{-3 \pm \sqrt{153}}{2}$$

$$\text{or, } P = \frac{-3 + 12.37}{2} = \frac{9.37}{2} = 4.68$$ (only positive price considered)

At P = 4.68, D = S* = 18.04

We observe that a grant of subsidy lowers price and boosts quantity.

2.7 Movement in Equilibrium

Factors influencing demand or supply will cause a corresponding change in equilibrium. Figure 2.11 displays the change in equilibrium due to an increase in income.

Change in Equilibrium through Change in Income

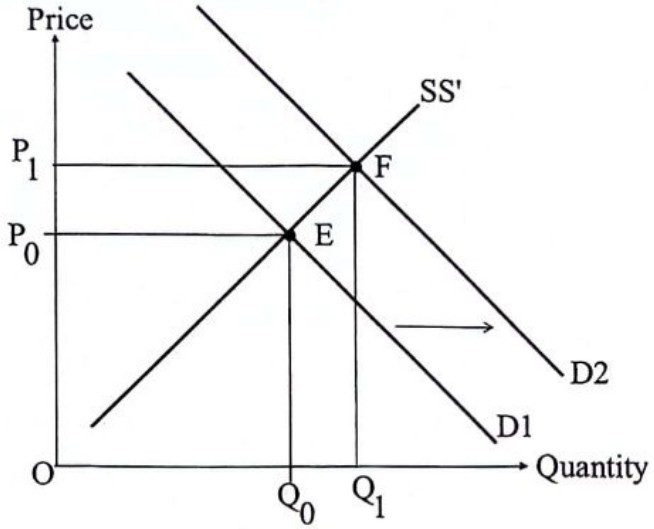


Figure- 2.11

Demand curve D_1 intersects supply curve SS' at point E. Initial equilibrium price and quantity are OP_0 and OQ_0 respectively. Increase in income causes an increase in demand from D_1 to D_2. New equilibrium point is F. Equilibrium price and quantity are P_1 and Q_1 respectively. An increase in income results in an increase in both equilibrium price and quantity. Here the good is assumed normal. In case of inferior good, demand curve shifts left.

Figure 2.12 illustrates the change in equilibrium via change in supply. Suppose an unfavourable rainfall occurred that adversely affected supply, causing a leftward shift in supply curve from S_1 to S_2. Equilibrium price increases and quantity decreases.

Change in Equilibrium Due to an Unfavourable Rainfall

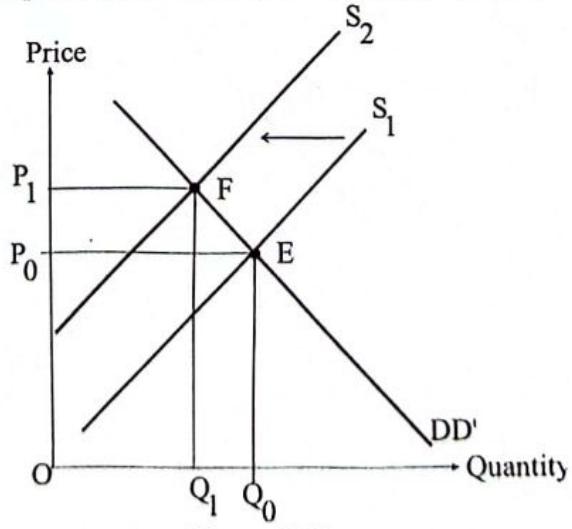


Figure- 2.12

Many other possibilities may be in place. Figure 2.13 depicts the change in equilibrium through increase in both demand and supply.

Change in Equilibrium via Equal Change in Demand and Supply

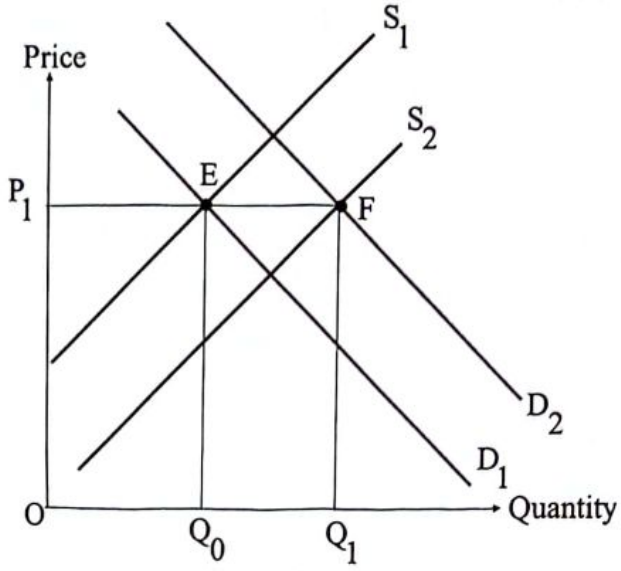


Figure- 2.13

If demand and supply increase by an equal amount, equilibrium price remains unchanged but equilibrium quantity increases.

If the increase in demand is, however, larger than the increase in supply then equilibrium price increases together with quantity. Figure 2.14 displays this case.

Change in Equilibrium via Larger Change in Demand

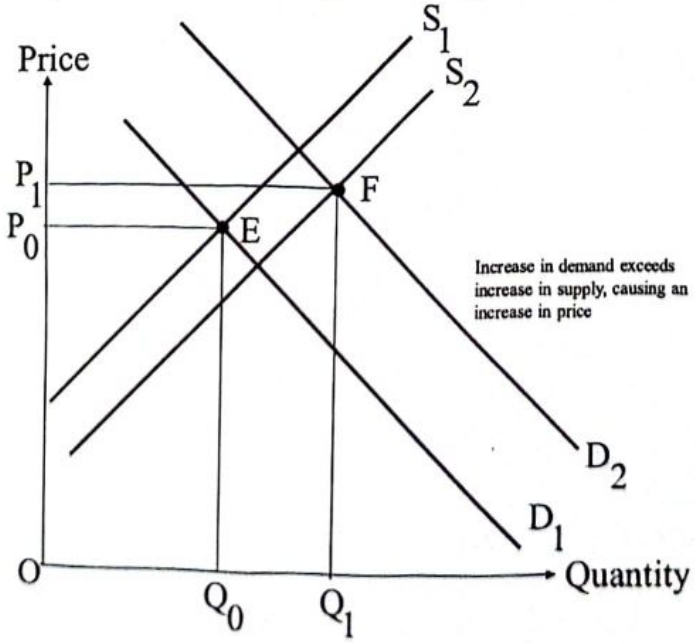


Figure- 2.14

In figure 2.15 equilibrium price decreases with increase in both demand and supply because increase in supply outweighs the increase in demand.

Change in Equilibrium via Larger Change in Supply

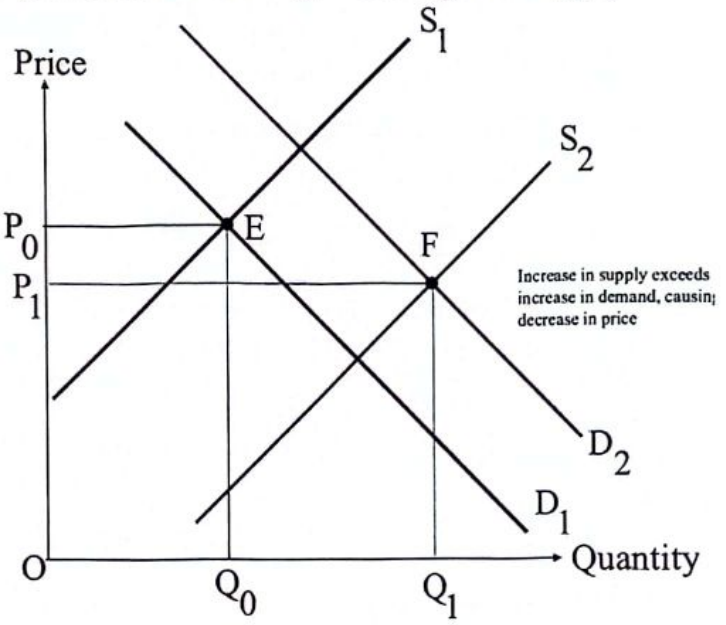


Figure- 2.15

Example 2.6

A market consists of three persons, Abiul (A), Bablu (B) and Chandrima (C), whose demand equations are as follows:

$A:\quad P = 35 - 0.5Q_A$

$B:\quad P = 50 - 0.25Q_B$

$C:\quad P = 40 - 2Q_C$

The industry supply equation is give by $Q_s = 40 + 3.5P$

i. Compute the equilibrium price and quantity
ii. Which individual does purchase the maximum amount?

Solution

i. In order to compute equilibrium price and quantity we need market demand which is the sum of individuals' demand. Simplify the demand equations given so that they can be summed.

$A:\quad 0.5Q_A = 35 - P, \Rightarrow Q_A = 70 - 2P$..... .....(1)

$B:\quad 0.25Q_B = 50 - P, \Rightarrow Q_B = 200 - 4P$.... ..... (2)

$C:\quad 2Q_C = 40 - P, \Rightarrow Q_C = 20 - 0.5P$.... ..... (3)

Market demand

$$Q_d = Q_A + Q_B + Q_C$$
$$= 70 - 2P + 200 - 4P + 20 - 0.5P$$
$$\therefore Q_d = 290 - 6.5P$$

Equilibrium condition $Q_d = Q_s$, which follows

$$290 - 6.5P = 40 + 3.5P$$
$$\text{or,} \quad 10P = 250$$
$$\therefore \quad \overline{P} = 25$$

Setting P = 25 into market demand and supply equations

$$Q_d = 290 - (6.5 \times 25) = 290 - 162.5 = 127.5$$
$$Q_s = 40 + (3.5 \times 25) = 40 + 87.5 = 127.5$$

Setting P = 25 into equations (1), (2) and (3) we compute the amounts purchased by three individuals.

Abiul's demand, $Q_A = 70 - 2P = 70 - (2 \times 25) = 20$

Bablu's demand, $Q_B = 200 - 4P = 200 - (4 \times 25) = 100$

Chandrima's demand, $Q_C = 20 - 0.5P = 20 - (0.5 \times 25) = 7.5$

Bablu purchases the maximum amount.

Exercise 2

1. Graph the demand function $Q_d = 200 - 5P$ and supply function $Q_s = 15P$ in the same diagram.

2. Suppose the demand and supply functions are as below:
   $Q_d = 120\text{-}2P$

   $Q_s = 8P$

   i. What will happen if the existing market price is 10?
   ii. Will price fall if price is set at 15? Explain the reason.
   At what price will market clear? Why?

3. Find equilibrium price and quantity assuming

   $Q_d = 20 - P^2$

   $Q_s = 5P$

4. Demand and supply functions are $Q_d = 98 - P$ and $Q_S = -2 + 4P$. Determine the impact of a subsidy at the rate of 2 Taka per unit of output.

5. Suppose the demand function is price independent as below. $Q_d = 100$. Compute the tax burden on producer and consumer assuming the supply function $Q_S = -2 + 5P$. Tax rate is Tk. 2 per unit.

6. Demand for good A: $Q_A = 400 - P_A^2 + 2P_B - 3P_C + \sqrt[3]{M}$. Compute the amount purchased at $P_A = 5, P_B = 10, P_c = 15$ & $M = 1000$. What happens to demand for A when price of good C rises to 20? What conclusion can you draw regarding the relationship between goods A and C?

7. Compute the amount of demand for commodity X from the demand function below.

   $Q_X = 580 - P_X - M^2$ (Given, $P_x = 10$ and income, M = 20).

   Do you think that the good X is inferior? Give and explanation.

8. a) Find market demand from three individuals' demand functions below

   $Q_1 = 70 - 2P$

   $Q_2 = 100 - P$

   $Q_3 = 20 - 2P$

   Suppose the supply equation is $Q_S = 5P$

   b) What are the amounts of equilibrium price and quantity?

   c) Compute each individual's demand in equilibrium.

9. Graphically examine the impact of a fall in both demand and supply on market equilibrium.

10. Suppose the market is initially in equilibrium. What change in price will occur due to the improvement in production technology?

11. What change in equilibrium price do you predict following an increase in income of the individuals?