Chapter 3

Demand, Supply, and Their Interaction

Introduction

In this chapter we will learn about perhaps two of the most used concepts, not only in economics but also in everyday conversations—demand and supply. Recall from Chapter 2, that households are the main consuming units and firms are the main producing units. We learn about the factors that may affect the decisions of households to demand goods and services, and the factors that may affect the decisions of firms to supply goods and services. We learn the distinction between demand and quantity demanded, and supply and quantity supplied.

Demand

We define demand as the units of a good or service that a household is willing and able to purchase.

Note that for demand to exist, two conditions must meet simultaneously.

- Willingness to purchase
- Ability to purchase

We cannot say that demand exists if either is missing.

An example may help. Suppose that you want to purchase a fancy wristwatch, say, a Rolex. However, you cannot afford it. It is too expensive given your financial situation. You cannot say that you have created demand for a Rolex wristwatch.

Suppose that you have the financial resources to purchase a Casio wristwatch. However, you find it ugly. In this case, you are *able* to purchase a Casio wristwatch, but you are not *willing* to purchase one. You cannot say that you have created demand for a Casio wristwatch. So, for demand to exist, both ability and willingness must be present.

There are numerous factors that may affect a household's willingness and ability to purchase a product. That is, there are numerous factors that affect the demand for product. We list here the most important ones.

1. The price of the product
2. The income and/or wealth of the household
3. Prices of the related products
4. Tastes and preferences
5. Expectations

Note that when we change one factor and want to find out the impact of the change in that factor on the amount purchased, we hold other factors constant. As we learned in Chapter 2 while talking about the economic vocabulary, the Latin phrase *ceteris paribus* means holding other factors constant. So, for instant in this case, when we want to see the impact of change in the price of the product on its amount purchased, we hold all other factors that may impact the amount purchased, constant. Using our list of factors that may affect the amount purchased as an example, we do not change income, wealth, prices of related products, tastes and preferences, or expectations.

Analogously, say we want to see the impact of changes in income on the amount purchased of a product, we hold the price of the product constant along with the other factors listed—wealth, prices of related products, tastes and preferences, and expectations.

The main point to keep in mind is that we only change one factor at a time and see how that change affects the amount purchased. There is a reason for this. Suppose that we changed the price of the product and tastes and preferences simultaneously. This may confound the effect of the change in the price of the product on the amount purchased leading us to an incorrect conclusion. The reason for holding all else constant will become clearer as we learn more about this. Note also that whether we state this explicitly or not, we always hold other factors constant.

Let's start with the change in price of the product and its impact on the amount purchased. The relationship between the price of the product and its amount purchased is called the law of demand.

The Law of Demand

There is an inverse relationship between *the price of the product* and its *quantity demanded*, holding all else constant.

That is, as *the price of the product* increases, its *quantity demanded* decreases, and as *the price of the product* decreases, its *quantity demanded* increases, holding all else constant.

Change in Demand versus Change in Quantity Demanded

You may have noticed that we used the term "*change in quantity demanded*" when referring to the impact of the change in the price of the product on the amount purchased of the product. As we will see shortly, we will use the term "*change in demand*" when referring to the change the amount purchased due to change in some other fact—other than the price of the product. This is, again, a matter of economic vocabulary. We want to distinguish between the change in amount purchased that is due to the change in the price of the product versus the change in amount purchased of the product that is the result of a change in some other factor—other than the price of the product.

Let us take an example. Table 3.1 provide data on the price of a gallon of gas and the number of gallons of gas purchased per week by an individual.

Table 3.1: Price of Gas and the Number of Gallons Purchased

[1]	[2]
Price of Gas (in Dollars)	Gallons Purchased
0.00	25
1.00	20
2.00	15
3.00	10
4.00	5
5.00	0

Source: M. Ashraf

In Table 3.1, we have the price of gas in Column [1] and the number of gallons purchased per week in Column [2]. The table shows the inverse relationship between the price of the product and its quantity demanded while holding all the other factors that may affect the amount purchased of the product constant.

Demand Schedule

At tabular representation of the Law of Demand, such as in Table 3.1, is called a Demand Schedule. It shows that as the price of gas, in this example, increases the quantity demanded of gas decreases, and vice versa.

Demand Curve

We can plot these data in a graph. A graphical representation of the Law of Demand is called a Demand Curve.

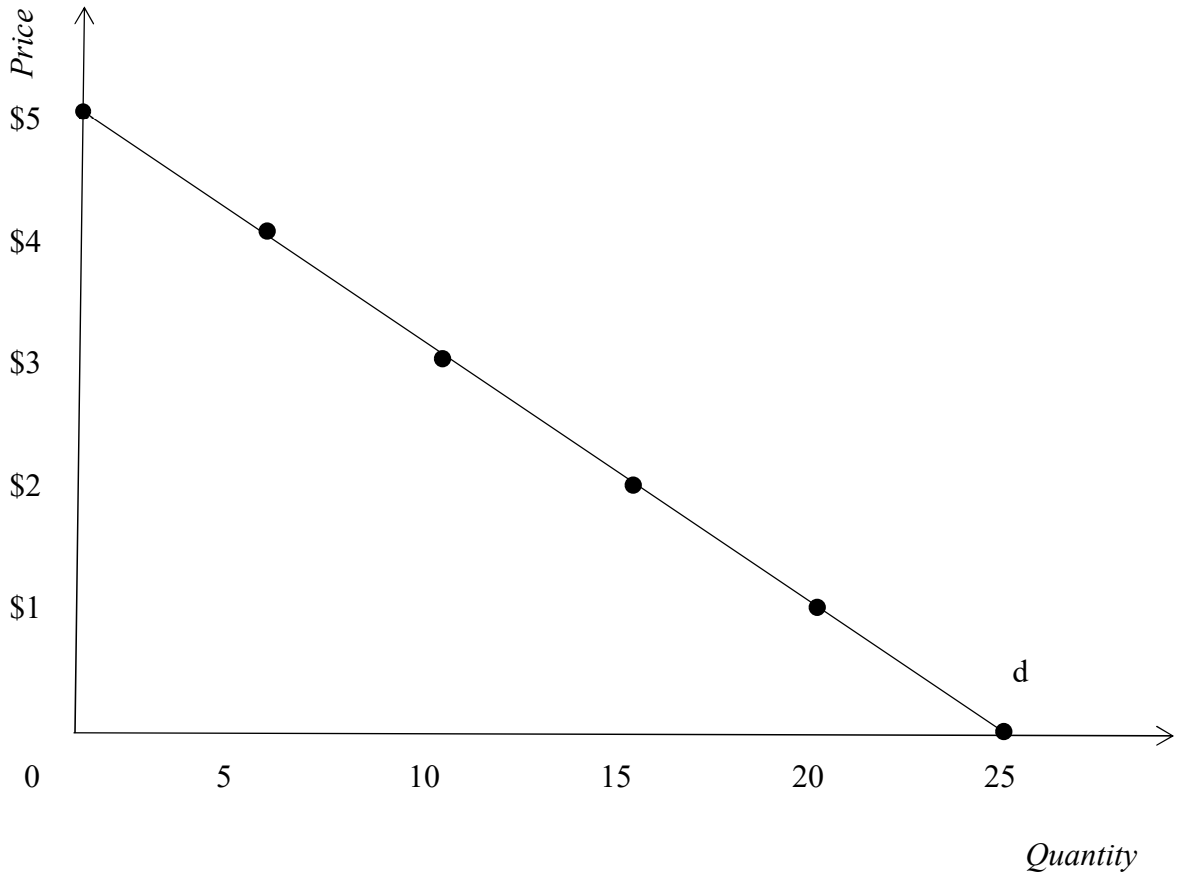

Figure 3.1: Demand Curve

Source: M. Ashraf

Figure 3.1: The amount purchased of the product, *Quantity*, is on the horizontal axis and the price of the product, *Price*, is on the vertical axis. The demand curve has a negative slope. It shows that when the price of the product increases, its quantity demanded decreases, and vice versa, holding all else constant.

In Figure 3.1, the amount purchased of the product, *Quantity*, is on the horizontal axis and the price of the product, *Price*, is on the vertical axis. The demand curve has a negative slope. It shows that when the price of the product increases, its quantity demanded decreases, and vice versa, holding all else constant.

A few points to note about Figure 3.1.

1. By convention we have the quantity of the product on the horizontal axis, and the price of the product on the vertical axis.
2. Note that the scale on the horizontal axis and the vertical axis is not the same. A given distance on the horizontal axis accounts for five units, while the same distance on the vertical axis accounts for one unit. This is an artifact of space available to plot the data. If

we had plotted both axes according to scale, either the horizontal axis would have been off the page on the right or the vertical axis would have been way too crowded making the diagram harder to read.

3. The slope of the demand curve is negative. As the price of the product increases the quantity demanded decreases, and as the price of the product decreases, the quantity demanded increases.
4. The demand curve always intersects the quantity axis as well as the price axis. In this example, when the price of the product is $5, the number of units purchased is zero, and when the price of the product is zero, the number of units purchased is 25. While it is always the case that a demand curve intersects the quantity axis and the price axis, we usually draw just the middle part of the curve. That is, we abstract from the details at both extremes. This is because, for our purposes, most of the interesting activity takes place in the middle of the demand curve.

Let us now dig a bit deeper and see the reason for this negative relationship between the price of the product and its quantity demanded. Once we understand this relationship, we will also understand why the demand curve intersects the price and quantity axes.

Recall the concepts of total utility and marginal utility from Chapter 1. We learned that total utility is the total benefit that we get from the consumption of a product, and marginal utility is the change in total utility due to the consumption of each additional unit.

As an example, in Table 1.1, we provided some values. I am reproducing Table 1.1 here.

Table 1.1: Total Benefit and Marginal Benefit

[1]	[2]	[3]
Unit	Total Benefit	Marginal Benefit
0	0	
1	20	20
2	39	19
3	57	18
4	74	17
5	90	16
6	105	15
7	105	0
8	100	-5

Source. M. Ashraf

In Table 1.1, Column [1] lists the number of units, Column [2] lists the total benefit gained from consuming these units, and Column [3] lists the marginal benefit gained from each additional unit.

Note that each additional unit consumed brings lower and lower marginal utility. In this example when we consumed the seventh unit, total utility did not change. This means that the marginal utility of the seventh unit is zero. When we consumed the eighth unit, even our total utility decreased from 105 to 100, and our marginal utility decreased to -5. That is, as opposed to

bringing us benefit, the eighth unit is causing us suffering. This observation is called the Law of Diminishing Marginal Utility.

The Law of Diminishing Marginal Utility

As we keep on consuming more and more of a product, each addition unit brings us lower and lower marginal utility.

One reason that the demand curve slopes downward rests in this observation. Here is why? When we consume a given unit, we assign a *subjective* monetary value to the marginal benefit that we get from the consumption of the additional unit. When the price of the additional unit is lower than the subjective monetary value assigned to the marginal benefit of that unit, the consumption of that unit is worth it. Otherwise, it is not. Since the marginal benefit of the last unit consumed is lower than the penultimate unit, our subjective monetary value assigned to the last unit is also lower than that of the penultimate unit's subjective monetary value. For us to be willing to purchase the next unit, the price of that unit must be lower than that of the penultimate unit.

Note also that the price of one additional unit is the marginal cost of consuming that unit. We are comparing marginal benefit with marginal cost; for us to consume an additional unit, the marginal cost must not be higher than the marginal benefit. It is important to keep in mind that while totals and averages are important, what matters for decision-making purposes is marginal.

What if the price of a unit is exactly equal to the subjective monetary value assigned to the marginal benefit of the unit? In this case we are indifferent.

We can now see why a demand curve intersects price axis as well as the quantity axis. In our example, when the price of the gas is $5 per gallon, the subjective monetary value assigned to the marginal benefit of the first gallon of gas is lower than the price paid for a gallon of gas. This is so even if we were able to purchase gas. So, we do not purchase any gas. On the other extreme, even when the price of gas is zero, we only purchase 25 gallons per week. The reason is that the subjective monetary value assigned to the 26^{th} gallon of gas is negative. So, we do not get the 26^{th} gallon of gas even when it is free.

Recall that when we are changing the price of the product, we are holding all other factors that may affect the amount purchased constant. Let us now change one of those factors at a time and see how it affects the amount purchased. Note that when we are changing each factor, we are holding other factors constant, including the price of the product.

Income and/or Wealth

Changes in income and/or wealth of the household may affect its purchasing decisions. The effect depends upon whether a good is a normal good or an inferior good.

Normal Good

Normal good is that good whose amount purchased increases with the increase in income and/or wealth, and whose amount purchased decreases when income and/or wealth decrease.

Inferior Good

Inferior good is that good whose amount purchased decreases when income and/or wealth increase and the amount purchased increases when income and/or wealth decrease.

An example of a normal good may be a new car, and an example of an inferior good may be a used car. It is more likely that when our income and/or wealth increase we would buy a new car. When our income and/or wealth decrease we are more likely to buy a used car. We are, again, holding all else constant.

It is important to note that the word "inferior" is not a reflection on the quality of the product. It only refers to our behavior when our income and/or wealth change. A used car may be of a very good quality.

To show this we shift the demand curve. Figure 3.2 shows the effect of an increase in income and/or wealth when the good in question is a normal good.

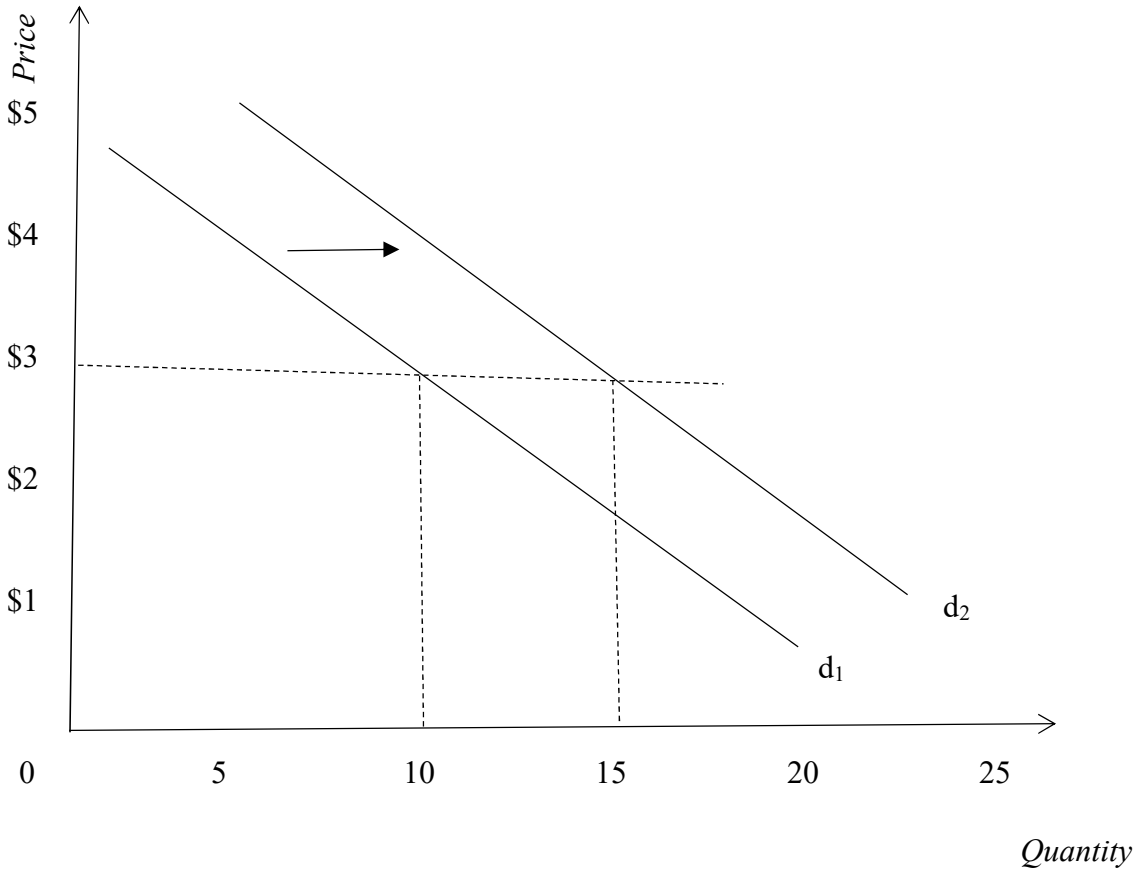

Figure 3.2: Increase in Income and/or Wealth (Normal good)

Source: M. Ashraf

Figure 3.2: The amount purchased of the product, *Quantity*, is on the horizontal axis and the price of the product, *Price*, is on the vertical axis. Since this is a normal good, as income and/or wealth increase, the amount purchased increases. To show this we shift the demand curve to the right, from d_1 to d_2. At any given price, in this case $3.00, the amount purchase increases from 10 units to 15 units.

In Figure 3.2, the amount purchased of the product, *Quantity*, is on the horizontal axis and the price of the product, *Price*, is on the vertical axis. Since this is a normal good, as income and/or wealth increase, the amount purchased increases. At $3.00 per unit, we were purchasing 10 units at our initial level of income and/or wealth. When our income and/or wealth increased we purchased 15 units. Since the variable on the horizontal axis, *Quantity*, changed, but the variable on the vertical axis, *Price*, did not change, we show this new relationship between price and quantity by relocating the demand curve. That is, we shift the demand curve to the right, from d_1 to d_2.

Furthermore, since this is a normal good—the amount purchased, and income/wealth have a positive relationship—we shift the demand curve to the right. Had this been an inferior good we would have shifted the demand curve to the left to show the negative relationship between the amount purchased and income/wealth changes.

Prices of the Related Products

Goods and services may be related in one of the two ways. They can be substitutes, or they can be complements. If two goods/services are neither substitutes nor complements, then they are not related.

Substitute Goods

Substitute goods are those goods that can be used instead. Because one can use one good instead of the other to accomplish a given activity, a change in the price of one affects the amount purchased of the other.

An example of this may be Macs and PCs. Suppose that the price of Macs increases. Since Macs and PCs are substitutes, economic agents may substitute PCs for Macs—they may purchase fewer Macs and more PCs. Figure 3.3(a) shows the relationship between the price of Macs and the number of Macs purchased.

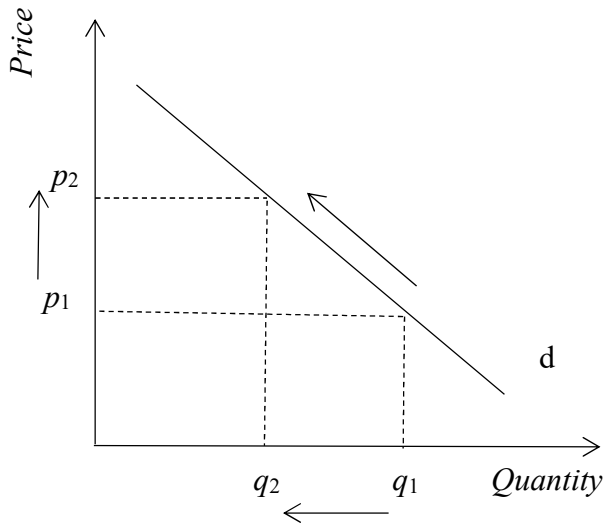

Figure 3.3(a): Macs

Source: M. Ashraf

Figure 3.3(a): The amount purchased of Macs, *Quantity*, is on the horizontal axis and the price of Macs, *Price*, is on the vertical axis. The curve labeled d represents the negative relationship between the price of Macs and the quantity demanded of Macs. When price increases from p_1 to p_2, quantity demanded of Macs decreases from q_1 to q_2.

In Figure 3.3(a), the amount purchased of Macs, *Quantity*, is on the horizontal axis and the price of Macs, *Price*, is on the vertical axis. The curve labeled d represents the negative relationship between the price of Macs and the quantity demanded of Macs. The law of demand says that the quantity demanded of Macs will decrease, holding all else constant. As the price of Macs increases from p_1 to p_2, their quantity demanded decreases from q_1 to q_2, and we move along the demand curve, d.

An increase in the number of PCs purchased by economic agents due to an increase in the price of Macs is shown in Figure 3.3(b).

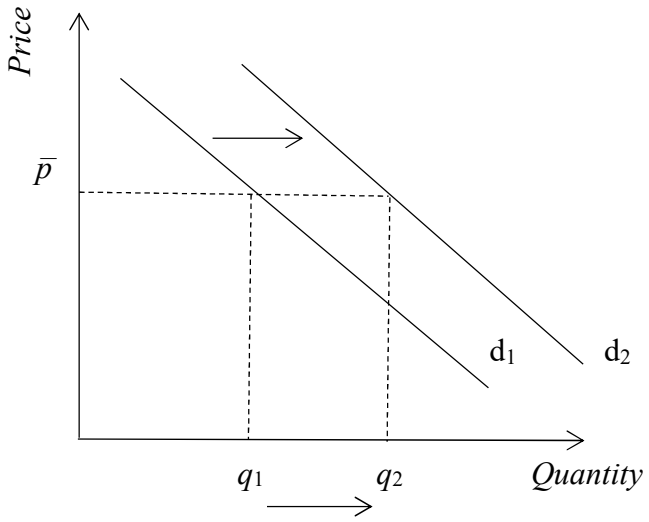

Figure 3.3(b): PCs

Source: M. Ashraf

Figure 3.3(b): The amount purchased of Macs, *Quantity*, is on the horizontal axis and the price of Macs, *Price*, is on the vertical axis. Since Macs and PCs are substitute goods, when price of Macs, economic agents increase the demand of PCs at any price, $\bar{p}$, and the number of PCs increases from q_1 to q_2. This is shown by shifting the demand curve of PCs to the right, from d_1 to d_2.

Figure 3.3(b) shows the impact of change in the price of Macs on the number of units purchased of PCs. Since Macs and PCs are substitute goods, when price of Macs, economic agents increase the demand of PCs at any price, $\bar{p}$, and the number of PCs increases from q_1 to q_2. This is shown by shifting the demand curve of PCs to the right, from d_1 to d_2.

Tastes and Preferences

Changes in tastes and preferences affect a household's decisions to purchase. Suppose that a new study shows that eating too much red meat is unhealthy. Holding all else constant, it will

decrease the amount of red meat purchased. To show this we shift the demand curve for red meat to the left. Figure 3.4 shows this shift.

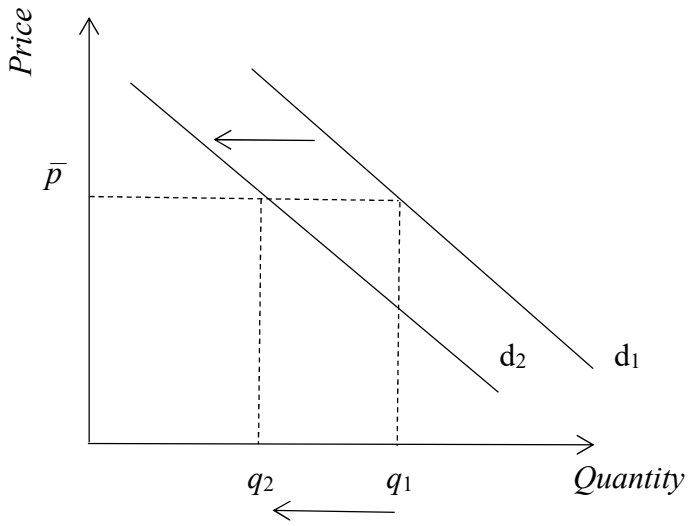

Figure 3.4: Red Meat

Source: M. Ashraf

Figure 3.4: The pounds of meat purchased, *Quantity*, is on the horizontal axis and the price of meat per pound, *Price*, is on the vertical axis. As economic agents' tastes and preferences change, they purchase fewer pounds of meat at any price, $\bar{p}$. To show the decrease in the number of pounds purchased, from q_1 to q_2, the demand curve shifts to the left, from d_1 to d_2.

In Figure 3.4, the pounds of meat purchased, *Quantity*, is on the horizontal axis and the price of meat per pound, *Price*, is on the vertical axis. As economic agents' tastes and preferences change, they purchase fewer pounds of meat at any price, $\bar{p}$. To show the decrease in the number of pounds purchased, from q_1 to q_2, the demand curve shifts to the left, from d_1 to d_2.

Expectations

Expectations about price of the product, income and/or wealth, prices of related products, among other variables, may affect the amount purchased.

Suppose that you hear some news that leads you to expect that the price of gas is going to increase tomorrow. It is likely that you will fill up the gas tank today even if you were not planning on getting gas before you heard the news. Figure 3.5 shows the effect of changes in expectations about the price of gas.

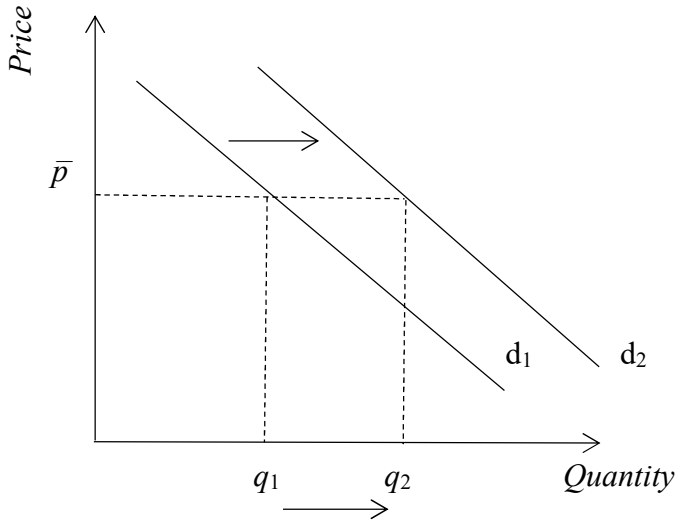

Figure 3.5: Changes in Expectations

Source: M. Ashraf

Figure 3.5: Gallons of gas purchased, *Quantity*, is on the horizontal axis and the price of gas per gallon, *Price*, is on the vertical axis. As economic agents expect an increase in the price of gas tomorrow, they purchase more gas today at any price, $\bar{p}$. To show this increase in the number of gallons of gas purchased, from q_1 to q_2, the demand curve shifts to the right, from d_1 to d_2.

In Figure 3.5, we have gallons of gas purchased, *Quantity*, is on the horizontal axis and the price of gas per gallon, *Price*, is on the vertical axis. As economic agents expect an increase in the price of gas tomorrow, they purchase more gas today at any price, $\bar{p}$. To show this increase in the number of gallons of gas purchased, from q_1 to q_2, the demand curve shifts to the right, from d_1 to d_2.

Note that this a change in demand, and not a change in quantity demanded. The reason is that, as of now, the price of product has not changed. We expect it to change tomorrow. Right now, the expectation that the price of gas will change tomorrow will lead to an increase in the number of gallons of gas purchased at a given price, $\bar{p}$. This will cause a shift in the demand curve to the right from d_1 to d_2. Tomorrow, however, when the price of gas does change, we will move along the demand curve, d_2.

Analogously, changes in expectations about income/wealth, prices of related products, etc., may affect the amount purchased at a given price of the product.

Important: Change in Demand versus Change in Quantity Demanded, Again

As we learned earlier, it is important to distinguish between the change in the amount purchased that is due to the change in the price of the product versus the change in the amount purchased of

the product that is the result of a change in some other factor—other than the price of the product. We use the term "*change in quantity demanded*" when the price of the product changes, and as a result, the amount purchased of the product changes. One the other hand, when some other factor, other than the price of the product, affects the amount purchased, we use the term "*change in demand*." This is, again, a matter of economic vocabulary.

To sum this point up,

- When the price of the product changes, and as a result the amount purchased changes, we move along the demand curve and say that quantity demanded has changed. This is the Law of Demand.
- When the amount purchased changes due to some other factor, other than the price of the product, we shift the demand curve and say that demand has changes. These factors include not only changes in income and/or wealth, prices of related products, tastes, and preferences, but also expectations about the price of the product, and expectations of changes in other factors that we discussed earlier.

Market Quantity Demanded

Market quantity demanded is the sum of individual quantities demanded. It is the quantity demanded by all the participants in the market at various prices.

Suppose that there are three households in the market of gas. Table 3.2 presents this example.

Table 3.2: Market Quantity Demanded

[1]	[2]	[3]	[4]	[5]
Price of Gas (in Dollars)	Gallons Purchased Household 1	Gallons Purchased Household 2	Gallons Purchased Household 3	Market Quantity Demanded (Q_d)
0.00	20	35	30	85
1.00	15	30	25	70
2.00	10	25	20	55
3.00	5	20	15	40
4.00	0	15	10	25
5.00	0	10	5	15

Source: M. Ashraf

Table 3.2 has five columns. Column [1] lists the price (dollars per gallon of gas), and Columns [2]-[4] list the quantities demanded by the three household in the market for gas, respectively. Column [5] sums up these quantities demanded of gas at each price by the three households. It represents the market quantity demanded.

Market Demand Curve

A market demand curve is the horizontal summation of individual demand curves. We represent market demand curve by D whereas the individual household demand curves are represented by d_1, d_2, and d_3, in Figure 3.6. Figure 3.6 has four parts—a, b, c, d. Figure 3.6(a) plots the demand

curve for Household 1—Columns [1] and [2] in Table 3.2. Figure 3.6(b) plots the demand curve for Household 2—Columns [1] and [3] in Table 3.2. Figure 3.6(c) plots the demand curve for Household 3—Columns [1] and [4] in Table 3.2. Finally, Figure 3.6(d) plots the demand curve for market—Columns [1] and [5] in Table 3.2.

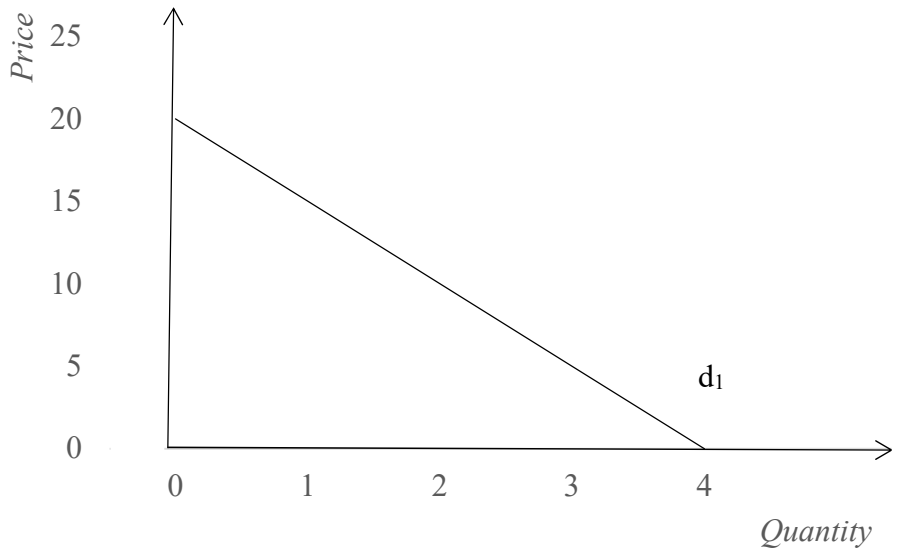

Figure 3.6 (a): Household 1 Demand Curve

Source: M. Ashraf

Figure 3.6(a): Gallons of gas purchased, *Quantity*, is on the horizontal axis and the price of gas per gallon, *Price*, is on the vertical axis. The curve, d_1, represents the demand curve for Household 1.

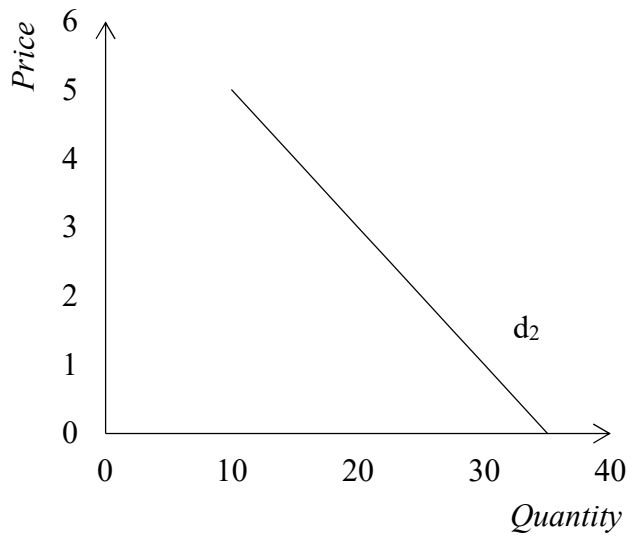

Figure 3.6 (b): Household 2 Demand Curve

Source: M. Ashraf

Figure 3.6(b) Gallons of gas purchased, *Quantity*, is on the horizontal axis and the price of gas per gallon, *Price*, is on the vertical axis. The curve, d_2, represents the demand curve for Household 2.

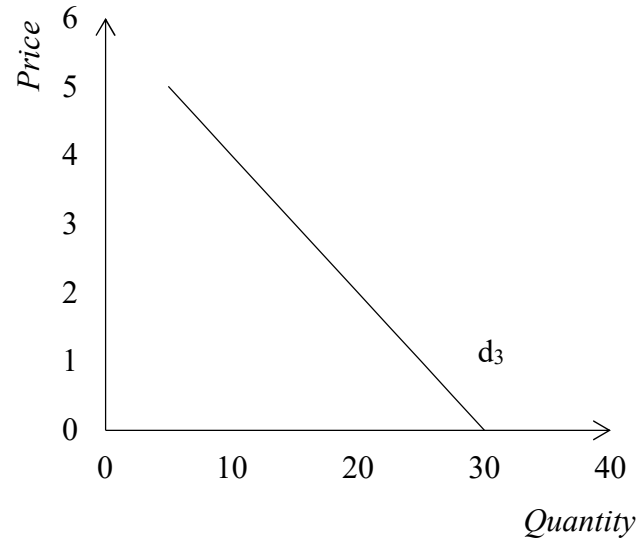

Figure 3.6 (c): Household 3 Demand Curve

Source: M. Ashraf

Figure 3.6(c): Gallons of gas purchased, *Quantity*, is on the horizontal axis and the price of gas per gallon, *Price*, is on the vertical axis. The curve, d_3, represents the demand curve for Household 3.

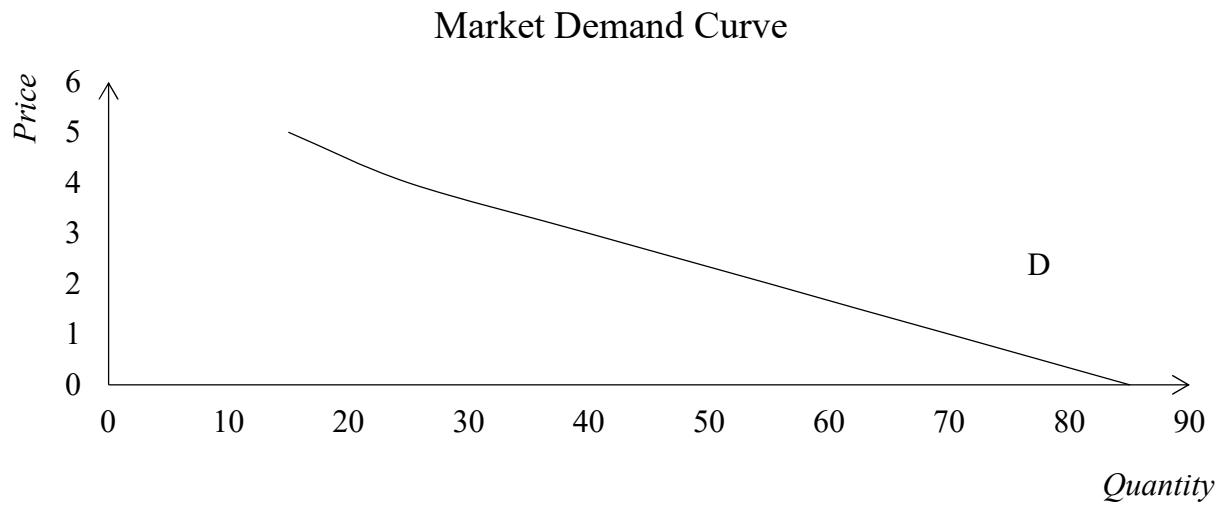

Figure 3.6 (d): Market Demand Curve

Source: M. Ashraf

Figure 3.6(d): Gallons of gas purchased, *Quantity*, is on the horizontal axis and the price of gas per gallon, *Price*, is on the vertical axis. The curve, D, represents the market demand curve.

Note that the market demand curve, D, is flatter than any of the individual demand curve. The reason is that the market demand curve is accounting for the changes in quantities demanded by all the household in the market for a given price change—note the changes in the values of the vertical and the horizontal axes.

Now we move on to the supply a good or service.

Supply

We define supply as the amount of a good or service that a firm is willing and able to supply.

Analogous to demand, note that for supply to exist, two conditions must be met simultaneously.

- Willingness to produce
- Ability to produce

If either of the two conditions is missing, supply will not exit.

Take the example of a firm that is willing to produce a computer program that makes it easier for the user to learn how to tune the piano. A nice idea except that the firm does not know how to

produce such a piece of software. While firm has the wiliness to produce this software, it does not have the ability to produce it. So, the supply of such program does not exist.

On the other hand, suppose that a firm has the knowhow of producing such a software, but does not want to produce one. Again, the program does not exist.

So, for the supply of a good or service to exist, both willingness to produce and ability to produce must exist simultaneously. Moving forward we will assume that the firm has the willingness and the ability to produce. Furthermore, we will take the example of firms that produce goods and services for profit. Note, however, that the tools learned here are equally applicable to non-profit firms.

We define profit as the difference between total revenue and total cost. That is,

$$Profit = Total\ Revenue - Total\ Cost \tag{3.1}$$

Total revenue is just price times quantity. That is,

$$Total\ Revenue = Price \times Quantity \tag{3.2}$$

If we represent *Profit* by the Greek letter π, *Total Revenue* by *TR*, *Total Cost* by *TC*, Price by p, and Quantity by q, then we can write Equations (3.1) and (3.2) as follows.

$$\pi = TR - TC \tag{3.3}$$

And

$$TR = p \times q \tag{3.4}$$

By (3.3) and (3.4), we get

$$\pi = (p \times q) - TC \tag{3.5}$$

Let us look at Equation (3.5) closely. Note that holding q and *TC* constant, when p increases, π increases, and when p decreases, π decreases. If a firm want to increase profit further, it will make sense increase q as well. This will increase π even more.

This gives us the Law of Supply.

The Law of Supply

As the price of the product increases, its quantity supplied increases, and as the price of the product decreases, its quantity supplied decreases, holding all else constant.

Just as we did in the case of demand, we can present the Law of Supply in tabular form. We call this Supply Schedule. Table 3.3 presents this positive relationship between the price of the product and its quantity supplied.

Table 3.3: Supply Schedule

[1]	[2]
Price of Gas (in Dollars)	Gallons Supplied
0.00	0
1.00	5
2.00	10
3.00	15
4.00	20
5.00	25

Source: M. Ashraf

Table 3.3 has two columns; Column [1] lists the price of gas per gallon, and Column [2] lists the quantity of gallons of gas supplied. It shows the positive relationship between the price of gas and its quantity supplied. Holding all else constant, as the price of gas increases, the quantity supplied of gas increases, and when the price of gas decreases, the quantity supplied of gas decreases.

A graphical representation of the Law of Supply is called Supply Curve. Figure 3.7 plots the data presented in Table 3.3.

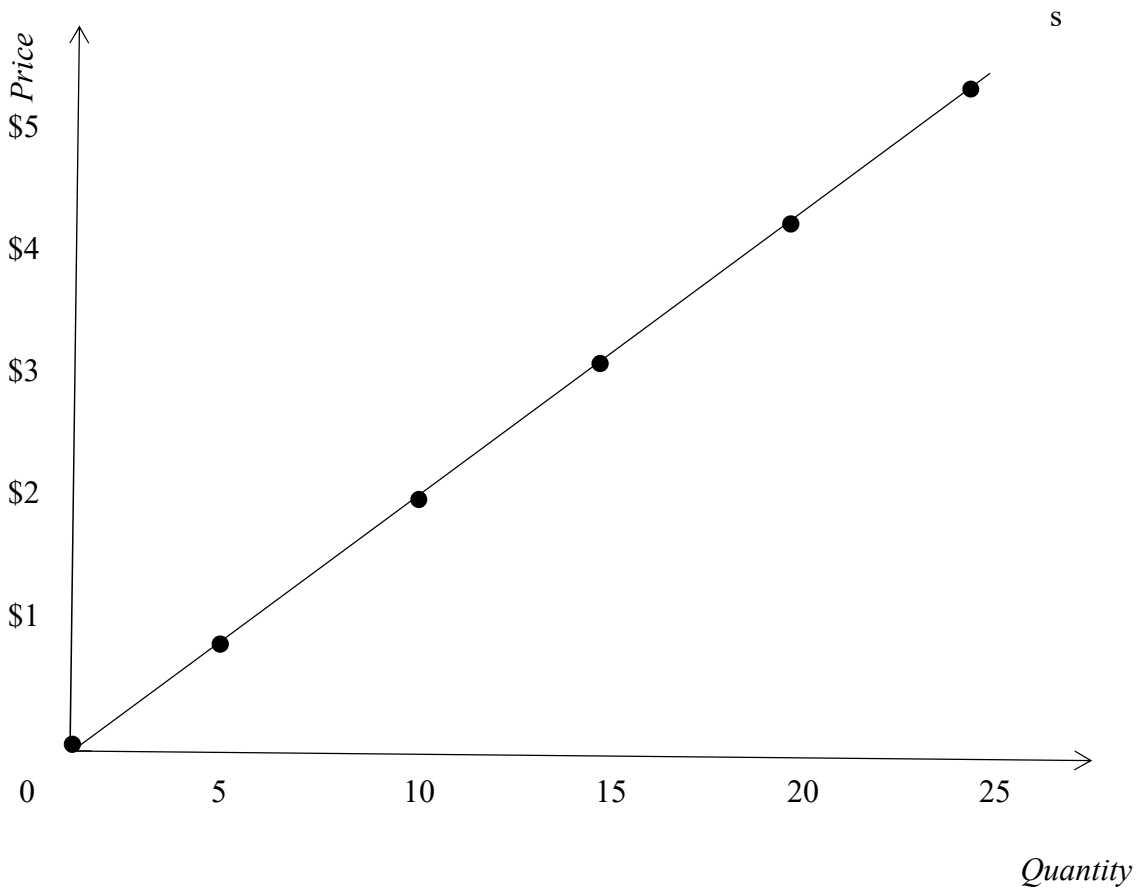

Figure 3.7: The Supply Curve

Source: M. Ashraf

Figure 3.7: Gallons of gas produced, *Quantity*, is on the horizontal axis and the price of gas per gallon, *Price*, is on the vertical axis. The curve, s, represents the positive relationship between price of gas and its quantity supplied.

In Figure 3.7, we have gallons of gas produced, *Quantity*, is on the horizontal axis and the price of gas per gallon, *Price*, is on the vertical axis. The curve, s, represents the positive relationship between price of gas and its quantity supplied. Holding all else constant, as the price of gas increases, its quantity supplied increases, and vice versa.

Note, however, that when a firm increases the quantity that it is producing, it may have to hire more workers or increase other inputs such as raw material. This will increase *TC*. So, when a firm increases *q*, it may also lead to an increase in *TC*. We can say, then, that so long as the change in *TR* is not overwhelmed by the change in *TC*, it makes sense to keep on increasing *q* when *p* increases.

Recall the concept of marginal from Chapter 1. It is the change in total due to the change in units. In this context, the change in *TR* due to change in q is Marginal Revenue. If we represent marginal revenue by *MR*, we may write this as follows.

$$MR = \frac{\Delta TR}{\Delta q} \tag{3.6}$$

Analogously, change in *TC* due to change in q is Marginal Cost. Representing Marginal Cost by *MC*, we may write this as follows.

$$MC = \frac{\Delta TC}{\Delta q} \tag{3.7}$$

We can then state this more formally as follows.

When the price of the product increases, it makes sense to increase its quantity supplied, so long as *MC* is not greater than *MR*.

Other Factors that May Affect the Amount Produced

What are the factors, other than the price of the product, that may affect the amount of a good or service produced?

Changes in Costs of Production

The costs of production are the main factor that affect the amount produced, holding all else constant, including the price of the product.

Take another look at Equation (3.3), or Equation (3.5). When *TC* changes, holding *TR* constant, π will change. Suppose that *TC* increases. Holding *TR* constant, π will decline. This will affect the decision to produce; an increase in *TC* will lead to a decrease in the amount produced, all else constant. The reverse will happen when *TC* decreases.

How do we show this in a diagram? Continuing to assume that there is an increase in *TC*. Figure 3.8 show this change in the amount produced due to an increase in the costs of production.

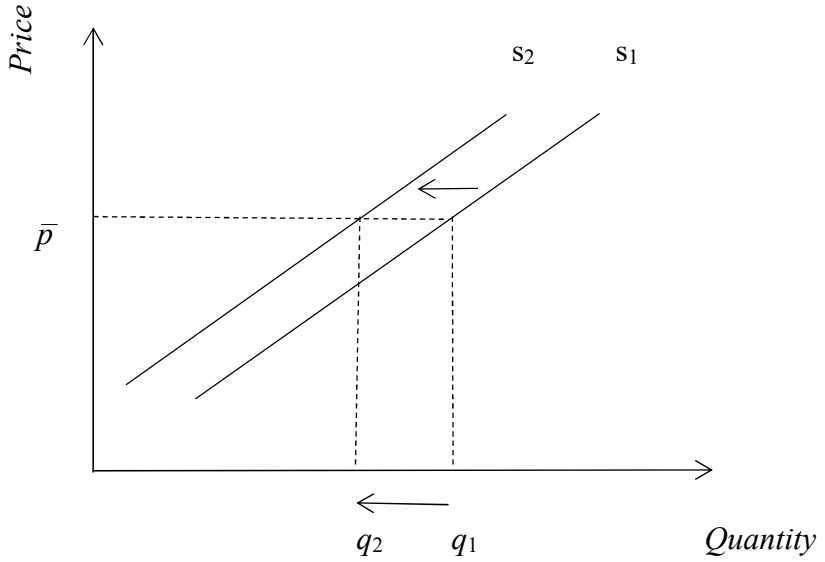

Figure 3.8: The Effect on the Amount Produced due to an Increase in *TC*

Figure 3.8: Gallons of gas produced, *Quantity*, is on the horizontal axis and the price of gas per gallon, *Price*, is on the vertical axis. As the cost of production increase, the number of gallons of gas produced decreases, from q_1 to q_1, at any given price, $\bar{p}$. We show this by shifting the supply curve to the left, from s_1 to s_2.

Figure 3.8 shows a decrease in the amount produced due to an increase in *TC*. Note that we shift the supply curve to the left, from s_1 to s_2, to show the changes in the amount produced that are not due to the changes in the price of product. At any price, $\bar{p}$, the amount produced declines from q_1 to q_2.

Change in Quantity Supplied versus Change in Supply

Note, again, the distinction between the terms "*change in quantity supplied*," and "*change in supply*." Analogous the terminology in the case of demand,

- When the price of the produce changes, and as a result the amount produced changes, we say that quantity supplied has changed, and we move along the supply curve.
- When the amount produced changes due to some other fact, other than the price of the product, we say that supply has changed, and we shift the supply curve.

Changes in the Prices of Related Products

When the prices of related products change, this change may lead to changes in the amount produced.

We saw in the case of demand that substitutes were those products that could be used instead, and complements were those products that went together. The counter parts of consumption

substitutes and consumption complements are production substitutes and production complements.

Production Substitutes

Production substitutes are those goods and services that can be produced instead. Examples include alcoholic drinks and hand sanitizers, paper products and masks, and so on.

Suppose that the price of hand sanitizers increases. Given that the firm, a distillery, can produce both alcoholic beverages and hand sanitizers, holding the price of alcoholic beverages constant, it makes sense to produce hand sanitizers by switching some of its equipment from the production of alcoholic beverages to producing hand sanitizer. This is because the profit of the distillery will increase if the distiller switched some of her equipment to producing hand sanitizers, all else constant.

We can show this with the help of diagrams. Figure 3.19 has two parts—3.9(a) and 3.9(b). Figure 3.9(a) plots the distillery's supply curve for hand sanitizers and Figure 3.9(b) plots the distillery's supply curve for alcoholic beverages.

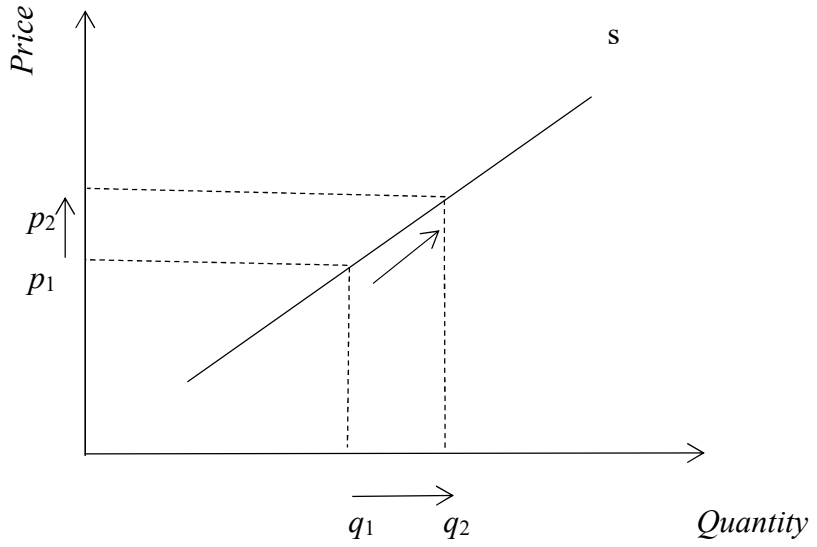

Figure 3.9(a): The Effect on the Quantity Supplied of Hand Sanitizer due to an Increase in the Price of Hand Sanitizer

Figure 3.9(a): Gallons of hand sanitizer produced, *Quantity*, is on the horizontal axis and the price of hand sanitizer per gallon, *Price*, is on the vertical axis. As the price of hand sanitizer increases, from p_1 to p_2, the number of gallons of hand sanitizer produced increases, from q_1 to q_2. We show this by moving along the supply curve, s.

In Figure 3.9(a), we have gallons of hand sanitizer produced, *Quantity*, is on the horizontal axis and the price of hand sanitizer per gallon, *Price*, is on the vertical axis. As the price of hand

sanitizer increases, from p_1 to p_2, the number of gallons of hand sanitizer produced increases, from q_1 to q_1. That is, the quantity supplied of hand sanitizer increases. We show this by moving along the supply curve, s.

Now that the distiller is using some of her equipment to producing hand sanitizer, the supply of alcoholic beverages decreases. We can show this change using Figure 3.9(b).

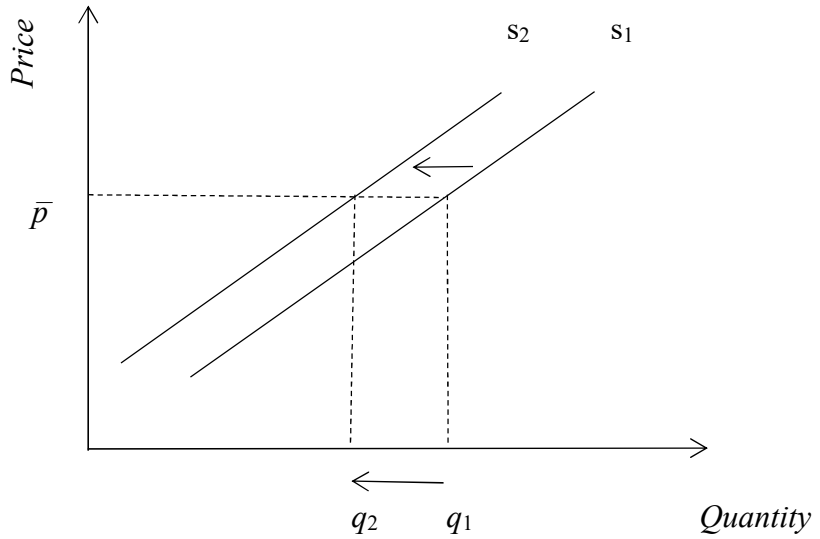

Figure 3.9(b): The Effect on the Number of Gallons of Alcoholic Beverages Produced due to an Increase in the Price of Hand Sanitizer

Source: M. Ashraf

Figure 3.9(b): Gallons of alcoholic beverages produced, *Quantity*, is on the horizontal axis and the price of alcoholic beverages per gallon, *Price*, is on the vertical axis. As the price of hand sanitizer increases, and the distillery switches to producing hand sanitizer using some of its equipment, the number of gallons of alcoholic beverage produced decreases, from q_1 to q_2, at any price, $\bar{p}$. We show this by shifting the supply curve of alcoholic beverages to the left, from s_1 to s_2.

In Figure 3.9(b), we have gallons of alcoholic beverages produced, *Quantity*, is on the horizontal axis and the price of alcoholic beverages per gallon, *Price*, is on the vertical axis. As the price of hand sanitizer increases, and the distillery switches some if its equipment to the production of hand sanitizer. As a result, the number of gallons of alcoholic beverage produced decreases, from q_1 to q_2, at any price, $\bar{p}$. We show this by shifting the supply curve of alcoholic beverages to the left, from s_1 to s_2.

Production Complements

Production complements are those goods and services whose production goes together. A good example is donuts and donut holes. Other examples include chicken wings and chicken breasts, and so on.

Let us take the example of classic donuts (the ones with a hole in the middle) and donut holes. Suppose that the price of donuts increases. It makes sense for the baker to bake more donuts. That is, the baker increases the quantity supplied of donuts. We show this in Figure 3.10(a).

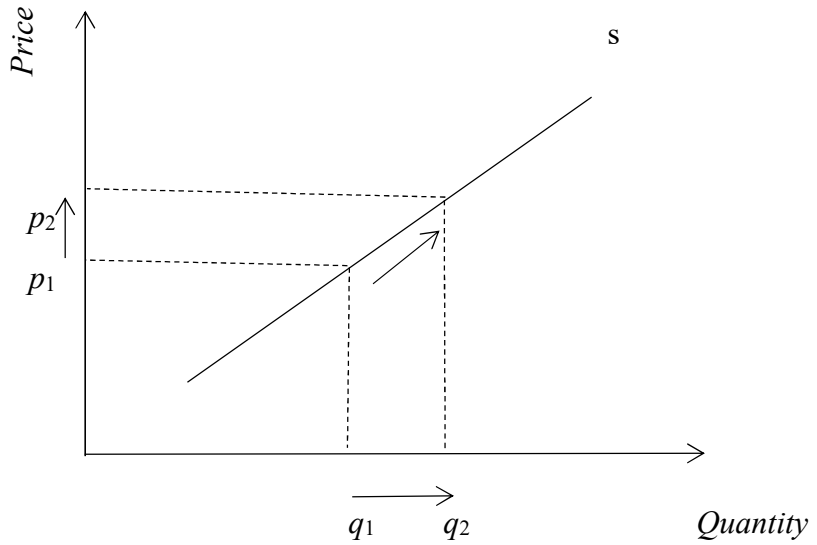

Figure 3.10(a): The Effect on the Quantity Supplied of Donuts due to an Increase in the Price of Donuts

Source: M. Ashraf

Figure 3.10(a): Number of donuts backed, *Quantity*, is on the horizontal axis and the price of donuts per donut, *Price*, is on the vertical axis. As the price of donuts increases, from p_1 to p_2, the number of donuts baked increases, from q_1 to q_2. We show this by moving along the supply curve, s.

In Figure 3.10(a), we have number of donuts baked, *Quantity*, on the horizontal axis and the price of donuts per donut, *Price*, is on the vertical axis. As the price of donuts increases, from p_1 to p_2, the number of donuts baked increases, from q_1 to q_1. That is, the quantity supplied of donuts increases. We show this by moving along the supply curve, s.

How may this increase in quantity supplied of donuts affect the supply of donut holes? Remember we are taking the example of classic donuts with holes in the middle. Since the baker is baking more donuts, the supply of donut holes also increases. Figure 3.10(b) shows this graphically.

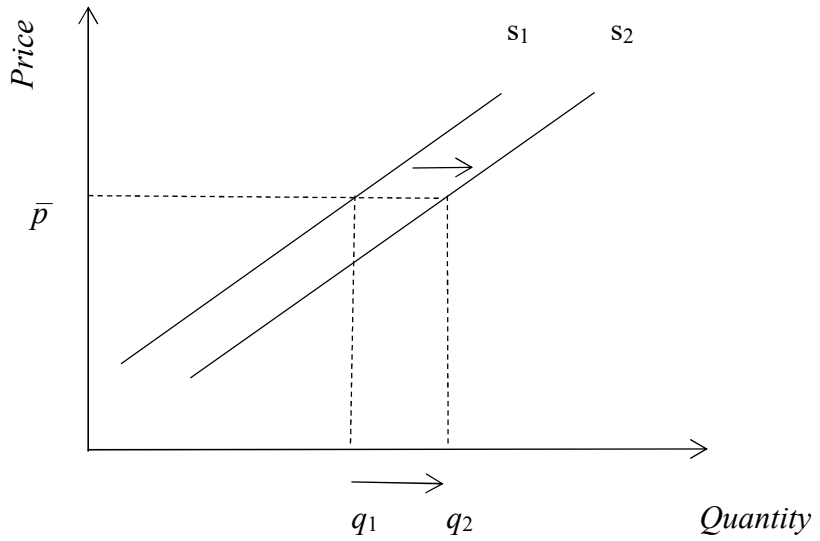

Figure 3.10(b): The Effect on the Number of Donut Holes Baked due to an Increase in the Price of Donuts

Source: M. Ashraf

Figure 3.10(b): Number of donut hole baked, *Quantity*, is on the horizontal axis and the price of donut holes per donut hole, *Price*, is on the vertical axis. As the price of donuts increases, and the baked is baking more donuts, the number of donut holes baked increases, from q_1 to q_2, at any price, $\bar{p}$. We show this by shifting the supply curve of donut holes to the right, from s_1 to s_2.

In Figure 3.10(b), we have number of donut hole baked, *Quantity*, is on the horizontal axis and the price of donut holes per donut hole, *Price*, is on the vertical axis. As the price of donuts increases, and the baked is baking more donuts, the number of donut holes baked increases, from q_1 to q_2, at any price, $\bar{p}$. We show this by shifting the supply curve of donut holes to the right, from s_1 to s_2.

Note, again, the difference between change in quantity supplied where we move along the supply curve, Figure 3.10(a), and change in supply where we shift the supply curve, Figure 3.10(b).

Market Quantity Supplied

Analogous to the case of demand, market quantity supplied is the sum of all the quantities supplied by various firms in the market.

Suppose that there are three oil refineries in the market that supply gasoline. Table 3.4 presents an example.

Table 3.4: Market Quantity Supplied

[1]	[2]	[3]	[4]	[5]
Price of Gas (in Dollars)	Gallons Supplied Refinery 1	Gallons Supplied Refinery 2	Gallons Supplied Refinery 3	Market Quantity Supplied (Q_s)
0.00	0	0	0	0
1.00	5	0	5	10
2.00	10	5	10	25
3.00	15	10	15	40
4.00	20	15	20	55
5.00	25	20	25	70

Source: M. Ashraf

In Table 3.4, Column [1] lists the price of gas per gallon, Columns [2]-[4], list the number of gallons supplied by Refinery 1 through Refinery [3], respectively, and Column [5] lists the total quantity supplied of gas in the market.

We plot these data in Figure 3.11(I) through Figure 3.11(IV). Figure 3.11(a) plots data for Refinery 1, Figure 3.11(b) plots data for Refinery 2, Figure 3.11(c) plots these data for Refinery 3, and Figure 3.11(d) plots the market quantity supplied of gas.

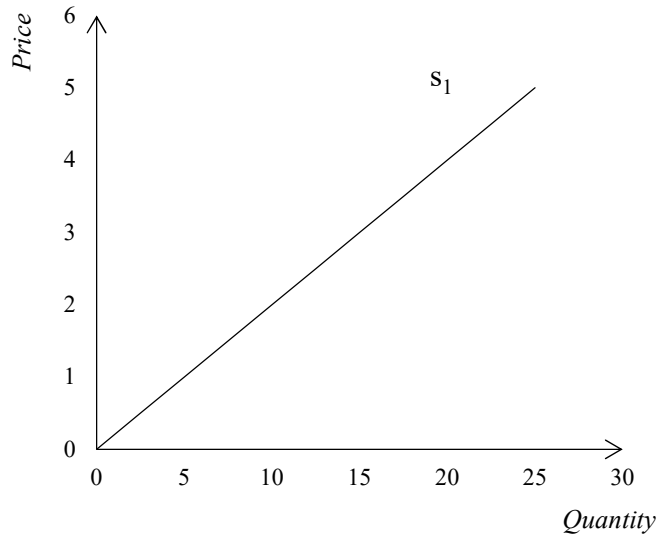

Figure 3.11 (a): Refinery 1 Supply Curve

Source: M. Ashraf

Figure 3.11(a): Gallons of gas produced by Refinery 1, *Quantity*, is on the horizontal axis and the price of gas per gallon, *Price*, is on the vertical axis. The curve, s_1, is the supply curve of Refinery 1.

Figure 3.11(a) plots the price of gas per gallon, and the number of gallons of supplied by Refinery 1—Columns [1] and [2].

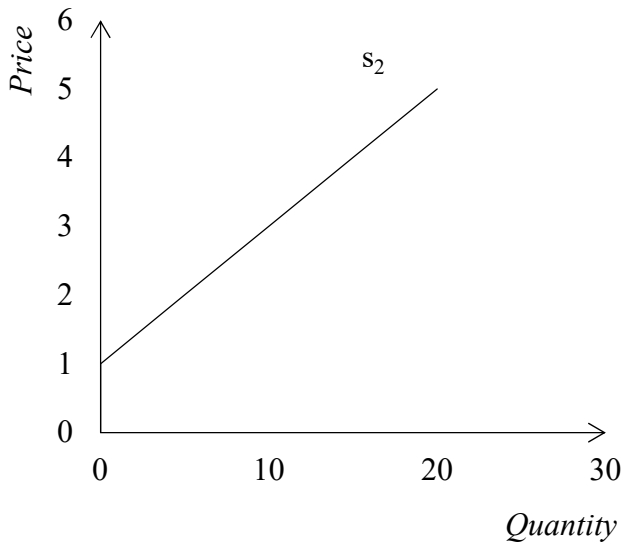

Figure 3.11 (b): Refinery 2 Supply Curve

Source: M. Ashraf

Figure 3.11(b): Gallons of gas produced by Refinery 2, *Quantity*, is on the horizontal axis and the price of gas per gallon, *Price*, is on the vertical axis. The curve, s_2, is the supply curve of Refinery 2.

Figure 3.11(b) plots the price of gas per gallon, and the number of gallons of supplied by Refinery 2—Columns [1] and [3].

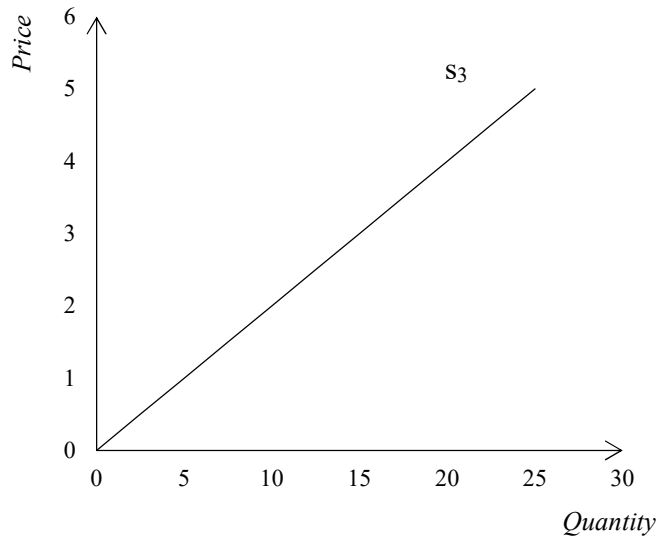

Figure 3.11 (c): Refinery 3 Supply Curve

Source: M. Ashraf

Figure 3.11(c): Gallons of gas produced by Refinery 3, *Quantity*, is on the horizontal axis and the price of gas per gallon, *Price*, is on the vertical axis. The curve, s_3, is the supply curve of Refinery 3.

Figure 3.11(c) plots the price of gas per gallon, and the number of gallons of supplied by Refinery 3—Columns [1] and [4].

In Figure 3.11(d) we plot data for the market—Columns [1] and [5].

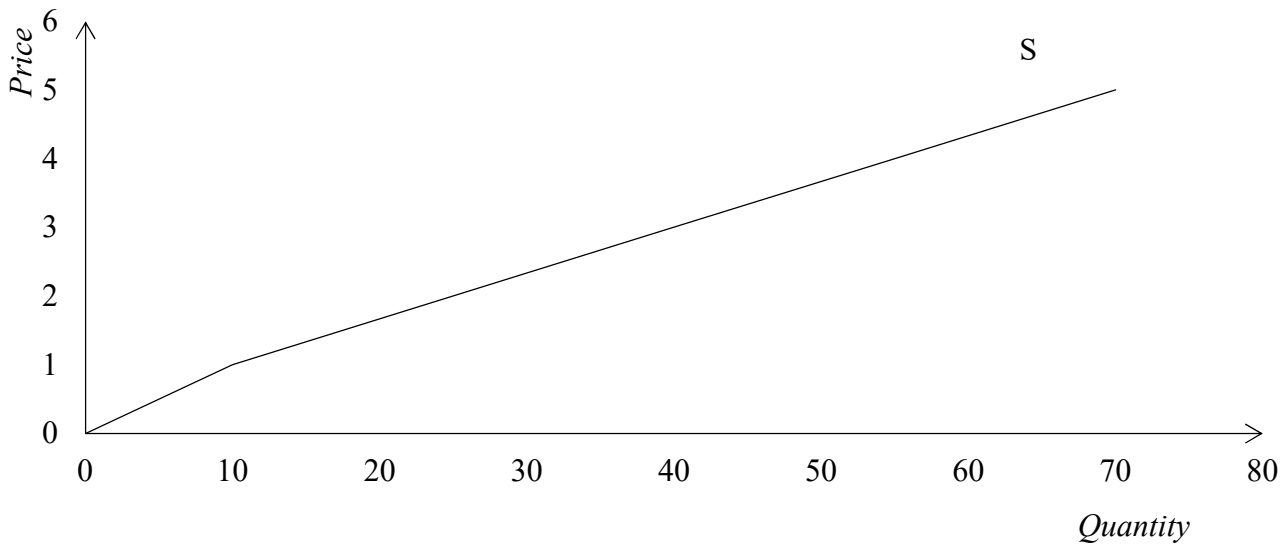

Figure 3.11 (d): Market Supply Curve

Source: M. Ashraf

Figure 3.11(d): Gallons of gas produced in the market, *Quantity*, is on the horizontal axis and the price of gas per gallon, *Price*, is on the vertical axis. The curve, S, is the market supply curve.

Figure 3.11(d) plots the price of gas per gallon, and the number of gallons of supplied in the market—Columns [1] and [5]. The market supply curve is represented by S.

Market Equilibrium

Market equilibrium takes place when quantity supplied, and quantity demanded are qual. That is,

$Q^* = Q_s = Q_d$. We represent this quantity by Q^*. Note that, by way to distinguishing, when we are talking about the market, as opposed to an individual firm or household, we use capital letters.

The price at which this condition is satisfied is called equilibrium price. This price is also called market-clearing price. We represent it by P^*.

We can use data in Table 3.2 (Columns [1] and [5]), and Table 3.5 (Columns [1] and [5]), find equilibrium market quantity (Q^*) of gallons of gas, and equilibrium market price (P^*) in the market. Table 3.5 lists these data.

Table 3.5: Market Equilibrium

[1]	[2]	[3]
Price (in Dollars)	Market Quantity Demanded (Q_d)	Market Quantity Supplied (Q_s)
0	85	0
1	70	10
2	55	25
3	40	40
4	25	55
5	15	70

Source: M. Ashraf

Table 3.5 has three columns—Columns [1], [2], and [3]. Column [1] lists the price of gas per gallon, and Columns [2] and [3] list the market quantity demanded (Q_d) and the market quantity supplied (Q_s).

Note that at price \$3.00, the market quantity demanded (Q_d) and market quantity supplied (Q_s) both equal 40 gallons. Figure 3.12 shows the market equilibrium graphically. In Figure 3.12, we abstract from details and only show the point where market quantity demanded (Q_d) is equal to the market quantity supplied (Q_s). That is, $Q^* = Q_d = Q_s = 40$. It also shows the equilibrium price, $P^* = 3.00$

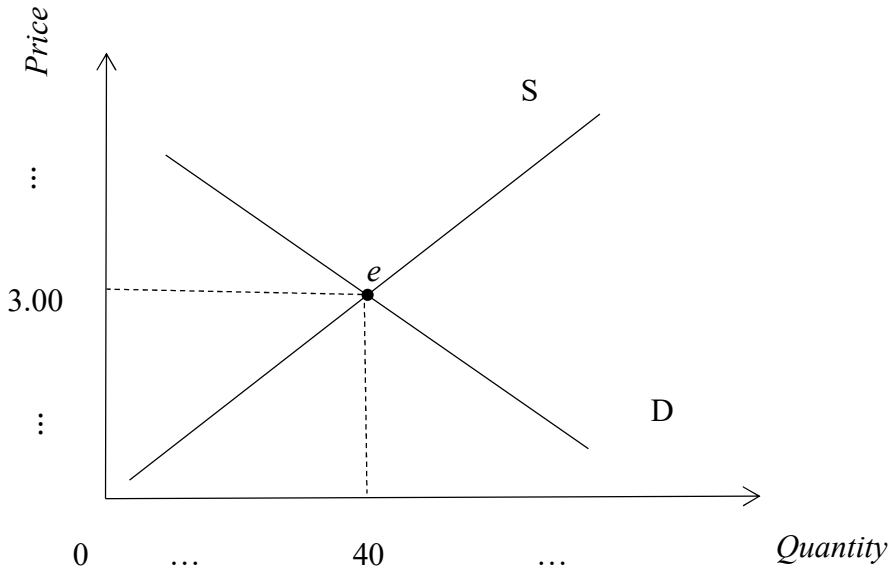

Figure 3.12: Market Equilibrium

Source: M. Ashraf

Figure 3.12: Gallons of gas produced in the market, *Quantity*, is on the horizontal axis and the price of gas per gallon, *Price*, is on the vertical axis. The curve, D, is the market demand curve, and the curve, S, is the market supply curve. The point *e* represents the equilibrium. <alt text>

In Figure 3.12, gallons of gas produced in the market, *Quantity*, is on the horizontal axis and the price of gas per gallon, *Price*, is on the vertical axis. The curve, D, is the market demand curve, and the curve, S, is the market supply curve. Where the curves D and S cross each other represent the market equilibrium. We draw a perpendicular line from point *e* to the horizontal axis (see the dotted line). At this point, market quantity demanded is equal to the market quantity supplied, $Q^* = 40$. We draw a horizontal line from point *e* to the vertical axis (see the dotted line). At this point, the equilibrium market price, P^*, is \$3.00.

Chapter Conclusion

In this chapter we learned about demand and supply, and the Law of Demand and the Law of Supply. We learned the various factors that may affect the households' decision to purchase goods and services at various prices, and the factors that may affect firms' decision to produce goods and services. We learned the distinction between the movements along the demand curve and shifts in the demand curve. We referred to the former as changes in quantity demanded, and the latter as changes in demand. We also learned about the movements along the supply curve and the shifts in the supply curve. We referred to the former as changes in quantity supplied and the latter as changes in supply. Finally, we learned about the concept of market equilibrium.

Review of Terms

Demand: The units of a good or service that a household is willing and able to purchase.

Note that for demand to exist, two conditions must meet simultaneously.

- Willingness to purchase
- Ability to purchase

The Law of Demand: There is a negative relationship between the price of the product and its quantity demanded, holding all else constant.

Demand Curve: A graphical representation of the negative relationship between the price of the product and its quantity demanded, holding all else constant.

Change in Quantity Demanded versus Change in Demand:

- When the price of the product changes and as a result the number of units purchased changes, we move along the demand curve, and we say that quantity demanded has changed.
- When some other determinant of demand, other than the price of the product, changes and as a result the number of units purchased changes, we shift the demand curve, and say that demand has changed.

Substitutes: Goods and services that can be used instead.

Complements: Goods and services that go together.

Normal Goods: Those goods whose demand increases as income and/or wealth increases, and whose demand decreases as income and/or wealth decreases.

Inferior Goods: Those goods whose demand decreases as income and/or wealth increases, and whose demand increases as income and/or wealth increases.

Market Quantity Demanded: The sum of quantities demanded of a good or service by all the households.

Supply: The units of goods and services that firms are willing to produce.

Note that for supply to exist, two conditions must meet simultaneously.

- Willingness to produce
- Ability to produce

The Law of Supply: There is a positive relationship between the price of the product and its quantity supplied, holding all else constant.

Supply Curve: A graphical representation of the law of supply.

Change in Quantity Supplied versus Change in Supply:

- When the price of the product changes and as a result the number of units produced changes, we move along the supply curve, and we say that quantity supplied has changed.
- When some other determinant of supply, other than the price of the product, changes and as a result the number of units produced changes, we shift the demand curve, and say that demand has changed.

Market Quantity Supplied: The sum of quantities supplied of a good or service by all the firms.

Equilibrium: The point where market quantity demanded is equal to market quantity supplied.