ARBAMINCH UNIVERSITY

COLLEGE OF BUSINESS AND ECONOMICS

DEPARTMENT OF ECONOMICS

READING MATERIAL FOR THE COURSE MICROECONOMICS II

FEBRUARY 2023 ARBAMICNH

CHAPTER ONE

MONOPOLISTIC COMPETITION

1.1 INTRDUCTION

Dear students, in pervious course on microeconomics we have seen the basic features of monopoly and prefect competitive market. As you know prefect competitive market assumes free entry and large number of small firms producing homogenous product. In such market environment, firms are worry only about the amount of output produced and take market price as given. In case of monopoly, however only single firm producing a product for which there is no close substitute dominates the industry. As a result, the monopolistic firm has power to set price and output level, which maximizes its profit.

Until 1920s, these two extreme forms of market model are the only model that used to explain the behavior of firms. However, by 1930s some economists began to question the capacity of these models to explain the modern market economics. They cannot explain several empirical facts. The assumption of homogenous product of prefect competitive market did not fit to the real world. Advertising and other selling activities, which are widely practiced by businesspersons, could not explained by both market models. Moreover, under the existence of legal monopoly on its trademarks and brand names for a firm, it is possible for other firms to produce similar product, which is not exactly the same. Such product viewed as a substitute by a consumer to some degree unlike non-existence of close substitute assumption of monopoly market model. From the viewpoint of a single firm therefore, production decision of its competitor will be a very important consideration in deciding how much it can produce and what price it can charge. This implies perfect competition and monopoly market models are useful tools for shedding light on how market works but they rarely represent the real market situation.

Edward Chamberlin (1933) from Harvard University in his theory of monopolistic competition and Joan Robinson from Cambridge University in her economics of imperfect competition working independently, comes up with a new model, which falls between the two extreme models. This model, which is the subject of this chapter, is termed as monopolistic competition market structure. Relatively it is a market model that can better explain the existing market

situations. For example, the way retail trade, fast food and cosmetics market works better explained by monopolistically competitive market model than monopolistic or perfect competitive market model.

If we take retail traders, they sell goods in many different stores by competing with one other through differentiating their product based on location, availability and expertise of sales peoples and the provision of credit terms. In addition, entry is relatively easy. Therefore, if the business is profitable new store will be established to supply slightly differentiated products. Such feature of retail trade better fits to monopolistic competition than to perfectly competitive and monopoly market. Thus, monopolistic competition said to exists when there are many firms, as in perfect competition and each firm produce a product that is slightly different from that of the other.

Learning Objective

At the end of this chapter, the students will be able to:

- Identify the features of monopolistic competitive market structure.
- Define concepts like product differentiation, product group and industry.
- Describe the demand and cost structure of monopolistic competitive firm.
- Explain how short and long run equilibrium of the firm attained.
- Define the excess capacity of monopolistic competitive firm.
- Describe the welfare effect of monopolistically competitive firm resource allocation.

1.2 MONOPOLISTICALLY COMPETITIVE MARKET STRUCTURE

Dear students, can you guess what do we mean by monopolistically competitive market means? Is there any character shared by monopoly and monopolistic competitive as well as perfect competition and monopolistic competitive market structure? What is there in monopolistic competition but not is perfect competition and monopoly? What are the features of demand; cost and products of firms operate in monopolistically competitive market? Is there any market for a

product that approximates monopolistically competitive market in your surrounding? Well students, we are going to answer these questions gradually while we deal with monopolistically competitive market in this chapter.

We began our discussion by stating the basic assumption of Chamberlin's large group model of monopolistic competition market. These are:

1. There are large numbers of sellers in the product group. This assumption implies each firm in the product group contributes small proportion of the total supply. As a result, there is no single firm dominance in setting market price and collusion between firms to gain market power is impossible.

2. Sellers found in the same product group produce differentiated product and yet they are close substitutes of one another. This is to mean that each firm makes its product different from other firm by changing their inherent characteristics of their product or through different sales promotion activities. As a result, firms get certain monopoly power to set price. However, their monopoly power usually small relative to monopolistic firm because of the existence of stiff competition from other firms producing similar product.

3. It is relatively easy for new firms to enter the market with their own brands and for existing firms to leave the product group if they are unprofitable. Since there is no barrier to entry, a firm cannot make positive profit in the long run.

4. The objective of the firms is profit maximization in both the short run and long run.

5. Firms assumed to behave as if it knew its demand and cost curves with certainty.

6. Both demand and cost curves for all products are uniform through out the group. This assumption made in order to present the equilibrium of the firm and product group on the same diagram.

As indicated in the assumption, a monopolistically competitive market structure has some element of both monopoly and prefect competition. The fact that there are many firms in a monopolistically competitive situation is a perfect competitive element that restricts the ability of firms to control price through product differentiation. A significant difference in price between

firms quickly leads customers to abandon the loyalties built by product differentiation. This will cause shift in preference of consumer from high price product to lower price close substitutes. Another perfect competitive element is easy entry of firms in a monopolistically competitive market even though product differentiation, which takes the form of brand name or firm's loyalty, can act as barrier to entry. Therefore, we cannot say that there is complete freedom of entry as in pure competition. Rather there is reasonable freedom of entry.

On the other hand, the product of each firm in monopolistic competition is differentiated. That is each firm sells a brand or a version of the product that differs in quality, appearance or reputation and it is a sole producer of its own brand. Such product differentiation gives monopolistically competitive firm some market power to set different price from their competitors rather than passively accepting the market price. Usually the greater the differentiation, the greater the discretionary market power of a given firm to set its product price. When a product is highly differentiated, the product of each seller is similar but not identical. This may give them a monopoly power over the specific product it sells.

From the above discussion, it is possible to conclude that monopolistic competition as a market structure in which:

- A large number of independent firms compete.
- Each firm produces a differentiated product.
- Firms compete on product quality, price and marketing activities.
- Easy enter and exit of firms to the market.

1.3 Product differentiation and the demand curve

Chamberlin develops his theory of monopolistic competition based on some empirical facts. There are very few monopolists because there are very few commodities for which close substitutes do not exist. Similarly, very few commodities are entirely homogeneous to make perfect competition assumption realistic. For instances there are no homogenous automobiles, soaps, suits, television sets, grocery stores, magazines and others. They are differentiated. In

most cases, each producer tries to differentiate his product to make it unique and reduces the number of its close substitutes. The process of making a product unique from other product is called product differentiation. Chamberlin uses the concept of product differentiation to develop the theory of monopolistic competition.

There are two types of product differentiation: real and fancied (spurious) product differentiation. Product differentiation is said to be real, if the products found in the same product group differ in terms of their inheritance characteristics. They may be different in the type of input used to produce the product; specification and location of the firm in terms of convince to be accessed by the consumer. For example, shampoos with conditioner and without conditioner are differentiated in their content. Grocery stores found near to the house of customer and far from the house of a customer are differentiated in terms of their location.

Fancied (spurious) product differentiation is a case where the products are the same but the producers that its product differs from other close substitutes convince consumers. Such differentiation occurs through advertisement, difference in packing, design, brand name and other sales promotion activities. Whatever the type, product differentiation determines the nature of demand curve facing a give firm.

The demand curve facing a firm will depend on output decisions and prices charged by other firms that produce similar product. That is the slope of demand curve facing the firm will depend on how similar the firm's products are. If large number of firms produces identical or homogenous products, then the demand curve facing the firms is flat. Each firm must sell its product at market price. Any firm that tries to raise its price above market price would loss all of its customers. On the other hand, if a firm has exclusive right to sell a particular product, it may raise its price without losing all of its customers.

Firm can gain certain monopoly power through product differentiation by making a given product unique to the mind of the consumer. This will create brand loyalty of consumer for a product and given some discretion power for the firms to set the price of their product different from their competitor price. As a result the demand facing individual firm becomes down ward sloping. The firm did not loss its entire customer through price rise even though some of them switch to its competitors product. However given the competitive element of monopolistically

competitive product group (large number of firm and easy entry), small rise in price results in large fall in quantity demanded. For instance if price increases from P_1 to P_2 in figure1.1, quantity demanded decreases from Q_1 to Q_2. Because increase in price leads the firm to lose some of its customers.

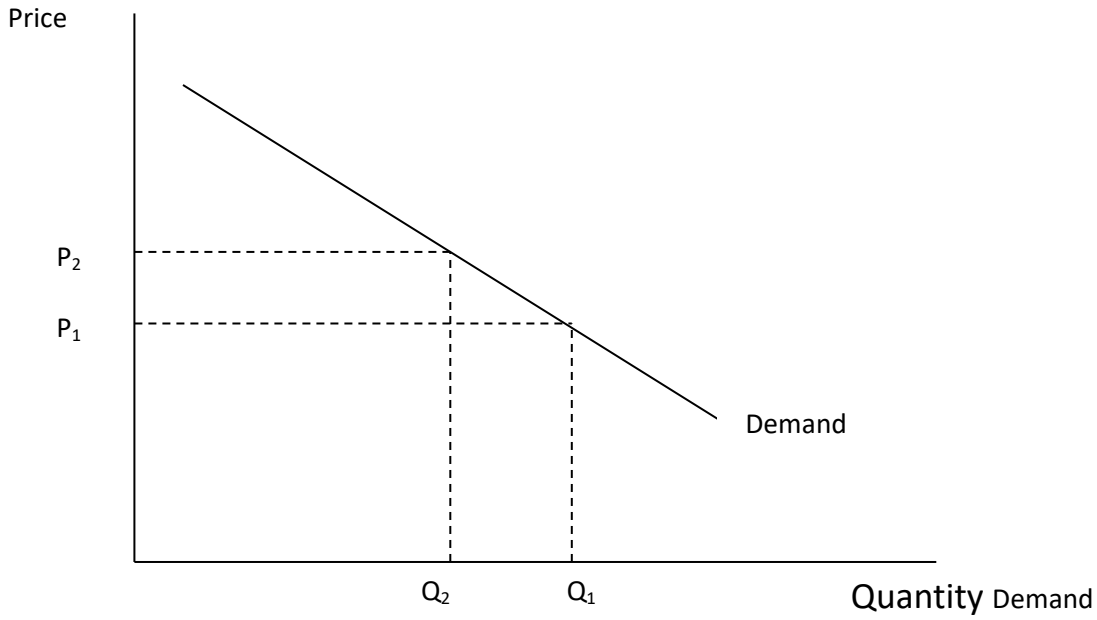


Figure1.1: Demand curve of monopolistically competitive firm

In summary product differentiation, which is the basis of non-price competition, give monopolistically competitive firm certain monopoly power and then down ward sloping demand curve. In other word in monopolistically competitive market structure, firms have a certain capacity to change the demand for their product through product differentiation. Even though firms in monopolistically competitive market faces downward sloping demand curve, their demand curve is highly elastic because of the existence of large number of firms producing closely substitute products.

1.4 COST OF MONOPOLOSTIC COMPETIOTION

Dear students, we have seen that monopolistically competitive firm undertake different activities and changes compositions of goods to differentiate their product from their competitors. For example, firms use intensive advertisements to increases demand and even to inform potential

buyers about the availability of the product. This causes strong attachment of consumer to the product so that price elasticity of demand for the product becomes very low. In other words, firms often devote considerable resources to differentiate their product from their competitors through such devices as quality and style variations, warranties and guarantees, special services features, and product advertisement. All of these activities require firms to employ an additional resource that incurs addition cost to them. This cost is known as selling cost or cost of product differentiation. Therefore, firms have to consider this cost during pricing and output decision in addition to traditional production costs.

Like perfect competition and monopolistic firm, traditional production cost of monopolistically competitive firm's average costs and marginal costs are all U-shaped. Such shape indicates the operation of law of diminishing marginal return in the short run and law of return to scale in the long run during production process. Moreover, Chamberlin tries to show the average and marginal selling costs curve of monopolistically competitive firm have U-shape. If we take advertisement, cost that comprises the major proportion of selling cost shows economies and diseconomies of scale.

As indicated in figure1.2, initially the amount of sells expansion through advertisement will not result in equally increase in selling cost. It is characterized by falling of the average selling cost because of increase return to scale of advertisement (economies of scale). However, when large quantity of output sold, after a certain level, firms have to spend more per unit in order to increase the amount of output sold. That is diseconomies of advertisement start to operate and average selling cost increase after its minimum point. Such feature of average selling cost give rise to U-shaped average selling cost. Therefore, since both production and selling costs have U-shaped, the total average and marginal costs of monopolistically competition firm is U-shaped similar to cost curves of monopoly and perfect competitive firm. However, the average and marginal cost of monopolistically competitive firm is greater than average and marginal cost of perfect competitive and monopolistic firm because of the additional costs incurred to during product differentiation.

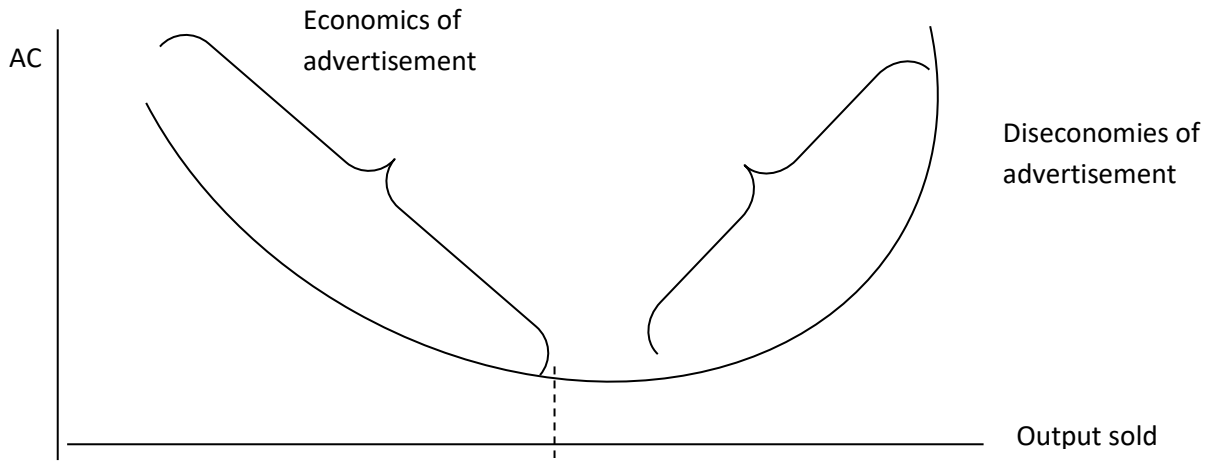


Figure 1.2:

1.5 THE CONCEPT OF PRODUCT GROUP AND INDUSTRY

It is defined in perfect competition that an industry is a group of firms producing a homogenous product. However, when products are differentiated like in the case of monopolistic competition, one cannot define an industry in this narrow sense. There is no automobile, soap or furniture industry. Each firm in the automobile, soap or furniture industry produces its own distinct product. This implies product differentiation create difficulties in defining the boundaries of an industry. Heterogeneous group cannot add together to from an industry and to their market demand and supply schedule.

To overcome this problem, Chamberlin introduces the concept of product group. It is formed by lumping together firm's producing similar products, which are close substitutes. They are group of product with higher price and cross elasticity of demand. The consumer preference for each product shifts to other product in the group when its price increases. For instance, we can from a product group by putting together different model of automobiles. Automobiles are differentiated product. They are close substitute (used for the same purpose) and their price and cross elasticity of each automobile model are high. If the price of one model increases consumers shift their preference to other model.

Dear students, how does chamberlain's theory work with the idea of product group? During the determination of equilibrium market price and output, industry demand and supply should be considered. This can be possible by summation of individual demand and supply which need common price. With product differentiation however, we cannot derive industry demand and supply curve as we did for perfect competitive market. We do not have a single equilibrium price for differentiated product, but a cluster of prices.

For this reason, in order to analyze his model of monopolistic competition, Chamberlin made assumption about demand and cost of firms in the product group. That is every firm in the product group faces the same demand curve with identical cost even though it is not the case in real situation. Such assumption enables us to get unique equilibrium price and to treat firms and market demand on the same graph. However, if firms supply different product to market then why should their demand and costs are identical? This is one point up on which Chamberlin model of monopolistic competition was criticized.

1.6 EQULIBRIUM OF MONOPOLOSTICALLY COMPETITIVE FIRM IN THE SHORT RUN

By now we have get familiar with the different component of profit of monopolistically competitive firm, i.e. their cost and demand structure. Each firm's product in the Chamberlin world is somewhat different from the product of its rivals. This situation gives rise to downward sloping demand curve for the firm. This implies a decrease in the price of individual product results in increase in sales volume of the firm by attracting customers of other rivalry firms. On the other hand, increase in price will result in decrease in the sales volume of the firm. This is because some customers shift their preference to other product because of increase in price. Such relationship between price and sells volume of firms can be indicated by individual demand curve as a result individual demand curve also known as planned sale curve.

As in the case of monopoly, since the demand curve of monopolistically competitive firm is negatively sloped, the corresponding marginal revenue sloped downward. This is indicated by figure1.3(a). Q_1 and P_1 represent short run equilibrium level of output and price respectively. . Both are characterized by the intersection of marginal revenue (derived from effective demand

curve) and the firms marginal cost curve. Having achieved this point, the firm would have no incentive to change its price from p_1. The equality of marginal revenue and marginal cost at output Q_1 means that firm believes that it would maximize its profit by maintaining its price at p_1. At the indicated point monopolistically competitive firm earn a positive profit equals to the area of shaded region.

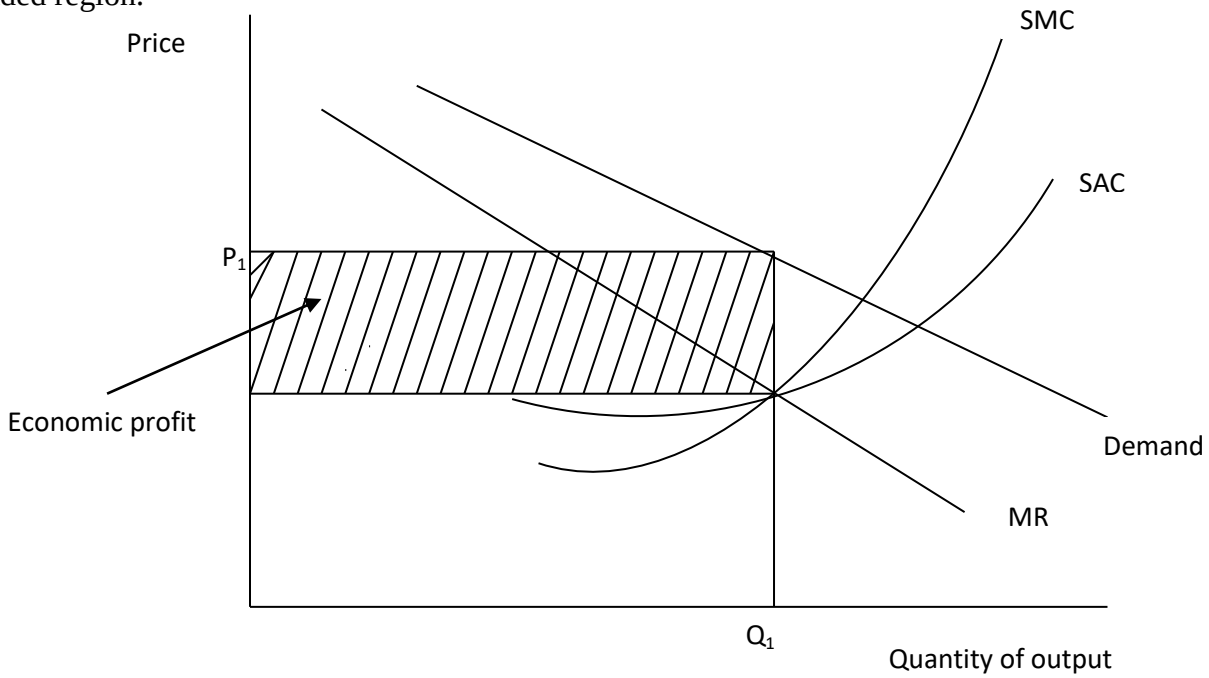


Figure 1.3(a) Short run equilibrium under monopolistic competition.

However, the fact that firms are at equilibrium will not grant positive abnormal profit to the firms. This is totally depending on a point at which marginal revenue equals to marginal cost. As indicated in figure1.3(b) below, if the point of intersection MR=MC (marginal cost equals marginal revenue) takes places where average cost equals to the demand curve, the firm earns zero (normal) profit single their cost equal to their revenue at this point

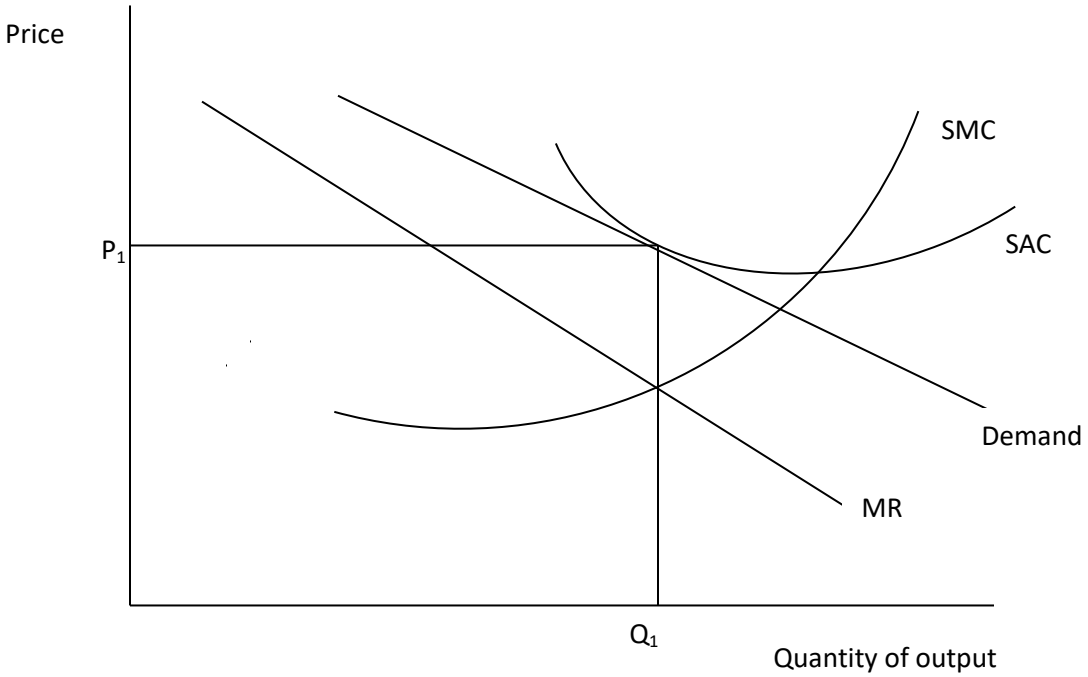
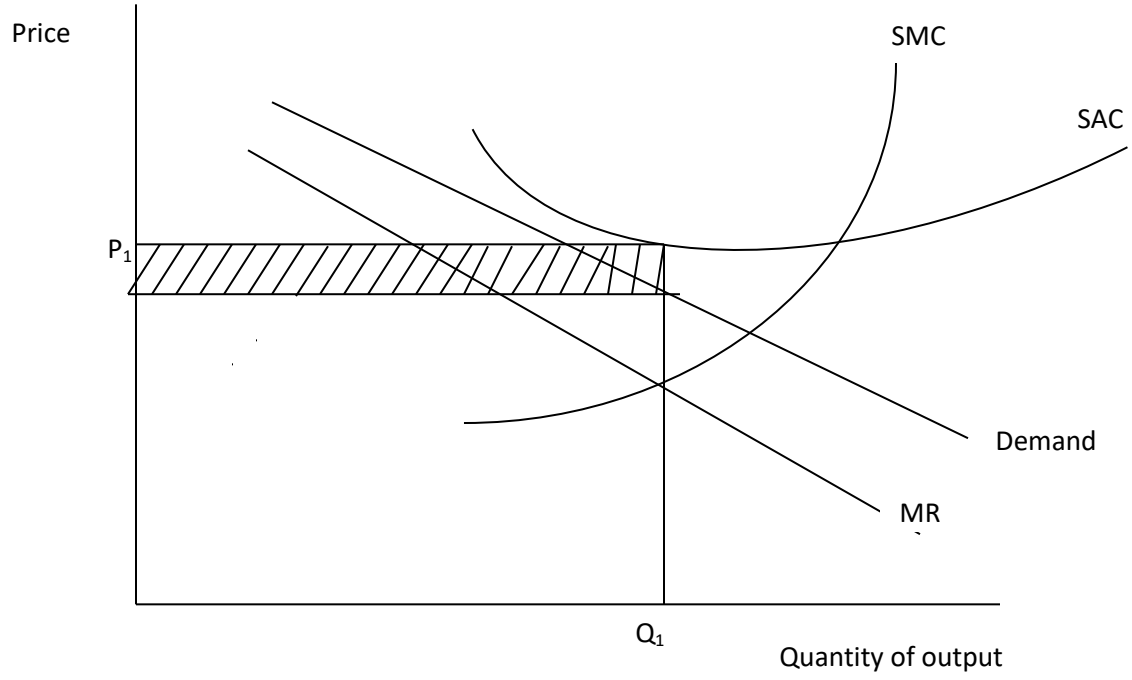


Figure 1.3(b) Short run equilibrium under monopolistic competition.

If the point of intersection takes place, where demand curve is below the average cost curve, the firm incurs a loss equal to the shaded region indicated by figure 1.3(c). This is because their total cost greater than total revenue.



Therefore, for monopolistically competitive firm to earn positive abnormal profit at equilibrium in the short run, the equality between MR and MC should take places when demand curve is greater than short run average cost curve.

1.7 Long run equilibrium

In the long run just like perfect competition, monopolistically competitive firm make change to the scale of their plant to minimize cost of production. They also decides to leave industry if they see the prospect to earning negative profit and enter in to the industry if there is a prospect of earning positive profit. Such adjustment process leads to long run equilibrium level of output and price, which is characterized by the tangency of long run average cost curve and demand curve. It is also characterized by the equality of long run marginal cost and marginal revenue. At this point total revenue equals to total cost resulting in zero economic profit. This will create disincentive to enter the market. The adjustments to such point takes place through change in the position of demand curve resulted from enter and exit of firms or price adjustment by the existing firm or a combination of the two.

In order to analyze how long run equilibrium level of output and price for a firm and an industry on the same diagram, Chamberlin made two heroic assumptions. Firms have identical cost and consumer preferences are evenly distributed among different product. That is even though the products are differentiated; all firms assumed to have identical cost and demand curves. Under these assumptions, it is possible to get a unique market equilibrium price. Given the above assumption, Chamberlin developed three distinct model of long run equilibrium.

1. Equilibrium with new firm entering the industry
2. Equilibrium with price competition
3. Equilibrium with price competition and free entry of new firms

1.7.1 Model 1 Equilibrium with new firms entering the product group

In this model, the existing firms are assumed to be in short run equilibrium realizing abnormal profit, i.e., existing firm do not have any incentive to adjust their price . Therefore, how is long run equilibrium run achieved? According to the equilibrium with new enter model, equilibrium

position can be attained through entry of new firms who are attracted by the short run positive economic profit. The entry of new firms and exit of old firms can causes shift in demand curve facing any single firm. That is increase in the number of firms through entry in the product group shifts the individual demand curve of the firm inward to the left. This is because market demand (which is relatively fixed) divided among more firms. The market share of individual firms decreases causing inward shift of individual demand curve of a firm. Therefore, entry and exit push demand curve facing any single firm toward equilibrium position where it is tangent to long run average cost curve.

As indicated in figure 1.4 below firm with long run average cost of LAC, long run marginal cost of LMC and facing a demand curve dd_1 , will set price at a point where marginal revenue equals to marginal cost in the short run. At this point firms in the product group earn abnormal

profit of area $ABCP_1$. Therefore, there is no incentive for these firms to change their price P_1 and output Q_1. However, the abnormal profits obtained by existing firms attract other new firms to enter in to the market in the long run.

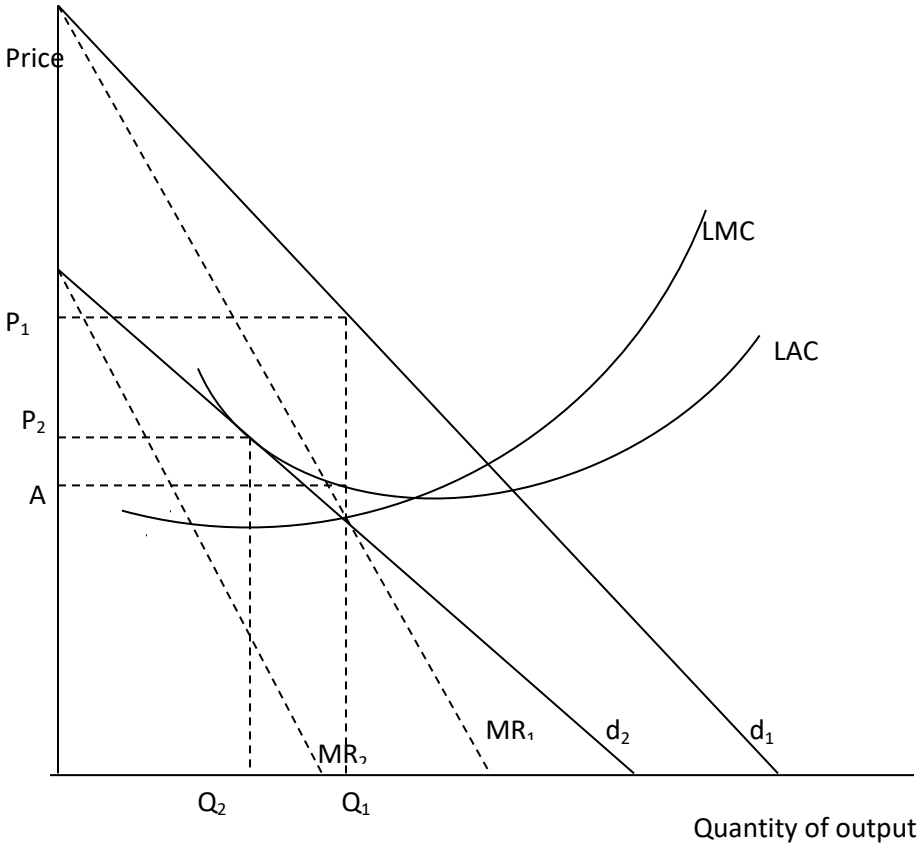


Figure 1.4: long run equilibrium with new entry of firms

As shown in figure 1-4, firms found in the product group reach short run equilibrium at price level p_1 and they do not have any incentive to change its price from p_1. However, the abnormal profit earned by existing firms attracts other new firms in to the market. When new firms enter in to the market, the market share of individual firm will decreases. This will causes inward shift in individual demand curve. Assuming that cost curves will not shift as entry occurs, each shift in demand curve result in establishment of new equilibrium at a point where new marginal revenue intersect marginal cost curve. That is, as more and more new firms entry in to the product group, there is continuous shift in the original demand curve, dd_1 . Such adjustment process continues until the shifted demand curve dd_2 ,tangent to long run average cost curve (LAC) at point E. At point E, a firm charges p_2 and produces Q_2 level of output and earns zero economic profit. When firms reach such tangency point, there is no further entry since further entry makes firms to earn negative profit (loss). Thus, the long run equilibrium becomes stable when the shifted demand curve is tangent to the long run average cost curve.

1.7.2 Model 2 Equilibrium with price competition

Equilibrium with price competition model assumes the number of firms in the industry is compatible with long run equilibrium. Therefore, no entry or exit that will take place in the long run. However, since short run equilibrium price is higher than long run equilibrium price, long run equilibrium level of price attained through price competition among firms in the product group.

To conduct the analysis of how long run equilibrium achieved under the assumption of price competition model, the second demand curve represented DD' is introduced as shown in figure 1.5. It is a curve that shows the actual sale of a firm at each price level after adjustment of price to capture more share of the market. This demand curve sometimes called actual sales or share of the market curve since it indicate the share of each firm in the product group. When competitors change their price, the market share of each firms changes and individual demand curve shifts accordingly. Connecting points that show market share of a firm when price adjustment made by competitor firm independently gives actual sales curve (market demand). A movement along DD' shows change in the actual sales of the existing firms as all of them adjusts their price simultaneously and have similar market share as before the price adjustment made.

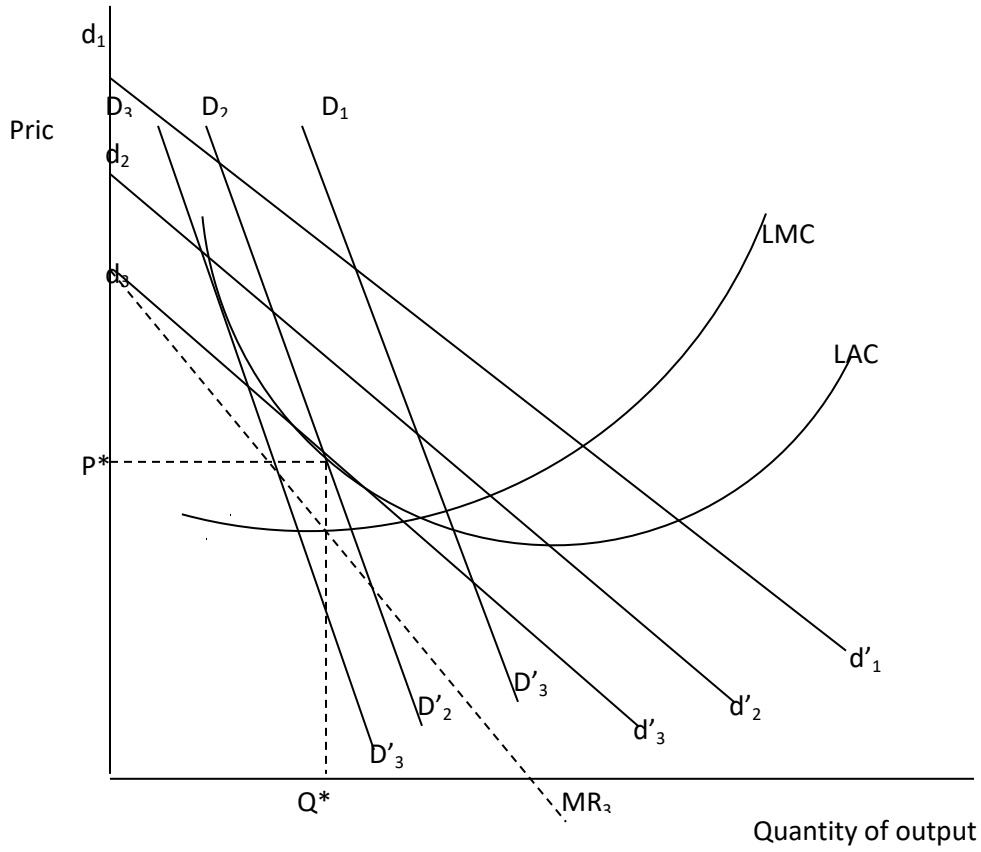


***Figure 1.4: long run equilibrium* with price competition**

Dear students, given the assumption of the model, how long run equilibrium is achieved through price competition? Let us began from short run equilibrium position like P_3 and see how long run equilibrium achieved through price adjustment of existing firm. As an attempt to maximize its profit a given firm reduce its price to increases its market share. However, the attempt is not realized, because all other firms having the same demand and cost condition have the incentive to act in the same way simultaneously. Each firm attempt to maximize their profit, ignoring the reaction of other competitor on the assumption that the effect of other firms on demand of its product is not significant.

Such action of firms shifts the individual demand curve inward resulting in small amount of sale than expected amount on the shifted demand curve dd_2 along the share curve. In the future if firms learn from their post experience, they will not do the same since it reduce their profit. However according to the model firms suffer from myopia and cannot learn form their experiences. It continues to behave on the assumption that its new demand dd_2 will not shift

further upon lowering their price. Thus the firm lower it price again in an attempt to get maximum profit, still other firms also do the same thing. This will causes inward shift in demand curve to dd_3. The process will continue until the LAC tangent to the intersection point of the shifted individual demand curve and actual sales curve at point E. This point represents long run equilibrium of monopolistically competitive firm competing through price adjustment.

1.7.3 Model 3 Equilibrium though price competition and free entry

Dear students, is the assumption of equilibrium with price competition model and new entry of firms to reach on long run equilibrium holds in real world? That means, is the number of firms in the product group in the short run is optimal as in the second model and is equilibrium achieved through free entry or exit only as in the first model. As Chamberlin suggests in actual life long run equilibrium is achieved both through price adjustment of existing firms and by new entry. This is the main assumption of the third model that we consider next.

As it is indicated Figure 1.6, price adjustment is made along the dd curve while entry (exit) cause shifts in DD curve. Equilibrium of the firm **is** stable if DD curve tangent to LAC at the intersection point between dd and DD curve (actual sales equals to planned sales). Let us see how the long run equilibrium of tangency solution achieved through price adjustment, entry and exit of firms. At short run equilibrium point, firms in the industry get abnormal economic profit. New firms being attracted to such abnormal profit, enter in to the market. This will cause shift in DD_1 curve inward stepwise as more new firms entry take place until they start to earn normal profit. At the same time, existing firms independently reduce their price on myopic assumption to maximize their profit through increasing market share emanated from price reduction. Reduction in price cause planned sales curve, dd shift inward along DD curve and assumed to stop at a point where dd curve tangent to LAC curve. However, if they continue price reduction below tangency point, each firm realizes a loss instead of positive or normal profit.

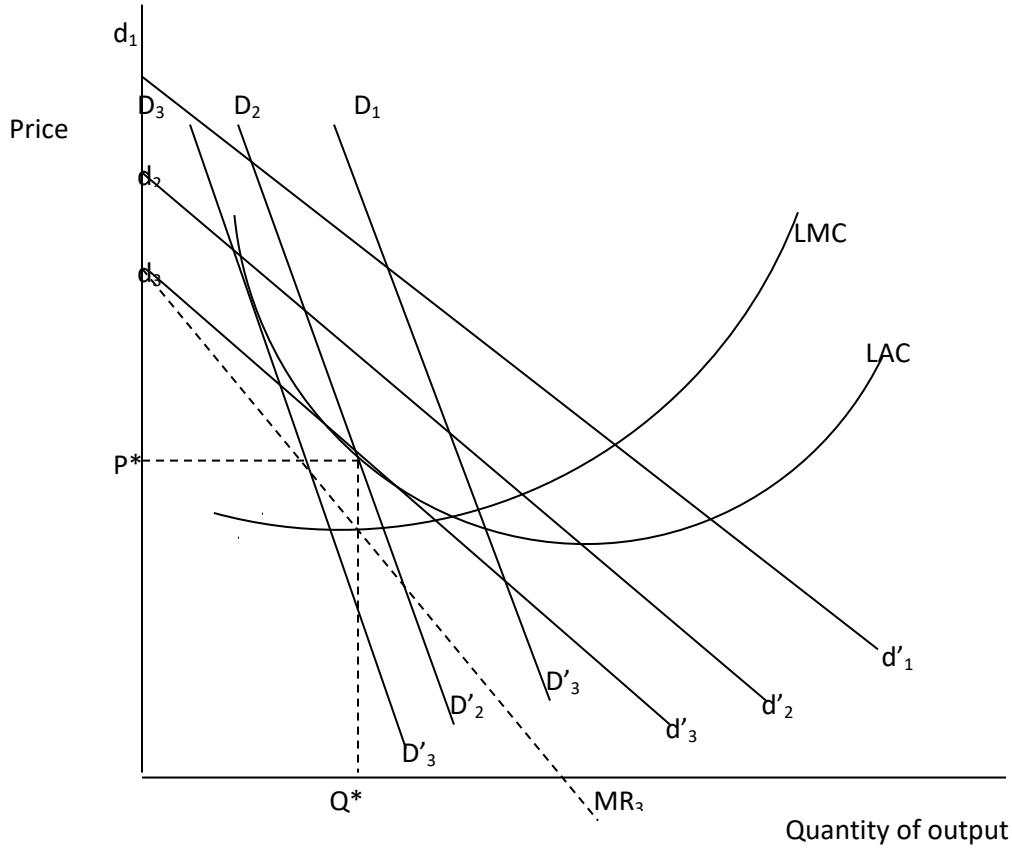


Figure 1.6: Equilibrium with price competition and free entry and exits

For example if firms reduce their price below P* they start to incur a loss and financially weak firms will eventually leave the industry first, so that surviving firms will have a large share. Exit will continue until dd curve (planned sales curve) tangent to the average cost curve at the cutting point of DD curve at point E as indicated in figure 1.6 . This point is the long run equilibrium of monopolistically competitive firm obtained through price competition and entry of new firms and exit of old firms.

1.8 Excess capacity and welfare loss in monopolist competition

As you remember from microeconomics I, firm in perfect competitive market structure operate at a minimum point of long run average cost curve in the long run. That means, it used plants at their full capacity and produced output at a minimum feasible cost. This implies resources allocated efficiently by firm operating in perfect competition market structure

compared to firms in other market models. In addition, output production decision take place at a point where P=LMC = min LAC in the long run. Thus, prices and output set at equilibrium maximize the total consumers and producer surplus compared to other firms operating in imperfect market structure. On this ground, we can use perfect competition firm decision as a benchmark to analyze the efficiency and welfare implication of firms operate in other market environment. Do firms in monopolistically competitive firm will tend to operate with excess capacity?

Long run equilibrium of the firm under monopolistic competition attained at a point where the perceived demand curve is tangent to LAC curve. Since the demand curve is downward sloping, the LAC is also downward sloping at the point of tangency. Thus, unlike prefect competition, the firm's equilibrium will not achieved at the minimum point of average cost curve. Instead, the tangency between the LAC curve and demand curve take places at down ward sloping portion of the LAC curve. That is, firms in monopolistic competition construct a plant smaller than the minimum cost size and operate it at less than the minimum cost output. Therefore monopolistically competitive firm in the long run produce output below their full capacity (below the optimal point). Their cost of production is higher than that of pure competition. This is because monopolistic competition firm incurs additional cost, which is known as selling cost.

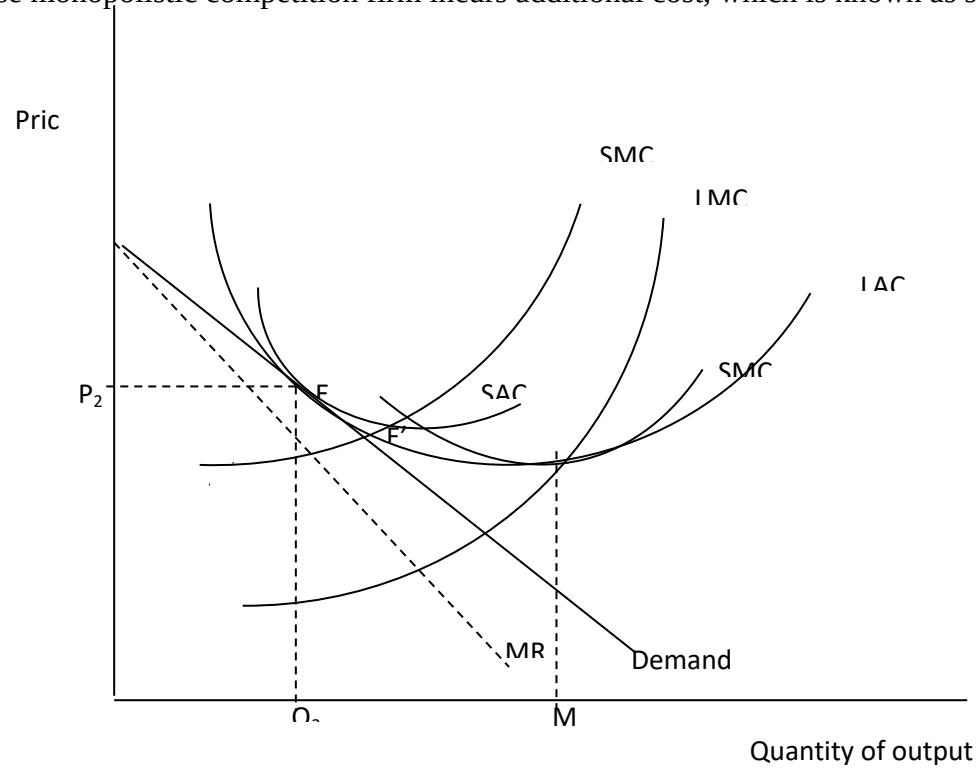


Figure 1.7 Excess capacity of monopolistic competition firm

It is clear from figure **1.7,** the short run cost curves of monopolistically competitive firm who behave in Chamberlin way building smaller plant size than a minimum cost plant and operate at point E. In addition, long run average cost curve is tangent to demand curve at point E before it reach minimum point. Therefore, firm in monopolistic competition would not even be producing at the minimum of it short run average cost, point E.

This implies monopolistically competitive firm working at suboptimal scales without exhaustively using the advantage of economies of scale. They are operating with excess capacity defined as the difference between the long run equilibrium level of output and the output level at a minimum point of LAC (equilibrium point of perfect competitive firms). It is the difference between M and Q_2

From social benefit point of View, Monopolistic competition decision did not maximize social welfare since equilibrium price is higher than MC and output is below social desired level. If attempt is made to equalize price and marginal cost, the firm incurs a loss in the long run. This is because long run marginal cost curve intersect DD_2 (shifted actual sales curve) below long run average cost curve. This implies the social desired point, P=MC cannot achieve with the assumption of monopolistically competitive market structure.

However, Chamberlin argued that the crisis of excess capacity and misallocation of resource is valid only if one assumes that demand curve of individual firm is horizontal. If demand curve is down ward sloping and firms enter in to price competition while entry is free, then point M

cannot be considered as social optimal level of output. Consumer wants to have varieties of products. Product differentiation and downward sloping demand curve reflect the desires of consumer to pay higher price in order to have choice among differentiated products. If such products produced at higher cost than minimum amount, it is socially acceptable rather than considered as social cost. Therefore, the difference between M and Q_2 would not be a measure of excess capacity for Chamberlin. Rather it represents social cost of producing and offering consumers a large diversity of products. For Chamberlin, excess capacity is the result of non-price competition coupled with free entry. In this case firm ignores it dd curve (since on price adjustment are made) and concern itself with its market share. In other words, actual sales curve

(DD) becomes the relevant demand curve of firms. Thus for Chamberlin excess capacity is the difference between Q_2 and Q_1 indicated in figure 1.

Recently, different types of research suggest that the argument of excess capacity is somewhat myopic. Avinash dixit, Michael Spence, Joseph stiglitz and other have suggested that product diversity offered to consumers by monopolistically competitive firm support the idea of social benefit. consumers have got more chance to select form wide variety of products when products are differentiated (diversified) and so the society benefit consumers have got more change to select from with variety of products when products are differentiated (diversified) . The society benefit more than its cost and social welfare is maximized

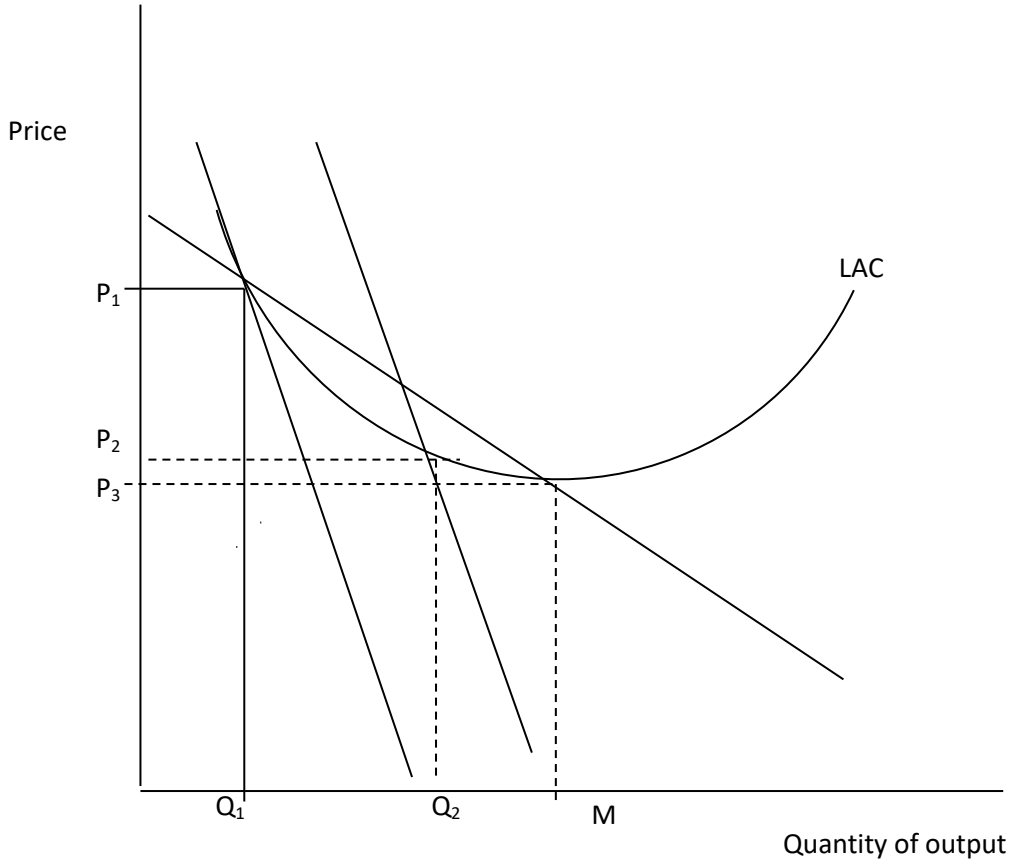


Figure 1.8 Chamberlin excess capacity

In general, compared to firm in a perfect competitive market, firm under monopolistic competition probably produces less and set a higher price. The demand curve confronting the

monopolistic competitor would not be perfectly elastic as in perfect competitive firm. Its marginal revenue therefore, is lower than price compared to the equality of marginal revenue with price in perfect competitive market. On the other hand, monopolistically competitive firms are likely to have lower profit greater output, and lower price compared to monopolistic firm.

1.9 Critiques of Chamberlin large group monopolistic competition market model

This model could be attacked on the following points;-

- The assumption of product differentiation is incompatible with the assumption of independent action and free entry of firms. It assumes that the firm actions are independent but firms are dependent on each other. There are also entry barrier for new firms.

- It is difficult to accept the myopic behavior of business firm implied in the model. Normally, business firms learn from their experience.

- The concept of industry is destroyed by recognition of product differentiation. Heterogeneous products cannot be added together to form industries demand curve in order to come up with a unique Equilibrium price.

- The model assumes a large number of firms with higher price elasticity of product sold in monopolistic competitive market. But, the do not objectively defined the number of firms and the level of elasticity required to have a monopolistic competitive market structure.

Contributions of the model

- Introduce the concept of product differentiation and selling strategy as two additional policy variables in optimal decision-making process of the firm. These factors are the basis of non-price competition, which is a typical form of competition in real world.

- It introduces the concept of share of the market demand curve as a tool of analysis.

Summary

- Monopolistic competition is a market structure in which large number of firms competes by selling differentiated products. Even though the products are differentiated, they are still close substitute.

- Product differentiation can be fancied or real. Fancied product differentiation is a case when the products are the same but the consumer is persuaded through different sells promotion activity such as advertisement that its product is unique from its close substitute

- Real differentiation is case when the inhertant character of the product is different. Each close substitute differs in terms of the input used, quality and location.

- Products differentiation gives monopolistic competition firm a certain monopolistic power to influence the price of its product. Compared to monopolistic firm the monopoly power is restricted by the existence of close substitute.

- Product differentiation give rise to downward sloping demand curve. Firms can increase price without losing all its customers or has to reduce price to attract more customers.

- Monopolistically competitive market has U-shaped cost curves like the case in a perfectly competitive market. However, cost of monopolistic competition firm includes selling cost in addition to traditional production cost.

- In monopolistic competition, there is a need for advertising to convince consumers that the product is indeed unique and better.

- In the short run, monopolistic competition firms acts as a monopolist and optimal decision by equating marginal revenue with marginal cost. At a point where marginal revenue equals to marginal cost, the firm earn positive or abnormal profit provided that it takes place where demand curve greater than the minimum point of short run AC curve.

- Long run equilibrium is of monopolistic competitive firm achieved at a point where demand curve is tangent to the falling portion of long run average cost curve. The tangency point arrive through adjustment caused by shift in demand curves due:
  - Price competition
  - entry of new firms attracted by short run abnormal profit
  - Both through entry of new firms and price competition at the same time
- Monopolistic competition firm in the long run make output decision at higher cost. It is produced at a point before the minimum long run average cost. As a result firms in monopolistic competition industry said to be inefficient. They could not use the full capacity.
- From social point of view monopolistic competition firm would not maximizes social welfare in the long run. This because they set prices above the marginal cost.

Review questions

1. Describe the feature of monopolistic competition that resembles perfect competitive and then monopolistic market structure.
2. Determine whether the following firms operate in a monopolistic, perfect competitive or monopolistically competitive market structure.
   a) barber shop
   b) restaurants
   c) Ice cream producers.
   d) laundry soap producers
   e) tooth paste producers
3. How does a firm under take product differentiation?
4. Does product differentiation have any implication on the demand for the product of a firm and its market power?

5. From demand curve of monopolistic competition and monopolistic firm, which one is more price elastic and Why?

4. Does cost structure of monopolistically competitive firm have any difference from firms found in other market structure? If yes how?

5. What is the difference between product group and industry?

6. State the assumption made by Chamberlin in order to get unique equilibrium price and market demand and supply for differentiated product.

7. State short run profit maximization condition of a monopolistically competitive firm.

8. Describe how long run equilibrium of monopolistically competitive firm achieved according to:

   A. Equilibrium with price competition model
   B. Equilibrium with entry and exit of firms model

9. What condition should satisfy for monopolistically competitive firm to maximize long run profit? How much profit would the firm earn at this long run equilibrium point?
10. Define monopolistic competition excess capacity.

11. State the condition at which output and price set to maximizes social welfare and achieve production efficiency.

12. Do the long run equilibrium level output and price maximize social welfare? Why?

13. Describe the contributions of monopolistically competitive market model to microeconomics theory.

CHAPTER TWO

OLIGOPOLY MARKET STRUCTURE

2.1 Introduction

Dear students, in theory of Microeconomics I, we have studied perfect competition and monopoly market structure. Both of them in common assume that the decision taken by any particular firm has no diffused effect on the environment in which other firms operate. Individual firm therefore safely neglect the reaction or behavior of its competitor in making its decision. Especially, the issue of strategic interaction between firms is irrelevant in perfect competition because the prevailing market price convey all the external information that was relevant to the firm. Is the above feature of firms can be applied to firms in oligopoly market structure? No, because when small number of large firms dominating a particular industry producing homogenous or differentiated product, any change in a firm's price or output influence the sales and profit of its competitors. As a result, each firm formulates its policies and strategies with an eye on its competitor decision. A market model, which considers such interdependence of few firms when making optimal decision, is called oligopoly market model/structure, which is the subject of this chapter.

The chapter begins with discussion about the characteristics and source of oligopoly market model; then, examine various collusive and non-collusive duopoly model optimal price and output determination under different behavioral assumption about the firms operating in different oligopoly industry.

Learning objective

At the end of the chapter, you are expected to:

- Differentiate oligopoly from other forms of market
- Identify how interdependence between firms affect their optimal decision
- Explain the difference between different duopoly models

- Explain how equilibrium price and output determined in collusive and non-collusive oligopoly market structure.

Oligopoly

As it is mentioned above, oligopoly is a market structure dominated by few sellers of homogenous or differentiated product. As a result, the action of each firm affects the other firm's decision in the industry. A beer industry in Ethiopia is a good example of such type of industry. Each of the major beer producers takes in to account the reaction of others when they formulate their price and output policies. Bedel or Dashen in this case know that its own action will have significant impact on the rest of the beer producers. Therefore, Bedel or any other producer considers the possible reaction of its competitor in deciding prices, degree of product differentiation to be introduced, the level of advertisement to be undertaken and the amount of service to be provided and so on.

Automobile industry, which produces different cars and aerospace industry producing different airplanes are also an example of oligopoly industry. Note also that, all oligopolists are not necessary large firms as given in the above example. Two grocery stores that exist in isolated community can be oligopolists given that their decisions are interdependent and they are the sole supplier of a specific product. This implies that the distinguishing feature of oligopoly is the interdependence of decision making by rivalry firms in an industry. Such interdependence between firms is the natural result of the existence of few numbers of firms in an industry.

In summary, oligopoly market structure is a market structure which contain firms characterized by the following features

- ❖ Few number of firms in a given industry
- ❖ Interdependence of firms in decision making
- ❖ Firms produce homogenous or differentiated product
- ❖ Firms have some power to set price

MICROECONOMICS II

Well students by now we have get familiar to the key features of the four different types market structure (perfect competition, monopolistic competition, oligopoly and monopoly)

To recap the main points, their comparison in terms of market power, entry condition of new firms and strategic behaviors of the firms are summarized in table 2.1.

Table 2.1 properties of monopoly, oligopoly, monopolistic competition and perfect competition

	Characteristics	Monopoly	Oligopoly	Monopolistic competition	Perfect competition
1	Number of firms in an industry	One	Few	Few or Many	Many
2	Type of product	Single (unique)	Homogenous or differentiated	Differentiated	Homogenous
3	Ability to set price	Price setter	Price setter but have very limited power	Price setter with limited power	Price taker
4	Profit maximization condition	MR=MC	MR=MC	MR=MC	MR= MC =P
5	Entry condition	No entry	Limited entry	easy entry	Free entry
6	Strategic dependence firms on its rivals	Has no rival	Yes	Yes	No
7	Example	Local natural gas utility	Automobile manufacturer	Retail trades	Apple farmers

Causes of Oligopoly

There are many cause of oligopoly market. Some of them are

1. **Economies of scale**: low costs cannot achieved in some industries unless a few firms are producing output that account for substantial percentages of the total market demand .That means the average cost of production reach minimum only when the output produced in large amount by a few firms. As result, the number of firms in such type of industry should be reduced in order to make use of the advantage of economies of scale in production. Economies of scale in sales promotion and advertising may also promote oligopoly.

2. **Barriers to entry**: - there are varieties of barrier that did not allow the entry of some firms in to the industry. This barrier may be technological, skill, cost, size of the market in relation to economies of scale , patent right and different activities of government such as licensing and marketing quota

3. **Collusion (merger of small firms):** Small firms collide to get market power and overcome their competitor's pressure. If they gain market power, firms set higher price and restricts output supply that maximizes their profit. Such firms develop to oligopoly while other removed from the market.

Dear students, from our pervious section discussion you have some idea about the general features of oligopoly market structure and its cause. Now let us identify different types of oligopoly model and see how equilibrium level of output and prices are determined in each model given their underlying assumption. For simplicity, we consider only the case of two firms that is termed as duopoly. In addition, we limit our self to the study of firms producing homogenous product. This will allow us to avoid the problem related to analysis product differentiation and focus on the study of strategic interaction between firms.

Based on the reaction pattern of firms in the industry, it is possible to classify oligopoly in to two groups. These are collusive oligopoly and non-collusive oligopoly. Non-collusive oligopoly is a condition in which firms operate independently to determine the optimal level of price and output. That is firms in the industry will not go in to contractual agreement to cooperate in

making optimal decision. Under such cases, negotiation and enforcement of binding agreement is not possible even though each firms make some expectation (assumption) about the reaction of its rivalry in response to its action or observe the decision of its rivalry while setting profit maximizing level of output and price. For example, if a firm in non-collusive oligopoly wants to increase output or price to maximize its profit, it has to assume something about the possible reaction of its rivalry and the effect of the reaction on profit maximization process.

Dear students do you think that the assumption firms make about their rival firm is the same in all different type of non-collusive oligopoly model. The answer to this question will obtain after discussing the different non-collusive oligopoly in subsequent subsections. Here are some of non-collusive oligopoly model that we will consider right now after a moment

1. Kinked demand model
2. Cournot duopoly model
3. Bertrand duopoly model
4. Stackelberg duopoly model

In collusive oligopoly however, firms get together to make open and formal agreement in setting prices and output so as to maximizes the total profit of the industry as in the case of cartel. It can be also implicit cooperation of firms in the industry without actually making explicitly agreement with one an other as in the case of price leader

2.2 Non collusive oligopoly

2.2.1 The kinked demand curve model

Dear students as you know from your pervious microeconomic course, Price in perfect competition, monopoly and monopolistic competition markets adjusts rapidly to changing cost or demand conditions. Is the adjustment of price possible to change in cost and demand conditions in the case of oligopoly market like in other market? For instance, is the price of beer or soft drink changes frequently as their demand and cost condition changes? You might answer these

questions based up on the assumption how oligopolist react to each other's decisions according to kinked demand curve model.

The kinked demand curve model, developed by Paul Sweezy in 1939, explains why prices are rigid in some oligopoly market. The model assume that oligopolist often have strong desire to keep stable price. Even under the condition when cost and demand changes, firms are reluctant to change their prices. If costs fall or market demand declines, they fear that the lower prices send the wrong message to their competitors and initiate price war among them. If costs and demand rises, they do not increase price because they are afraid that their competitors may not raise their price.

According to this model therefore, demand curve facing each firm in oligopoly market is kinked at prevailing market price (Chamberlin's intersection of individual and market demand) reflecting the following behavioral pattern of oligopolists. Rivalry firms expected to follow decrease in price but ignore price increase. That means if a firm increases its price, due to increase cost of production or increase demand for its product, it would loss most of its customer and cause total revenue to decrease. This is because other firms in the industry would not follow the increase in price. As result, given that the product produced in the industry is homogenous, consumer preference shifts from the other hand an oligopolist could not increase its market share by lowerintend to maintain prices constant even under the condition where their demand and cost changes as shown in figure 2.1. The demand curve is much more elastic above point E (kinked point) than below the kink on the assumption that the competitors will not follow price increase but quickly follow price decrease.

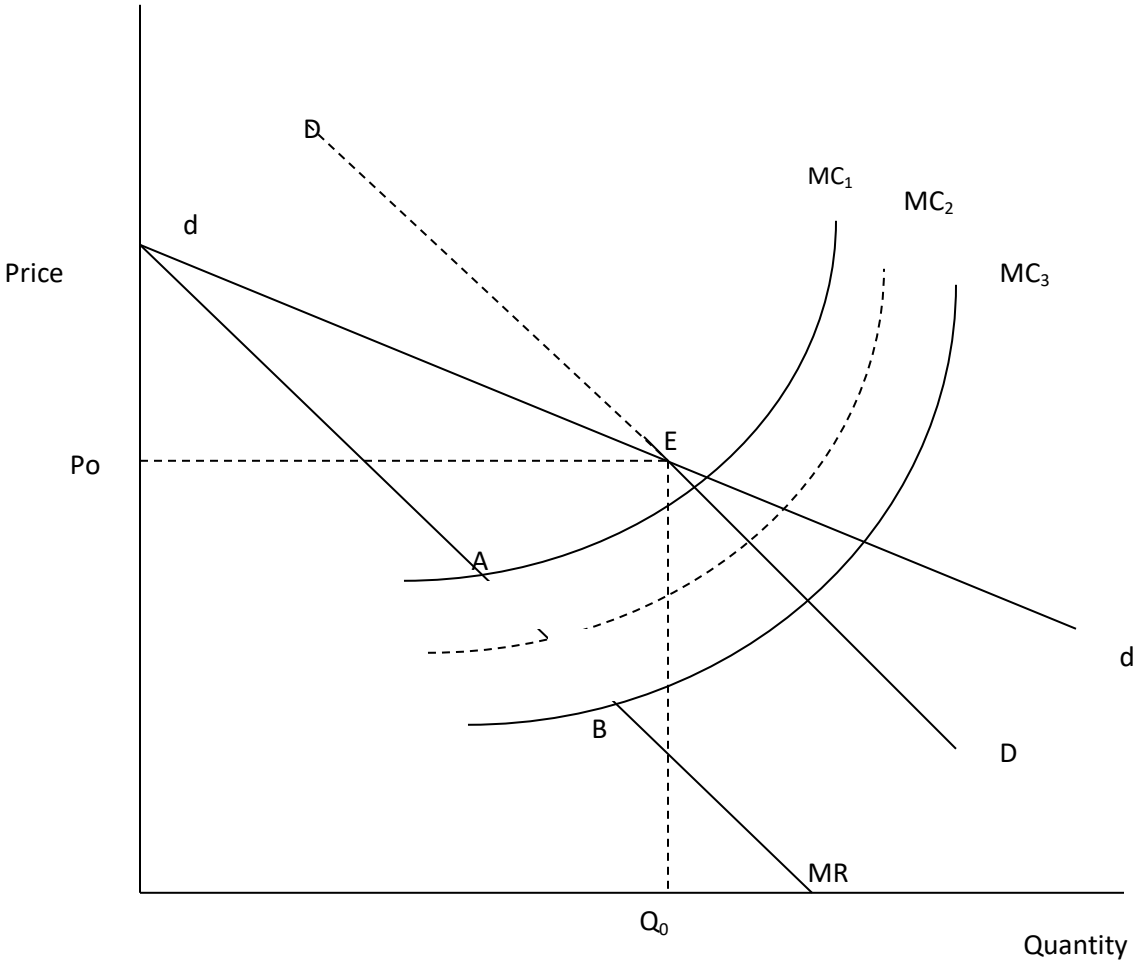


Figure 2.1: The kinked demand curve

As shown in the above figure 2.1, an oligopolist firm faces two demand curves for different ranges of prices. Above P_0 the relevant demand curve for the firm is dE. Because if the firm increases its price, it would lose some of its customer to firm that maintained their previous price. The firm will then face a demand curve given by dE, which is very elastic. On the other hand, if the firm decreases its price below P_o form the intention of increasing their market share, they will not able to increase their market share, since other firms also decrease their price in order to keep up their customers. Therefore, below P_o the relevant demand curve of the firm is ED. This implies the demand curve facing oligopolies is not straight line, rather kinked at a certain price.

Well students, we have seen that oligopolist is reluctant to price change in response to change in their cost and demand condition. Thus, their demand curve is kinked at the intersection point of market and individual demand curve to reflect the rigidity of prices. Now let us see how their marginal revenue curve derived and how they undertake optimal decision. Normally, marginal revenue curve derived from demand curve. So the marginal revenue curve associated to kinked demand curve is discontinues at the level of output corresponds to the kinked point. It has two segments as indicated in figure 2.1, dA and BMR. Segment dA corresponds to the upper part of demand curve, while the segment BMR corresponds to the lower part of demand curve and the kink point on demand curve corresponds to the discontinuous portion of marginal revenue curve.

The point of kink defines equilibrium of the firm since at any point to the left of the kink, MC is below MR, while to the right of the kink; MC is larger than MR. Thus profit of the firm maximized at the point of the kink. However, this equilibrium is not necessary defined by the intersection of MC and MR curve. So long as MC passes through segment AB, the firm maximizes its profit by producing Q_o and charging p_o level of price. This level of price and output is compatible with wide range of cost.

To sum up, the kinked demand curve model give us some insight about why price and output will not change despite changes in cost and demand in oligopoly market structure. The only case where a rise in cost results in increase in price is when the rise in cost equally affects all firms in the industry. It is important to note here that a kinked demand curve model does not explain how equilibrium price and output determined like other models rather, explain why price once set remain fixed. Lastly some economists have been very critical of the model's assumption .It would certainly be a mistake to conclude that oligopolies in general are unresponsive to change in cost as well as unresponsive to change in demand in the world of technological advancement and change in taste of consumer preference. Perhaps we observe the opposite in many oligopoly industries.

2.2.2 Cournot model

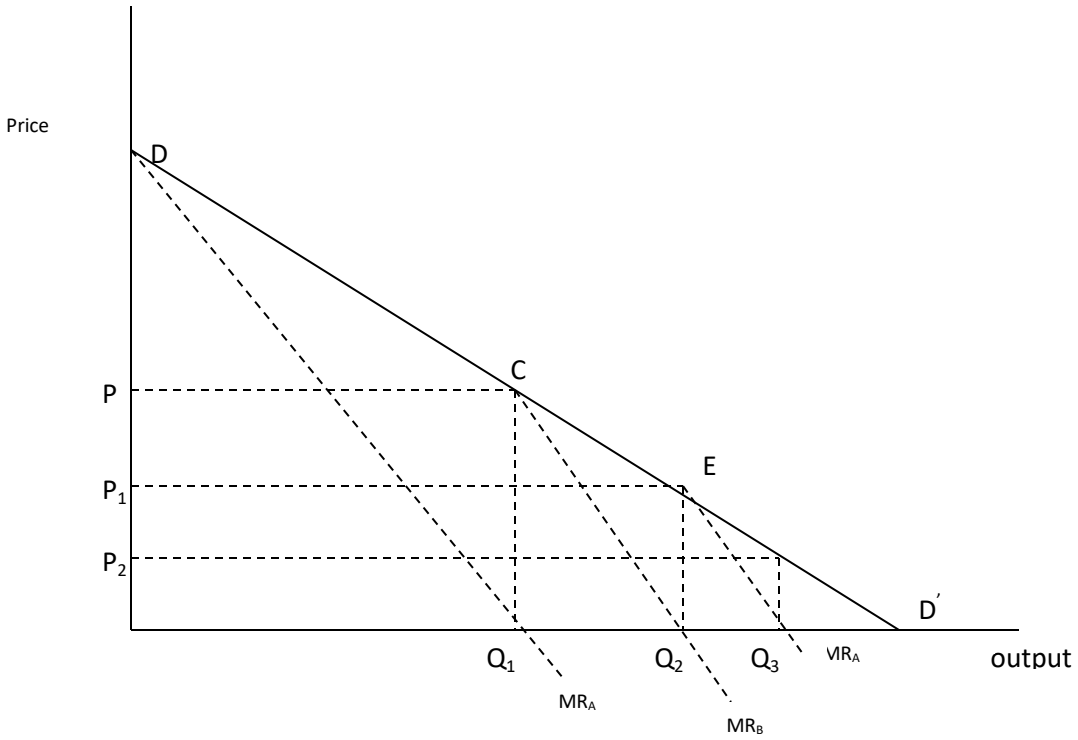
A French mathematician, Augustine Cournot in 1938 using two firm producing homogenous products, illustrated cournot model for the first time. He illustrates the model assuming two firms having identical cost facing linear market demand. Given these assumptions, each firms known

that the market price will depend on the total output of both firms. Thus to maximize their profit each of the cournot duopolist simultaneously decides, how much to produce by taking its rivals' output constant at existing level regardless of what output it decides to produce . Thus, each firm takes the other firms output level as given and chooses its own output level to maximize profit. The level of output that it chooses will, of course depend on how much it thinks its rival will produce. In other words, each firm recognizes that its own decision about output y_i will affect its revenue through affecting market price but any one firm has output decisions do not affect those

of any other firm. That is, each firm recognizes that $\partial p / \partial y_i \neq 0$ but assume that $\partial y_j / \partial y_i = 0$, for $j \neq i$.

Dear students now let us see cournot simplified illustration of the model. He started his illustration by assuming that there are two firms (firm-A and firm-B), each producing mineral water at zero cost and face linear demand curve DD as shown in figure 2.2. . Each firm also acts on the naïve assumption that its competitor will not change its output when deciding its profit maximizing level of output**.**

Assume that firm A is the first to start producing and selling mineral water assuming that firm B produce nothing. Firm-A therefore thinks that its effective demand curve is the market demand because the firm thinks that it will be the sole producer of mineral water. So to find the profit maximizing level of output and price, we use the marginal principle (MR=MC). Since it is assumed that cost of production equals to zero MC is also zero. Therefore profit maximization condition of the firm reduced to MR= 0. This point corresponds to Q_1 level of output that is half of the total market demand.



Now firm-B assume that firm-A will keep its output fixed at Q_1 and define CD' as its relevant demand curve to determine its profit maximizing level of output. Applying the same marginal rule to the perceived demand section, firm-B produce half of the market which is not supplied by firm-A. That is B's profit maximizing level of output is $\frac{1}{4} = (\frac{1}{2}.\frac{1}{2})$ of the total market demand. This point represented by Q_2.

In the next round, firm-A assumes B will produce fixed level of output as before ($\frac{1}{4}$ of the total market), it will produce half of what is not supplied by B, $\frac{1}{2}\left(1-\frac{1}{4}\right) = \frac{3}{8}$ of the total market demand firm-B. Also reacts in the same fashion and produces $\frac{1}{2}\left(1-\frac{3}{8}\right)=\frac{5}{16}$ of the total market. This action and reaction pattern continues, since the firms are acting on the naive behavioral assumption (firms cannot learn from their experience).Eventually, the equilibrium level of output

obtained, when each firm produces one-third of the total market. This equilibrium level can obtained as follows

Firm A's equilibrium level of output at different successive period;

Period-1: $\frac{1}{2}$

Period-2: $\frac{1}{2}\left(1-\frac{1}{4}\right)=\frac{3}{8}=\frac{1}{2}-\frac{1}{8}$

Period-3: $\frac{1}{2}\left(1-\frac{5}{16}\right)=\frac{1}{2}-\frac{1}{8}-\frac{1}{32}$

Period-4: $\frac{1}{2}\left(1-\frac{43}{128}\right)=\frac{43}{128}=\frac{1}{2}-\frac{1}{8}-\frac{1}{32}-\frac{1}{128}$

We can get equilibrium level of output for firm-by adding up the different level of output firm-A produces by assuming a given level of output supply by firm-b's: $=\frac{1}{2}-\frac{1}{8}-\frac{1}{28}-\frac{1}{512}.....$

$$=\frac{1}{2}-\left[\frac{1}{8}+\frac{1}{8}*\frac{1}{4}+\frac{1}{8}*\left(\frac{1}{4}\right)^2+\frac{1}{8}*\left(\frac{1}{4}\right)^3+.....\right]$$

The expression in parenthesis is infinite geometric progression with common ratio r $=\frac{1}{4}$. Applying the summation formula for an infinite geometric series, $G_n = \frac{G_1}{1-r}$ (G_n- the sum of N geometries infinite series, G_1- the first term of geometric infinite series and

r- Common ratio

$= \frac{1}{2}-\frac{\frac{1}{8}}{1-\frac{1}{4}}=\frac{1}{3}$ -Of total market demand

For firm –B:

Period-1: $\frac{1}{4}=\frac{1}{2}\left(1-\frac{1}{2}\right)$

Period-2: $\frac{5}{16}=\frac{1}{2}\left(1-\frac{3}{8}\right)=\frac{5}{16}=\frac{1}{4}+\frac{1}{16}$

Period-3: $\frac{21}{64}=\frac{1}{2}\left(1-\frac{11}{32}\right)=\frac{1}{4}+\frac{1}{16}+\frac{1}{64}$

Period 4: $\frac{85}{256}=\frac{1}{2}\left(1-\frac{43}{128}\right)=\frac{1}{4}+\frac{1}{16}+\frac{1}{64}+\frac{1}{256}$

We can write B's equilibrium level of output as $\frac{1}{4}+\frac{1}{4}\left(\frac{1}{4}\right)+\frac{1}{4}\left(\frac{1}{4}\right)^2+\frac{1}{4}\left(\frac{1}{4}\right)^3,,,$

$=\frac{G_1}{1-r}=\frac{\frac{1}{4}}{1-\frac{1}{4}}=\frac{1}{3}$ Of the total market demand.

Example: If the market demand for cournot's mineral water in the example above is, equals to 120, what level of output maximize the profit of each firm.

Solution: we said under the above assumption (zero cost and cournot behavioral assumption) the two firms maximize its profit by producing $\frac{1}{3}$ of the total market demand each, that is,

$\frac{1}{3}(120)=40$

Therefore, under cournot costless production assumption, the output level that maximizes the profit of a duopolist is equal to 1/3 of the total market. By similar analogy, it is also possible to generalize for N-firm cases. That is for an industry with n-firms the output, which

maximizes the profit of a firm, is $\frac{1}{n+1}$ of the total market demand. For example if there are four firms in an industry act under cournot naïve assumption, the output level that maximizes the profit of each firm is $\frac{1}{5} = \left[\frac{1}{1+4}\right]$ of the total market demand.

Dear students, is the costless production (identical cost and demand) assumption of cournot in the above analysis is realistic? No, because there are different type of cost involved in production in real world and definitely, the cost of production in most cases different from one firm to the other. Hence, let us reconsider the model after relaxing identical cost and demand assumptions. In other words how much should each firm produce to maximizes their profit if they under take production of their output at different cost and demand condition. This can be determined using another approach called a reaction curve approach that we consider next.

2.2.2.1 Reaction curve approach

Under this approach, we try to see how cournot duopolist choice output level that maximizes their profit after relaxing the identical cost and demand assumption. Here we use the reaction curves of the two firms to determine the optimal level of output of the duopolist under the basic cournot behavioral assumption. So before using the reaction curves as a tool for determination of the optimal choose of the firms, it is helpful first if we understand what a reaction curve is and how one can derive a reaction curve.

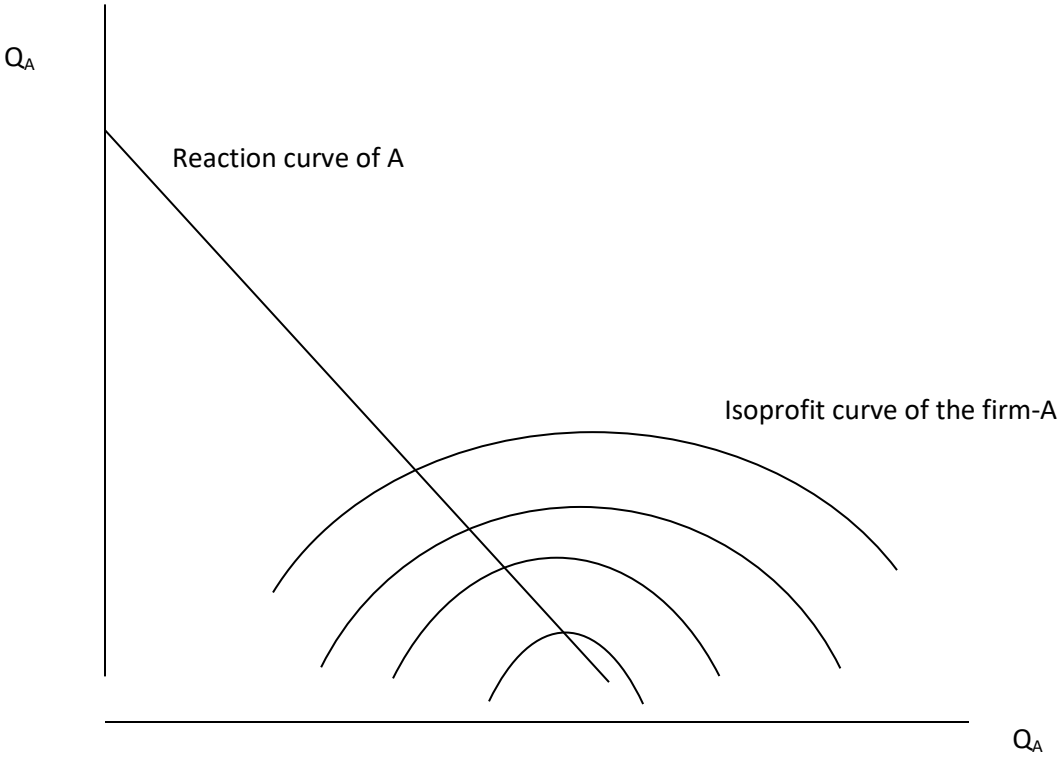


Figure 2.3.: (a): Isoprofit of firm-A

A reaction curve is a graphic representation of reaction function. A reaction function is a function that shows the functional relationship between the optimal output level of one firm and its beliefs about other firm optimal choice. For instance, reaction function of firm-A shows, how firm-A will react in making its output decision to its perception of how much it thinks firm-B will produce and sell. That is for firm-A to decide to produce let say Y_1 level of output, it has to forecast first the amount of output firm-B produce such as Y_2. A function which shows the amount of Y_1 as a function of Y_2 gives the reaction of firm-A. Similarly, reaction function of firm-B defined in the same fashion.

Graphically the reaction curve of cournot duopolists derived from their respective isoprofit curve. A curve contains a locus of point that yields the same level of profit for the firm. Isoprofit of firm-A is the locus of points defined by different level of output of firm-A and its rival B which yields the same level of profit to firm-A. Similarly, isoprofit curve of firm-B is the locus of point defined by different level of output of firm-B and its rival firm-A which yields the same level of profit to firm B. The isoprofit curves of the two firms given in figure

2.3 (a) & (b). From the definition, it should be clear that the isoprofit curves are a type of indifference curve

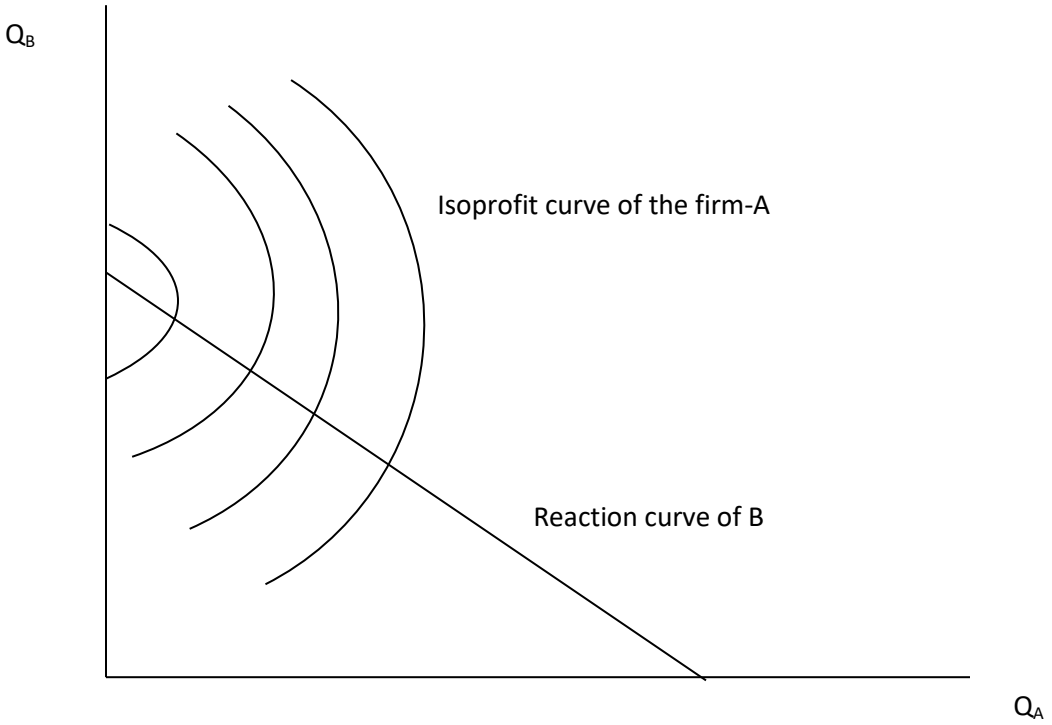


Figure 2.3.: (b): isoprofit of firm- B

Properties of isoprofit curve

1.Isoprofit curves for substitute commodities are concave to the axis along which we measure the output of the rival as indicated in figure 2.3.a and b. Therefore, isoprofit of firm-A is concave to axis that measures the output of A and isoprofit curve of firm-B is concave to the quantity axis of firm-B. The shape of isoprofit curve of firm-A shows how A react to B's output decision so as to retain a given level of profit. For example, consider the isoprofit curve of firm-A, π_A and firm-B, π_B as in the figure- 2.4.below. It is concave to A's quantity axis

Let us suppose that B decide to produces B_1 amount of output, firm-A will realizes the same level of profit by producing A_h or A_g amount of output. Assume firm-A decide to produce A_g amount of output. If firm-B increases its output to B_2, firm-A must decreases its output to A_f to maintain the same level of profit. If firm-A continue producing A_g amount while firm-B increase its output level to B_2 the total amount of output supplied to the market increase and result in

decrease in prices and hence profit of the firms. If B further increases its output to point B_3, firm-A should decrease its output to A_e, otherwise it result in reduction of price and then profit .Beyond point E, increase in output by firm-B result in fall in market price and increase cost of production which result in decrease in profit of the firm. This is indicated by out ward shift in isoprofit function to π_{A2} ,representing lower level of profit .This implies the isoprofit line which is found far from quantity axis represent lower level of profit while the isoprofit curve found nearer to quantity axis represent higher level of profit

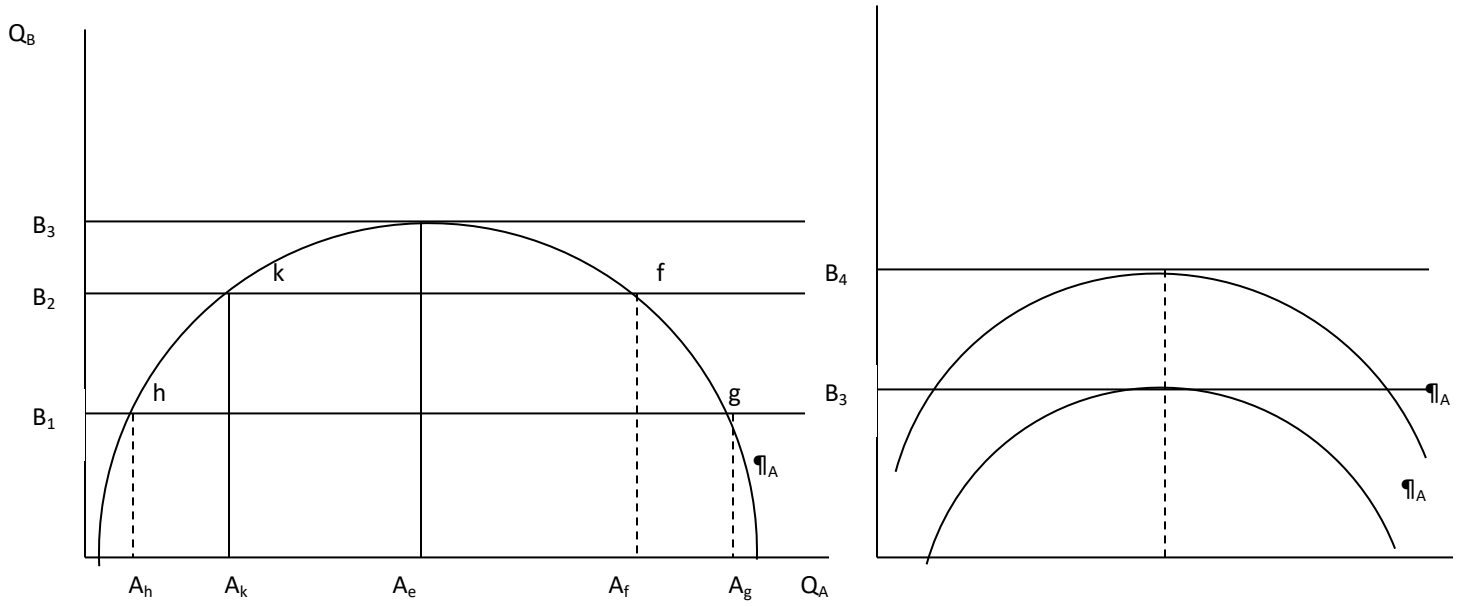


Figure 2.4.: isoprofit curves

2. For firm-A the highest points of successive isoprofit curves lies to the left of each as we go further away from A's quantity axis and lies to the right of each other as we go towards to quantity axis. On the other hand the highest point of the isoprofit curves of firm-B lies to the right of each other as we move further away from the quantity axis)Q_A and lies to the left as we move toward the quantity axis. Joining these respective highest points of isoprofit curve of the two firms gives their reaction curve. Hence, the reaction curve of firm-A is a locus of highest point of Isoprofit that firm-A can attain, given the level of output of rival B. The reaction curve of firm-B also represent the locus of highest isoprofit point that firm-B can attain as indicated in figure 2.3. (a) and (b).

Dear students we have seen what a reaction curve is and how to derive it form isoprofit curve. Now let us seen how reaction curves used to determine the equilibrium level of output for cournot duopolist. Each firms reaction curve tell us how much to produce given the output of its competitor. Therefore, at equilibrium the belief that each firm make about other's firm output level during setting their output is equal to the actual amount of output produced by its rival. This point corresponds to the intersection of two reaction curves, point e as shown in figure 2.4.

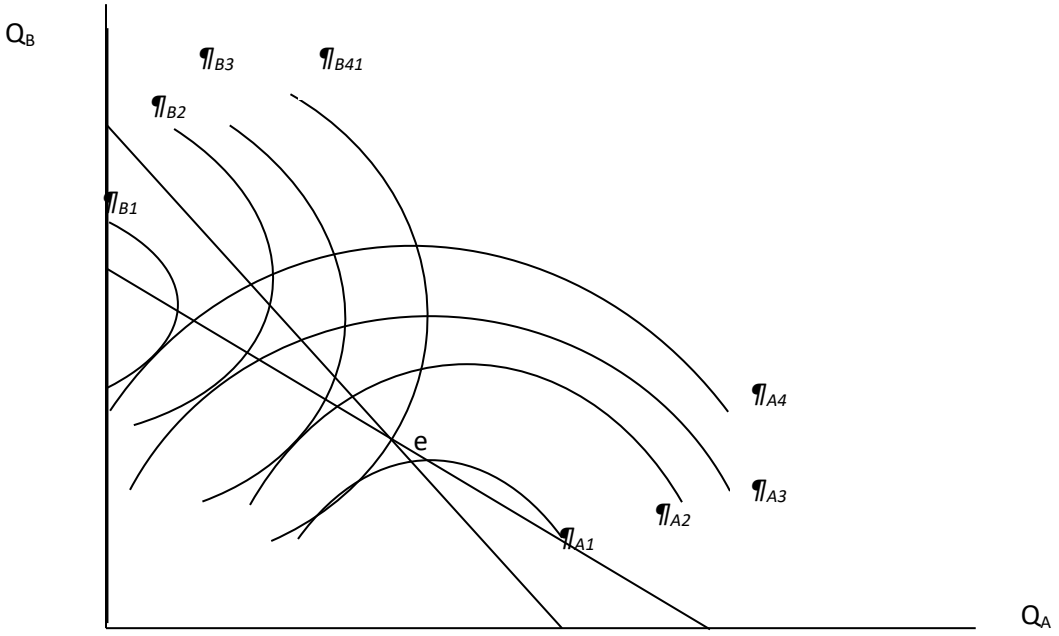


Figure 2.4.: cournot's duopoly model equilibrium

Note that at point e, each firm maximizes its own profit but the industry's (joint profit) profit is not maximized. This can easily seen by referring to the contract curve. It is the curve formed by joining the tangency point between the two firms' isoprofit curves. Points on this curve represents optimal point (maximize industry's profit). Points off contract curve however represent lower level profit to one firm or both profits. Therefore, since point e found off the contract curve it cannot maximizes industry's profit and represents suboptimal level of output. Such suboptimal resource allocation is the result of naïve cournot behavioral assumption of firms cannot learn forms their experience. Had they learn from experience, they would show a different strategic behavior. For instance, they would have come together and agree to share the market in such a way that would raise the profit of the two firms or the industry as the whole.

2.2.2.2 Mathematical version of Cournot's duopoly model

So far, we have seen graphical presentation of cournot model. Now let us see mathematical treatment of the model. Determining equilibrium output level of the cournot duopolists mathematically given their cost and demand function. Here we begin from the assumption of the model, each firm decide how much to produce by treating its competitor level of output fixed at existing level. For example, if the units of output that firm-2 produce currently is Y_2, firm 1 assume firm 2 continue producing Y_2 amount of output while deciding to produce Y_1 unit of output. So the total output supplied to the market equals $Y=Y_2 +Y_1$ and the market price of the product, $P(y) = P(Y_1+Y_2)$. Given the cost function of firm 1, $C_1(Y_1)$ and firm 2, $C_2(Y_2)$, we can define the profit maximization problem of the firms as follows.

For firm 1: Max $P(Y_1+Y_2)\, Y_1-C_1(Y_1)$

For firm 2: Max $P(Y_1+Y_2)\, Y_1- C_2(Y_2)$

Following the usually optimization procedure, take the first order condition of the profit function of each firm with respect to choice variable (their output level). The result of first order condition gives the reaction function of each firm. Then solve the two-reaction curves to gather simultaneously to get the equilibrium output level of the two firms.

Example: Suppose that two firms producing identical product and supply to a market with a linear demand function, $p(y) = 60 - 2y$. Where $y = y_1 + y_2$ and y_1 represent unit of output produce by firms-1 and y_2 represent unit of output produce by firm two. The cost of production of firm 1 and firm-2 is given by $c_1(y_1) = y_1^2$ and $c_2(y_2) = 4y_2$ respectively .Find the output level that the two firms should produce to maximizes their profit under cournot behavioral assumption.

Solution: starts solving the problem by defining the profit maximization problem of the two firms.

Firm-1 $\max \pi_1 = \max\left[\, p(y_1 + y_2)\right] Y_1 - c_1(y_1)$

$$\Pi_1 = [60 - 2(Y_1 + Y_2)]Y_1 - Y_1^2 = 60Y_1 - 2Y_1^2 - 2Y_1Y_2 - Y_1^2$$

$$\Pi_1 = 60Y_1 - 3Y_1^2 - 2Y_1Y_2$$

F.O.C: $\frac{\partial \pi_1}{\partial y_1} = 0$

$$\Rightarrow \quad \partial \frac{\left(60y_1 - 3y_1^2 - 2y_1y_2\right)}{\partial y_1} = 0$$

$$60 - 6y_1 2y_2 = 0$$

$$\Rightarrow y_1 = 10 - \frac{1}{3}y_2 \ldots\ldots\ldots (1)$$

Equation (1) represents the reaction curve of firm –1

Firm 2 $Max\Pi_2 = \max[p(y_1 + y_2)]y_2 - c_2(y_2)$

$$\Pi_2 = [60 - 2(y_1 + y_2)]y_2 - 4y_2$$

$$\Pi_2 = 60y_2 - 2y_1y_2 - 2y_2^2 - 4y_2$$

$$\Pi_2 = 56y_2 - 2y_1y_2 - 2y_2^2$$

F.O.C: $\frac{\partial \Pi_2}{\partial y_2} = 56 - 24_1 - 4y_2 = 0$

$$\Rightarrow \ y_2 = 14 - 0.5y_1 \ldots\ldots\ldots\ldots\ldots (2)$$

Equation (2) represents the reaction function of firm 2. Solve simultaneously the two reaction curves together to get the cournot equilibrium level of output.

$y_1 = 10 - \frac{1}{3}y_2 \ldots\ldots (1)$ – Reaction curve of firms -1

$y_2 = 14 - 0.5y_1 .....(2)$ -Reaction curve of firms –2

Substituting equation (1) in equation (2)

$$y_2 = 14 - 0.5(10 - \frac{1}{3}y_2) = 14 - 5 + \frac{1}{6}y_2$$

$$y_2 = 9 + \frac{1}{6}y_2 \rightarrow \frac{5}{6}y_2 = 9$$

$$y_2 = \frac{54}{5} = 10.8 \text{ (Equilibrium level of output of firm –2)}$$

$$y_1 = 10 - \frac{1}{3}y_2 = 10 - \frac{1}{3}(10.8) = 10 - 3.6$$

$$\underline{y_1^* = 6.4}$$

The total output of the industry at equilibrium is the sum of Y_1 and

$$Y_2, (y = 6.4 + 10.8 = 17.2)$$

The above result can represented graphically as shown in figure 2.5 below

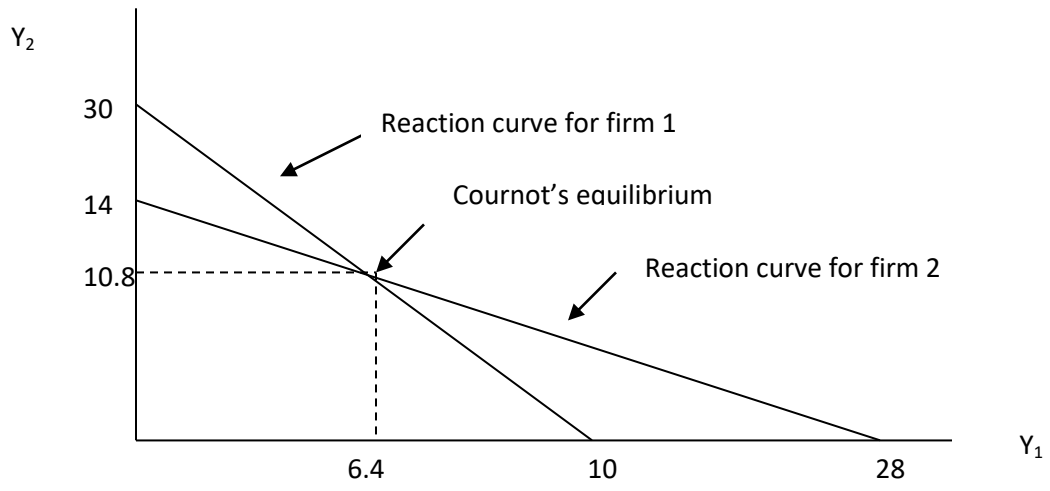


Figure 2.5 Cournot equilibrium

The market price of the product

$p(y^*) = 60 - 2(y^*)$

=60-2(17.2)

=60-34.4

P(Y*) =25.6

The profit of each duopolistic is

$\Pi_1 = py_1^* - c(y_1^*)$

$\Pi_1 = 163.84 - 40.96$

$\Pi_1 = 163.84$…….. Profit of firm-1

$\Pi_2 = py_2^* - c(y_{2^*})$

= (25.6) (10.8)–4(10.8)

= 276.48-43.2

$\Pi_2 = 233.28$…..Profit of firm–2

Total industry's profit, $\Pi = \Pi_1 + \Pi_2$

= 163.84+233.28

$\Pi = 397.12$

2.2.3 The Bertrand duopoly model

In cournot model, we have seen that firms are choosing quantities of output produced and letting the market to determine price. However, in case of Bertrand model, firms set their

price and letting the market to determine the amount of output sold. This implies the strategic variable up on which firms are competing to maximize their profit is price rather than output for Bertrand duopolist. Similar to cournot model however, each firm makes decision about the level of price that maximizes their profit simultaneously by assuming their competitor's price fixed at existing level.

The model also assumes that firms operating in the industry produce homogenous product with identical cost. This implies that each firm faces the same demand curve and consumer will prefer to purchase from lower price seller or firm. Thus if the two firm charge different price, lower price firm will supply the entire market while the firm which charges higher price sell nothing. If both firms charge the same price, the consumers are indifferent between the two firms' product. This leads to a return to firm-1 of the form:

$$\pi_1(p_1, p_2) = \begin{cases} [(p_1 - c)y(p_1)].....(1) \\ [(p_1 - c)y(p_1)](\frac{1}{2})....(2) \\ 0.....(3) \end{cases}$$

Equation (1) to (3) represent the profit earned by firm-1, when it set price less than, equal to and greater than firm-2 respectively.

Therefore, Bertrand model is an oligopoly model in which firms producing homogenous product set price simultaneously that maximize their profit by assuming their competitors price fixed at a certain level.

It is known that price cannot be set less than marginal cost since each firm has the incentive to decrease their price to increases its profit by reducing production level. So let us see how Bertrand duopolist set price under the case where price is greater than marginal cost for the two competing firms.

Suppose that both firms sell their product at some price greater than marginal cost. If firm-1 lower its price by small amount while the other firm keeps its price fixed, the entire consumer will prefer to purchase from firm-1 and the other firm sell nothing as stated above.

However, the other firm also acts in the same way (have the incentive to reduce its product) if its price is greater than marginal cost. Therefore, price greater than marginal cost cannot be stable equilibrium because each firm has an incentive to cut price as long as production remain profitable. The only equilibrium point where firms have no incentive to change their decision is where price equal to marginal cost. This is the same as competitive market equilibrium condition. Both firms set price equals to marginal cost in the short run and both will set price equal to average cost in the long run because of constant cost assumption, which leads to earning of zero profit.

The equilibrium price level of Bertrand model can be also determined through reaction curve approach. As we have seen under cournot model, reaction curves are derived from Isoprofit maps. However, Bertrand Isoprofit curve represent different thing from cournot's isoprofit curve. Bertrand model isoprofit curves contain locus of point that represents a combination of prices of a firm and its competitor that yields the same level of profit to the firm. Unlike cournot isoprofit curve , the shape of Bertrand duopolist isoprofit curve is convex to the price axis of the firms.

Dear students, what does the shape of Bertrand duopolist isoprofit imply? The shape of Isoprofit of Bertrand duopolist show how a firm reacts to price cut by its competitor. For example if the competitor of a firm cut price, the firm also adjust its price to maintain its profit at the same level. Such process continues up to the minimum point of the isoprofit curve, which represents lower level of profit. If the competitor cut price beyond the minimum point, the firm cannot adjust its price to keep the same level of profit. The profit of the firm decreases due to fall in price and increase in output level. This can be indicated by moving to the lower level of Isoprofit curve.

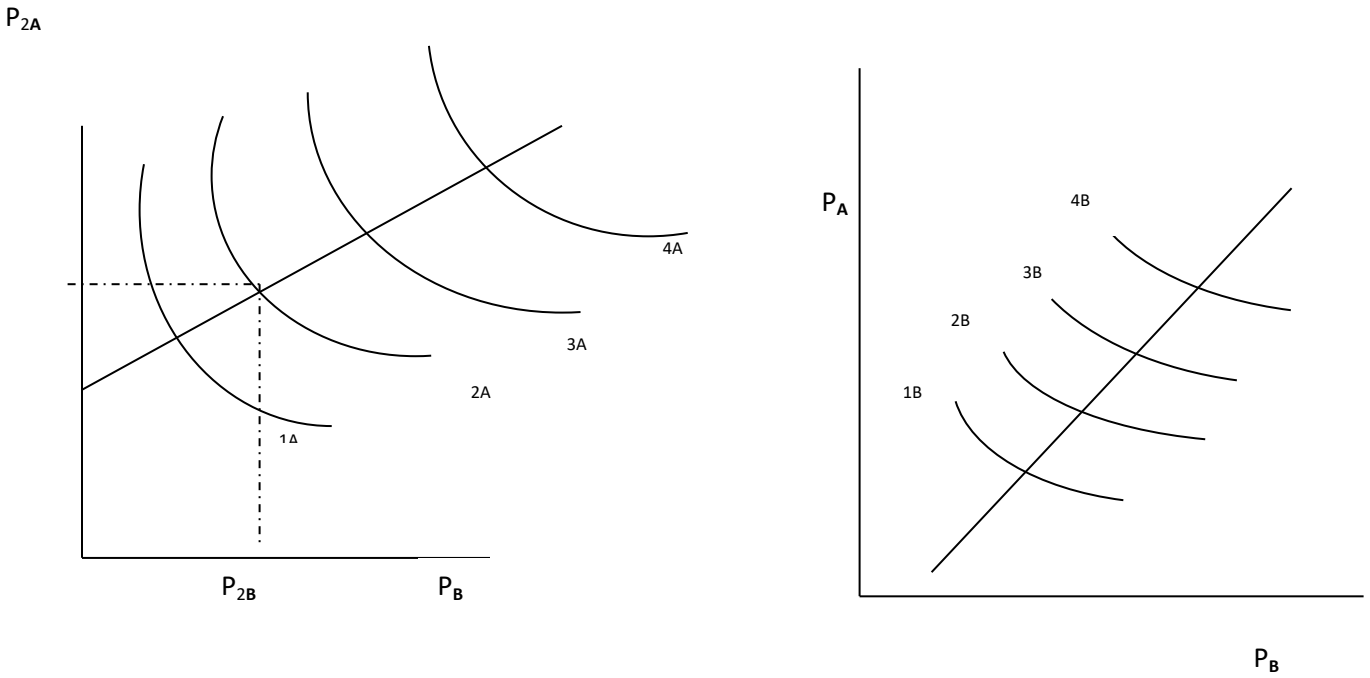


Figure: 2.6. Reaction and Isoprofit curves of Bertrand duopolist

For example, firm-A in figure 2.6 moves from Isoprofit curve π_{2A} t[illegible]ofit curve π_{A1} when firm-B cut its price below P_{2B}. This implies Isoprofit curve found nearer to the price axis of the duopolist represent lower level of profit. If we join the minimum point of successive isoprofit curves of firm-A, it result in reaction curve of A. They are locus of point firm-A can attain by charging a certain price, given the price of its rival. The reaction curve for firm-B also derived in the similar way by joining the lowest point of isoprofit curves given the price level of firm-A. Given the two reaction curves, Bertrand equilibrium defined by the intersection of the reaction curves of the firms as indicated by figure 2.7.

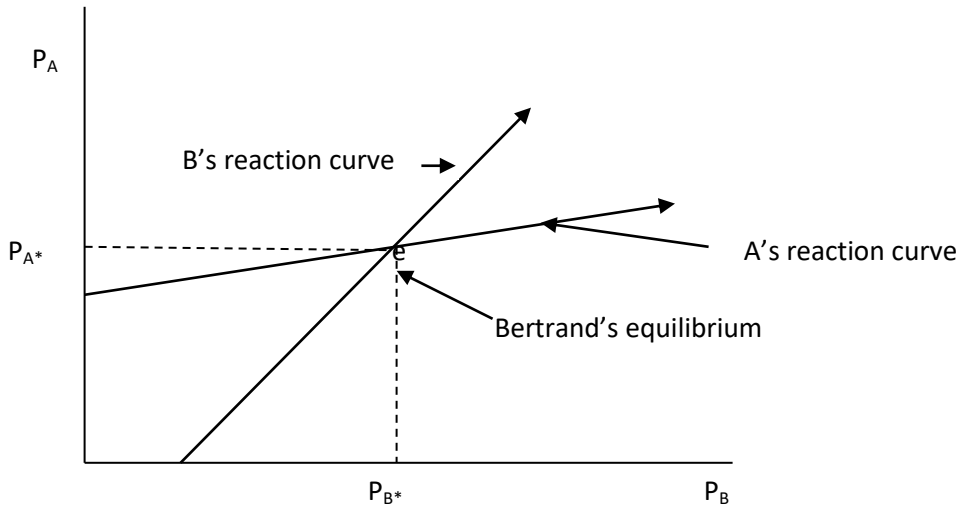


Figure: 2.7. Bertrand equilibrium

Price level (P_A*, P_B*) is the equilibrium level of Bertrand duopoly model. Also like cournot model, Bertrand equilibrium does not lead to maximization of industry (joint) profit, due to the fact that firms behave naively (firms set their price by assuming its rival keep its price fixed and they never learn from past experience) to decide the price that maximizes their profit. The industry profit could be increased if firms recognized their past mistakes and abandoned the Bertrand pattern of behavior.

Although the Bertrand model used to understand the strategic interaction of oligopolist on price setting, it has plenty of shortcomings for various reasons. For one thing, firms, which produce exactly the same product, seem to compete more by focusing on non-price competition than on price competition. Moreover, if they focus on price competition, they set the same price in accordance with the model; there is no real assurance that they split the market equally. Also like cournot model, Bertrand model is criticized for its naïve assumption of firms.

Stackelberg Model

Dear students, in the previous duopoly model we have seen that duopolists make simultaneous optimal decision about level of output produced and price charged. However, according to Stackelberg model firms make decision about output that maximizes their profit sequentially. That is, there is a firm known as a dominant (stackelberg leader) which knows

the other firm behaves naively in cournot fashion (i.e. known the reaction function of naïve firm). The firm, which behaves in cournot, fashion (take competitor's output as given) and make decision after observing leader's decision is called the follower. The leader has extra information and potential than the follower firm to make decision before the follower firm. In choosing its own output, therefore, the leader could account the effect of its output on follower behavior while the follower naively took leader's output as given.

For instance, IBM is often considered as a dominant firm in the computer industry. Small firms in the industry wait for the decision made by IBM in order to make decision how much to produce and the type of product they supply to the market. In general, the leader firm (the first mover) decides to produces certain amount of output, which maximizes its profit; it will take into consideration the impact of follower firm. The follower firm, after identifying the level of output produced by the leader firm, responds by producing certain amount of output to maximize its profit. Each firm act in the stated way while making its output decision because each of them know that the total output produced determined the market price and then profit they earn.

Given the structure of the model, what output should the leader choose to maximize its profits? Leader firm recognizes its influence on the action of followers firm and total level of output when making decision on the level of output to maximize profit. This relation ship between follower and leader optimal choice can be summarized with the help of reaction function of follower firm. So the leaders first determine the reaction function of its follower and then incorporate it to its own profit function. Then it maximizes the newly formed profit function like monopoly firm by setting marginal revenue equals to marginal cost. On the other hand follower firm react to the optimal choice of the leader according to its reaction function to come up with its profit maximizing level of output.

The stackleberg solution can also be illustrated graphically using isoprofit curves and reaction curves. Both firms have the same shaped isoprofit curve as in the case of cournot. The highest profit level is represented by the isoprofit curve found near to the quantity axis of each firm and the lowest level of profit is represented by isoprofit curve, which found away

from the quantity axis. Given such properties of isoprofit curves of the firms, they are acting in the following ways to determine their optimal output level.

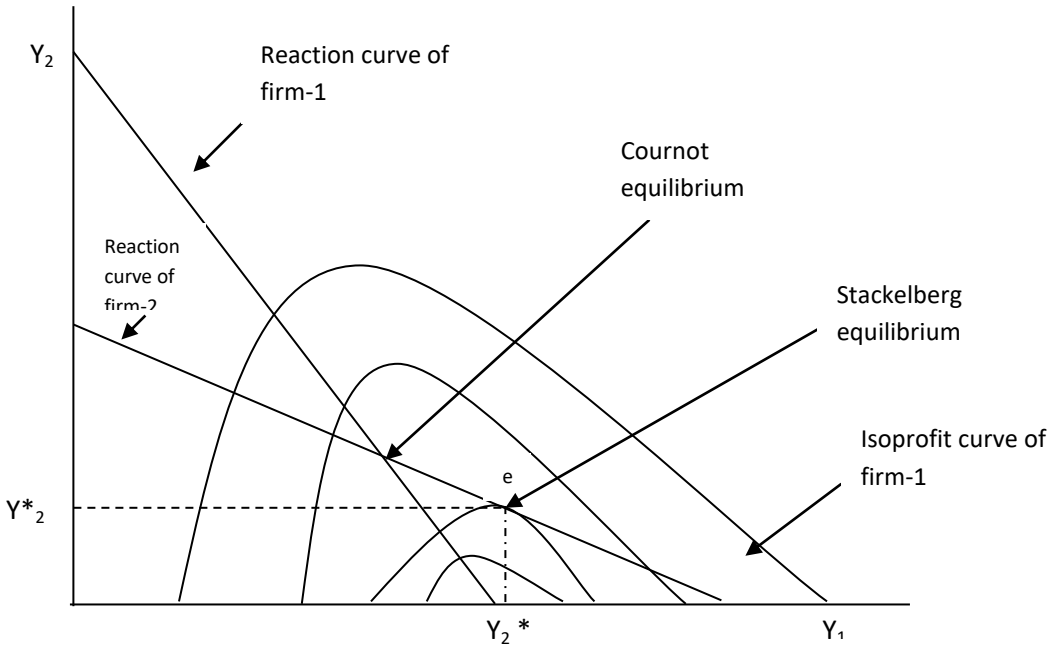


Figure: 2.8. Stackelberg equilibrium

Firm 2 as a follower will choose an output along its reaction curve, while firm-1 (the leader) choose the output level on the reaction curve of firm-2 that gives him the highest maximum profit. As a result, the equilibrium point of the stackelberg duopolists is not defined by the intersection of their reaction curve. This is because the leader firms no more take the follower's output as given. It knows the follower output would depend on its own output level in accordance with its reaction function. This implies the equilibrium point of the Stackelberg model defined by the tangency of the isoprofit of the leader with the reaction curve of the follower as indicated by figure 2.8 below.

Since the leader, firm-1 makes choose on the reaction curve of follower, firm 2, point e represents stable stackleberg's equilibrium. At point-e, the leader get higher profit and the follower firm get lower profit compared to cournot equilibrium.

In short if one firm is sophisticated, it will emerge as a leader and stable equilibrium will established since the naïve firm act as a follower. However if both firms are sophisticated,

both wants to be a leader to get higher profit. In this case, market situation becomes unstable. Such situation is known as Stackleberg disequilibrium. The effect of such situation will be either a price war until one of them surrender and agree to act as follower or collusion of both firms abandoning their reaction function and move to a point close to edge worth contract curve where both of them get higher profit

Numerical illustration of Stackleberg model

Consider the demand and cost function used for cournot model

$P= 60-2(y_1 + y_2)$

$C_1= y_1^2$, $C_2= 4y_2$

Find

a) Stackleberg equilibrium assuming firm – 1 is a leader

b) Stackleberg equilibrium assuming firm – 2 is a leader.

Solution

a) If firm-1 is a leader, it is the one which chooses output level that maximizes its profit first by incorporating reaction function of its follower in to its own isoprofit function as follows:

Follower's profit function,

$\pi_2 = [60-2(y_1+y_2)]\, y_2 -4y_2$

$\pi_2 = 60y_2 - 2y_1\, y_2 - 2y_2^2 - 4y_2$

$\pi_2 = 560y_2 - 2y_1\, y_2 - 2y_2^2$

Take first order partial derivat) y_2 to determine the reaction function of follower f

$$\frac{\partial \pi_2}{\partial y_2} = \frac{\partial\left(56y_2 - 2y_1y_2 - 2y^2{}_2\right)}{\partial y_2} = 0$$

$$56 - y_1 - 4y_2 = 0$$
$$\Rightarrow y_2 = 14 - 0.5y_1$$

Leader's profit function can define as:

$$\pi_1 = [60 - 2(y_1 + y_2)]y_1 - y_1^2 \ldots(2)$$

$$\pi_1 = 60y_1 - 3y_1^2 - 2y_1y_2$$

To determine its optimal level of output the leader incorporate follower's reaction function into its own profit function:

$$\pi_1 = 60y_1 - 3y_1^2 - 2y_1(14 - 0.5y_1)$$
$$\pi_1 = 32y_1 - 2y_1^2$$

Then take first order condition to determine the level of output that maximizes the profit of the leader.

$$\frac{\partial \pi_1}{\partial y_1} = 32 - 4y_1 = 0$$

$$\Rightarrow 4y_1 = 32$$
$$y_1 = \frac{32}{4} = 8$$
$$y_1^* = 8$$

$\Rightarrow$The leader produces 8 unit of output to maximize its profit.

To determine follower's optimal choice substitute leader's output level in the reaction function of the follower firm.

$$y_2 = 14 - 0.5y_1$$
$$y_2 = 14 - 0.5(8) = 10$$
$$y^* = 10$$
$$p = 60 - 2[y_1 + y_2]$$
$$= 60 - 36 = 24$$
$$p^* = 24$$

Profit of the leader

$$\pi_1 = 60y_1 - 3y_1^2 - 2y_1y_2$$
$$= 60(8) - 3(64) - 2(8 \times 10)$$
$$= 480 - 352$$
$$\pi_1 = 128$$

Profit of follower

$$\pi_2 = 56y_2 - 2(y_1y_2 - 2y_2^2)$$
$$= 56(10) - 2(80) - 2(100)$$
$$= 300$$
$$\pi_2 = 300$$

b) Assume firm-2 is a leader and firm-1 is a follower

Solve backward starting form the follower profit maximization

$$\pi_1 = [p(y_1 + y_2)]y_1 - C_1(y_1)$$
$$\pi_1 = 60y_1 - 3y_1^2 - 2y_1y_2$$
$$F.O.C$$
$$\partial\pi_1 / \partial y_1 = 60 - 6y_1 - 2y_2 = 0$$
$$y_1 = 10 - \frac{1}{3}y_2 .....(1)$$

Equation one above represent the reaction function of firm-1, the follower and then Firm-2(the leader) substitutes the reaction function of the follower, firm-1 into its profit function to determine profit maximizing level of output as follows:

$$\pi_2 = 56y_2 - 2y_1y_2 - 3y_2^2$$
$$\pi_2 = 56y_2 - 3y_2^2 - 2y_2(10 - \frac{1}{3}y_2)$$
$$= 56y_2 - 2y_2^2 - 20y_2 + \frac{2}{3}y_2^2$$
$$\pi_2 = 36y_2 - \frac{4}{3}y_2^2$$
$$F.O.C.$$
$$\frac{\partial\pi_2}{\partial y_2} = 36 - \frac{8}{3}y_2 = 0$$
$$y_2 = 36(\frac{8}{3}) = 13.5$$

To determine the optimal level of output for the follower, substitute the optimal output level of the leader (firm-2) in the reaction function of the follower: $y_1 = 10 - \frac{1}{3} y_2$

$$y_1 = 10 - \frac{1}{3}(13.5) = 10 - 4.5 = 5.5$$
$$y_1 = 5.5$$
$$y = y_1 + y_2 = 13.5 + 5.5 = 19$$
$$p = 60 - 2y = 60 - 2(19) = 22$$

Leader profit's

$$\pi_2 = R_2 - C_2$$
$$= 22(13.5) - 4(22)$$
$$= 297 - 88$$
$$\pi_2 = 209$$

follower's profit

$$\pi_1 = R_1 - C_2 = 22(5.5) - (5.5)^2$$
$$= 121 - 30.25$$
$$\pi_2 = 90.75$$

2.3 Collusive oligopoly

All oligopoly models described up until now are an example of non-collusive oligopoly. In such type of industry each firm make independent decision to maximize its profit even though each of them take other's likely behavior in to account during the process of decision making. Now we consider other possibility in which firms found in a given industry make collusive agreement implicitly or explicitly to some degree in setting price and output. Firm enter in to such collusive agreement in order to cultivate the advantage of increasing profit, decreasing uncertainties and to create better opportunity to prevent other's entry to the industry. To see how firms operating in such arrangement make decision we will consider cartel and price leader ship in this sub section.

2.3.1 Cartel

A cartel is a formal organization of firms producing the same product. It is formed to coordinate the policies of member firm so as to increase their joint profit by limiting the scope of competition among them. It also reduces uncertainty arising from their mutual interdependence. Here we will study two typical forms of cartels.

a) Cartels aiming at joint profit maximization

b) Market sharing cartel

2.3.1.1 Cartel aiming at joint profit maximization.

Cartel aiming at joint profit maximization is formed as its name indicates with the objective of maximizing the total industry's profit. In order to achieve this objective member firm appoint a central agency to which they delegate the authority to decide not only the total quantity and price at which the industry's profit maximized but also allocation of output and profit among the member of cartel.

To make such decisions, it is assumed that central agency have access to information about the cost of individual firms and know market demand. Given the information about cost and demand, central agency determine price and output that maximizes industry's profit defined by the intersection of marginal revenue and marginal cost curve. Marginal revenue curve can be derived from market demand and the marginal cost used for decision can be obtained by summing up individual marginal cost. In this case, the cartel act as multiplant monopoly and chooses $y_{1,}y_{2,}y_3 - - - - y_n$ to maximize the total industry profits:

$$\pi = py - \left[c_1(y_1) + c_2(y_2) + - - - (y_n)\right]$$

Take first order condition of industry profit function to determine profit maximization level of output and price:

$$\frac{\partial \pi}{\partial y_i} = MR(y) - MC_i(y_i) = 0$$

Since total revenue depends on the sum of all cartel members' output levels, marginal revenue is the same no matter whose output level is sold. At the profit maximization point therefore, this common marginal revenue will be equated with each firm's marginal production cost.

For simplicity let us assumes there are only two firms in the cartel with marginal cost $MC_1$and MC_2 as indicated in figure 2.9. So the industry's marginal cost (MC) obtained by summing up marginal costs of the two firms. From the market demand DD, we can derive industry's marginal revenue. The intersection point of MC and MR gives profit-maximizing level of output and price.

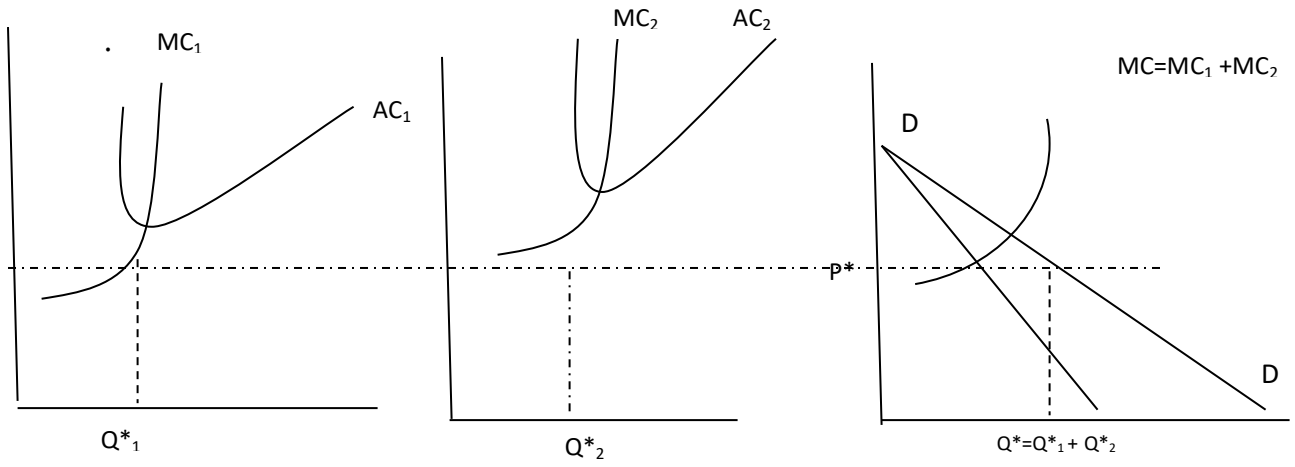


Figure: 2.9 Joint profit maximizing cartel

At the same time central agency, allocate production between the two firms similar to Multiplant monopoly by equating the MR to individual marginal cost. Mathematically the profit maximization of cartel can be derived as

Max $\pi = R_1+R_2-C_1-C_2$

Y_1, Y_2

$\pi = p\,(y_1+y_2)\,(y_1+y_2) - C_1\,(y_1) - C_2\,(y_2)$

Taking F.O.C for joint profit maximization

1. $\dfrac{\partial \pi_1}{\partial y_1} = \dfrac{\partial[(y_1+y_2)(y_1+y_2) - c_1(y_1) - c_2(y_2)]}{\partial y_1} = 0$

2. $\frac{\partial \pi_1}{\partial y_1} = \left[\frac{\partial (y_1 + y_2)(y_1 + y_2) - C_2(y_1) - C_2(y_2)}{\partial y_2} \right] = 0$

Rearranging equation (1) and (2) we can get

MR= MC_1 = MC_2 Since $\frac{\partial R_1}{\partial y_1} = \frac{\partial R_1}{\partial y_2} = \frac{\partial R}{\partial y}$

Cartels aiming at joint profit maximization determine the amount of output produced by each member firm using the above condition (MR= MC_1 = MC_2)

Numerical illustration

Assume that the Market demand facing the members of a cartel is P = 60-2 (y_1+y_2) and their cost of production is given by C_1= Y_1^2 , C_2= $4y_2$ .Find the level of output and price that maximizes the industry's profit.

Solution

We derive profit maximization condition for cartel aiming at joint profit maximization as MR= MC_1 = MC_1

$$MR = \frac{\partial TR}{\partial y} = \frac{\partial (60 - 2y).y}{\partial y} = 60 - 4y$$

$$MC_1 = \frac{\partial c_1}{\partial y_1} = \frac{\partial y_1^2}{\partial y_1} = 2y$$

$$MC_2 = \frac{\partial c_1}{\partial y_2} = \frac{\partial_4 y_2}{\partial y_2} = 4$$

1) MR = MC_1

2) MR = MC_2

$\Rightarrow$ 60-4y = $2y_1$ Where y = y_1+y_2

60 – 4(y_1+y_2) = $2y_1$

$60 – 4y_1 - 4y_2 = 2y_1$

$60 – 6y_1 - 4y_2 = 0$

From Equation (3)

$60 – 4y = 4$

$60 – 4y_1 - 4y_2 = 4$

$56 – 4y_1 - 4y_2 = 0 \ldots (4)$

Solve simultaneously equation 3 and 4

$- \quad 56 - 4y_1 - 4y_2 = 0$

$\underline{60 - 6y_1 - 4y_2 = 0}$

$4 - 2y_1 = 0$

$\Rightarrow \underline{Y_1 = 2}$

Substitute in equation (1)

$60 - 6y_1 - 4y_2 = 0$

$60 - 12 - 4y_2 = 0$

$48 - 4y_2 = 0$

$\Rightarrow Y_2 = 2$

Total output that maximizes industry's profit is the sum of individual firm's output

$Y = y_1 + y_2 = 12 + 2 = 14$

$\underline{Y = 14}$

$P = 60 - 2 (y)$

$= 60 - 2(14) = 22$

P= 22

Joint profit of the industry $\pi(y_1 + y_2) = [p(y_1 + y_2)][y_1 + y_2] - c_1(y_1) - c_2(y_2)$

$\pi(y_1 + y_2) = 60y_1 + 56y_2 - 3y_1^2 - 2y_2^2 - 4y_1y_2$

$\pi(y_1 + y_2) = 60y_1 + 56y_2 - 3y_1^2 - 2y_2^2 - 4y_1y_2$

$= 60(2) + 56(12) - 3(2)^2 - 2(12)^2 - 4(2)(12)$

$= 120 + 672 - 12 - 288 - 96$

$= 792 - 396 = \underline{396}$

In Practice however, cartels rarely achieve maximum joint profit. There are several reasons why cartel's industry profit cannot be maximized. Some of them are

1. Mistakes in the estimation of market demand. Mistake in estimation of market demand leads to mistake in the derivation of the MR and hence price and output which maximizes profit.
2. Mistakes in estimation of MC due to incomplete knowledge of the individual firm's costs at different level of output. Such error leads to equilibrium level of output and price, different from the expected cartel solution.
3. Slow process of cartel negotiation. Since member firms have different cost and market share, to bring them to common level of price it takes time. When the time taken for making decision is longer, the price of goods and serves changes for what it is expected to be. So the information used by central agency for decision making becomes out dated and correct level of price that maximizes the industry profit can not be set.
4. Stickiness of the negotiated price. Even when market condition changes, once price set, it need long time for negotiation and set profit maximizing price.

5. Cheating by member firm during bargaining process through giving biased information in order to achieve large market share.

6. Existence of high cost firms. If a firm operates with higher than equilibrium MC, it reduces the total joint profit. As a result, it has to close down to maximize joint industry's profit. Nevertheless, there is no such thing with firm aiming of joining industry maximization.

7. Fear of government interference to change the level of price which maximizes cartels' industry profit

8. The wish to have good public image cartel agency will not increase price to profit maximization level of the industry.

2.3.1.2 Market Sharing Cartel

In market sharing cartel the member firms agree on how to share the market but they keep a considerable degree of freedom concerning the style of their output, their selling activities and other decisions. Each firm therefore operates in one area or region agreed upon without encroaching on others' territories. This form of cartel is more common in real world and more popular than cartel aiming at maximization of joint industry profit. There are two basic methods for sharing market by the member firm of cartel: non-price competition and quota.

1. **Non- price competition**

In such form of cartel the member firm agree on a common price at which they sell their output. The price up on which they agreed set by the process of bargaining. In the bargaining process, low cost firm pressing for lower price and high cost firm press for higher price. At the end common price which allow all members certain amount of profit, is set. At such price firms compete to maximizing their profit by increasing their sell volume through different way of non-price competition like quality, style, selling activities and advertising. Such form of cartel is unstable most of the time compared to cartel aiming at joint profit maximization. Because, whenever there is cost and liquidity difference, low cost firms have the incentive to cheat by lowering their price and initiates price war among member firms, which result in instability.

2. Sharing of the market by agreement on quotas

In this case, member firms agree to supply a certain quantity of output at agreed price. The quota allocation made based on the cost structure of the firms. If they have identical costs, the monopoly solution will emerge by sharing the market equally. However if costs are different, the quota of market share differs between the firms. Under such cases quota sharing depend on the bargaining power of the firms. During bargaining process past levels sales and or the basis for productive capacity of the firms are considered for decision.

The other form of sharing market is made through defining geographical boundaries to which each member firm supply their product. Like non-pricing competition, market sharing cartels or regional sharing cartels agreement are also unstable. The agreements are violated intentionally or by mistake by low cost firm who have the incentive to expand their output by cutting price.

Most of the above forms of cartels are unstable. The firms will not act according to output and price level upon which they agreed due to a number of reasons. Some of the reasons includes: the member firms have different costs, different assessments of the market demand and even have different objective. So most of the time they wants to set price at different level. Furthermore, each member of the cartel tempted to cheat by lowering price slightly to capture larger share of market than allocated for the firm. This implies there should be some sort of enforcement mechanism for a cartel to be successful. Threat in the long run for the member who breaks the agreement should be there. Also gaining certain monopoly power to set price by cartel is other factor for the success of cartel i.e., if the potential gain form cooperation are large ,cartel member have more incentive to solve their organizational problem and hence profit for cartelization is large enough to give incentive for the members to act according to the contractual agreement.

2.3.2 Price leadership

Dear students, unlike firms in cartel, which agree explicitly to cooperate in setting price and output, firms in price leadership collusive oligopoly, agree to cooperate implicitly in making decisions about price and output without any formal discussion. They enter in to such agreement voluntarily to avoid any uncertainty about the competitor reaction. In such type of model, one firm implicitly recognized as the leader and set price. The other remaining firm, the follower take price as given and adopt the price set by the leader firm even though its profit did not maximized.

This follow from the assumption that the two firm selling identical products. If one charged a different price form the other, all of the consumers would prefer the producers with the lower price. In addition, if two firms do not agree implicitly on common price, there is possibility to enter in to a price war. Price war through reduction of prices cause low profit level and even causes destruction of the firm. These conditions may force oligopoly firms to cooperate without actually making explicitly agreements with one other.

There are various form of price leadership, the most common ones are:

1. Price leadership by low cost firm
2. Price leadership by large (dominant) firm
3. Barometric price leadership

2.3.2.1 Low cost price leadership

This model assumes that there are two firms in the industry producing homogenous product at different cost. One firm produce at low cost compared to its competitor. Moreover, firms may have equal or unequal market share. Given firms with the stated features, low cost firm becomes the leader and set price, which maximizes its profit. Follower firm by scarifying some of its profit take the price set by the leader. This is to avoid a price war, which would eliminate the firm from the industry if price set lower then its LAC.

However, the price set by the leader firm using marginal principle (MC=MR) would remain at the stated position through maintaining output constant. Deviation of output from the point where MR=MC due to over or under supply of output by follower firm will change the price and then the profit of the leader will not maximized. This implies that the follower must supply a quantity sufficient to maintain the price set by the leader. So at the optimal price level, the firms must also enter agreement on the share of the market formally or informally. Otherwise even though the follower adopt leaders price, producing higher or lower level of output required to maintain the price (set by the leader) in the market push the leader to non-profit maximizing position. In this respect, the follower is not completely passive; it can affect the market price and then the profit of the leader unless they enter in to formal or informal agreement to supply certain proportion of the total output.

Numerical illustration

Recall that the examples we use for others duopoly model with:

Market demand: $P = 60-2(y_1+y_2)$

Cost $C(y_1) = y_1^2$ $C(y_2) = 4Y_2$

When we see their cost structure, firm two is a low cost firm so that it can be taken as the leader. So, it is the one who set price using the marginal principle but the two firms go into agreement about the share of the market at leader's profit maximizing level of price. Let assume they agree to share equally. With this assumption, the demand curve relevant to leader's decision would be modified as:

$P= 60-2(Y_1+Y_2)$, $Y_1=Y_2$

$P= 60-2(Y_2+Y_2) = P=60-4Y_2$

$$\Pi_2 = PY_2 - C_2$$

$$\Pi_2 = (60-4Y_2) - 4Y_2 = 56Y_2 - 4Y_2^2$$

Take F.C.O $\frac{d\Pi_2}{dY_2} = 0$ to determine equilibrium level of output that maximizes leader's profit.

$$\frac{d\Pi_2}{dY_2} = d\frac{\left(56Y_2 - 4Y_2^2\right)}{dY_2} = 0$$

$$56\text{-}8Y_2=0 \qquad Y_2=Y_1=7$$

$P=60\text{-}4Y_2$

$=60\text{-}4(7) = 60\text{-}28=32$

P*=32

However, $p = 32$ and output level $Y_1=7$ would not maximizes the profit of the follower firm. The price that maximizes the profit of the follower firm can be determined through maximizing the its profit function as follows;

$$\Pi_1 = R_1 - C_1 = (60 - 4Y_1)Y_1 - Y_1$$

$$\Pi_1 = 60Y_1 - 5Y_1^2$$

Take F.O.C $\frac{d\Pi_1}{dY_1} = 60 - 10Y_1 = 0$

$$\underline{Y_1 = 6}$$

$P=60\text{-}4Y_1$

$P=60\text{-}4(6) =60\text{-}24=36$

$P^*=36$

The output level which maximizes the profit of firm one (follower) would be $Y_1 =6$ units and charge a price P*=36 if it did not recognizes the leader ness of firm two.

2.3.2.2 Dominant firm price leadership

In such oligopoly industry there is one large firm having large share of the total market with a group of smaller firms supply the rest. The larger firm, which is also known as, the dominant firm become the leader and set price that maximize its profit. The other smaller firms, which could have little influence over price, would be a price taker like firms in perfect competitive firm. That is each of the small firms produces an amount determined by setting marginal cost equals to price announced by the leader and the leader supply the residual.

Given the structure of the model, what price would the dominant firm set to maximize its profit? Is the leader firm considering the impact o f other small firms while setting price?

By assumption, the dominant firm knows the market demand and the marginal cost of small firms. This assumption enables the dominant (the leader) firm to derive its own demand function form the market demand and marginal costs of smaller firms. That is since small firms in the industry behave like prefect competitive firm, the dominant firm equate price with the sum of their marginal costs to get their supply function ($p = \sum SMC_i$). Then the leader firm's demand function, which is also known as, the residual demand curve, can be obtained by subtracting the supply function of the smaller firms from the market demand.

Once the leader identify its demand function, it act like a monopoly to set price and output level which maximizes its profit by equating marginal revenue with its marginal cost . Here the marginal revenue used for decision is derived from residual demand that actually measures how much output it will be able to sell at each given price.

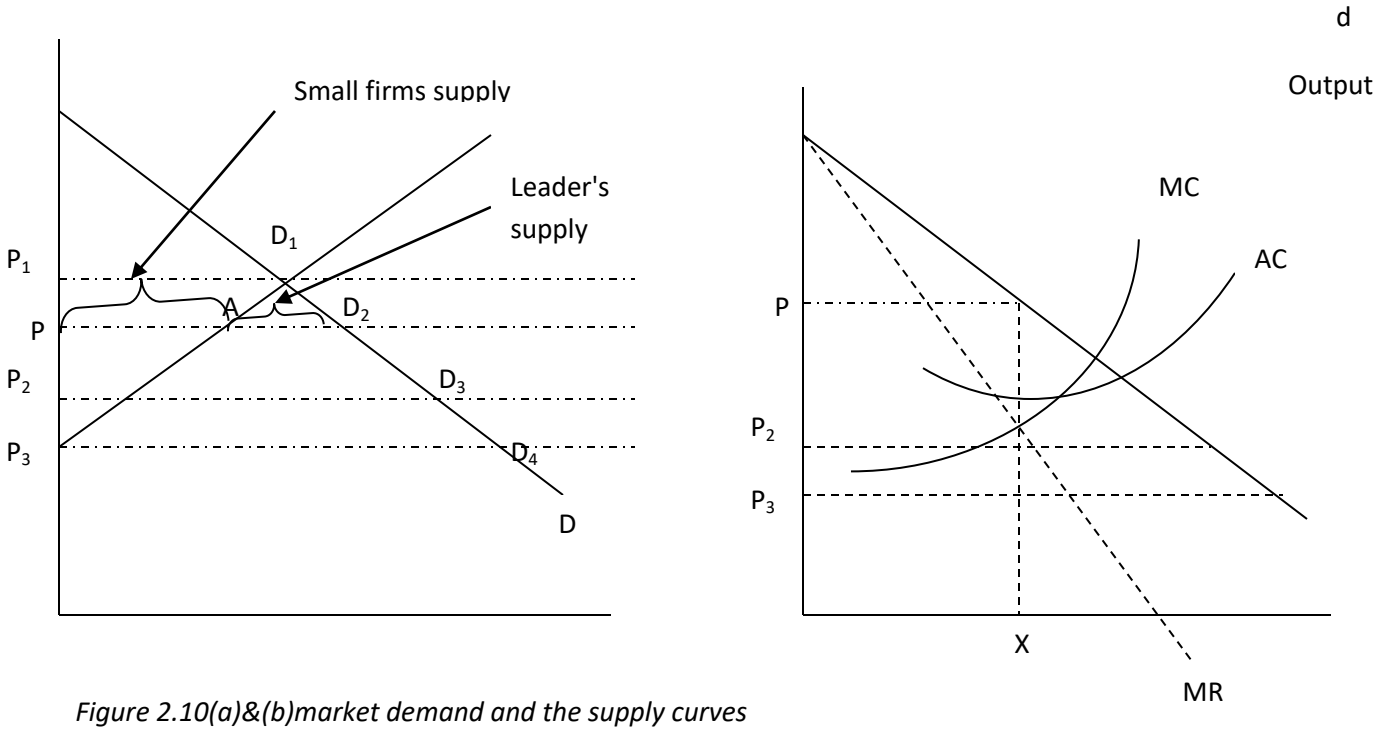


Figure 2.10(a)&(b)market demand and the supply curves

As indicated in figure 2.10. for example at P_1 the demand for the product of the leader will be zero, because the total quantity D_1 is supplied by smaller firm. As price fall below p_1 the demand for the leader's product increases. At p the total demand is D_2 out of which PA is supplied by small firms and the remaining AD_2 is supplied by the leader.

Having derived the demand curve of the leader as in figure 2.10(b) and given its MC, the dominant firm will set price at which his MR=MC. However smaller firms may or may not maximizes it profit depending up on its cost structure at the set level of price.

Numerical illustration

Suppose that the market demand facing the industry's product is D (P) =50-0.3P and the supply function of smaller firms as a function of price is S=0.2P

So the dominant firm's demand function can be derived as Y= D-S

=50-0.3p=50-0.5P

P= 100-2Y

If dominant firm's cost function is C=2Y then its profit function, $\Pi = R - C$

$\Pi = PY - 2Y$

$\Pi = (100 - 2)Y - 2Y$

$\frac{d\Pi}{dY} = \frac{d[(100 - 2Y)Y - 2Y]}{dY} = 0$

98-4Y=0

$\rightarrow$ $Y^* = \frac{98}{4} = 24.5$

Leader will set price P=100-2X =100-2(24.5)

P=51

At this price the total quantity demanded

D= 50-0.3(51) =34.7

D=34.7

The amount supplied by smaller firms is = 0.2P

S=0.2(51) =10.2 $\Rightarrow$ S=10.2

2.3.2.3 Barometric price leader ship

In this type of price leadership oligopoly, there is a firm which have good knowledge of the prevailing condition in the market and can forecast better than other about the future development in the market. Such type of firm used as the barometer for other firms to reflect the changes in economic environment. Such type of firm acts as a leader and when its price changes, other firm follow change in price. Usually a barometric firm may or may not be a firm with low cost or larger firm. However, it is a firm which establishes good reputation in the past in forecasting economic changes. Even a firm belonging to other industry having

good reputation may also use as a barometric leader to affect the decision of other firms. For example, a firm in steel industry might be taken as barometric price leader for motor car industry.

Review Exercise

I. Answer the following question briefly

1).Discuses the behavioral assumptions made about firms operating in the following duopoly model

a) Cournot duopoly model b) kinked demand curve model

c) Stackelberg duopoly d) dominant firm price leadership.

2). According to kinked demand curve model why does price rigidity occur in oligopolistic market? What are the limitations of this model?

3) explain how different types of price leader oligopoly determine profit maximization level of price; a) low cost price leadership b) dominant firm price leadership

4) In most cases, the profit maximization level of price cannot maximize the profit of the industry. Why?

II. Choose the best answer for the following questions.

1). All of the following oligopoly model have something in common except

a). cournot's duopoly model c). Kinked demand curve model

b). Bertrand duopoly model d). Stackelberg duopoly model

2). In which of the following model optimal decision made by firms simultaneously

a). low cost price leadership c). Stackelberg duopoly model

b). Bertrand duopoly model d). Dominant firm price leadership

3). In which one of the following duopoly model the strategic interaction between firms made on quantity of output produced.

a). low cost price leadership c). Stackelberg duopoly model

b). Bertrand duopoly model d). Dominant firm price leadership

4) One of the following is true about duopoly models;

a) In Bertrand duopoly model firms are making decision at the same time about output that maximizes their profit.

b) The isoprofit curve found near to the price axis in case of Bertrand model represent higher level of profit like the of cournot model.

c) Firms in cournot model get higher profit if the decided to operate on contract curve rather deciding to produce at the intersection between the reaction curves.

d). In low cost price leadership follower firm act passively.

III work out questions;

1). Suppose the market for TV set have one dominant firm and five smaller firms. The market demand facing firms is Y= 400-2P. The dominant firm has constant marginal cost of 20. The small firms each have a marginal cost of MC= 20+5Y.

a). verify that the total supply curve for the five small firms is Y_s = P-20

b). Find the dominant firms demand curve

c). Find the profit maximizing quantity produced and price charged by the dominant firm, and the quantity produced and price charged by each of the small firms.

d). suppose there are ten small firms instead of five how does this change your result?

e). suppose the marginal cost of each of the five firms changed to MC = 20+2Y. How does this change in result.

2). Assume that four firms producing identical product in an oligopolistic industry form a cartel aiming at maximization of joint profit. The total market demand facing the cartel is Y = 20-2P and each firms marginal cost function is given by $Mc = \frac{1}{4}Y$;

a). find the level of output and price that maximize the profit of cartel industry.

b). how much should each firms produce at cartel's profit maximizing level of price.

c). how much profit can the cartel will earn.

3). given the demand function of two duopolist as

p = 40- 0.4y where $y = y_1 + y_2$, output produced by two firms

y_1- output produced by firm – 1

y_2 – out put produced by firm - 2

If the cost function of the two firms given as

$Tc_1 = 0.6\ y_1^2$ $Tc_2 = 10.4\ y_2$

a) Find the equilibrium price and output level of each firms assuming both firms are operating under cournot's assumption
b) Find the equilibrium price and output level of each firms assuming the two firms are Stackleberg duopolist and firm 2 is the leader firm.
c) Assuming these two firms are merged to form one monopoly firm, calculate the equilibrium and output of the firm.
d) If the two firms agreed to share the market in such a way that low cost firm produce three fourth of the total output determine the price and quantity that will maximize the profit of low cost firm

4). suppose that the market of a give product has one dominant firm and few small firms. The market demand of the firms is Q=80-3P.The cost of dominant firm is $C_1 = 20Q_d$ and the total cost of the small firms is $C_2=0.5Q^2_s+20Q_s$ the supply function of small firms is equal to Qs = 20-P.Assuming the market structure is dominant firm price leadership type:

Find: a) dominant's firm demand function.

b) Profit maximization level of output and price for both dominant and smaller firms.

c) If the dominant firm is a low cost firm and set price for the market in such way that the quantity of output produce by the dominant and small firms is equal, find the profit maximizing level of price and output of the dominant and small firms.

d) If the follower (smaller) firm wants to maximize their profit by setting price, what level of price and output maximizes their profit?

CHAPTER THREE
GAME THEORY

3.1 Introduction

Dear students in previous chapter we have seen that how each firm in oligopoly market take in to account its rival's reaction to make decision on level of price and output that maximizes their profit using classical economic theory. Such strategic interaction between firms can be also studied by a tool known as game theory. It was developed in 1920 and grew rapidly during World War II in response to the need to develop formal way of thinking about military strategy. In this chapter, we will see this theory to give you some flavor of how it works and how it can be used to study economic behavior in oligopolistic market.

The chapter begins with explanation of the basic concepts of game theory. It then defines a dominant strategy and Nash equilibrium and their usefulness in the analysis of oligopolistic behavior. Next, it describes the prisoner's dilemma and its applicability to the analysis of price and non-price competition. Finally, we conclude the chapter by analyzing repeated and sequential game

Learning objectives

At the end of this chapter, students able to

- Define a game, payoff, strategy
- Identify optimal strategy of players
- Differentiate between pure and mixed strategy
- Describe prisoner dilemma
- Determine equilibrium of simultaneous and sequential game
- Differentiate between Nash and dominate strategy equilibrium
- Describe the behavior of firms using game theory
-

3.2 Game theory and Strategic Behavior

Basic Concepts

It is known that oligopolistic firms interact strategically to make decision in a variety of ways. Such interaction of economic agents and the expected reward of their decision can be studied

using game theory. It helps us to show how an oligopolistic firm can make strategic decision to gain a competitive advantage over its rivals or how it can minimize the potential harm from a strategic move by a rival. However, what do we mean by the term game? A game is any situation in which players (participants) make decision by taking in to account each other's action and response and the outcome of the game depends on the decision of each player. For example, Cournot duopolist set price by taking in to account the reaction of its competitor and hence the level of profit obtained depends on decision made by the two firms. Such decision-making represents a game.

All games have three basic elements: players, strategies and payoffs. Each decision maker in a game is called a **player**. These players may be individuals, firms (as in oligopoly markets), entire nation (as in military conflict) or organization. Players are assumed rational in the sense that each player chooses the course of action that yields the most favorable outcome. Moreover, players start to play the game by assuming that their competitors are just rational and as smart as they are.

A strategy is a course of action a player will take under each contingency in playing of the game. In the price setting, a strategy might be increase price or decreasing price depending up on the action of its rival

Usually the number of strategies available of each player will be finite and many aspect of game theory can be illustrated for situation in which each player has only two or three strategies. A strategy is said to be optimal strategy if it maximizes expected return of the strategic choice. In the above example if increasing price maximizes the profit of the firm it is said to be the optimal strategy of the firm who take the action.

The final return to the players of a game to chosen combination of strategy is termed as payoffs. In other words, a payoff is the outcome or the consequence of each combination of strategy played by the two players. Payoffs are usually measured in the level of utility obtained by the player although frequently monetary payoffs (say, profits for firms) are used instead. In general it is assumed that players can rank the payoffs of a game from most preferred to least preferred and

choose the highest ranked payoff attainable. In the above price setting game example, the return to strategy (Payoff) of the game to increase or decrease price is different level of profit for each firms for their respective action. Therefore, by ranking the profit gained under different strategy, each firm plays strategy that gives it the highest possible level of profit.

A table, which summarizes the payoffs for all the strategies open to the firm and rivals response, is called the payoff matrix.

Dear students, we can illustrate the basic elements of a game using a simple advertising game played by two firms as summarized in Table 3.1.

Firm- A's Strategies

Firm B's Strategies	A	D
A	(7,5)	(5,4)
D	(6,4)	(6,3)

Table 3.1 Payoff matrix for advertising game.

The game contain two players, firm-A and firm-B and each firm has two strategies; to advertise (A) and do not advertise (D).The actual level of profit firms earn depends on the decision they made to advertise or not to advertise as well as its competitor decision. Thus, each strategy by firm- A (advertise or do not advertise) can be associated with each of firm B's strategies (advertise and do not advertise). The four possible outcomes from this simple game are illustrated by the payoff matrix in Table-3.1.

In the payoff matrix, the first number in each of the four cells represents payoff to the player that found to the left of the table associated with the strategy it chooses. Where as the second number represents the payoff of player found across the top of the table associated with its strategy. In the above example the first number of each cell represents the payoff firm-B obtain by choosing specific strategy and the second number belongs to firms A's payoff decides to advertise, firm-B earns a profit equals to 7 and firm-A earns a profit equals to 5. On the other hand, if firm-B advertise while firm-A decides not to advertise, firm-B get a profit of 5 and firm-A gets a profit

of 4. The others payoff found in the rest of the cells for others combination of strategies interpreted in the same way.

3.3 Dominant Strategy and Nash Equilibrium

Well students, in the preceding section we have seen that how a game is represented by a payoff matrix and identify the payoff associated with different combinations of strategies. Now let us see how firms choose optimal strategy among different strategies when playing a game. We will also study how equilibrium of a game is determined.

Consider two firms, firm-A and firm-B producing homogenous product. Both have two strategic options to maximize their profit; decrease price or do not decrease price. What strategy should each firm choose if the expected payoff to the game is summarized in Table-3.2

Firm-A

Firm-B		**decrease**	**Doesn't decrease**
	Decrease	(10,5)	(15,0)
	Doesn't decrease	(6,8)	(10,2)

Table 3.2 Pay off matrix for pricing game.

Let us consider firm-A first. If firm-B decreases its price, firm-A will earn a profit of 5 by decreasing price and 0 if it does not. Thus the optimal strategy for firm-A is to decrease its price while firm B decreases its price. On the other hand, if firm-B does not decrease its price, firm-A will earn a profit of 8 by decreasing its price and 2 if it does not decreases. Thus, firm-A is better off by decreasing its price also while firm- B does not decrease its price. This means firm-A will always get large profit if it decreases its price regardless of what firm-B does. Thus we can say decreasing price is the dominant strategy for firm-A. Dominant strategy is an optimal strategy of a player no matter the strategy chosen by other firm. In the example above decrease price strategy, provide greater profits to firm- A, no matter what B does.

The same is true for firm B. whatever firm-A does (decrease price or does not decrease price) firm-B is better off (earn large profit) by decreasing its price. That is if firm-A decrease price,

firm-B's profit is equal to 10 by decreasing price and 5 if it does not. Similarly, if firm-A does not decrease its price firm B's profit would be 15 by decreasing its price and 10 if it does not. Thus, the dominant strategy for firm- B is to decrease price.

Therefore, the optimal strategy for both firms is decreasing of price. Whenever player has dominant strategy, we call the outcome of the game is an equilibrium in dominant strategy. In the above pricing game strategy; (decrease, decrease) with the outcome represented by left top cell payoff represents equilibrium in the dominant strategy of the game. In the case of advertising game summarized by table 3.1, advertising is a dominant strategy for firm-A. No matter what firm-B does, advertisement is the strategy that give maximum profit to firm-A than does not advertise strategy. Similarly, advertising strategy gives maximum profit than does not advertise strategy. So advertising is a dominant strategy for firm B. this implies the strategy (advertise, advertise) represent equilibrium in dominant strategy.

One additional point that we should notice here is that the advertising game and price setting game indicated above represent a game in which player move simultaneously. Each player selects a strategy before observing any action or strategy chosen by the other player. Not all games are of this type. As we will see later on, sometimes one player most goes first. In such type of game, the order play can make big difference in the outcome.

Activity 3.1

1) Describe the following concepts
   a) Game, strategy, player, payoff and payoff matrix
   b) Dominant strategy and optimal strategy.
2. The following payoff matrix represents the utility that husband and wife get from buying microeconomics and macroeconomics textbook.

Husband

Wife		**microeconomics**	**macroeconomics**
	microeconomics	(4,4)	(2,3)
	macroeconomics	(3,1)	(1,5)

Determine: a). the dominant strategy of the husband if any

b). the dominant strategy of the wife if any.

c). the optimal strategy of each firms.

d). equilibrium in the dominant strategy of the game if any.

Nash equilibrium

Dominant strategy equilibrium does not exist always. For example, the game shown in table 3.2 does not have dominant strategy equilibrium. Here when B chooses left the payoffs to A is 2 or 0. When B chooses right, the payoffs to A is 0 or 1. This means that when B chooses left, A would want to choose top and when B choose right, A would want to choose bottom. Thus A's optimal choice depends on what he thinks B will do.

Player B's optimal choice also depends on what he thinks player-A will do. That is the optimal strategy of firm-B is to play right when A play bottom and left when A play top. So the strategies (Top, left) and (bottom, right) are the equilibrium of the game. Such type of equilibrium is said to be Nash equilibrium named after John Nash, the Princeton university mathematician and 1994 Nobel Prize winner who first formalized the notion in 1951.

		Player-B	
		Left	Right
Player-B	Top	(2,1)	(0,0)
	bottom	(0,0)	(1,2)

Table 3.2 Nash equilibrium

The Nash equilibrium is a situation in which each player chooses an optimal strategy, given the strategy chosen by the other player. In words a Nash equilibrium is a set of strategies such that each player beliefs (accurately) that it is doing the best it can given that the other player play its

equilibrium strategy. Note that neither of the players knows what other person will do when he has to make choice of strategy. But each person has some expectation what the person choose will be. There Nash equilibrium is a pair of expectation, such that, when other choice is revealed, neither player wants to change its behavior. In our example, (Top, left), (bottom, right) are a Nash equilibrium.

This is because if A choose top, then the best strategy for B is to choose left since the payoff to B form choosing left is 1 and from choosing right is 0. In addition, if B chooses left, then the best thing for A is to choose top since A will get a payoff 2 rather than 0. Thus, if A chooses top, the optimal choice for B is to choose left and if B choose left, then optimal choice for A is top. This indicates each player optimal choice will be made after making certain expectation about other player's strategic choice.

Nash equilibrium is a generalization of cournot equilibrium that we have seen in chapter two. In cournot duopoly model each firm choose its output level that maximizes its profit by assuming the other firm continuing to produce the output level it had chosen, i.e. by taking the strategy of its rival firm as if it keep constant level of output. Under this assumption cournot, equilibrium occurs when each firm is maximizing profits given the other firm's behavior, which is similar to Nash equilibrium.

Dear students, have you notice any difference between Nash equilibrium solution and a solution of a game in which each player has a dominant strategy? Yes, if each player has a dominant strategy then that strategy is its best choice regardless of what other players do. In Nash equilibrium, on the other hand each player adopts a strategy that is its best choice given what the other players do at equilibrium. However, dominant strategy equilibrium is Nash equilibrium, but all Nash equilibria are not a dominant strategy.

Nash equilibrium has some problems. The first problem with the concept of Nash equilibrium is that there are games that have no Nash equilibrium as in the case of matching pennies game. In matching pennies game, there are two players, Row and Column. Each player has a coin, which he can arrange so that either the head side or the tail side faces up .thus each player has two

strategies; head and tail. Once the strategies are chosen, there are payoffs to each player which depend on the choice that both players make. These choices are made independently and neither player knows others choice. If both player shows heads or tails ,then row wins a dollar and a column loses a dollar .If on there hand ,one player exhibit heads and the other shows tail, then column wins a dollar and row loses a dollar. The payoff matrix for the game is shown in table 3.3

The game has no Nash equilibrium because there is no combination of heads or tails leaves both players satisfied. Row's payoff is the negative of Column's payoff. Such type of game is a zero sum game, the interest of the players are opposite. As a result, one player or the other will always want to change their strategy.

		Column	
		Head	Tail
Row	Head	(1,-1)	(-1,1)
	Tail	(-1,1)	(1,-1)

Table 3.3 matching pennies game

Second problem with Nash equilibrium of a game is that it does not necessarily lead to paretoefficient outcomes. This will be illustrated using prisoner's dilemma game in the next section. Another, problem with Nash equilibrium is that the game may have more than one Nash equilibrium as in the case of the example above. Under such cases, it is possible to identify a unique equilibrium by a process known as elimination of dominated strategy.

3.3.1 Elimination of dominated strategies

When there is no dominant strategy equilibrium, we have to restore to the idea of Nash equilibrium. Our problem then is to try to eliminate some of the Nash equilibrium as being unreasonable. One sensible belief to have about players' behavior is that it would be unreasonable for them to play strategies that are dominated by other strategies. This suggests that when given a game, we should first eliminate all strategies that are dominated and then calculate

the Nash equilibrium of the remaining game. This procedure is called elimination of dominated strategies; it can sometimes result in a significant reduction in the number of Nash equilibrium. For example, consider the following game.

		Column	
		Left	Right
Row	Top	(2,2)	(0,2)
	Bottom	(2,0)	(1,1)

Table 3.4 a game with dominated strategy

Note that there are two pure strategy Nash equilibria, (top, left) and (bottom, right). Therefore, to get a unique Nash equilibrium applies the iterative elimination of dominated strategy in favor of its dominant strategy. Here if we start from Row player, the strategy bottom dominates the strategy top. This implies eliminate the strategy top to find the equilibrium of the game and left Row player with bottom strategy. The payoff matrix after elimination of Row's dominated strategy represented by table 3.5.

		Column	
		Left	Right
Row	Bottom	(2,0)	(1,1)

Table 3.5 elimination of dominated strategy.

In this simplified after elimination of the dominated strategy, bottom continue determining the dominated strategy for column player. That is left is a dominated strategy by right .So eliminate a strategy left and end up with unique Nash equilibrium (Bottom, right)

Dear student, iterative elimination of dominated strategies enables us to solve games in which each player has more than two strategies. Let us take a game involving two players, each of whom has three strategies to choose from. All that we have to do is to eliminate dominated strategies from a player, then go to the other player and eliminate his dominated strategies from

the remaining strategies and payoffs after the first elimination and repeat the process until we end up at the equilibrium. This three by three model is shown in table 3.6.

		Column		
		Left	Center	right
Row	Top	(-5,-1)	(2,2)	(3,3)
	middle	(1,-3)	(1,2)	(1,1)
	Bottom	(0,10)	(0,0)	(0,-10)

Table 3.6 a three by three game

The process of iterated elimination of dominated strategies is illustrated by actually eliminating the Row and Column's dominated strategies turn by turn as follows.

For the Row player, top and middle strategies dominate bottom strategy. Therefore, we can eliminate the bottom as a dominated strategy. This is because if the Row player expects the column player to play left, she would choose middle, if she assumes the column player would play center, she would go for top; and if she assumes the column player will choose right, she will choose top again. That is, no matter what the column player does, the Row player will not choose bottom as her strategy. This implies the Bottom strategy is dominated by Top and middle and can be eliminated.

		Column		
		Left	Center	right
Row	Top	(-5,-1)	(2,2)	(3,3)
	middle	(1,-3)	(1,2)	(1,1)

Table 3.7 eliminating dominated strategy for Row player

After bottom strategy is eliminated, let us identify dominated strategy for Column player. When we see into the payoff of Column player strategy left is dominated by center and Right .This is because if column think that Row play top, column play right. If column thinks that Row play middle, column play center. So left strategy is strictly dominated by left and right and should be eliminated.

		Column	
		Center	right
Row	Top	(2,2)	(3,3)
	middle	(1,2)	(1,1)

Table 3.7b eliminating dominated strategy for Column player

At this round, the Row player's dominated strategy is the middle, so we can eliminate the middle strategy.

		Column	
		Center	right
Row	Top	(2,2)	(3,3)

Table 3.7c eliminating dominated strategy for row player

Finally, column chooses Right over left, yielding a unique outcome after the iterated elimination of dominated strategies, which is (Top, Right).

The iterated elimination of dominated strategies is a useful concept, and when it applies, the predicted outcome is usually quite reasonable. Certainly, it has the property that no player has an incentive to change their behavior given the behavior of others. However, there are games where it doesn't apply.

Activity 3.2

1) Differentiate between dominant strategy equilibrium and Nash equilibrium
2) Why Nash equilibrium is not paretoefficient?
3) Describe elimination of dominated strategy method of finding unique Nash equilibrium.

4) Two firms producing the same product have a choice to produces high quality (H) and low quality (L). The resulting profit is given by the following payoff matrix.

Firm-2

Firm-1		**Low**	**High**
	Low	(-10, -30)	(100 ,160)
	High	(90, 80)	(50,50)

a) Determine the Nash equilibrium of the game

b) Suppose that the firms coordinate the action, what would be the equilibrium outcome of the game.

5) Two competing firms are each planning to introduce a new product. Each will decide whether to produce product A, product B, or product C. They will make their choice at the same time. The resulting payoffs are as shown below.

Firm-2

Firm-1		**Product-A**	**Product-B**	**Product-C**
	Product-A	(-10,-10)	(0,10)	(10, 20)
	Product-B	(10,20)	(-20,-20)	(-5, 15)
	Product-C	(20, 10)	(15,-5)	(-30,-30)

a) Find the Nash Equilibria of the game if any

b) Determine a unique Nash equilibrium of the game by using elimination of dominated strategy method.

3.4 The Prisoners' Dilemma

Dear students, having described the basic features of game theory, we now turn our attention to an important type of game known as the prisoner's dilemma. It has been the source of some in sight with which we approach modern oligopoly theory as well as many other areas of economics, behavioral and political science.

The game consider a situation where two prisoners who are partners in a crime where questioned in two separate rooms and communication is not allowed. Each prisoner had a choice of confessing for the crime and there by implicating the other or denying that he had participated in the crime.

If only one suspect confessed, then he would go free while the other suspect (who does not confess) will receive 6 year sentence. If both suspects denied being involved in the crime, then both would be held for 1 year. If both confessed, they would be held for 3 years in prison. The payoff matrix for the game is given in table 3.8.

Suspect (player)-B

Suspect (player)-A		**Confess**	**Deny**
	Confess	(-3,-3)	(0,-6)
	Deny	(-6,0)	(-1,-1)

Table 3.8 Prisoners' dilemma game

Which strategy is the optimal strategy for the two suspects? What is the equilibrium out come of the game? Well students, to answer these questions let us compare the payoff that the player receives by choosing a specific combination of strategies. Let us start form player. A.

If player-B decides to deny, player-A is better off confessing since it will left free. If player B decides to confess, still player- A is better off by confessing since it receives 3-year sentence rather than 6 year sentence. Thus whatever player B does, player A is better off by confessing. That is the dominant strategy for player A is confessing. Also the dominant strategy for firm B is confessing. The reason is that if player A confesses, players B get a three year jail sentence and six year jail sentence if the does not. This implies the unique Nash equilibrium of the game is both players to confess. This equilibrium is also dominant strategy equilibrium, since each player has the same optimal choice independent of the other player.

But the equilibrium outcome (confess, Confess) is not a paretoefficient outcome. Because if they coordinate there action and choice a strategy (deny, deny) both suspects are better off. That is the two suspects receive only one-year imprisonment by denying. The problem is however there is no way for the two suspects to communicate with one another to make sure that the two suspects cooperate. If each could trust the each other, then they could be better off by choosing a strategy (deny, deny).

Prisoners' dilemma game is useful in analyzing the behavior of oligopoly. It can be used to indicate the situation under which firms would be tempted to cheat on a cartel agreement by cutting price from agreed level or increasing the output produced more than its quota.

Suppose that there are two firms' production oil, firm- A and firm- B form cartel. Each firm has two possible strategies: to stick with the cartel agreement or to cheat. There are four possible outcomes, depending up on which strategy each firm pursues. The payoff matrix is given in table 3.9.

		Firm-B	
		Stick to agreement	**cheat**
Firm-A	**Stick to agreement**	(4,4)	(1,5)
	cheat	(5,1)	(3,3)

Table 3.9 cartel cheating game.

As indicate in the payoff matrix, cheating is a dominant strategy for both firms. That is firm-A get a profit of 5 million by cheating and 4 million by stick to the agreement while firm-B stick to the agreement. When firm-B decide to cheat firm-A get a profit of 1 million by sticking to the agreement and 3 million by cheating. This indicates firm-A get higher return by cheating whatever strategy chosen by firm B. Similarly firm-B gets higher return by cheating whatever strategy chosen by firm-A. So both firms would cheat even though they would be better off if they would both stick to the agreement and sustain cooperative solution. This example is the same as prisoners' dilemma game.

Activity 3.3

- Think of U.S. and Japanese trade policies as prison's dilemma. The two countries are considering policies to open or close their import markets. The payoff matrix to their decision is shown below.

Japan

U.S.		Open	Close
	Open	(10, 10)	(5,5)
	Close	(-100, 5)	(1, 1)

Assume that the two countries know the payoff matrix and believe that the other country act in its own interest. Does either country have a dominant strategy? What will be the equilibrium policies if each country acts rationally to maximize its welfare?

3.5 Mixed Strategies Nash equilibrium

In all of the games that we have seen so far, we consider a strategy in which players once make a specific choice, it will stick to it. Such type of strategy is said to be a pure strategy. It is a condition in which players choose a strategy with a probability equals to one. There is another form of strategy that we consider in this section. It is a situation in which agents (players) assign a probability to each choice (strategy) and play their choices according to those probabilities. For example firm-A might choose to play top 50 percent of the time and bottom 50 percent of the time, while B might choose to play left 50 percent of the time and right 50 percent of the time. This kind of strategies are said to be a mixed strategies. Strategies in which a player makes a random choice among two or more possible actions, based on a set of chosen probabilities.

If firm-A and firm-B follow the mixed strategies given above, then they will have the probability of ¼ of ending up in each of the four cells of the payoff matrix. Thus the average payoff to A will be zero, [= (¼ x 0) + (¼ x 0) + (¼ x (-1) + $\frac{1}{4}$ x (1)] and the average payoff for B will be ½, [= (¼ x 0) + (¼ x (-1) + 0 x ¼) + (3 x ¼)].

Firm-B

Firm-B		Left	Right
	Left	(0,0)	(0, -1)
	Right	(1,0)	(-1,-3)

Table 3.10 Game with no Nash equilibrium in pure strategies.

Students, one advantage of mixed strategies over pure strategies is that, it allows us to determine Nash equilibrium to some game which do not have Nash equilibrium in pure strategies like the game represented by table 3.10. But how can Nash equilibrium in mixed strategies determined? Is it differs from Nash equilibrium in pure strategy?

Nash equilibrium in mixed strategies refers to an equilibrium in which each agent chooses the optimal frequency with which to play his strategies given the frequency choices of the other agent. In other words Nash equilibrium in mixed strategies is a pair of mixed strategy (P_r, P_c) such that each agent's choice a probability that maximizes his expect payoff, given the strategy of the other agent. Where P_r represents the probability that Row plays his strategies and P_c represents the probability that column play its strategies.

Let us consider the matching pennies game once again to illustrate how to determine equilibrium in a mixed strategies.

Column

Row		Head	Tail
	Head	(1, -1)	(-1, 1)
	Tail	(-1,1)	(1, -1)

Table 3.11 matching the pennies game.

Suppose that Row believes column plays head with probability P. Then if Row plays head, Row gets q with probability P and -1 with probability (1-P). So the expected payoff of player Row

while player column play head is equal to 1P + (-1) (1-P) = 2P-1. Similarly if Row plays Tails, Row gets -1 with Row's expected payoff by playing tail while column play head is equal to -1P + 1 (1-P) = 1-2P.

The expected payoffs for both Row and column player are summarized Table3.12 below

Column

Row	**Head**	**Tail**	**Row's expected payoff**
Head	(1, -1)	(-1, 1)	1p+(-1)(1-p) =2p-1
Tail	(-1, 1)	(1, -1)	-1p+1(1-p) = 1-2p
Column's expected payoff	**-1q+1(1-q) =1-2q**	**1q +(-1)(1-q) = 2q-1**	

Table 3.12 Expected pay off both players

Now let q be the probability that column would play Head then, if column plays head, column gets -1 with probability q and 1 with probability (1-q). So the expected payoff of column by playing head, while Row play head is equals to -1q + 1 (1-q) = 1-2q. We can find the expected payoff for Row player using the same fashion to be 2p-1 as indicated in the above-expected payoff Table.

Dear students, given the expected payoff for the two player how can we determine the optimal strategy of them? To determine their optimal strategy we have to compare their expected payoff. If 2P-1>1 -2P, then Row is better off on average playing Head than Tail. Similarly if 2P-1<1-2P, Row is better off playing Tail than Head. On the other hand, if 2p-1 = 1-2P, then Row get the same expected payoff no matter what it does. In this case, Row can play Head, Tail or could flip a coin and randomize its play. For column, also we can determine the optimal strategy following the same fashion.

As we define earlier, a mixed strategy Nash equilibrium involves at least one player playing a randomized strategy, and no player able to increase their expected payoff by playing a pure strategy. Randomized strategy however, requires equality of expected payoffs. If a player is supposed to randomize over strategies, then both of these strategies must produces the same expected payoff. Otherwise, the player would prefer one of them and would not play the other. So to find the probability with which player chooses a given strategy can be obtained by equating the expected payoff of the two strategies of a given player.

That is:

For Row, $2P - 1 = 1 - 2P$

$4P = \rightarrow P = ½$

For Column, $1 - 2q = 2q - 1$

$4q = 2 \rightarrow q = ½$

So the Nash equilibrium in mixed strategies for the matching pennies game is defined by the probability which maximizes the expected payoff for Row and column. That is at equilibrium Row play 50 percent of the time head and 50 percent of the time tail. Also column play 50 percent of the time head and 50 percent of the time tail. So the unique Nash equilibrium in mixed strategies of the game becomes (½, ½)

Activity 3.4

1). differentiate between pure strategy and mixed strategy.

2).describe a Nash equilibrium in mixed strategy.

3). given the following payoff matrix,

		Column	
		Left	Right
Row	Left	(-3,-3)	(2, 0)
	Right	(0, 2)	(1,1)

Find: a). pure strategy equilibrium of the game

b). mixed strategy equilibrium of the game

c). the expected payoff of Column and Row player

d). the probability that the strategic choice of the player fall in a (bottom, right)

3.6 Repeated Game

Dear Students, up to now we have been assuming that players, play the game only one (one shot game) and there is no communication between players. Now let us consider the case where there is a possibility to repeat the game. Do you think that the equilibrium outcome of the game changed if the game is to be played repeatedly?

In repeated game if one player chooses to defect on one round, then the other player can choose to defect on the next round. That means the player who defects in the first round can be punished by the other player for his bad behaviors in the next round. So each player has the opportunity to establish a reputation for cooperation and there by encourage the other player to do the same in a repeated game. However, such type of result expected depending up on whether the game played for fixed number of times or an indefinite number of time.

In the case of fixed number of repetition, the equilibrium outcome of the game is similar to one shot game if there is no way to enforce cooperation in the last round. Basically players cooperate because they hope that cooperation in present will induce further cooperation in the future. But this requires that there will always be possibility of future play. Since there is no possibility of future play in the case of fixed (finite) numbers of repeated game, players do not cooperate in the last round. Thus, the outcome (result) of playing for fixed number of game is the same as playing one shot game.

However, if the game is going to be repeated an infinitive number of times, and then players have influence on their opponent's behavior through the tit-for-tat strategy. This means do to your opponent what he or she has just done to you. That is beginning by cooperating and continues to cooperate as long as your opponent cooperates. If one player refuses to cooperate this time, the other player refuses to cooperate next time. As long as both parties care enough about future payoffs, both parities cooperate fear of retaliation in the next round. This will result

in Pareto efficient equilibrium outcome. Such game might explain price setting strategy in cartels and other oligopolist firm operating in the same industry.

For example, consider a price setting game played by duopolist producing homogenous product. If each firm charges high price then both get larger profit. This is the situation where both firm cooperate to maintain Pareto efficient outcome. But if one firm is charging a high price, and the other lower its price, the one who cut its price capture the other's market and their by get even higher profit. However, if both firm cut prices, both firms ending up making lower profits. Whatever price the other fellow is changing, the dominant strategy of each firm is to cut price and the equilibrium out come becomes Nash equilibrium. The result of the game is summarized in table below 3.13

Firm-2

Firm-1		**Lower price**	**High price**
	Lower price	(5,5)	(0,20)
	High price	(20,0)	(10, 10)

Table 3.13 price setting game

However, if the game is repeated an infinite number of times, there may be other possible outcomes since firms use tit-for-tat strategy. If one firm cut price in this week and get higher profit at the expensive of the other, the other firm retaliate in the next round by cutting its price and get higher profit.

If each player knows that the other players playing tit for tat, then each player fear of cutting price which initiate price war, they would cooperate. So to avoid such price war both firms prefer to maintain higher price and get Pareto efficient level of profit. This outcome is represented by bottom right cell in the price setting game payoff matrix example.

For tit-for-tat strategy to become an optimal strategy, however there are certain conditions that must be holds. First, a reasonable stable set of players is required. If the numbers of players change frequently, there is little chance for cooperative behavior to develop. Second, there must

be small number of players (otherwise, it becomes difficult to keep track of what each is doing). Third, it is assumed that each firm can quickly detect and willing to retaliate if other firm cheat. Cheating (defect) that goes undetected for a long time encourage cheating.

Lastly, it must be perceived by the player that the game is repeated infinitively for uncertain number of times. In most market however, the game is repeated for long and uncertain period of time. As a result, in some industries, particularly those in which only a few firms compete for long period under stable demand and cost condition, cooperation prevails even though there are no contractual agreements are made.

3.7 Sequential Game

As we have seen in most of the games that we have discussed so far, both players move at the same time and it is known as simultaneous game. In this section, we are going to consider a case where on player move first and the other player play its strategy after observing the strategy played by its opponent. Such type of game is called sequential game. An example of such type of game includes the Stackleberg model of oligopoly- One firm (the leader) first set its output before the other does; an advertising decision by one firm and the response of its competitor; entry- deterring investment by an incumbent firm and the decision whether to enter the market by a potential competitor; or a new government regulatory policy and the investment and output response of the regulated firm. Is there any difference in the equilibrium outcome of a game when played simultaneously and sequentially? How can we go about it to determine the equilibrium of sequential game? We will try to give answer to such type of question in this section

Consider a game given in table 3-14. In the first round, player A has a strategy to move top or bottom. Player B after observing the optimal strategy plays a strategy left or right. The return to each combination of strategies chosen as summarized in table 3.14.

Player B

		left	Right
Player A	Top	(1,9)	(1,9)
	bottom	(0,0)	(2,1)

Table 3.14 the payoff matrix of a sequential game

When the game is present using a payoff matrix, it has two Nash equilibria (top, left) and (bottom, right). However, we will show below that one of this equilibrium is not reasonable equilibrium. The payoff matrix hides the fact that one player gets to know what the other player has chosen before she makes her choice. As a result sequential games are easier to visualize if we present the possible move in the form of decision tree. Such representation of a game is called extensive form of a game. It shows how player sequential play the game one after the other. The above game, therefore should be present is the extensive form as in figure 3.1 to easily identify the equilibrium of the game

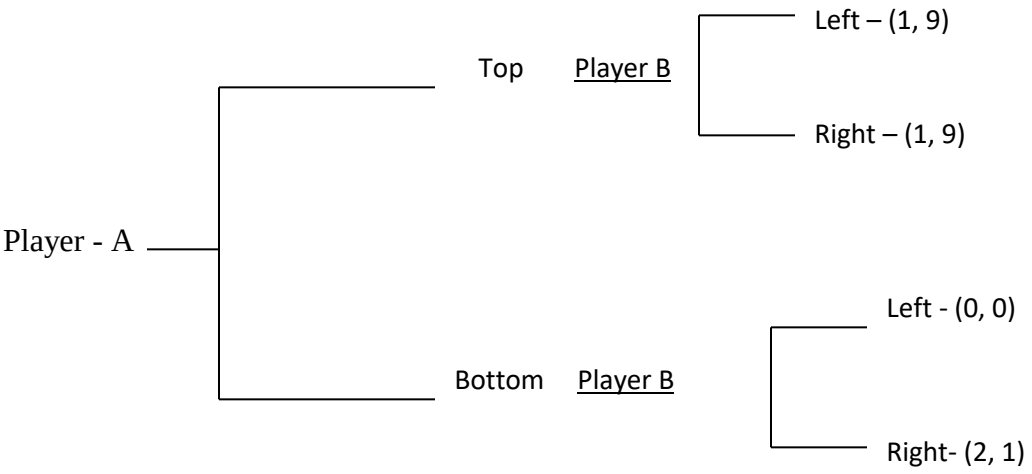


Figure 3.1 a game in extensive form.

In this game, first player-A has to choose from strategy top or bottom, and player-B after detecting the strategy chosen by player-A, choose a strategy left or right. With this basic rule of the game, the equilibrium of the game can be determined by playing the game backward starting from the player, which moves second. Suppose that player-A has already made her choice and we are identify the branch that corresponds to A's choice. For example if player-A chosen top, then it does not matter what player B does, the payoff faced by the player is (1, 9). If player-A choice to play bottom ,then the reasonable choice for player-B is to choose right and the payoff corresponds to the indicated combination of strategy is (2, 1).

Now think about player A's initial choice. If she choose top, the outcome will be (1, 9) and thus she will get a payoff of 1. But if she chooses bottom, she gets a payoff of 2. So the reasonable

thing for her is to choose bottom. Thus the equilibrium outcome of the game will be (bottom, right), so that the payoff to player A will be 2 and to player B will be 1.

The strategies (top, left) are not a reasonable equilibrium in this sequential game. That is they are not an equilibrium given the order in which the players actually get to make their choices. It is true that if player-A choose top, player-B could choose left but it would be silly for player-A to ever choose top.

For player B's point of view this is rather unfortunate, since she ends up with a payoff of 1 rather than 9. What might she do about it? She can threaten to, for example, to play left if player A plays bottom. If player B would actually carry out this threat, she would be well advised to play top. For top gives her 1, while bottom- if player B carries out her threat will only give her 0.

Activity 3.5

1) What are the difference between sequential game and simultaneous game?

2) Two Doupolist firms A and B are planning to maximize their profit through investing in new technology that improves their product quality. Market research indicates that the following table gives the resulting profits to each firm for the alternative strategies.

Firm-B

Firm-A	Invest	Not invest
Invest	(25,20)	(40,30)
Not invest	(30,25)	(5,0)

a) If the two firms play simultaneous game to decides in making the investment, determinate the equilibrium of the game. Is the equilibrium is dominant or Nash equilibrium?

b) Suppose that firm-A move first and firm-B play (decides) after observing the strategy chosen by firm A. What is the equilibrium of the game assuming that the threat from firm B is not credible? Use extensive form of game representation.

Summary

- Game theory is a tool that is used for examining strategic behavior in economic circumstances
- A game is any situation in which players (participants) make strategic decisions i.e. decisions that take into account each other's actions and responses.
- A game is cooperative, if the player can communicate and arrange binding contracts otherwise, it is non-cooperatives.
- Strategic decisions result in payoffs to the players and the optimal strategy for a player is the one that maximizes her expected payoff.
- A Nash equilibrium is a set of strategies such that all players are doing their best given the strategies of the other players. We will say that a pair of strategies is a Nash equilibrium if A's choice is optimal given B's choice, and B's choice is optimal given A's choice. Equilibrium in dominant strategy is a special case of Nash equilibrium.
- A dominant strategy is a strategy that will maximize the expected payoff of a player no matter what the other player does.
- The prisoner's dilemma is a type of game that is very much help fully in understanding oligopoly behavior. In particular, it helps explain why firms have a tendency to cheat on cartel agreement. However, if the game is repeated indefinitely, then firms may not cheat. When the game is repeated a fixed known number of times, on the other hand cheating solution is return.
- The dominant strategy equilibrium can be found by eliminating dominated strategies of each player alternatively mostly in the case of more than three strategies case.
- A pure strategy is strategy in which a player makes a specific choice or takes a specific action with probability equal to one. Where as, mixed strategies are those in which a player makes a random choice among two or more possible actions, based on a set of chosen probabilities.
- Nash equilibrium in mixed strategies refers to an equilibrium in which each agent chooses the optimal frequency with which to play his strategies given the frequency choices of the other agent.

- A game said to be sequential game if player move in turn. While simultaneous game a case where a player move at the same time by assuming a given strategic choose for the other player.

Key concepts and terms

- Game
- Player
- Payoff
- Strategy
- Simultaneous game
- Expected payoff
- Elimination of dominated strategy
- dominant strategy
- optimal strategy
- Nash equilibrium
- mixed strategy
- repeated game
- pure strategy
- pare optimality
- prisoner dilemma
- sequential game
- payoff matrix
- extensive form

Review questions.

Answer the following question briefly

a) We know that a single-shot prisoner's dilemma game results in a dominant Nash equilibrium strategy that is Pareto inefficient. Suppose we allow the prisoners to retaliate after their respective prison terms .formally what aspect of the game would affect? Could a Pareto efficient outcome result?

b) What is the dominant Nash equilibrium strategy for the repeated prisoner's dilemma game when both players know that the game will end after one thousand-time repetition?

c) Letu and Lata are playing a number matching game. Each chooses 1, 2 or 3. If the numbers match, Letu pays Lata 3 birr. if they differ Lata pays Letu 1 birr .

i) Describe the payoff matrix for this game, and show it does not have a Nash equilibrium strategies pair.

ii) Show that with mixed strategies this game does have Nash equilibrium if each player plays each number with a probability $\frac{1}{3}$. Find the expected payoff of the two players.

Problems.

1) Two firms, A and B exist in a particular market. Each has two strategies. The payoff matrix for each combination is shown below.

Firm-A

Firm-B

	Left	right
Top	(-5,-6)	(5,10)
Bottom	(10,5)	(-6, -5)

a) If firm A move first, what strategy would it choose? What strategy would firm-B then move?

b) If firm B moves first what strategy, would he choose? What strategy firm-A then choose to move.

c) Represent the game under question (a) and (b) with extensive form or game tree.

2) consider the game shown below :

Column

Row

	Left	Middle	Right
Top	(1,0)	(1,2)	(2,-1)
Middle	(1,1)	(1,0)	(0,-1)
Bottom	(-3,-3)	(-3,-3)	(-3,-3)

a) Determine the dominant strategy of Row what ever Column does

b) Which strategy of Row is dominated strategy?

c) Which strategy of column is dominated strategy?

d) Determine the equilibrium of the game using elimination of dominated strategy method.

3) From the following payoff matrix, where the payoffs are the profits or losses of two firms,

Firm-B

Firm-A

	Low price	High price
Low price	(1,1)	(3,-1)
High price	(-1,3)	(4,2)

Determine

a) Whether firm-A has a dominant strategy

b) Whether firm-B has a dominant strategy

c) The optimal strategy for each firm.

d) The Nash equilibrium if there is

CHAPTER FOUR

PRICING OF FACTORS OF PRODUCTION AND INCOME DISTRIBUTION

4.1 INRODUCTION

In the preceding chapters, have completed our examination of the product market, where the prices of goods and services are determined. The mechanism of determination of factors prices does not differ fundamentally from the pricing of commodities. The difference lies in the determination of the demand and supply of productive resources and in the reversal of the role played by firms and consumers. Factors price are determined in market under the forces of demand and supply. Firms supply of commodities to the market, but they demand inputs; consumers demand commodities from the market places, but they supply some very important inputs. This is what circular flow of economic activities for simplified economy in which there are firms and households with their respective objectives all about.

4.2. BASIC CONCEPTS OF FACTOR MARKET

Production function is the relationship between inputs and outputs. The firm's demand for a factor input depends upon the input's physical productivity and the demand for the good the factor is being used to produces. A business firm participates in both the product market, where it sells the goods and services it produces, and in the factor market, where it buys factors such as the land, labor and capital it needs to produces the output. Factor markets differ from product market in three important aspects.

First, factor market tends to be more competitive than product market. In product market, firms compete against other sellers/firms on same or similar products. In many cases producers can sufficiently differentiated their product and can exercise same control over prices. In factor market, all business firms tend to compete for the same factor resources. For instances, General Motors, Microsoft television stations ... etc competes for the general pool of labor, capital and land thought producing quite different goods and services. They all need word processing specialists, computers, trucks drivers and mangers. It is, therefore, rare that one firm can exercise sufficient control over a particular factors market to be able to influence the prices of those factors. Most firms are price takers in factor market in a sense that business firms simply must pay the going rate for the factors of productions.

Second, the demand for factors of production is a derived demand in a sense that its demand comes from the demand for the goods and services produced by the factors of production. The firm buys factors of production because they produce goods and services that generate revenue for the firm. The garment industry, for instances, buys sewing machines because it helps to produce suits, shirts, and dresses that consumers will buy or need. The principle of derived demand is essential to understanding the workings of factor markets. If consumers reduce their demand for lettuce, the demand for workers employed in lettuce decline, the demand for farmland used for lettuce and even the demand for water used in farm irrigation will also fall.

Third, the production of a good requires the cooperation of different factors of production. Farm workers can produce no corn without farmland and farmland without farm labor is useless. Both farmland and farm workers require farm implements (ranging from hand tools to sophisticated farm machinery) to produce corn. Thus, it is joint determination of factors demand.

The determination of prices of factors of production is something related the supply and demand of products as it is a derived demand. The theory of prices is related to the behavior of production function. All production functions exhibits the law of diminishing returns as larger quantities of variable factors are combined with fixed amounts of the firm's other factors, the marginal physical product (the amount of extra output of an extra works) of the variable factor will eventually decline. The interdependence of the marginal physical product of land, labor, and capital does not make the problem of factors pricing in a market setting difficult.

The determination of factor prices differs depending on the type of market structures (perfect market and different ranges of imperfect market). In this regard, we will first examine the pricing system of these inputs under perfectly competitive market. Subsequently we relax our assumption and see how the theory woks under imperfect competition. In these sections, we will examine the economic forces that govern wages and other conditions of employment.

FACTOR PRICING IN PERFECTLY COMPETITIVE MARKET

We have seen how firm's make factor employment decisions based on the objective function under production chapter specifically in module –1. We have developed the optimization conditions of production and input employment; how much of each input the firms would

demand under various sets of circumstances based on its decision of the level of output. This is an important beginning for constructing a model of input pricing and utilization under perfect competitions.

For our better understanding lets, we review some of the main points. We showed there that a firm minimizes its cost by picking the combination of inputs for which the ratios of their marginal products to their prices are all equal. That is, a cost-minimizing firm should set

$$\frac{MPx}{Px} = \frac{MPy}{Py} = ------ = \frac{MPz}{pz}$$

Where MPx is the marginal production of input x, Px is the prices of input x, MPy is marginal product of input y, Py is the prices of input y, and so on. If it did not hold, firm always make certain adjustments in such a way that it reduce costs and hence optimize his objective function. Going a step further, it can also be shown that the above cost minimizing firm's ratios equals to the reciprocal of the firm marginal cost. That is

$$\frac{Px}{MPx} = \frac{Py}{MPy} = ------ = \frac{Pz}{Mpz} = MC$$

Where MC is its marginal cost

More over, we have seen that the profit maximizing firm must operate at the point for which marginal cost equals marginal revenue. It follows, therefore, that

$$\frac{Px}{MPx} = \frac{Py}{MPy} = ------ = \frac{Pz}{Mpz} = MC = MR$$

Where MR is the firm's marginal revenue

Rearranging the terms in equation above we get

$$MPx \times MRx = P, MPy \times MRy = Py, ----------- MPz \times MRz = Z$$

We concluded that the profit maximizing firm should employ each input up to the point where its marginal product multiplied by the firm's marginal revenue equals in the inputs per unit price. In this competitive product and input markets, factors are paid the value of their marginal physical product, which is determined by the force of total demand and supply.

A firm has a demand for factors (labor and capital) is related the contribution of the factor to the objective function of the firm. The contribution of labor, for an instance, to the firm's profit function is determined by two things: the quantity of additional output a unit labor input can

produces and the price that the firm can sell its product. The analysis of the demand for the labor differs when labor is the only variable factor of production and when there are several variable factors.

4.3.1.DEMAND OF A FIRM FOR A SINGLE VARIABLE FACTOR IN SHORTRUN: LABOR

Our first step in analyzing the demand for an input is to consider the demand curve of an individual firm for some input (call labor) under the assumption that labor is only variable factor in the firm's production process. Our analysis of demand labor underlines the following assumptions:

a) A single commodity x is produced in perfectly competitive market. For example a firm is producing wheat and its prices P is given for all firms in the market
b) The goal of the firm is profit maximization
c) There is a single variable input in the firm's production process: Labor and all other inputs are fixed. Workers who are assumed to be homogeneous in our example of wheat, for instances, varies in their ability to produce, but the farm, machinery, fertilizer, seeds and so on are all fixed.
d) Perfectly competitive market.

   The price of labor services, w, is given for all firms as the firm is price taker. This implies that the supply of labor to the individual firm is perfectly elastic. This can be denoted by a straight line parallel to the horizontal axis (Figure 4.1). At the going market wage rate the firm can employ (hire) any amount of labor it wants.
e) Technology is given. The available technology enables the firm to produce certain level of output.

Given the above assumption, the demand curve for labor by the firm is the quantity of input that the firm would demand at each possible price (wage). The firm will demand certain amount of input for which the value of the extra output produced by the employment of the last unit of input is equal to the prices of the product.

That is

$$\frac{dX}{dL} = MPP_L = \mathrm{P_x}$$

Profits maximizing firms operate in second stage of production. In the second stage, MPP_L is falling but positive. If we multiply the MPP_L at each level of employment by the given prices of the output P_x, we obtain the Value of Marginal Product or Marginal Revenue Product in monetary term-VMP (MRP). In short:

$$VMP = MPP_L .. Px$$

A profit maximizing firm will hire a factor as long as it adds more to total revenue than to the cost. This is so, as firm is guided by profit maximization objective in the factor market which is basically the same as profit maximizing decisions in the product market as deciding on the quantity of inputs determines the level of output. Hence, the higher the prices of an input, the lesser the firm wants to buy. It is a down-word sloping curve because the greater the amount of factor used, the lower is the marginal revenue product as the law of diminishing returns holds. In addition, as the firm is a price taker in the product market to some extent, higher levels of output will results in lower marginal revenue. From these one can see with the quantity of factor increases, both marginal physical product and hence the marginal revenue tend to decline, so that MRP (which MPP x MR) declines.

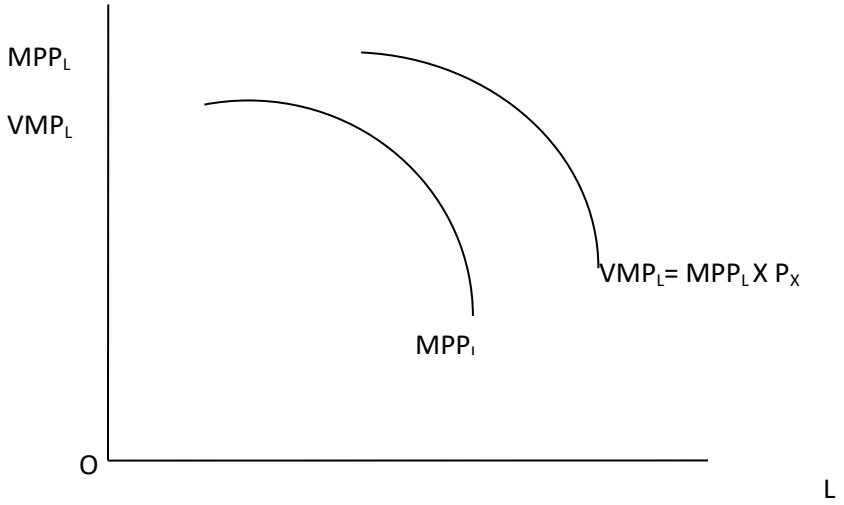


Figure 4.1. Demand curve of the firm

VMP_L curve is the firm's demand curve for a factor as it determines the level of extra output produced by additional labor and hence demands for labor. Hence, how do equilibrium level of employment is determined given the labor demand and supply?

For a competitive employer of labor, the marginal cost of hiring one more worker per hour is the wage, w. Hiring an extra worker raises the firm's profit if the marginal benefit, marginal revenue

product of labor is greater than the marginal cost (the wage)from one more worker: MRPL > W. If the marginal revenue product of labor is less than the wage, MRPL < w, the firm can raise its profit by reducing the number of workers its employs.

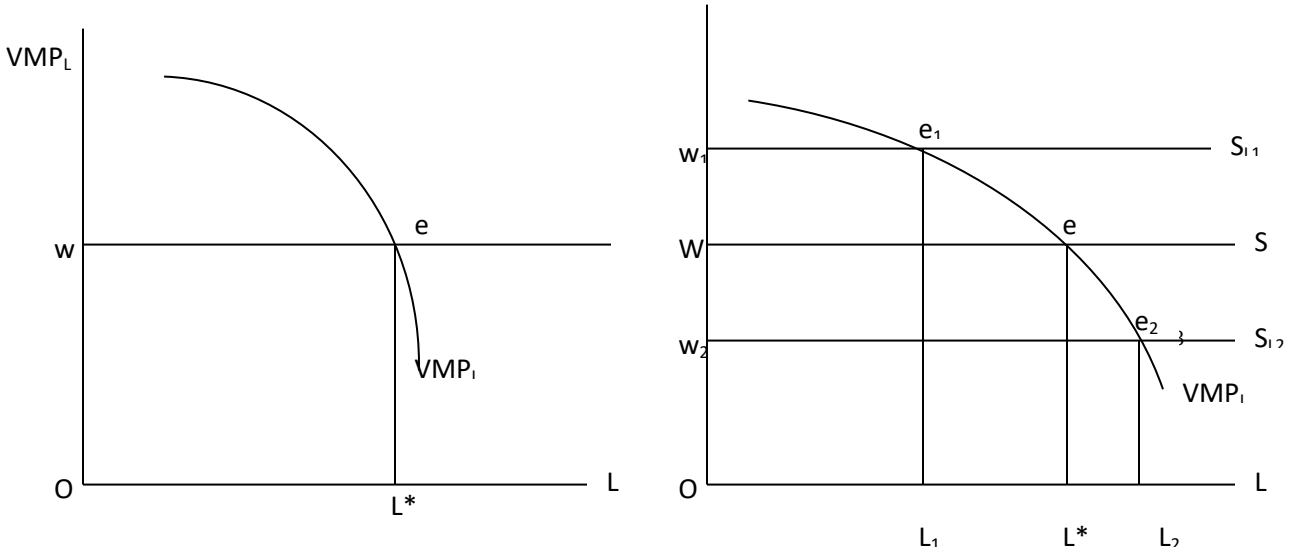


Figure 4.4-A Demand curve of the firm Figure 4.4-B Demand curve when wage changes

Thus, the firms maximizes its profit by reducing the number of workers until the marginal revenue product of the last labor is exactly equals to the marginal cost of employing that work, which is the wage; MRP_L = w. This is indicated by point 'e' on figure 4.4-B.

As the wage rate changes, the firm will move along its VMP_L curve to determine the profit maximization level of employment. If the market wage is raised to w_1 from original point, the firm will reduce it demand for labor to L_1 in figure 4.4 -B in order to maximize its profit (at e, where $W_1 = VMP_L$). Similarly, if the wage falls to W_2, the firm will maximize its profit by increasing its employments to L_2. .It follows from the above analysis that the demand curve of a firm for a single variable factor, labor, is value of marginal product curve and is downward sloping.

Formal derivation of the equilibrium of the firm is as follows:

The production function is specified as $X = f(L)_k$

The total cost consists of the variable cost W.L and the fixed cost F can be stated as

$$C = W. L + F$$

The revenue of the firm is $R = P_x . X$ which is $R= P_x . [f(L)]$.

The firm wants to maximize its profit

$$\pi = R - C$$

$$\pi = P_x .[f(L)] - (W. L + F)$$

The first order derivative of the profit functions with respect to labor equal to zero we obtain

$$\frac{d\prod}{dL} = \hat{P}_x . \frac{dX}{dL} = \overline{w} = 0$$

Rearranging

$$Px . (MPP_L) = W \qquad \text{given} \quad \frac{dx}{dL} = MPP_L , \qquad VMP_L = W$$

The above discussion can be illustrated with numerical example by assume a production process, which involves a fixed amount of machinery giving rise to a total fixed cost of Birr 50, and the labor which is the only variable factor. The wage rate is 40 and the prices of the commodity produced are 10. The production function is specified by the information of the first four columns of table 4.1. Column 6 shows total revenue (= X . P_x), column 10 indicates total variable cost (=L.W). Finally column 12 shows the profit of the firm (π = R – TVC – FC)

Table 4.1: Data for the derivation of the demand curve for the firm

The production function				Costs, revenues, profit							
Unit of fixed capital K	Unit of labor L	Total output (unit) X	Marginal physical product of labor MPPL	Price of product P_x £	Total revenue R = X . P_x £	Value of marginal physical product of labor VMP_l (£)	Total fixed cost £	Wage rate w £	Total variable Cost TVC =W. L £	Total Cost TC=TVC +F C	Profit TI = R – TC £
10	0	0	_	10	0	0	50	40	0	50	-50
10	1	20	20	10	200	200	50	40	40	90	110
10	2	38	18	10	380	180	50	40	80	130	250
10	3	54	16	10	540	160	50	40	120	170	370
10	4	68	14	10	680	140	50	40	160	210	420
10	5	80	12	10	800	120	50	40	200	250	550
10	6	90	10	10	900	100	50	40	240	290	610
10	7	98	8	10	980	80	50	40	280	330	650
10	8	104	6	10	1040	60	50	40	320	370	670
10	9	108	4	10	1080	40	50	40	360	410	670
10	10	110	2	10	1100	20	50	40	400	450	650

Source: Kotisyanos , 1984

There are two ways of looking at profit maximization of the firm based on the Table 4.1 .

A. Total revenue or total cost approach

Profit is at a maximum where the differences between total cost and revenue are greatest. The maximum deviation is at point were the distances between two curve is the largest. This is at point where MR =MC, which is MRP = W = MC_L at labor utilization is equal to eight (see table above).

B. The VMPL approach

The supply of labor to the individual firm is the straight lines equal to given wage rate for competitive firm. The equilibrium is where the VMP_L intersect the supply S_L=w. According to our data, this occurs at wage rate, $40 and labor employment equals to 8. (See Table xx). Under both approach profit is maximized at the 8^{th} level of employment where $W = VMP_L$.

Example

Suppose certain hypothetical firm has a Cobb – Douglas production function for Canadian thread mill is specified $Q = L^{0.6} k^{0.2}$. Suppose further that mill's capital, K, is fixed at 32 units, labor is only variable input. Determine, MPP_L, VMP_L, and profit maximizing level of output?

Solution:

$F = L^{0.6} k^{0.2} = L^{0.6} (32)^{0.2} = 2L^{0.6}$,then extra level of output or MPP_L can be determined by looking the extra output from the last worker when firm's goes from 31 to 32 workers is

$F = (2 \times 32^{0.6}) - (2 \times 31^{0.6})^{0.3}$.The VMPL at this point is $VMPL = MPP_L \times W = 0.3 \times 5 = 1.5$.

The firm can sell its output at $50 per unit, the firm's $MRP_1 = P_x MP_L = \$50 \times 0.3 = \$15$

Thus, when the price is $50 and wage is 15, at this level the firm hires 32 workers. More generally, the marginal product of labor function, when we hold capital fixed at k = 32, is $MPL = 1.2 L^{-0.4}$. This is obtained by holding capital fixed at k = 32 and differentiating the short run production function, $f = 2L^{0.6}$ with respect to labor:

$$MPL = \frac{dq}{dl} = 0.6 \text{ x2 x } 2^{0.6-L} = 1\text{-}2L^{-0.4}$$

The above calculator method for discrete change from 31 to 32 workers can best be estimated by infinitesimally small change in labor. We can find MPL at L = 32 is exactly $0.3 = 1.2 (32)^{-0.4}$

4.3.2. DEMAND OF A FIRM FOR SEVERAL VARIABLE FACTORS

Suppose the now that the firm uses more than one variable. What is the demand curve for factor of production? Do you think VMP_L is demand curve for labor? Unlike the case of one Variable, the VMP_L is not longer demand curve for the several variable factors of production. Because when the many varied factors are used together in production change in price of one factor lead to change in employment of the other factor of production. Change in employments of other factor in turn

shifts the MPP curve of inputs whose price initially changed as the productivity of a given labor is not the same when it is associated with different levels of factors such as capital.

Consider the case of two variable inputs: labor and capital. The firm will employ labor and capital to the point where the value of the marginal product of each factor is equal to the prices of the factors. If the inputs are independent, a change in the quantity of one input has no effect on the marginal product of the other; the demand curves for each factor can be derived separately as it is done for labor.

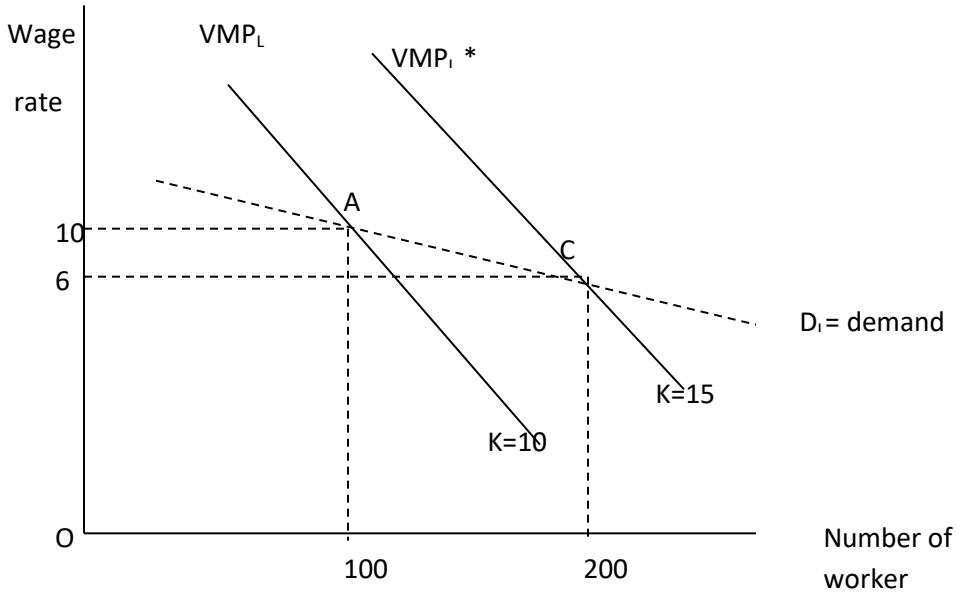
Thus: Value of marginal product of labor $(VMP)_L = (MP)_L .Po = P_L$

Value of marginal product of labor $(VMP)_K = (MP)_K .Po = P_K$

However, the demand for one factor depends on the nature of the relationship between the inputs. Because most of the times inputs are complementary so that the marginal product of one input increases with higher employment of the other inputs. The marginal product of labor for each unit of labor, for instances, increases with a larger quantity employed of the complementary inputs such more tools and machinery.

To see this point clearly, consider the impact of a decline in the wage rate that makes the firm hire more labor. The lower wage causes the marginal cost to falls so that the firm expands output. As the firm tries to expand output by increasing employment of labor, it will probably necessary to hire more capital. With capital usage increases, the VMP curve of capital and the demand for labor curve shift to the right, including a further increase in the quantity of labor employed. The resulting demand curve for labor looks like the one shown by figure xx with dotted line. Point A also lies on curve VMP_L - initial marginal revenue product curve for input combination associated with its price. Its very construction assumes that the employment of other inputs is fixed, and it would be demand curves for labor if none of other factors were variable. Nevertheless, what would happen when the price of labor decline to $6 and other inputs were variable? The marginal revenue product of labor now exceeds its new prices and the firm expands labor employment. However, increasing employment of labor would shift the marginal revenue product of other factor from K=10 to K=15.

These change further increase the labor and the system goes on. After all of these changes have worked their way through the firm's cost minimization decision system, the firm would be on a different marginal revenue product of labor- (VMP_L)*. Now the employment of labor would be determined by the point where its new marginal revenue product curve intersects. The firm now demands about 200 labor with wage rate \$6. This indicated by Point C lies on curve (VMP_L)* - the marginal revenue product curve for and input combination associated with higher prices. As a result, we can be sure that points A and c would both lie on the firm's demand curve for input (labor). Other points for other prices could be determined in a similar fashion. The result of the determination is the demand curve for labor. This demand curve is represented in figure4.5 by curve D_L , as would be expected it can be shown that all demand curves of this types slope down and to the right.



Finger 4.5: demand for labor allowing for changes in the capital

Alternatively, When there are varies factors are used together in production; the demand curve for labor is derived using Iso-quant analysis. This has been discussed in one of the previous chapters. The change in the wage rate has in general three effects:

- Substitution effects
- Output effects (income effect or sales effects)

- Profit maximizing effect

This can be presented using simplified diagram 4.6. Suppose that initially the firm produces the profit maximizing output x, with the combination of factor K, L, given the (initial) factors prices w_1 and r_1, whose ratio defines, the slope of the Iso-cost line AB.

Suppose wage rate falls to w_2, so that the Iso-cost line AB (the prices of capital remain the same) shifted to AB* as the ratio changes. The firm using the same expenditure can now produce ten higher outputs denoted by the Iso-quant X_2, using K_2, L_2 amount of capital and labor respectively. The equilibrium moves from point e_1 to e_2. The movement can be splited in to two separate effects:

- substitution effect
- Output effect

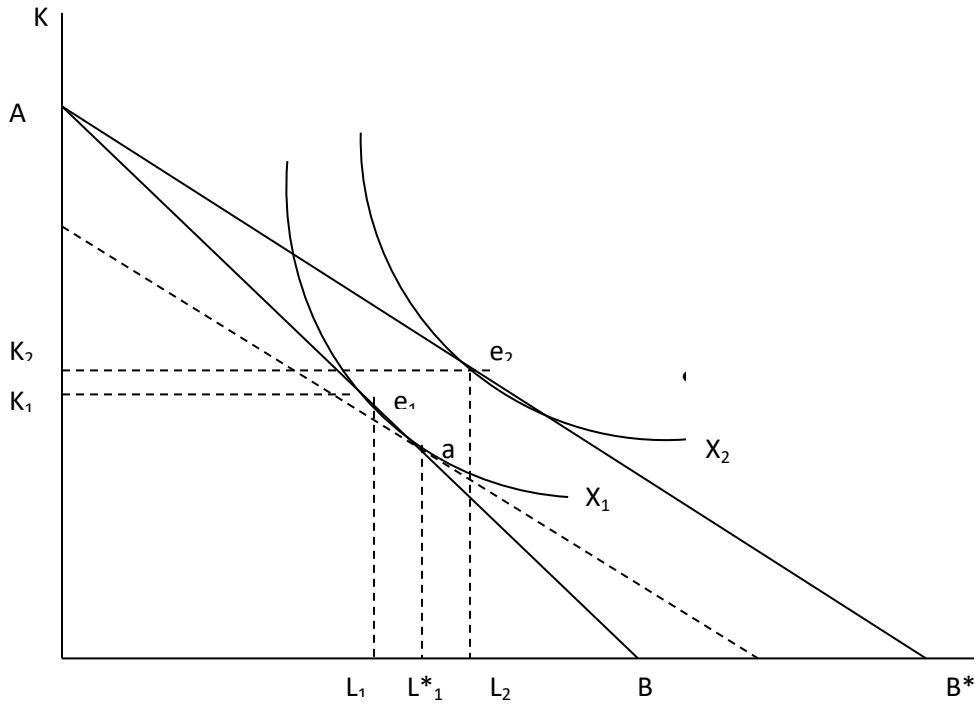


Figure 4.6: Derivation of demand curve for variable input

To separate the two effect draw an Iso-cost parallel to the new one AB* so that it reflects the new prices ratio, but tangent to the old Iso-quant X_1. The tangency occurs at point 'a'. The movement

from point 'e', to 'a' along old Iso-quant is pure substitution effect that show the cheaper labor substituted for capital. Thus, the employment of labor increases from L_1 to L_1*. But, as the firm can buy more labor and capital with the same expenditure, it can produce the higher output X_2, employing K_2 of capital and L_2 of labor. The increase of employment from L_1* to L_2, corresponding the movement from ' a' to '$e_{2'}$, is the output effect.

Point '$e_{2'}$ is not the final equilibrium of the firm. It would be it the firm were to spend the same amount of money as initially. However, keeping the total cost expenditure constant does not maximize the profit of the firm. The firm will increase its expenditure and its output in order to maximize its profit. The understand this let us assume that the initial equilibrium of the firm is denoted by point H in figure xx where the firm's MC is equal to the prices of X. The fall in the wage rate shifts the MC curve downwards to the right, and the profit maximizing output of the perfectly competitive firm increases to X_3. This requires an increase in expenditure equal to the shaded area X_1HGX_3.

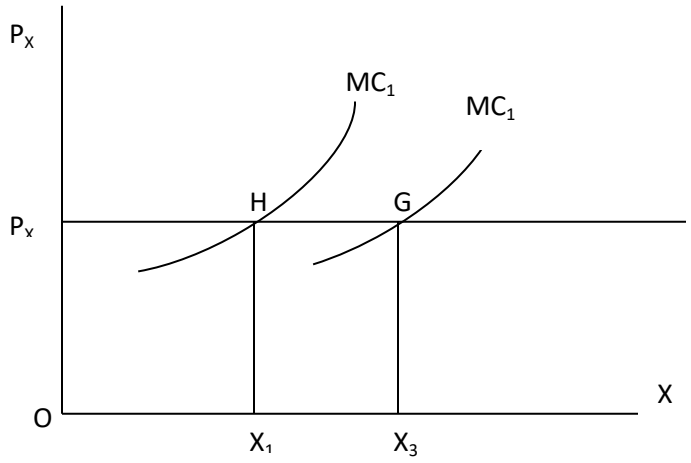


Figure 4.7: Effect of increase in expenditure

This, Iso-cost line AB* must shift out wards, parallel to itself at a distance corresponding to the increase in the firms' outlays (see figure 4.8 below). Actually, the new Iso-cost can be determined by dividing the increase (addition) in total cost by price of capital, r, and adding the result to the distance OA. The new point 'A', on the vertical axis is the vertical intercept of the required Iso-cost and parallel to AB' a new Iso cost line A*B*. The final equilibrium of the firm will be

denoted by the point of tangency of the new Iso-cost A*B* with the Iso-quant denoting the profit-maximizing output X^X at e_3 of figure 4.8.

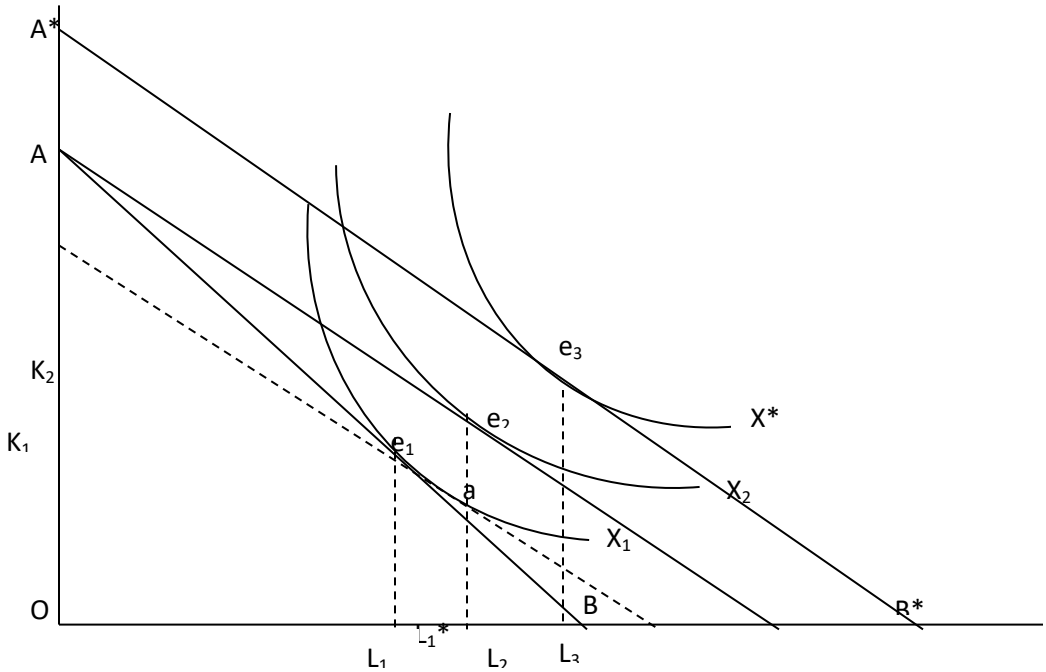


Figure 4.8: Derivation of demand curve for variable input

In sum, the substitution effect of a decrease in the wage rate causes a decrease in the MPP, even though, the output effect and profit maximizing effect result in an increased employment of both inputs. Last two effects exceed the former one hence the MPP_L curve shift outward.

Given the prices of the final commodity, P_x, the VMP_L shift to the right when several variable factors are used in the production processes. The new equilibrium demand for labor is then denoted by point B on VMP_{L2}. By repeating the above analysis with different wage rates we can generate a series of point such as A, B and C. The locus of these points is the demand for labor by the firm when several factors are variable. (See figure 4.9 below)

This long run demand for a factor is negatively sloped as the three effect of an input -prices change must cause quantity demanded of the factor to vary inversely with prices.

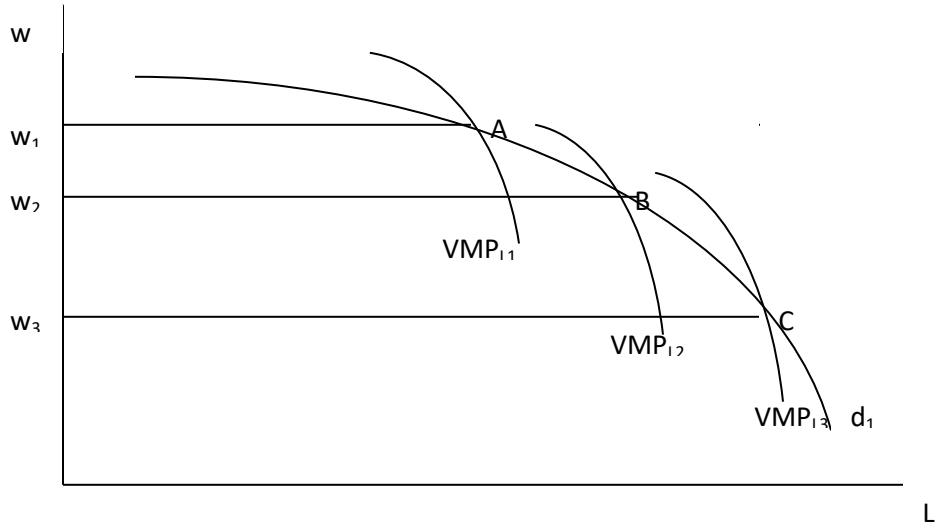


Figure 4.9 : Demand curve for the firm under more than variable inputs

This is somewhat the demand for factors in the long run when all factors can vary because of adjustments of the structure of production.

4.3.3. **THE MARKET DEMAND CURVE FOR A FACTOR**

Having derived the individual firms demand for inputs, the next step is to derive market demand curve for an input. Recall how we derived a market demand curve for a commodity in previous section. We summed horizontally over the demand curves of individual consumers of the commodity. Do you think we can apply the same technique to drive market input demand?

Although these provide a first approximation, it would not yield the correct result because it would neglect the effect of changes in the input prices on the product price. For instances, as the prices of the input falls all firms will seek to employ more of this factor and expand their output. Thus, the supply of the commodity shifts downwards to the rights, leading to a fall in the price of commodity, P_x. Since these prices is one of the components of the demand curves of the individual firms for the factor, these curves shift down ward to the left.

As inputs such as labor are used in many output markets, thus, to derive the market demand curve for labor, we first determine the labor demand curve for each output market and then sum across output markets to obtain the factor market demand curve.

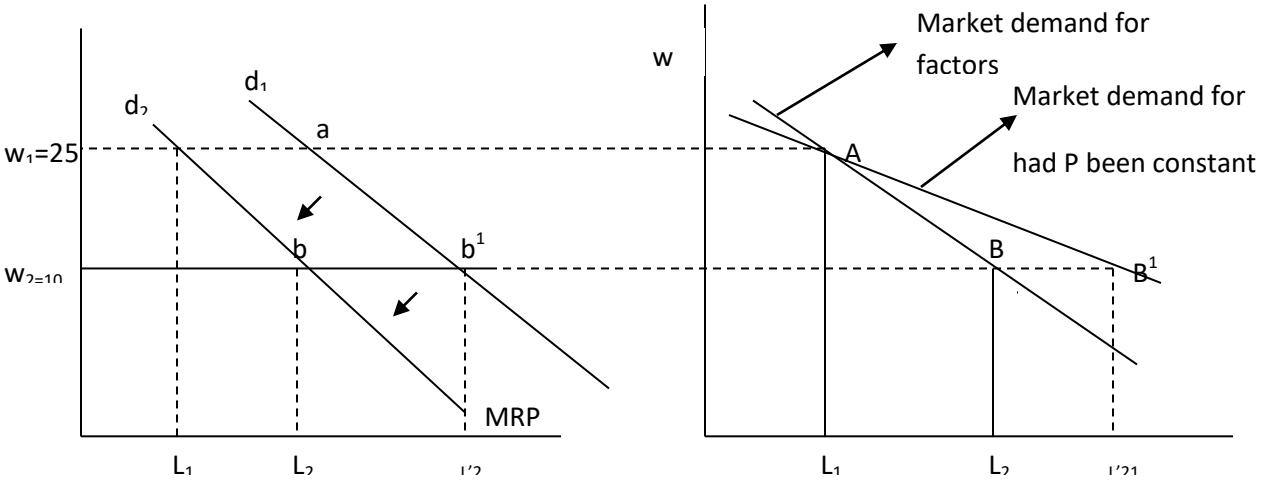


Figure 4.10A: Demand curve of a single firm

Figure 4.10B: Market demand curve for labor

Earlier we derived the factor demand of a competitive firm that the output market price depends on the factor's prices. As the factor's price falls, each firm, taking the original market prices as given, uses more of the factors to produce more output. This extra production by all the firms in the market causes the market prices to fall. As the market price falls, each firm reduces its output and hence its demand for the input. Thus a fall in input price causes less of an increase in factor demand than would occur if the market price remained constant. This can be illustrated with figure 4.10. Initially suppose the wage rate is w_1 (e.g. $w_1 = 25$) and output market prices P_x (e.g. P_{x1} = 9Birr). The firm is at point 'a 'on its demand curve and employs L_1 units of labor.

Summing over all employing firms, we obtain the total demand for the input at wage rate w_1. Assume next that the wage rate declines to w_2 ($w_2 = 10$). Other thing being equal, the firm would move along its demand curve d_1, to point b^1, increasing the employed labor to L'_2 because cost decline that motivate firm to produce more. As a result of more output, the price of product decline, that in turn leads to decline in employment and less demand for inputs. The marginal revenue product of labor decline and have inward shift of demand curve for labor.

The equilibrium under new wage rate is not at point b^1, but at point b on new demand curve d_2. Summing horizontally over all firms we obtain point B of market demand curve. If the fall of the commodity–price was not taken in to account, we would be led to an overestimation of the

demand for labor following a decline in wage rate. This indicated by point B' of the figure 4.10 - (b). Thus the market demand curve for labor is shown by the line AB **(steeper)** rather than AB'. This long run demand for a factor is negatively sloped as the three effects of an input–prices change must cause quantity demanded of the factor to vary inversely with prices.

In summary, the determinants of the demand for a variable factor by individual firm depend on:

a. The prices of input
b. The marginal physical product of the factor
c. The prices of the commodity produced by the factor as $VMP_L = P_x \cdot MP_L$
d. The amount of other factors which are combine with labor (e.g. capital)
e. Technological progress as it changes the MPP of all inputs and hence their demand,

We have derived the demand curve for the individuals and the market. The next thing to be done is deriving the corresponding individual as well as market supply of under competitive market structure in such away that we see the market equilibrium.

4.4. SUPPLY OF LABOR IN PERFECTLY COMPETITIVE MARKET

The supply of labor to the market depends on different factors. Some of these are:-

a. The prices of labor (wage rate)
b. The tastes of consumers (that defines trade- off between leisure and work)
c. The size of the population
d. The labor - force participation rate
e. The occupational, educational and geographic distribution of the labor forces

The relation between the supply of labor and the wage rate defines the supply curve. The other factors can be considered as shift factors of the supply curve. As we are interested in the supply curve, we assume all other factors as given. Just like for the supply of commodity in product market, the market supply for factors is the supply of labor by individuals. Thus, we begin by the derivation of supply of labor by a single individual and then that of market.

4.4.1. THE SUPPLY OF LABOR BY AN INDIVIDUAL

For ordinary rational economic agent, higher the price of input is required to increase the quantity of input willingly supplied. But an individual labor face with certain constraint

especially related to the time available for the agent. This take us to the theory of consumer preference covered in module one of the course. An individual economic agent has only 24 hour with a day and tend to allocate his/her time for work and for leisure which in turn affect the supply of labor for work. We derive the supply curve using this theory.

Hence, the supply of labor by an individual can be derived by indifference curves analysis. A simple consumer choice problem is between two goods "income from work" and "leisure" in the standard consumer choices problem. The individual is assumed to have preferences over the two goods that can be summarized in the form of an indifference map. The supply of labor directly related to the amount of time an individual is willing to work.

The derivation can be illustrated with Figure 4.11 on which the horizontal axis measures the hours available for leisure (and work) over a given period of time. For example, there are OZ maximum hours in a day, which an individual can use for leisure or for work. On the vertical axis we measure money income. The slope of a line from Z to any point to the vertical axis represents the wage per hour. If the individual were to work all the OZ hours and earn a total income of OYo, the wage rate would be $w = \frac{OYo}{OZ} =$ [slope of ZYo line]. The steeper the line or indifference curves the higher the hourly wage rate.

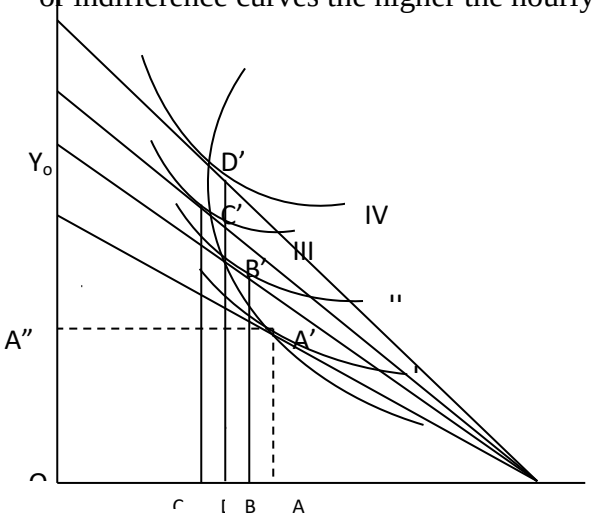


Figure 4.11-1;The optimal choice of Leisure and income

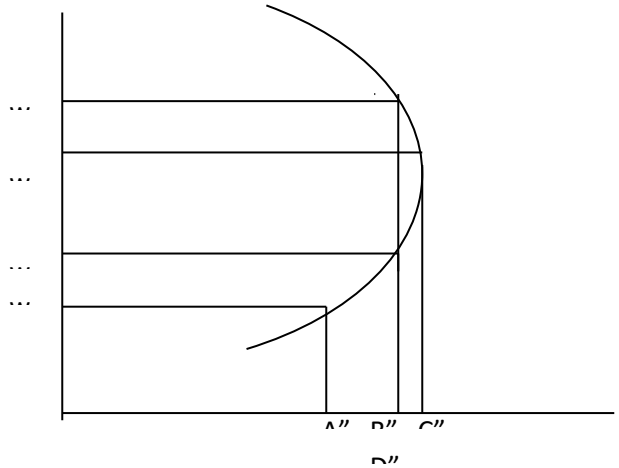


Figure 4.11-2 labor supply curve

For example on indifference curve I, the individual is in equilibrium by working AZ hours (OA^{11}) and get wage rate W_1. If the wage rate increases to W_2 the individual will work more hours (BZ>AZ) and will earn a higher income (BB^1) and will have less hours (OB) for leisure.

The equilibrium at this time is at point B^1. Similarly when wage rate rise to W_3, the equilibrium become C^1.

As we know from consumer behavior, individual tend to work more hours as wage increase up to certain point. At some higher wage rate the hours offered for work may decline because of some other reasons. Higher wage creates disincentives for longer hours of work after a certain point. When rates of pay reaches high levels, the incomes of such individuals may become so high that they may choose to reduce the amount of work and they do rather than increase leisure time. Because of these the supply of labor is backward bending curve.

As can be seen from above diagram, if wage rate is increased to W_4, the individual will work BZ hours, the same as wage rate W_2. If the wage rate increases still further (to W_5 $)_1$ the hours supplied for work decline even more: They drop back to AZ. This is so for the fact that longer working hours implies less leisure hours. This pattern of response to higher wage rates produces a backward – bending supply curve for labor as. Thus, the supply of labor can be obtained from the locus of the equilibrium point A', B', C', D', etc. This is shown by figure 4.11-2. As wage rate increases, the individual's income rise, and this enable the worker to have shorter leisure activities. However, the time for such activities is less. Beyond a certain level of wage rate, the supply of labor decreases as worker prefers to use his income on more insures activities.

This nature of supply curve of labor is the result of income and substitution effects that accompany increases in the prices paid to labor, the wage rate. The substitution effect suggests that as wage increase people tend to substitute their leisure time by working more hours and increases the amount of time they work. On the other hand, the income effect shows that as the people are getting higher income because of the increases in wage rate, the person feel wealthier and starts to enjoy more leisure time by cutting his labor supply. These means substitution and income effect works together. At lower level of employment the substitution effect tends to be greater than the negative income effect so labor supply tend to increases with an increases in wage rate. Gradually , however, the negative income effect tends to dominate the positive substitution effect and hence, individual reduces their labor supply if wage rate keeps on increasing at this high wage rate.

4.4.2. THE MARKET SUPPLY OF LABOR

Although there is disagreement on individual backward bending labor supply pattern among economist, in short run market supply of labor may have segments with positive and segments with negative slope. But, in long run the market supply must have a positively sloped. Because, more wage is an incentives for young workers, and change the jobs. The others maintain back word-bending supply curve as people tend to supply more labor until the income reach the level required for a comfortable standard of living. It seems that a positive aggregate supply of labor work in general case.

Just as the market supply curve in product markets could be determined by summing the quantities individual firms would supply at various prices/wage rate. This is mainly because any negative effect of an increase in wage can be off sated, as the all individual do not behave in the some way. That is when someone is tend to decrease the supply of labor the others may increase the willingness to supply that makes the supply curve upward sloping.

4.5. EQUILIBRIUM PRICE AND EMPLOYMENT OF AN INPUT

The market demand and supply curves of an input determine the inputs equilibrium price. The price of input will tend in equilibrium to settle to the level at which the quantity of the input demanded equals the quantity of the input supplied. This is indicated by using figure4.12. This point B is the equilibrium position for input market with price of the input is Po and quantity of input Qo. If the prices were higher than Po, then the quantity supplied would exceed the quantity demanded and there would be down word pressure on the prices and vice versa. Hence, the market model is valid for the determination of the equilibrium prices of a commodity or productive resources.

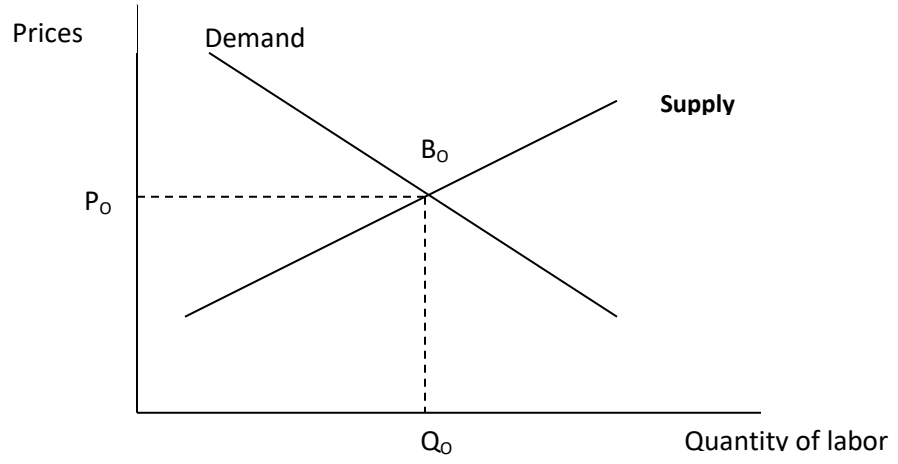


Figure 4.12: Determination of equilibrium prices and quantity of inputs

4.6. FACTOR PRICING IN IMPERFECTLY COMPETITIVE MARKET

We have seen how prices of input are determined under perfectly competitive market. The next step is the determination of input pricing under imperfect competition. But what would the theory say about a case in which there was perfect competition in the market for input but imperfect competition (monopoly, oligopoly, monopolistic, competition) in the relevant product market? The input price under imperfections in the commodity and the factor markets is determined in the same manner as the case of perfectly competitive markets. The demand and supply determines the prices of factor and the level of its employment though the determinants differ from perfect market. Further more, there are different structures of market based on the power of economic agent in two markets (product and input market). There are four known simplified models are under these. These are:

Model	**Product market**	**Factor market**
A	Monopolistic	Perfectly competitive
B	Monopolistic	Monopsony
C	Monopoly	Monopsony +unionized labor supply
D	No monopoly	No monopsony but unionized labor

The above models are extension of the marginal productivity theory of factor pricing and income distribution. We will see each of them in dome detail.

4.6.1.MODEL–A: MONOPOLISTIC POWER IN THE PRODUCT MARKET

In this model, we assume that the firm has monopolistic power in the product market, while the factor market is perfectly competitive. The analysis of firm's demand for labor differs when it is a single variable factor and when there are many variable factors. We will see each one detail independently.

4.6.1.1Demand for a single variable factor by a monopolistic firm

To illustrate how the factor prices are determined under this condition, we make some assumptions. Assume:

A. A firm with monopolistic power in a product market. Recall how the market demand curve for output of a firm with monopoly power behaves in product market. We have said that the

demand for the product of the firm is down-ward sloping and the marginal revenue is smaller than the price at all levels of output.

B. Firm in the market that the firm uses a single variable factor, labor in perfect market. The supply of labor to the individual firm is perfectly elastic and the wage rate is given or determined by the market.

Under these conditions the demand for labor by an individual firm is not the VMP_L cure but marginal revenue product curve. We may illustrate the derivation of the Marginal Revenue Product of labor curve, graphically using the example of the previous section, with the differences that the prices of the commodity produced declines as output increases.

Because of the theory underlying the monopolist the price and marginal revenue differs. There is difference between VMP_L (= MPP_L. P_x) and MRP_L (=MPP_L , MR_x). The few differs, due to the fact that P_x >MRx at all levels of output and employment, hence VMP_L >MRP_L. Except that both the VMP_L and MRP_L have negatively sloped because their components (MPP_L, P_x , MR_x) decline as output expands and the prices of the product falls.

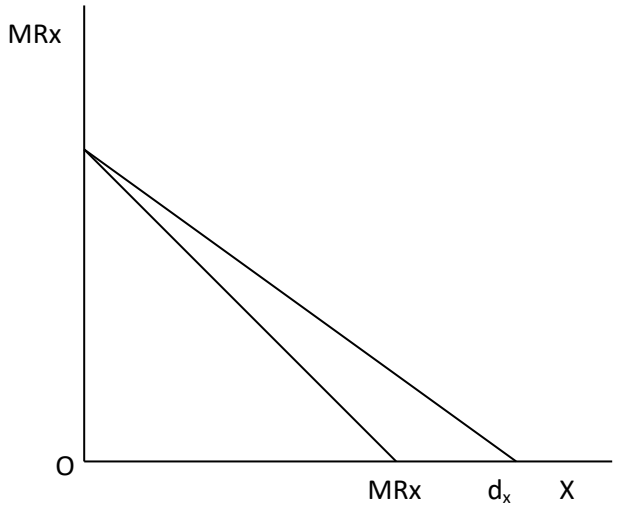


Figure 4.13A: Imperfect product market

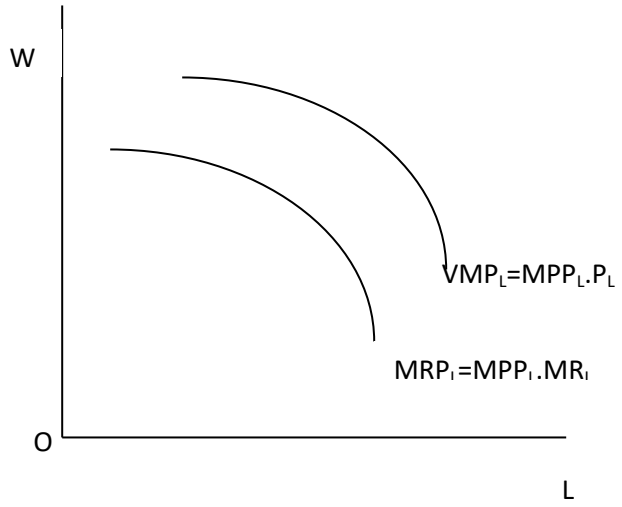


Figure 4.13B: perfect factor market

This can be derived algebraically as follows by first deriving parts MRx and MPP_L , and then MRP_Las well as MRx from total revenue function.

1. Let the demand function for the product in generalized form be Px = f_1 (Q_x).

Total revenue of the firm's is $TR=P_x .Q_x$ then,

The marginal revenue is obtained by taking the first order derivative with respect to Q_x

$$\frac{d(TR)}{dQ} = px.\frac{dQx}{dQx} + Qx.\frac{dpx}{dQx}$$

Or

$$MR_x = P_x + Q_x.\frac{dp_x}{dQ_x}$$

2. The production function with labor as the only variable factor is $Q_x=f_2(L)$

By taking first order derivative we get MPP_L $\frac{dQx}{dL} \equiv MPP_L$

3. The marginal revenue product of labor is the change in total revenue attribute to a unit change in labor $MRP_L = \frac{d(TR)}{dL}$

Given $TR=P_x, Q_x$, the derivative of total revenue with respect to L is

$$\frac{d(TR)}{dL} = Px,\frac{dQx}{dL} + Qx\left[\frac{dQx}{dQx}\frac{dQx}{dL}\right]$$

Or $MRP_L = \frac{dQx}{dL}\left[Px + Qx,\frac{dQx}{dQx}\right]$

But from (2) $\frac{dQx}{dL} = MPP_L$ and from (1) $MR_x = \left[Px + Qx,\frac{dPx}{dQx}\right]$

Therefore: $MRP_L = MPP_L .MR_x$

Thus, the profit maximizing firm's the demand for labor is marginal revenue product curve as the decision to hire extra labor is based on the additional revenue it generate. . The supply of labor to the individual firm is perfectly elastic shown by horizontal line S_L. Then, the equilibrium is determined by the interaction of the two (demand and supply) like that of competitive market. The equilibrium is at point 'e' when $MRP_L=MC_L=W$ with 'L 'level of employment. To the left of 'e' a unit of labor adds more to the revenue of the firm than the amount of its cost: hence it pays the firm to increase its employment. Conversely at any point to the right of 'e' an additional unit of labor adds more to total cost than to total revenue. Thus, firm employ labor up to the point of equality.

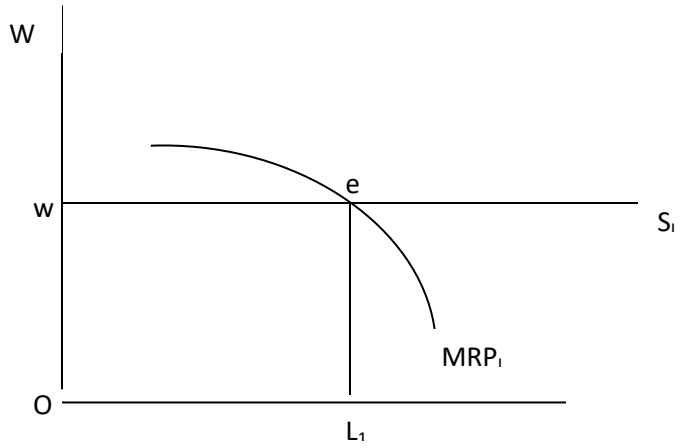


Figure 4.14: Determination of equilibrium

Formal derivation of the equilibrium of the monopolistic firm is as follows;

The firm wants to maximize its profit

$$\Pi = R - C = P_x Q_x - (WL + F)$$

Given P_x: $f_1(Q_x)$ and $Q_x = f_2(L)$

The fist order condition for Π max is that the derivative of Π w.r.t is equal to zero

$$\frac{d\Pi}{dL} = p_x, \frac{dQ_x}{dL} + Q_x \left[\frac{dP_x}{dQ_x} \frac{dQ_x}{dL} \right] \text{-W=0}$$

Rearranging we obtain $\frac{dQ_x}{dL} \left[p_x + Q_x, \frac{dQ_x}{dQ_x} \right] = \text{w}$

We have shown that $\frac{dQ_x}{dL} = MPP_L$ and $\left[p_x + Q_x x, \frac{dP_x}{dQx} \right] = \text{MRx}$

Therefore

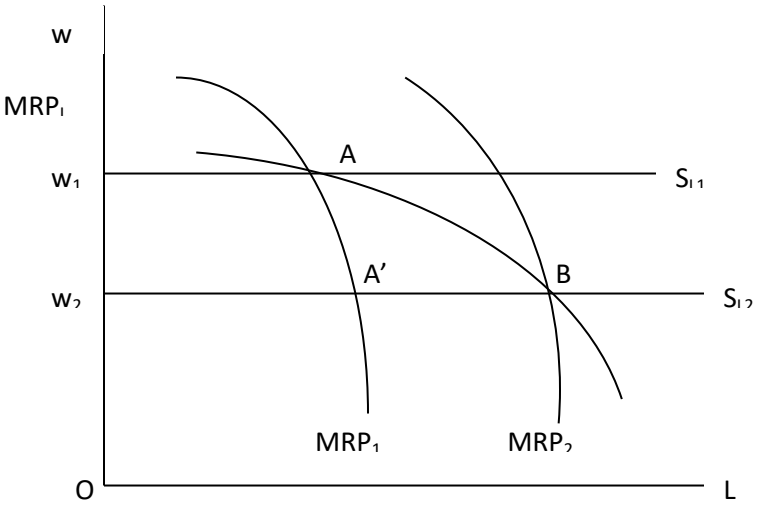
(MPP_L) (P_x) $\left[1 + \frac{1}{e_p}\right]$ =W where MRx, $P_x \left[1 + \frac{1}{e_p}\right]$

$$MRP_L = W$$

This shows the relations among commodity price, factor price, elasticity of demand and the production functions.

4.6.1.2. DEMAND OF VARIABLE FACTOR BY A MONOPOLISTIC FIRM UNDER SEVERAL FACTORS

Unlike the case of one variable, marginal-revenue product curve is not demand curve, for several variable case, rather the demand curve is formed from points on shifting MRP curves. The analysis is similar to that of the previous sections the case of perfectly competitive market. Suppose that the market price of labor is w_1 with MRP_1 (see figure 4.15).The monopolistic firm is in equilibrium at point A, employing L_1 units of labor. If the wage rate fall to w_2 the firm would move along its MRP_2, curve to point A', if other things remained constant. However, the fall in wage rate has three effects (substitution, output and profit –maximizing effects) that result in shift of the marginal revenue produce curve to the right which also lead equilibrium point to B. By similar analogy one can derive other point of equilibriums. Connecting points such as A and B at various level of 'w' we obtain the demand curve of labor. From our analysis one can conclude that the demand curves of inputs are negatively sloped irrespective of the condition of competition in the product market.



4.6.1. Figure 4.15: Demand curve when there are several variables inputs

The market demand for a factor is derived in the same way as in the case of perfectly competitive market from the summation of the demand curves of the individual monopolistic firms. In

aggregating these curves, we must take into account their shift as the price of the factors falls: as all monopolistic firms expand their output, the market price falls. The individual demand curve and the marginal revenue As opposed to competitive m curve for the commodity produced shift to the left. Graphically, the derivation of demand curve is exactly the same as perfectly competitive market.

The market price for the factor is determined by the market demand and supply, just like that of perfectly competitive market. The difference was that the figure is based on the MRP_L and not on VMP_L. This means that when the firm has a monopolistic power, the factors are paid the MRP_L which is smaller than VMP_L as the MRP_L is the market demand for imperfect market and $MRP_L < VMP_L$. This effect has been called monopolistic exploitation by Robinson. This is indicated by figure 4.16 (a). Monopolistic exploitation says a productive factor is exploited if it is paid a price less than the value of its marginal product (VMP).

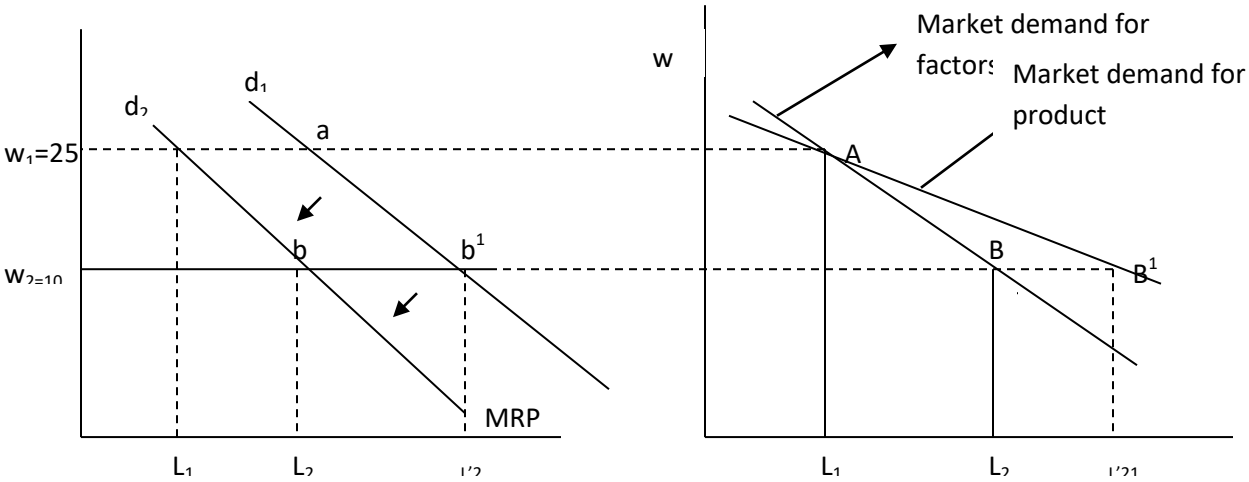


Figure4.16A: Demand curve of a single firm

Figure 4.16B: Market demand curve for labor

But the market supply is not affected by the fact that firms have monopolistic power. Thus, the market supply of labor is the summation of the supply curve of individuals as derived earlier. The equilibrium is determined by the interaction of supply and demand. Thus, the analysis is the same, but there is an important difference is that the market demand is based on the marginal revenue product of the factors not on value on marginal product of factors.

This can be derived algebraically.

For a perfectly competitive firm

$VMP_L=MRP_L$

Because $VMP_L= MPP_L$. Px and $MRP_L=MPP_L$.MR,

$Px = MR_x$ so that $VMP_L=MRP_L$

But for monopolist $Px > MR_x$ so that $VMP_L<MRP_L$

Thus, when the commodity market is competitive the profit maximizing level show $VMP_L=MRP_L$. But for the monopolistic firm in product market, the payments of factors are paid less then value of the marginal product, hence inefficiencies. The amount Wc Wm shown by the figure above indicated that profit maximizing behavior of imperfectly competitive firms causes the factors prices less than its VMP_L .Furthermore , the level of employment is lower in industries which are not perfectly competitive Lc>Lm.

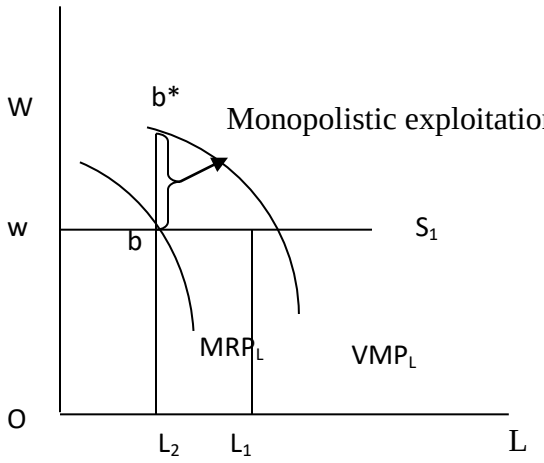


Figure 4.17: Monopolistic exploitation (a)

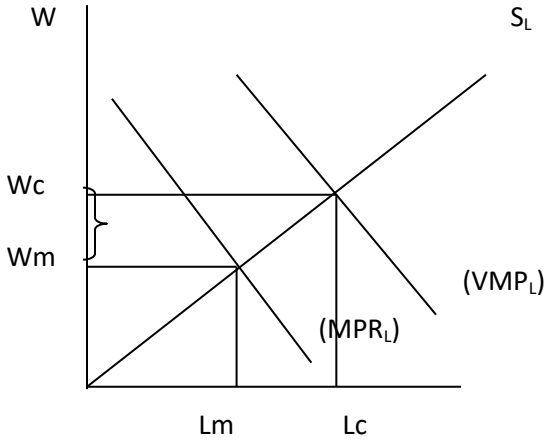


Figure4.17: demand curve for labor (b)

4.6.2. MODEL-B: THE FIRM WITH MONOPOLY POWER IN COMMODITY MARKET AND MONOPSONISTIC POWER IN THE FACOR MARKET

Assume:

-The monopoly in products market, a single seller of product

- Monopsony power in factor market- a single buyer of factor of production: labor

Both parties want to maximize profit of their activity. We will look at the equilibrium level under this model when labor is only variable factor and for several factors as we did for model A. Does this ever happen?

It is difficult to tell the story that fit to the bill. Group small firms maybe set up to provide tools, supplies, or material for a single large manufacturing firm. This firm may be the only of its type in the area, and its requirements might be very specialized.

4.6.2.1. EQUILIBRIUM OF MONOPSONIST, WHO USES A SINGLE VARIABLE FACTOR

Suppose that a firm is the sole employer in a town in local market- monopsony. The firm uses only one factor, Labor (L), to produce final good. What do the demand and supply curve look like? How equilibrium is determined? The labor demand for the firm is MRP_L as for the case of model – A, and perfectly competitive markets. The firm values the last extra worker it hires by marginal revenue product of that worker. Hence, the firm has a downward sloping demand curve as shown in figure4.18.

The supply curve for labor to individual firm is not horizontal and perfectly elastic because the firm is large- a monopsonist firm in the labor market. The supply of labor is positively sloping (upward-sloping) as the monopsonist expands the use of labor by pay a higher wage. The higher its daily wage, w_1, the more people want to work for the firm. Because the firm pay all workers the same wage, the monopsony must pay more to each worker it was already employed. When we multiply the input prices by the level of employment we find total expenditure of monopsonist. Hence, the supply of labor curve is shown by the average expenditure, at different level of employment.

However, what is relevant for the determination of level of employment is marginal expenditure that can be derived from change in total expenditure at all level of employment. Hiring an additional unit of input increases the total expenditure on the factor by more than the price of this unit because all previous units employed are paid the new higher price. The marginal expenditure (ME) curve lies above the supply curve (average expense curve). Because the prices per unit rise as employment increases, the marginal expense of the inputs is greater than its prices at all levels of employment. Hence, the ME curve has a positively sloped and lies above and to the left of the supply of inputs curves.

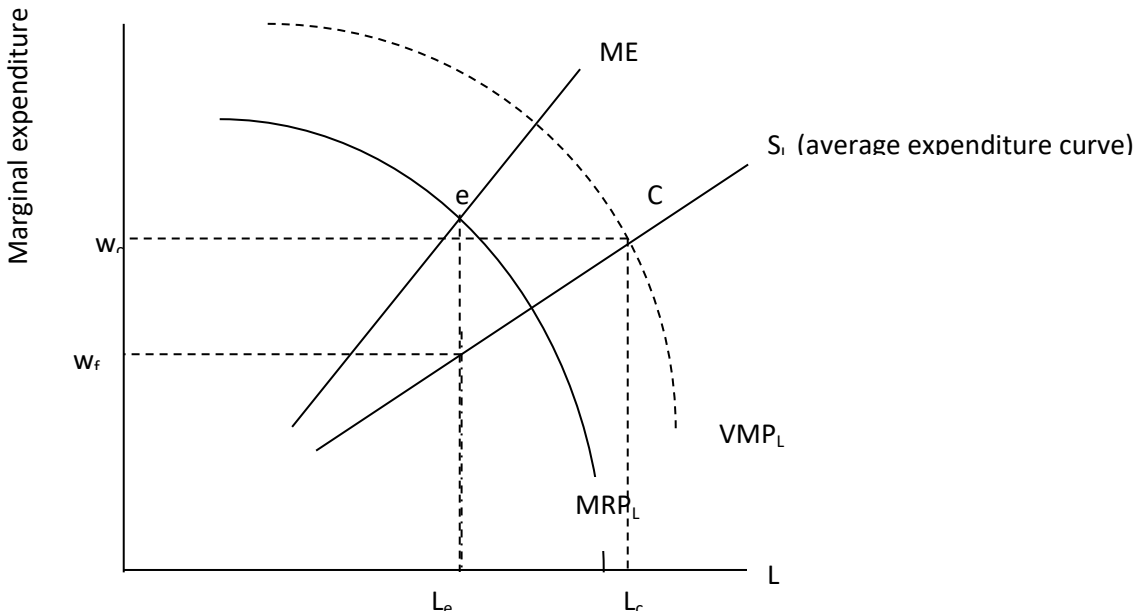


Figure 4.18: Demand and Supply curve of monopolist

As can be seen from the table since the price per unit of input rises as employment increases, the marginal expenses (ME) of the input is greater than its prices at all level of employment. Under these conditions, the firm is in equilibrium when its marginal expenditure on the factor is equal to MRP_L or it buys labor services up to that point of equality. That is, at point 'e' on figure 4.18. Where ME =MRP_L. This is shown in figure xx above. If the last unit is worth more to the buyer than its marginal expenditure, the buyer purchases another unit. This refers to area to the right of 'e'. On the other hand, if the last unit is less valuable than its marginal expenditure, the buyer purchases one less unit. This is shown by area to the left of 'e'.

Thus at equilibrium point, 'e', the wage rate that the firm will pay for the L_e units of labor is W_F. However, if the market is competitive, the intersection of demand and supply curve determines the equilibrium at point C with the level of employment L_c and corresponding payment W_c. Thus, the monopsonist hires less labor and pay lower wage as compared to the perfectly competitive market. The monosony power is the ability of a single buyer to pay less than the competitive price profitably. The size of the Gap between the value the monopsony places on the last worker (the

height of its demand curves and what it pays depend on the elasticity of supply at the monopsony optimum.

By creating a wage differences between the value on the monopsony and the value to the supplies, the monopsony causes a welfare loss in monopsonist exploitation. The exploitation arises from monopsonostic power of firms, and is something in addition to monopolistic exploitation. The difference between wage paid by competitive firm and monopsonistic firm is monopsonistic exploitation. Each units of labor receives its MRP which is less than the VMP.

4.6.2.2. EQUILIBRUM OF A MONOPSONIST WHO USES SEVERAL VARIABLE FACTOS

Recall that under perfectly competitive market, the firm hire labor up to the point where

$$\frac{MPP_L}{MPP_W} = \frac{w}{r}$$

How do monopsonistic determine equilibrium level of employememt?

If the factor markets are monpsonistic, changes in the amount of factors employed causes changes in the prices of factors. Thus 'w' and 'r' are not given. The monopsonist must look at the marginal expense of the factors. A monopsonist who uses several variable factors will use the input combinations at which the ratio of the MPP_L to the ME is equal for all variable inputs. The least combination is obtained when the marginal rate of technical substitution ($MRTS_{L\cdot K}$) equals the marginal expenses of input ratio. For the two input case the equilibrium condition of the monopsonist may be stated as follows

$$MRTS_{L.K} = \frac{MPP_L}{MPP_K} = \frac{ME_L}{ME_K}$$

$$\frac{MPP_L}{ME_L} = \frac{MPP_K}{ME_K}$$

4.6.3. Model–C: Bilateral monopoly

Bilateral monopoly arise when a single seller (Monopolist) face a single buyer (Monopsonist) in the labor market. Assume that all the firms are organized in a single body which acts as like monopsonist. Thus, we also assume labors are organized in a labor union which acts like a monopolists. Hence, we have two monopolies participating in a market one on supply side and the other on the demand side. How do the two party bargains? Is there a unique equilibrium for the market like that of the above two models?

These can be better presented through graphical approach. The figure 4.19 below shows how the two parties interact in the market. The monopsonists (single buyer's) demand curve is D_b which is MRP_L of input being demanded. From the point of view of monopolist (labor union) D_b represent average revenue curve, hence, AR=Db. The seller's (Union) MRs curve can be derived by usual graphic techniques and it is below the ARs and will cut any horizontal line at its mid-point (see figure4.19).

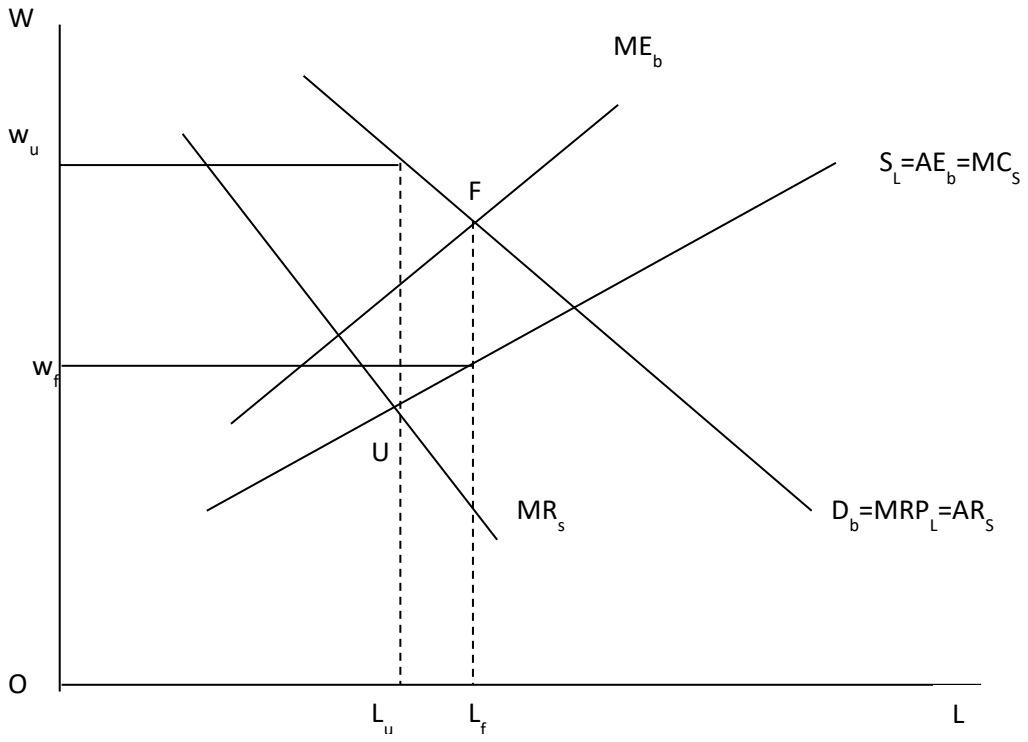


Figure 4.19 : The determination of equilibrium under bilateral monopoly

The supply of labor facing monopsonist is the upward sloping curves S_L which similar technique we have seen under monopsony. From point to view of the monopolist (labor union) the S_L is its marginal cost. Assume that monopolist's behave as if his prices were determined by outside force just like perfectly competitive market sellers, and hence MCs is supply curve. Given the above cost and revenue curve we can find the equilibrium position of each participant in the market.

The monopsonist maximizes his profit at point F where marginal expense of labor (ME_b) equals to the marginal revenue product of labor. The monopsonist desire L_F units of labour and pay a wage rate equal to W_F. The monopolist (labor union), on the other hand, maximizes Wu profit (gains) at

point U, where his marginal cost is equal to Wu marginal revenue. This, he wants to supply L_u units of labor and receives a wage equal to Wu.

As you can see from the diagram the point of equilibrium for the two parties differs. The price desired by the monopsonist (firm's management) is the lower limit of price, W_f ,while the price desired by the monopolist seller, Wu is upper limit prices, since the price goals of two monopolists can not be realized, the price and quantity in the bilateral monopoly market are indeterminate in economic sense.

The equilibrium situation in bilateral monopoly situation is indeterminate. The model gives only the upper and lower limit within which the wage will be determined by bargaining. The level at which the price will be settled depend on the bargaining skills and power of the participants. The power of each participant is determined by his ability to inflict losses to the opposite party and his ability to withstand losses inflicted by the opponent. Hence, the outcome of the bargaining cannot be known with certainty. It depends on bargaining skills, political and economic power of the labor union and the firms, and on many other factors.

4.6.3. MODEL-D: COMPETITIVE BUYER-FIRM VERSUS MONOPOLY UNION

In this case we assume that firms have no monopolistic or monoposonistic power, but the labor force is unionized and behave like monopolist. The situation is presented in figure xx. In this case labor supply curve, $S_{L,}$ is shown by marginal cost of the union as in the case of bilateral monopoly. The market demand for labor is D_L derives from VMPL through summation of individual firm's demand. It also represents MRs. How do wage is determined under these condition?

The determination of wage and other factor's payment is depending on the goals of the union. There are three common goals of labor union. These are:

A) The maximization of employment

The employment is determined by intersection of demand and supply curve through the market force. Hence the labor union will demand a wage rate equal to W. The firms, being price takers, will maximize their profit by equating W to the VMPL. The OL is total employment.

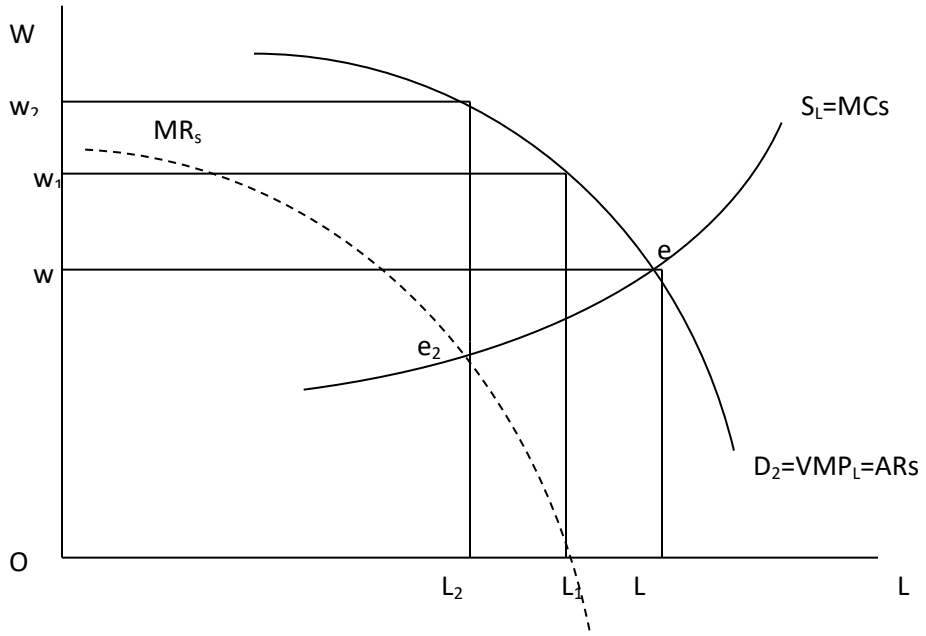


Figure xx. Employment determination under union

B) The maximization of the total wage bill.

If the goal of union is total wage bill maximization, they set wage at point where MRs is zero. Hence, the equilibrium of the union is at point ez. The corresponding wage rate is w_1 and level of employment is at L_{s1} (see figure xx)

C) The maximization of the total gains to the union as whole

The goal is attained by setting wage at point where MC=MR of the union. Thus, the equilibrium under this condition is at point e_2. This points identified by w_2 level of wage that correspond with L_2 level of employments (see figure xx)

In sum, if the firms do not have monopsonistic power, the wage rate and the level of employment are determined by the good of the union.

4.7. THE ELASTICITY OF INPUT SUBSTATION, TECHNOLOGICAL PROGRESS AND INCOME DISTRIBUTION

In the previous section, we examined the determinants of factor price. As factor price change, the firms' structure of employment will change as it affects the profit maximizing behavior and income distribution. Under microeconomic theory of production we have seen the elasticity,

technological progress and other factors as major shifting factors that are necessary for policy purpose. We will relate that theoretical concept with the input market and income distribution especially substitutability of factors. In the section we will examine how the substitutability of productive factors and technological progress affect income distribution.

4.7.1.THE ELASTICITY OF INPUT SUBSTITUTION AND THE SHARES OF FACTORS OF PRODUCTION

How do changes in factors prices affect the shares of factors and income distribution?
What is its consequence?

From our micro economic theory, rational economic agent tends to substitute a cheaper input for a relatively more expensive one. The ability to substitute one input for another is reflected in the elasticity of substitution between the two inputs. A large elasticity indicates that the two inputs are close substitutes in production. Now if there is a close substitute available, then when the price of an input rises, the firm can simply substitute the other input. Therefore, if labor and capital are close substitutes, then when the wage rate rises firms will substitutes capital for labor, and the decline in employment will be greater. Hence, the demand for an input will be more elastic when it has close substitutes are available.

This will result in a change of the K/L ratio, and the size of this effect depends on the responsiveness of the change of the K/L ratio to the factor price change which we call elasticity of substitution. We discussed this in first module of microeconomics in connection with the production function. Recall that the elasticity of substitution is defined as the ratio of the percentage change in the K/L ratio to the percentage change of the $MRTS_{L,k}$.

$$\sigma = \frac{d(k/L)/(k/I)}{d(MRTS_{L,k})/(MRTS_{L,K}}$$

In the perfect input markets the firm is in equilibrium when it chooses the input combination at which the MRTS is equal to the ratio of factor prices.

$$\text{MRTS}_{L,K} = \frac{W}{r}$$

Thus, in equilibrium with perfect factor markets the elasticity of substitution may be

$$\sigma = \frac{d(K/L)/(K/L)}{d(MRTS_{L.K})/(MRTS_{L,K})}$$

The sign of the elasticity of substitution is always positive because the numerator and denominator change in the same direction. When wage to interest ratio increase labor is relatively more expensive than capital and this will induce the firm to substitute capital for labor, so that in K/L ratio would increase.

The value of elasticity ranges from zero to infinity. If σ =0 it is impossible to substitute one factor for another; K and L are used in fixed proportions (as in the input –output analysis) and the isoquants have the shape of right angles. If $\sigma = \infty$ the two factors are perfect substitutes: the isoqants become straight lines with a negative slope. If $0 < \sigma < \infty$ factors can substitute each other to a certain extent: the isoquant are convex to the origin.

The Cobb –Douglas production function has σ =1. In general the larger the value of σ, the greater the substitutability between K and L

We may classify σ in three categories:

σ <1: inelastic substitutability

σ =1: Unitary substitutability

σ >1: elastic substitutability

There is an important relationship between the above values of σ and the distributive shares of factors. By definition

$$\left[\frac{Shareof}{labour}\right] = \frac{w'L}{X} \quad \text{and} \quad \left[\frac{Shareof}{Capital}\right] = \frac{r.K}{X}$$

The concept of the elasticity of substitution of factors has been introduced by Sir John R.

$$\frac{ShareofL}{Share\ of\ K} \quad \frac{w'/r}{K/Ls}$$

We can easily find the effect of a change in the w/r ratio on the relative shares of the two factors. Assume that σ <1. This implies that a given percentage change in the w/r ration results in a smaller percentage change in the K/L ratio, so that relative–share expression increases. Thus, if σ =1, an increases in the w/r ratio increases the distributive share of labor. For example assume that σ =0.5. Then a 10 percent increase in w/r results in a 5 percent increase in the K/L ratio. The new relative shares are

$$\left(\frac{wL}{rk}\right) = \frac{(w/r)}{K/L)}\frac{(1+0.10)}{(1+0.05)} = \frac{1.10}{1.05}. > \left(\frac{wL}{rk}\right)$$

Clearly, new relative share ratio > initial relative share ratio

If σ > 1 change in w/r leads to a smaller percentage change in K/L so that the relative share of labor decreases: For example assume that σ =2. A 20 percent increase in w/r leads to a 40 percent increase in K/L. The new share ratio is

$$\left(\frac{wL}{rk}\right) = \frac{1.2}{1.4}\left(\frac{wL}{rk}\right) < \left(\frac{wL}{rk}\right)$$

Clearly if σ >1 the relative share of labor decreases following an increase in the w/r ratio.

With a similar reasoning it can be shown that if σ =1 the relative shares of K and L remain unchanged.

In summary, an increase in the w/r ratio will cause labor's share, relative to capital's share. It should be noted that there is a two-way causation between w/r and K/L. Changes in the capital - labor ratio result in changes in the relative factor prices, and hence in changes in the shares of the factors to total output . The effect of changes of the K/L ratio on factor shares can be explored with the use of the elasticity of substitution. The analysis is analogous to the one we used above for changes in the w/r ratio.

From the above discussions, it is clear that the concept of the elasticity of substitution is very important in the neoclassical theory of income distribution. It is extremely useful in examining the way in which changing input prices or input ratios affect income shares. Given that changes in w/r lead to changes in K/L and vice versa, it follows that prediction a bout factor shares

following changes in one of these rations are bound to be misleading if they do not take into account the possibility of the associated changes in the other ration.

4.7.2. TECHNOLOGICAL PROGRESS AND INCOME DISTRIBUTION

Up until now we have assumed a given production function. However, technological change takes place continuously, and this shifts the production function, leading to changes in the K/L ratio and the elasticity of substitution. Thus, it is important to consider the effects of technological progress on factor shares. Technological progress shifts the iso quant's down words, given that the same level of output that can be produced with smaller quantities of factor inputs as technological progress occurs. The progress can be classified into three types, neutral, capital-deepening and labor–deepening. These are:

A. Technological progress is neutral if at a constant K/L ratio the $MRTS_{L.K}$ remains unchanged. Since in equilibrium $MRTS_{L.K}$ = w/r, it follow that when technological progress is neutral both the K/L ratio and the w/r ratio, are unchanged. Consequently, the relative shares of factors remain unchanged.

B. Technological progress is capital-deepening if at a constant K/L ratio the $MRTS_{L.K}$ declines. This implies that at equilibrium the w/r ratio declines, as r increase relative to w, while K/L remains constant. Consequently, the ratio of factors shares declines, i.e., n the share of labor decrease and the share of capital increases.

C. Technological progress is Labor –deepening if at a constant K/L ratio the $MRTS_{L.K}$ increases. Then, at equilibrium, the w/r ratio increase as technological progress Takes places. This implies that the shares of labor will increase and the share of capital will decrease.

In short, the relative share of labor increases if technological Progress is labor –deepening , remain unchanged if technological progress is neutral , and decreases if technological changes is capital- deepening.

Review Exercise

1. How do the substitution and income effect of time affect the supply of labor individual under perfectly competitive market?
2. Discuss what do the demand for labor in the long run look like when wage rate rises?

3. The demand for computer engineers in the local market is given by $W = 760 - 0.1Q_e$and their supply curve $W = 60 + 0.04Q_e$ where, W is the wage rate and Qe is the number of engineers.
   A. Calculate wage and employment levels that would prevail if market for engineers is perfectly competitive.
   B. If the product market is perfectly competitive and engineers organize themselves into a power union, then, what wage and employment the union will demand to maximize the total gain (profit) of its members.
4. Suppose the production function for a firm is given by $Q = L^2K$. The firm spends a total cost of production = birr 600. Moreover, the price of labor and capital are birr 8 and 4 respectively.
   A. Find the optimal level of labor and capital
   B. Find the optimum level of production
   C. Suppose the wage rate declines to 4;
      i. Find the elasticity of factor substitution
      ii. Find the change in the share of capital and labor. Interpret your result.

CHAPTER FIVE

GENERAL EQUILIBRIUM ANALYSIS AND WELFARE ECONOMICS

5.1 Partial versus General Equilibrium Analysis

Partial equilibrium analysis studies the behavior of individual decision-making units and individual markets, viewed in isolation. Egs:

i. How an individual maximizes satisfaction subject to his income,
ii. How a firm minimizes its costs of production and maximizes profits under various market structures,
iii. How the price and employment of each type of input is determined.

In doing so, we have abstracted from all the interconnections that exist between the market under study and the rest of the economy. In short, the basic characteristic of a partial equilibrium approach is the determination of the price and quantity in each market by demand and supply curves drawn on the ceteris paribus assumption. Only when an industry (or a market) is small and has few direct links with the rest of the economy is partial equilibrium analysis appropriate.

However, a fundamental feature of any economic system is the interdependence among its constituent parts. The markets of all commodities and all productive factors are interrelated, and the prices in all markets are simultaneously determined. For example, consumers' demands for various goods and services depend on their tastes and incomes. In turn, consumers' incomes depend on the amounts of resources they own and factor prices. Factor prices depend on the demand and supply of the various inputs. The demand for factors by firms depends not only on the state of technology but also on the demands for the final goods they produce. The demands for these goods depend on consumers' income. Thus, there is circular interdependence of activities within an economic system.

These effects are studied by general equilibrium analysis. General equilibrium studies the interdependence or interconnections that exist among all markets and prices in the economy and attempts to give a complete, explicit, and simultaneous answer to the questions of what, how and for whom to produce. General equilibrium analysis is not used all the time because dealing with each and all industries in the economy at the same time by its very nature is very difficult, time consuming and expensive.

General equilibrium is a state in which all markets and all decision - making units are in simultaneous equilibrium. A general equilibrium exists if each market is cleared at a positive price, with each consumer maximizing satisfaction and each firm maximizing profit.

The first and simplest general equilibrium model was introduced in 1874 by Leon Walras in the Walrasian system, all prices and quantities in all markets are determined simultaneously through their interaction with one another (by the solution of the system of equations). Thus the first task in establishing the existence of a general equilibrium is to describe the economy by means of a system of equations: the number of unknowns should be equal to the number of equations. In the Walrasian system one of the equations is a redundant (not an independent) equation and deprives the system of a solution since the number of independent equations is less than the number of unknowns. In this model, the absolute level of prices cannot be determined. General equilibrium theorists have adopted the device of choosing arbitrarily the price of one commodity as a numeraire (or unit of account) and express all other prices interims of the price of the numeraire. With this device each price is given relative to the price of the numeraire. Even if there is equality of independent equations and unknowns there is no guarantee that a general equilibrium solution exists. Leon Walras was never able to prove the existence of a general equilibrium.

In 1954 Arrow and Debreu provided a proof of the existence of a general equilibrium in perfectly competitive markets, in which there are no indivisibilities and no increasing returns to scale. In 1971 Debreu and Hahn proved the existence of a general equilibrium for an economy with limited increasing returns and monopolistic competition, without indivisibilities. There is no proof so far that shows the existence of a general equilibrium in oligopoly and monopoly markets. Apart from the existence problem, two other problems are associated with equilibrium: the problem of its stability and the problem of its uniqueness.

5.1.2 General Equilibrium in a Two-Factor, Two-Commodity, Two Consumers (2x2x2) Economy

Assumptions of the 2x2x2 model:

1. There are two factors of production (Land K) whose quantities are given exogenously. These factors are perfectly divisible and homogeneous.
2. Only two commodities (X and Y) are produced. Technology is given. The isoquant maps have the usual properties (smooth and convex to the origin implying diminishing MRTS

between factors along any isoquant).Each production function exhibits constant returns to scale. The two production functions are independent (no externalities in production).

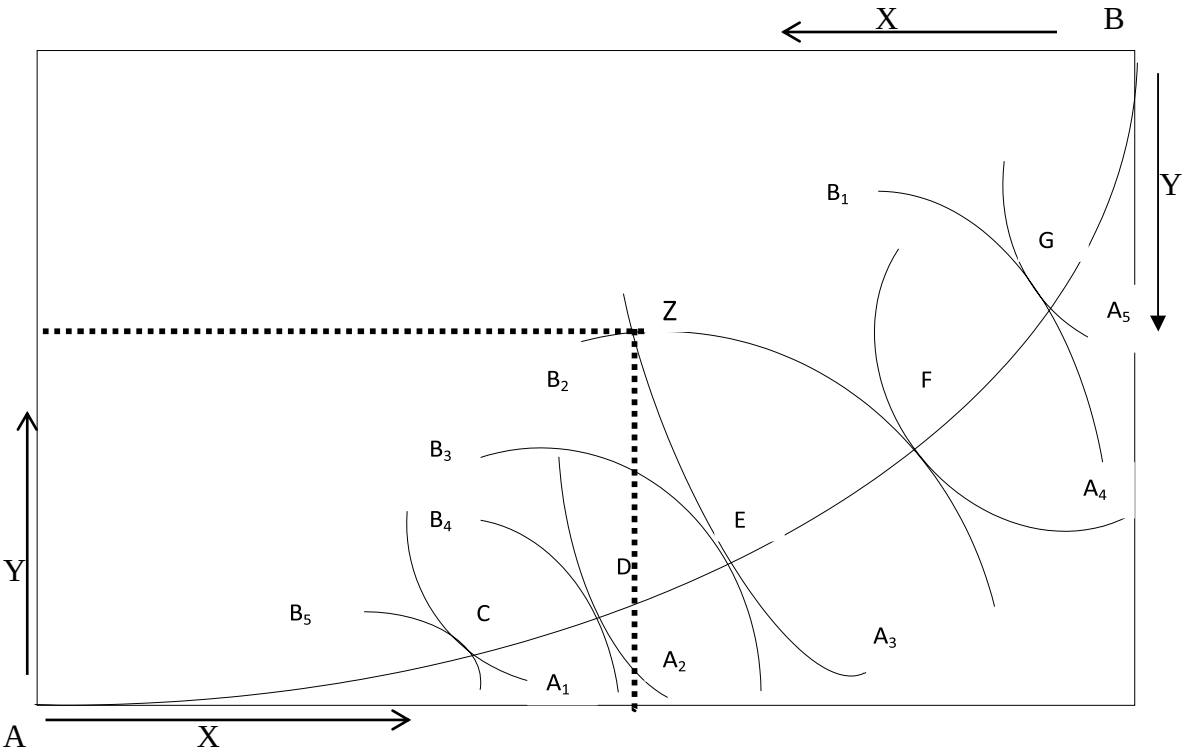
3. There are two consumers in the economy (A&B) whose preferences are represented by ordinal indifference curves, which are convex to the origin, exhibiting diminishing MRS between commodities. Consumers' choices are independent (no externalities in consumption).
4. The goal of each firm is profit maximization and that of each consumer is utility maximization.
5. The factors of production are owned by the consumers.
6. There is full employment of factors of production, and all incomes received by their owners (A&B) are spent.
7. There is perfect competition in both commodity and factor markets. Consumers and firms face the same set of prices (Px, Py, w, r).

In this model a general equilibrium is reached when the four markets (two commodity and two factor markets) are cleared at a set of equilibrium prices (Px, Py, w, r) and each participant economic agent (two firms and two consumers) is simultaneously in equilibrium. Three static properties are observed in a general equilibrium solution, reached with a free competitive market:

A. Efficient allocation of resources among firms (equilibrium of production)
B. Efficient distribution of commodities between the consumers (equilibrium of consumption)
C. Efficient combination of products (simultaneous equilibrium of production and consumption)

5.1.2.1. Equilibrium of Consumption (Efficiency in Distribution)

Given the total quantities of X and Y to be distributed between A&B, there will be an infinite number of Pareto optimal equilibria of distribution. Any point on the Edgeworth contract curve of consumption is Pareto optimal.



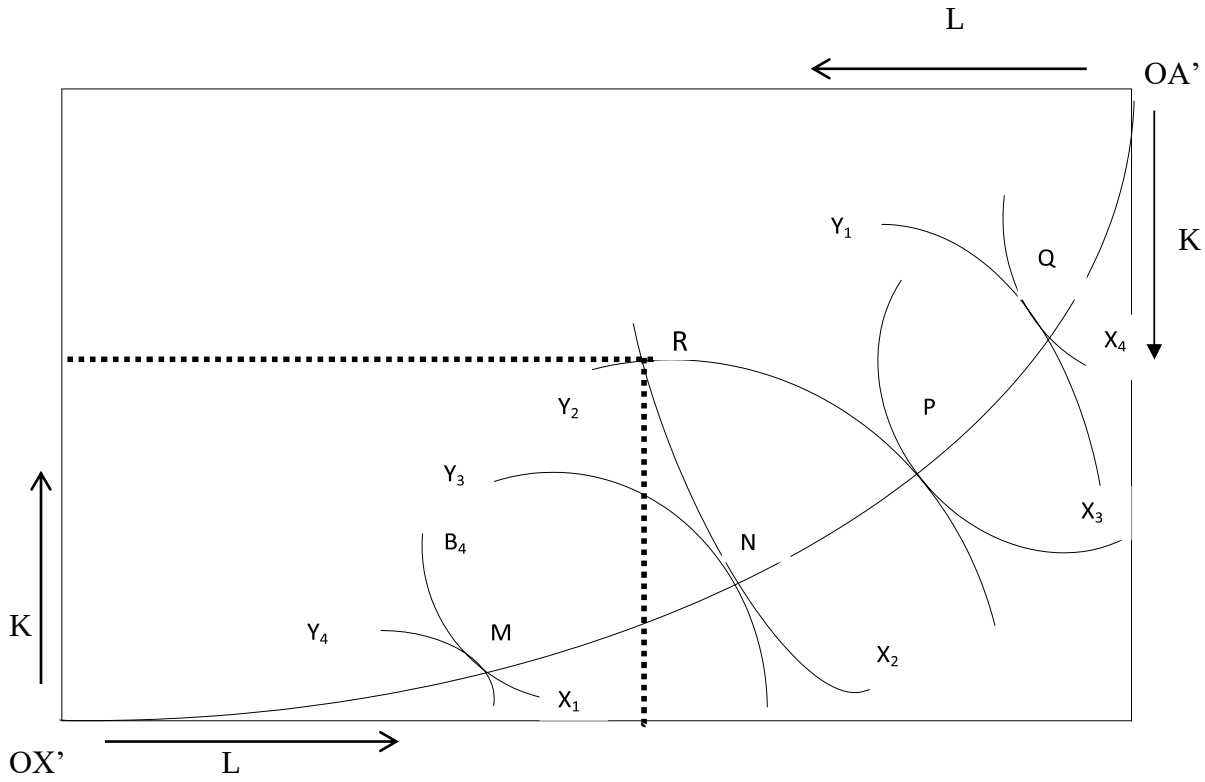
Edgeworth box of consumption

Any point in Edgeworth box of consumption shows six variables: X, Y, XA, XB, YA&YB. However, not all distributions are Pareto-optimal. Pareto - efficient distribution of commodities is one such that it is impossible to increase the utility of one consumer without reducing the utility of the other. Only points of tangency of the indifference curves of the two consumers represent Pareto - efficient distributions.

The locus of these points is called the Edgeworth Contract Curve of Consumption. At each point on this curve $MRSxy^A = MRSxy^B$. Point Z (or any point off the Edgeworth contract curve of consumption) is a point of inefficient consumption because it is possible to increase the utility of at least one consumer without making the other worse off (consider movement to E, to F or to any point between E and F on the contract curve). Of the infinite number of points where the condition $MRSxy^A = MRSxy^B$ holds; only one point is realized in perfect competition. This point is where $MRSxy^A = MRSxy^B = \frac{P_X}{P_Y}$.

5.1.2.2 Equilibrium of Production (Efficiency in Factor Allocation)

The joint equilibrium of production of the two firms in our simple model can be derived by the use of the Edgeworth box of production.

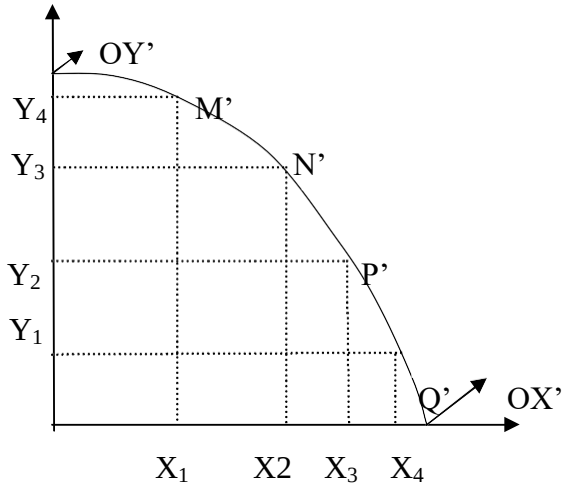


Edgeworth box of production

The size of the box refers to the total amount of Land K available to the economy. Any point inside the box indicates how the total amount of the two inputs is utilized in the production of the two commodities. If this economy was initially at point R, it would not be maximizing its output of commodities X and Y because, at point R, $MRTSLK^X \neq MRTSLK^Y$. The economy can move from point R to point N and increase its output of Y without reducing its output of X. Alternatively, it can move to point P increasing its output of X without reducing its output of Y. At points M, N, P and Q, an X isoquant is tangent to a Y isoquant so that the $MRTS_{LK}^X = MRTS_{LK}^Y$.

The curve OXMNPQOY is the Edgeworth contract curve of production. It is the locus of tangency points of the isoquants for X and Y at which $MRTS_{LK}^X = MRTS_{LK}^Y$. The general equilibrium of production occurs at a point which satisfies this Pareto optimality criterion of efficiency in factor substitution. Since this occurs at any point along the Edgeworth contract curve of production, there is an infinite number of possible Pareto-optimal production equilibria. However, with perfect competition, one of these equilibria will be realized, the one at which the $MRTS_{LK}^X = MRTS_{LK}^Y = \frac{W}{r}$.

In a general equilibrium, the amounts of X and Y which maximize the profits of firms must be equal to those which consumers want to buy in order to maximize their utility. Consumers decide their purchases on the basis of commodity prices, P_X & P_Y. Thus, in order to bring together the production side of the system with the demand side, we must define the equilibrium of the firms in the product space. From each point of the Edgeworth contract curve of production, we can read off the maximum obtainable quantity of one commodity, given the quantity of the other. The locus of all the Pareto-efficient outputs (or of all the minimum attainable combinations of the two commodities) given the resource endowment K and L) and the state of technology is the Production possibility frontier (PPF/PPC).



At any point on the curve all factors are optimally (efficiently) employed. Any point inside the curve is technically inefficient, implying unemployed resources. Points above the curve are unattainable, unless additional resources or a new technology or both are found. The PPF is also called the product transformation curve because it shows how a commodity is transformed into another, by transferring some factors from the production of one commodity to the other.

The negative of the slope of the PPF is called the marginal rate of product transformation ($MRPT_{XY}$) and it shows the amount of Y that must be sacrificed in order to obtain an additional unit of X.

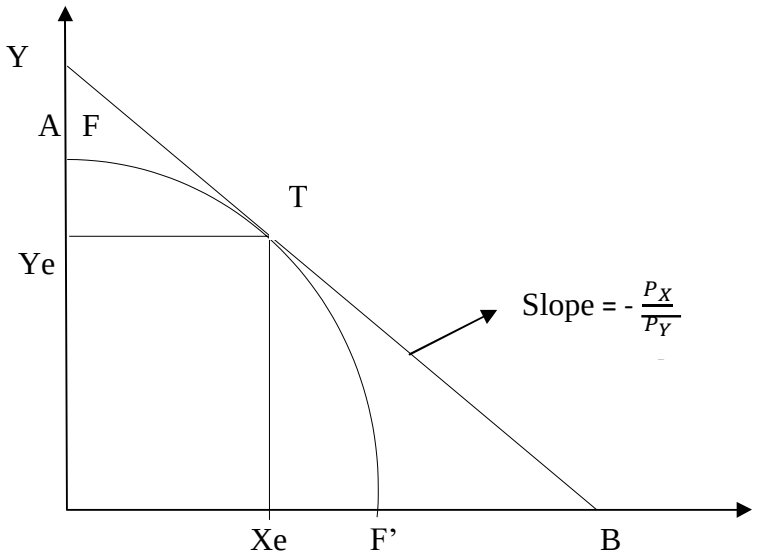
$$MRPT_{XY} = -\frac{dy}{dx} \; by \; definition$$

$$MRPT_{XY} = \frac{dMC_X}{dMC_Y}.$$

In perfect competition the profit maximizing producer equates the price of the commodity produced to the marginal cost of production: $MC_X=P_X$ and $MC_Y=P_Y$.

$$MRPT_{XY} = \frac{MC_X}{MC_Y} = \frac{P_X}{P_Y}$$

Assuming that the market prices of the commodities define the slope of line AB (in figure below), the general equilibrium of production is given by point T. The two firms are in equilibrium producing the levels of output Ye and Xe.

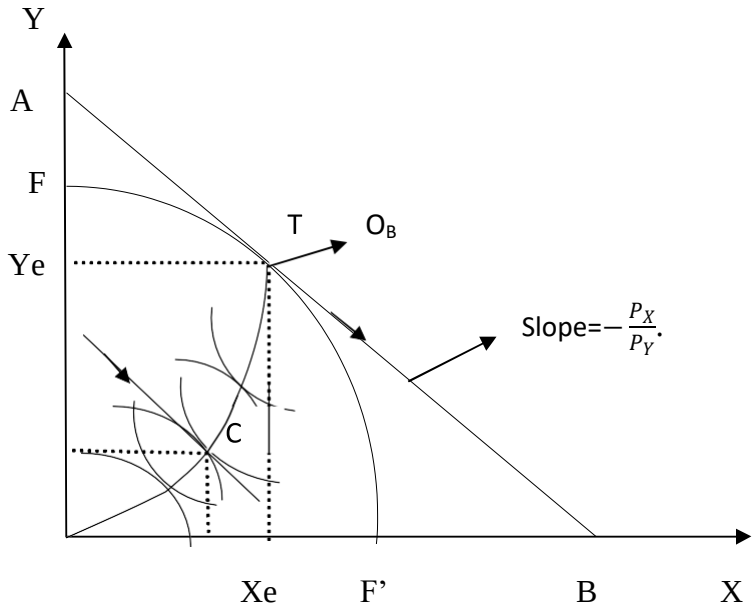


Equilibrium of Production

5.1.2.3 Simultaneous Equilibrium of Production and Consumption (Efficiency in Product-Mix)

The general equilibrium of the system as a whole requires the fulfillment of the condition: $MRPT_{XY}=MRS_{XY}^{A}=MRS_{XY}^{B}$. In perfect competition this condition is satisfied since $MRPT_{XY}=\frac{P_X}{P_Y}$ (equilibrium of production), $MRS_{XY}^{A}=MRS_{XY}^{B}=\frac{P_X}{P_Y}$ (equilibrium of consumption) and it follows that, $MRPT_{XY} = MRS_{XY}^{A} = MRS_{XY}^{B} = \frac{P_X}{P_Y}$.

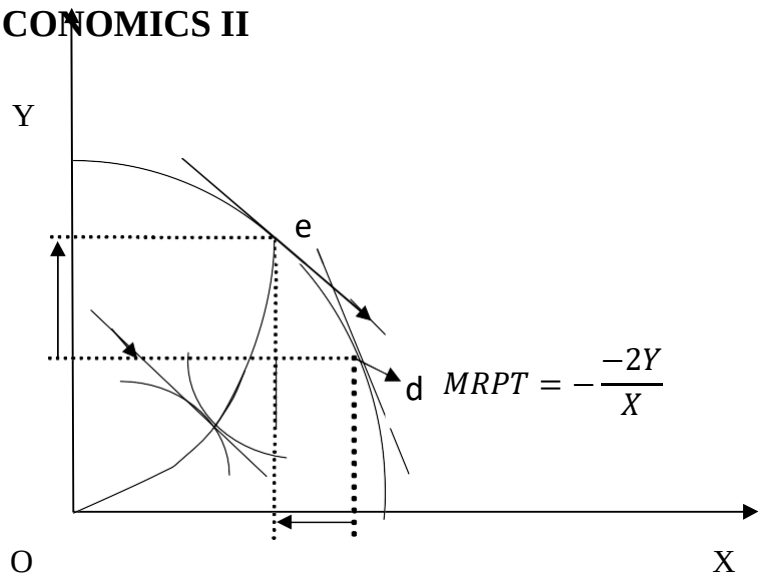
Only when the rate at which the consumers are willing to exchange one good for another (MRS_{XY}) equals the rate at which a good can be transformed into another in production ($MRPT_{XY}$) the production sectors' plans are consistent with the household sectors' plans, and the two are in equilibrium.



Equilibrium of Production

The economy is in equilibrium (of production) producing Xe units of X and Ye units of Y where the slope of PPF (=$MRPT_{XY}$) equals the commodity price ratio (P_X/P_Y} at point T. Given the Xe and Ye amounts of the commodities, we can draw the Edgeworth box of consumption with the dimensions O_AYe and O_AXe. Then, the consumers will have an efficient distribution of X and Y between them along the contract curve. The unique equilibrium (of consumption) will be at a point of tangency of the X and Y isoquants with the common slope equal to the slope of the PPF at point T. If this happens to be at point C, A maximizes his/her utility by consuming O_AG units of X and O_AH units of Y. Individual B maximizes his/her utility, consuming GXe units of X and HYe units of Y. Divergence between MRS_{XY} and $MRPT_{XY}$ implies disequilibrium of the economy.

Suppose that the $MRPT_{XY}= \frac{2Y}{X}$ while $MRS_{XY}=\frac{2Y}{X}$, this conveys that the economy can produce two units of Y by sacrificing one unit of X, while the consumers are willing to exchange one unit of X for one unit of Y. This means firms produce a larger quantity of X and a smaller quantity of Y relative to the preferences of the consumers. Firms must reduce X and increase the production of Y for the attainment of general equilibrium (see the figure below).



After determining the equilibrium quantities of the inputs and the commodities, the next step is to determine the prices (P_X, P_Y, w and r].

From the Walrasian general equilibrium framework, we have the following equations:

$MRTS_{L,K}{}^{X} = {}^{w}/_{r} = MRTS_{L,K}{}^{Y}$ ……1

$w = MPP_{LX}.P_X = MPP_{LY}.P_Y$ ……2

$r = MPP_{kX}.P_X = MPP_{kY}.P_Y$ ……3

$MRS_{Y,X}{}^{A} = MRS_{Y,X}{}^{B} = {}^{P_X}/_{P_Y}$ ……...4

Dividing (2) by (3) gives: $\frac{w}{r} = \frac{(MPP_{LX}.P_X)}{(MPP_{kX}.P_{X)}} = \frac{(MPP_{LY}.P_Y)}{(MPP_{kY}.P_Y)}$

Which is identical to equation (1) there are only 3 independent equations with four unknowns? There will be no unique solution. We choose one of the prices as a numeraire (unit of account) and express the other prices in terms of (relative to) the numeraire. Let the numeraire be PX.

From (1), w = r. $MRTS_{LK}$---------- (5)

From (3), r = $MPP_{KX}.P_X$ ----------(6)

Substituting (6) in to (5), w = MPP_{KX}.PX. $MRTS_{LK}$---------- (7)

From (4), $P_Y = P_X$. MRS_{YX}---------- (8)

We can derive the relative prices from (6), (7) and (8):

i. $\frac{w}{P_X} = MPP_{KX}.MRTS_{LK}$ ii. $\frac{r}{P_X} = MPP_{KX}$ iii. $\frac{P_Y}{P_X} = MRS_{Y,X}{}^{B}$

Note that the change of numeraire leaves the relative prices unaffected. At its present stage, general equilibrium theory is largely non-operational and unrealistic. But, by

viewing the economy as a vast system of mutually interdependent markets, it makes the student aware of the complexity of the real world. Moreover, the solution which exists under certain assumptions and its optimality properties can be used as a norm to judge the significance and implications of deviations of the various markets from this ideal state of equilibrium.

5.2 WELFARE ECONOMICS

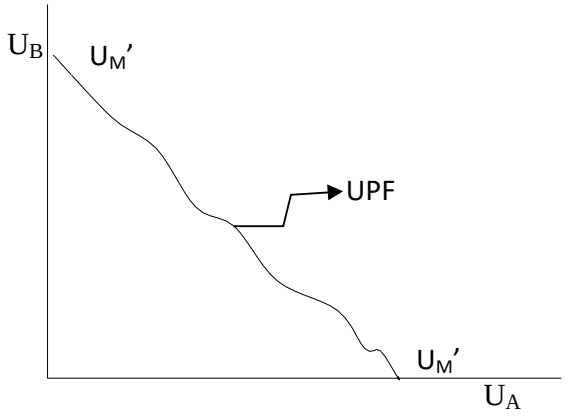
5.2.1 Definition of Welfare Economics

Welfare Economics studies the conditions under which the solution to the general equilibrium model can be said to be optimal. It examines the conditions for economic *efficiency* in the production of output and the exchange of commodities and *equity* in the distribution of income.

Note that the above definition points out that the maximization of society's well – being requires not only efficiency in production and exchange but also equity in the distribution of income.

5.2.1 Utility Possibility Frontier/Curve (UPF/UPC) and Grand Utility Possibility Frontier (GUPF)

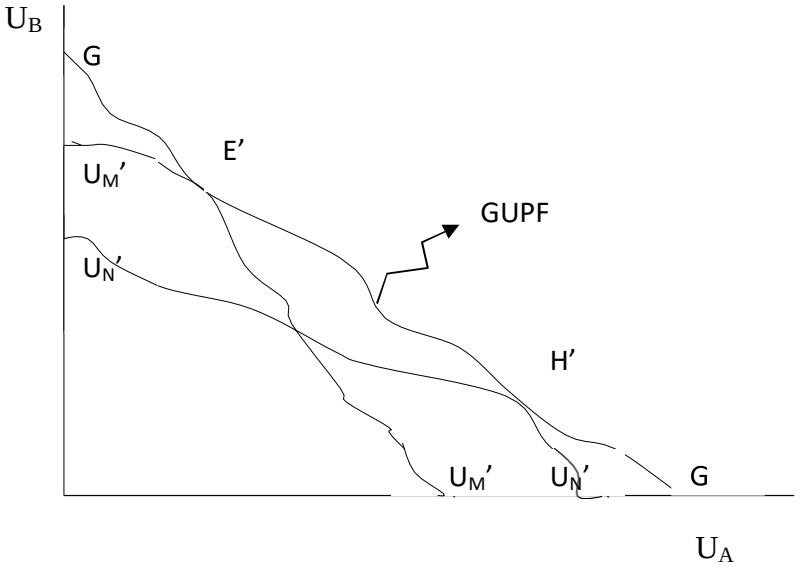
The UPF shows the various combinations of utilities received by individuals A and B (i.e., U_A and U_B) when our simple economy is in general equilibrium or Pareto optimum in exchange; it is the locus of maximum utility for one individual for any given level of utility for the other individual.



UPF U_M'U_M' shows the various combinations of utilities received by individuals A and B (i.e., U_A and U_B) when the economy composed of individuals A and B is in general equilibrium or Pareto optimum in exchange. The frontier is obtained by mapping

consumption contract (OC) in the Edgworth box of consumption from output or commodity space to utility space.

Note that UPF is associated with Pareto efficient allocations given equilibrium of production (i.e., given a point on PPF where $MRPT_{X,Y}=\frac{P_X}{P_Y}$). This means we have another UPF for any other point on PPF. In general we can have as many UPFs as there are points on PPF. GUPF is the envelope of these UPFs associated with Pareto optimum points of production and exchange.



U_M'U_M' is UPF drawn when the economy is in production equilibrium. U_N'U_N' is another UPF drawn on the assumption that the economy is in equilibrium of production at point *d* on its PPF. By joining points E', H', and other points of equilibrium similarly obtained, we can derive GUPF which is curve GE'H'G in the above diagram.

The GUPF indicates that no reorganization of the production – exchange process is possible that makes someone better off without, at the same time, making someone else worse off. Given GUPF of the above sort, in order to determine the Pareto optimum point in production and exchange at which social welfare is maximized, we need a social welfare function.

5.2.1 Social Decision Mechanisms

The only way we can decide which of the Pareto efficient points on the GUPF represents the maximum social welfare is to accept the notion of interpersonal comparison of utility. Before

we investigate the implications of this concept, it is worthwhile considering first how one might go about bringing together the individual consumer's preferences to construct some kind of "social preferences". Two approaches that are of major interest are:

A. Majority voting approach
B. Rank – order voting approach

A. Majority voting approach (MVA)

Majority voting approach is one way to aggregate individual preferences. In this form of aggregation, allocation X is said to be preferred to allocation Y if a majority of the individuals prefer X to Y. For example, in an economy consisting of three individuals, if two of them prefer X to Y and one of them prefers Y to X, using majority voting approach we conclude that the society prefers X to Y.

However, there is a problem with this method in that it may not generate transitive social preference ordering. Suppose we have the following voting result.

Choice	Person A	Person B	Person C
	X	Y	Z
	Y	Z	X
	Z	X	Y

The table shows that ·

- Persons A and C prefer X to Y and person B prefers Y to X. Hence X > Y. ·
- Persons A and B prefer Y to Z and person C prefers Z to Y. Hence Y > Z.

If this social preference ordering were transitive we could conclude that X > Z. However, from the table we know that persons B and C prefer Z to X implying that Z > X. Since the preferences are not transitive, there will be no "best" alternative from the set of alternatives (X, Y, Z). Which outcome society chooses will depend on the order in which the vote is taken. That is, for example, if the three people vote first on:

- X versus Y and then vote on the winner of this contest versus Z, the best alternative will be Z.
- Z versus X and then vote on the winner of this contest versus Y, the best alternative will be Y. ·

- Y versus Z and then vote on the winner of this contest versus X, the best alternative will be X.

Therefore, majority vote can be manipulated by changing the order in which things are voted so as to yield the desired outcome.

B. Rank–Order Voting Approach (RVA)

Here each person ranks the allocations according to his preferences and assigns a number that indicates its rank in his ordering. Consider the following table.

Allocations	Person A	Person B	Sum of the Ranks
X	1	2	3
Y	2	1	3

Since the sum of the ranks is equal for both alternatives, the society is indifferent between X and Y. Rank order voting has also a limitation. It can be manipulated by introducing new alternatives that change the final ranks of the relevant alternatives. For example, consider the following table.

Allocations	Person A	Person B	Sum of the Ranks
X	1	3	4
Y	2	1	3
Z	3	2	5

Note that the introduction of a new alternative (i.e., alternative Z) resulted in Y being preferred to X despite our earlier conclusion that the society is indifferent between X and Y when alternative Z was not introduced.

To summarize, both majority voting and rank – order voting have limitations in that their outcomes can be manipulated by astute agents. The question that normally follows is "Are there other social decision mechanisms, apart from majority voting and rank – order voting, that are immune to the limitations of these two voting approaches?" In other words, are there other social decision mechanisms that satisfy the following properties?

- Given any set of complete, reflexive, and transitive individual preferences, the social decision mechanism should result in social preferences that satisfy the same properties.
- If everybody prefers alternative X to alternative Y, the social preferences should rank X ahead of Y.

- The preferences between X and Y should depend only on how people rank X versus Y, and not on how they rank other alternatives.

It can be quite difficult to find a mechanism that satisfies all the above properties. In fact, Kenneth Arrow has proved the following remarkable result which is known as Arrow's Impossibility Theorem. "If a social decision mechanism satisfies properties a, b and c, then it must be a dictatorship: all social rankings are the rankings one of individual."

Arrow's impossibility theorem shows that three very plausible and desirable features of a social decision mechanism are inconsistent with democracy. That is under democratic system, there is no perfect way to "aggregate" individual preferences to make one social preference. If we want to find a way to "aggregate" individual preferences to form social preferences, we will have to give up one of the properties of a social decision mechanism described in Arrow's impossibility theorem. Suppose we drop property (c). If we do that, certain kinds of rank – order voting become possibilities as discussed in the following sub – section.

5.2.4 Social Welfare Function

A social welfare function is just some function of individual utility functions: $W(U_1(X), \ldots, U_n(X))$ It gives a way to rank different allocations that depends on the individual preferences. In the above definition, $U_i(X)$ is each individual i's preference over the allocations that summarize the individual's value judgments about the allocations. For example, person i prefers X to Y if and only if Ui (X) > Ui (Y). There are different ways of formulating social welfare function from individuals' preferences, some which are:

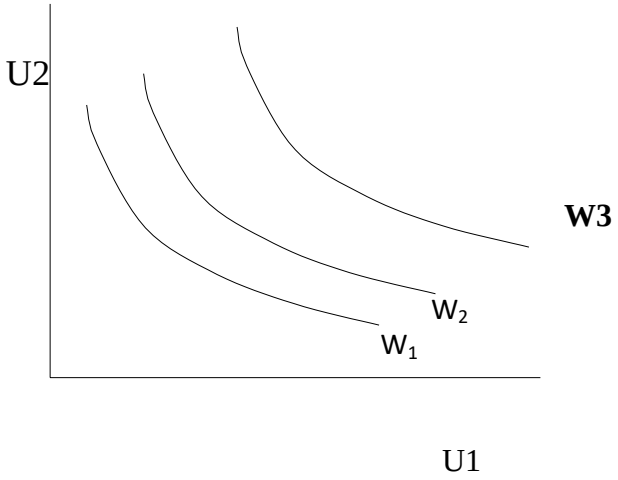
A. By adding the individual utilities and use the resulting number as a kind of social welfare function. That is, $W(U_1(X), \ldots, U_n(X)) = \sum U_i(X)$.

   This is sometimes known as classical utilitarian or Benthamite welfare function. In this form of social welfare function, we say allocation X is socially preferred to allocation Y if $\sum U_i(X) > \sum U_i(Y)$. A slight generalization of the utilitarian welfare function is the weighted sum – of- utilities welfare function. $W(U_1(X), \ldots, U_n(X)) = \sum a_i U_i(X)$.

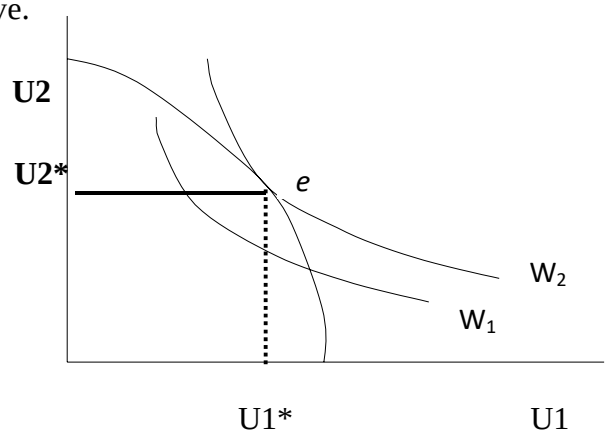
   Where the weights $a_1, \ldots, a_n$, are supposed to be numbers indicating how important each agent's is to the overall social welfare.

B. Considering the welfare of the worst off agent as that affects the social welfare of an allocation. That is: $W(U_1(X), \ldots, U_n(X)) = \min \langle U_1(X), \ldots, U_n(X)$

Given the welfare function defined as above, we can construct iso-welfare curves as shown below.



Iso-welfare curves show those distributions of utility that have constant welfare. The allocation that maximizes social welfare can then be obtained by bringing together our GUPF and the iso-welfare curves. Social welfare is maximized when GUPF is tangent to the highest possible iso-welfare curve.



The economy maximizes social welfare when it achieves general equilibrium at an allocation which generates U_1^* and U_2^* levels of utility to consumer 1 and consumer 2 respectively.

5.2.2 Fair Allocations, Envy and Equity

The welfare function approach is a very general way to describe social welfare. But because it is so general it can be used to summarize the properties of many kinds of moral judgments. On the other hand, it isn't much use in deciding what kinds of ethical judgments might be

reasonable ones.

Another approach is to start with some specific moral judgments and then examine their implications for economic distribution. This is the approach taken in the study of fair allocations. Suppose that we were given some goods to divide fairly among *n* equally deserving people. How would you do it? It is probably safe to say that in this problem most people would divide the goods equally among the *n* agents. Given that they equally deserve, what else could you do?

One appealing feature of this equal division is that it is symmetric. Each agent has the same bundle of goods; no agent prefers any other agent's bundle of goods to his/her own, since they all have exactly the same thing. Unfortunately, an equal division will not necessarily be Pareto efficient. If agents have different tastes they will generally desire to trade away from equal division. Let's suppose that this trade takes place and that it moves us to a Pareto efficient allocation. The question that arises is: is this Pareto efficient allocation still fair in any sense? Does trade from equal division inherit any of the symmetry of the starting point? The answer is: not necessarily.

Consider the following example. We have three people, A, B, and C. A and B have the same tastes, and C has different tastes. We start from an equal division and suppose that A and C get together and trade. Then they will typically both be made better off. Now B, who didn't have the opportunity to trade with C, will envy A – that is, he/she would prefer A's bundle to his/her own. Even though A and B started with the same allocation, A was luckier in his/her trading, and this destroyed the symmetry of the original allocation. This means that arbitrary trading from an equal division will not necessarily preserve the symmetry of the starting point of equal division. Is there any way to get an allocation that is both Pareto efficient and equitable (symmetric) at the same time?

An allocation is said to be *equitable* if no agent prefers any other agent's bundle of goods to his/her own. If some agent *i* does prefer some other agent *j*'s bundle of goods, we say that *i envies j*. If an allocation is both equitable and Pareto efficient, we will say that it is a *fair* allocation. Instead of just any arbitrary way to trade, if we use the special mechanism of the competitive market, a trade away from equal division will result in a Pareto efficient allocation. It is also impossible for A to envy B in these circumstances. A competitive equilibrium from

equal division must be a fair allocation. Thus the market mechanism will preserve certain kinds of equity: if the original allocation is equally divided, the final allocation must be fair.

Review Questions

1. Do you think the general equilibrium exists?

2. What condition should be met for simultaneous general equilibrium to occur?

3.Given the following Edge worth box shown in the figure 5.2 below, explain how the simple economy comes to equilibrium?

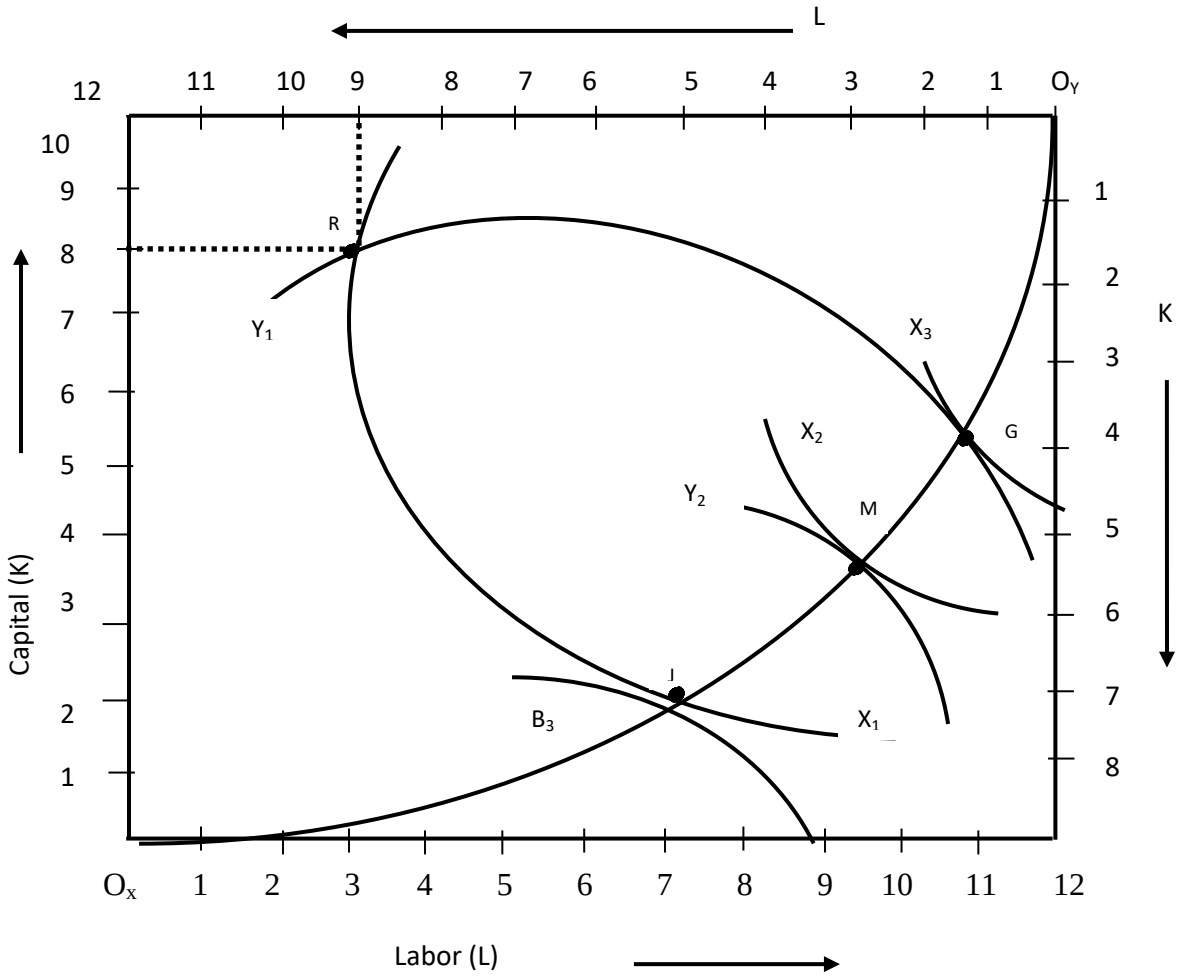


Figure 5.10 ; The Edge worth box diagram for production

CHAPTER 6

INFORMATION ASYMMETRY

Information is vitally importance to firms, consumers, and input owners. Up until now we have generally assumed that economic agents have complete information about the matters that influence their economic choices or decision –full information. For instance, we have said that when a firm is making production decisions is absolutely certain about the prices it will be paying for the inputs and the prices it will be selling the output. Under this situation the market allocation lead to efficient association of resources.

However, in real world, the information on certain issues fluctuate overtime and is not perfect, some parties to a given transaction might have more or better information than the others. Hence, market few is to achieve efficient allocation of economic resources. There are two major problems: uncertainty and imperfect information. These problems form an area called "Economics of information". In information economics information itself is a commodity, which economic agents can acquire only at some cost. Information provided by those in business for instances speculators, retailers, agents, stockbrokers, and others are valuable commodity for the other parties.

The general objective of this chapter is to introduce the concept of information economics to see the problem related to in formations, and the mechanism to reduce information problems.
Accordingly, after completing this chapter, you will be able to;

- Explain the causes of information problems.
- Mention the remedial measures.
- Describe how information costs affect the contracts between parties to a business contract.
- Understand how opportunistic behavior affects business contracts works?

6.5.1.INFORMATION AS ECONOMIC COMMODITY AND OPTIMAL SEARCH RULE

Many peoples such as speculators, intermediaries, and others in the information business are often unpopular. Most of the time peoples such as production workers, views them as more middleman which are parasites on the effects of others who do the real work. Sometimes farmers

complain about the speculators who buy form them when the price is low and resale later at a higher price. Consumers complain about rising grocery prices, which they attribute to greedy grocery's.

But on closer examination, we can see that the economic role of sales agents is essentially the same as that of production workers. These agents add genuine economic value by increasing the extent to which goods and services find their way to the consumers who value them most. For instances, one of the most common problems consumer confront is the need to choose among different versions of a product with many complex feature that they do not fully understand. The middlemen assist them in giving information about the quality. They supported the fact that many people go to great lengths to avoid paying for the services of sales agents. Many manufacturers cater to them by offering consumer a chance to buy direct and side step the middleman's commission

These economic agents also assist manufactures or producers in their sale product. Hence, the information provided by those in the "information business" (speculators, realtors, agents, intermediaries, stock brokers and others) is a valuable commodity.

Because of the above reasons and others, which will be mentioned in detail shortly, economic agents spent a huge quantity of scarce resources on economics of information. People and businesses voluntarily pay billions of dollars to acquire information on prices, locations and quantities. This information includes data on the prices, quantity and quality of good, location, and product performance.

In contrast with models of perfectly competitive, monopoly and other market structure where information is free, in real world most of the time it is scarce. If it were not, we would not need, the Wall Street Journal, CNN, The Reporters, the Ethiopian Herald, Ethiopian TV and Radio…etc. And we would not need to shop around for bargains or spend time looking for jobs. These and other information are distributed over the population in bits and pieces and every market participant have no equal assess to them.

Because of its scarcity, information acquiring typically does have its costs. Information gathering is an activity like any other. People value all the time, effort, money or financial costs and related benefits of gathering information. That is, the cost benefit principle provides a strong conceptual framework for looking at the way to optimize the information cost. These information costs include the cost of telephoning, shopping, checking credentials, inspecting goods, monitoring the honesty of workers or customers, placing Ads and reading Ads… etc. For instances, consumer incurs search cost while shopping, reading or consulting experts in order to acquire pricing and quality information. This information is costly, as we have limited capacity to acquire, process, store, and retrieve facts and figures about the required issue even though some technological change such as Internet has reduced it.

Information cost has substantial effect on real-world markets. It is one of the crucial costs that affect the transaction costs. The buyers and sellers must first find each other and they agree on the prices and other terms of the contract. Knowledge of existences and location of willing buyer is valuable information to sellers just as knowledge of a willing seller is valuable information to the buyers.

Price is the central variable for the market adjustment and has signal implication in market for goods and services. With regard to information we have said that it is scarce and valuable commodity. By similar analogy the price system of information economizes on the commodity certain (costs) by allowing people to pay for the search information. Many models discussed above we have seen so far assume perfect information where its cost is zero. The fact that economic models ignore information cost does not make this model useless. They give insight to the force-generating trend in prices and quantities occur along period where information limits not to be important. Now we relaxed our assumption in that information is not free. It is appropriate to ask and understand how markets work in short run. That is, how economic agent optimizes information when it includes cost.

We know that in a perfect competitive market all buyers pay the same price for the same product. In many real world markets, however, the prices of even these homogenous goods differ from store to store, and shops to shops. Consumers or buyers feel difference in prices and want to find

explain why homogenous product sell for different prices in different location as the cost of going to the cheapest store may outweigh the advantages of the lower prices.

Because of these rational economic agents (buyer) use the optimal search rule to optimize his transaction. The optimal – search rule states that people will continue to acquire economic information as long as the marginal benefits of gathering information exceed the marginal cost That is, the buyer must balances the expected gain from further search against the cost of further search or search for lower price until the expected marginal benefit of additional search equals the marginal cost of search.

Example, when a person decides to buy a new car, the more information that person has on the prices and on technical qualities of various automobiles, the better the eventual choice is likely to be. But it is costly to drive all over town to the various dealers, take time off from work or from leisure activities to compare prices, acquire and master technical information on new car. Because of these, prospective buyer must draw the line at the point where the marginal benefits from acquiring information equal with marginal cost.

This optimal search rule can be illustrated using diagram. Suppose a consumer has just moved to a new town and is looking for the best place to buy a particular product. The consumer might visit several stores to collect varied price information. Thus, after some comparison shopping, the consumer will have a sample of the various prices charged say the product is BM car.

Let vertical axis measures the benefits and costs of search per visit. Horizontal axis measures the lowest known price (s) that the consumer has collected through search. Your marginal cost of search is $C ($5 for case) per dealer visited and is shown by horizontal line in the figure. The costs include time cost and the amount spent on transportation and advice. Your expected marginal benefit of visiting one more dealer depends on the lowest price that you have found. The marginal benefits differ with prices. The lower the price you have already found, the lower is your expected marginal benefit of visiting one more dealer, as shown by the curve

Until point 'e' where the price at which the marginal cost of search equal the marginal benefit of search (the consumer's reservation price), the buyer marginal benefit is greater than the cost and hence they search for the lowest price possible. The reservation prices are the highest price at which the consumer will buy a good. Consumer will to search for lowest prices if the lowest prices so far found exceeds the reservation pries but will stop searching and buy it if the lowest price found is less than or equal to the reservation prices.

The reservation price is $5 in figure xx. If the lowest price sampled is $6, the consumer should still search because the marginal benefit of search exceeds the marginal cost of search. If the lowest price is below $5 say $4 the Consumer will purchase the good because the marginal cost of search exceeds the marginal benefit of search. The lowest price sampled is $5, because $5 in the highest price the consumer will pay for the product.

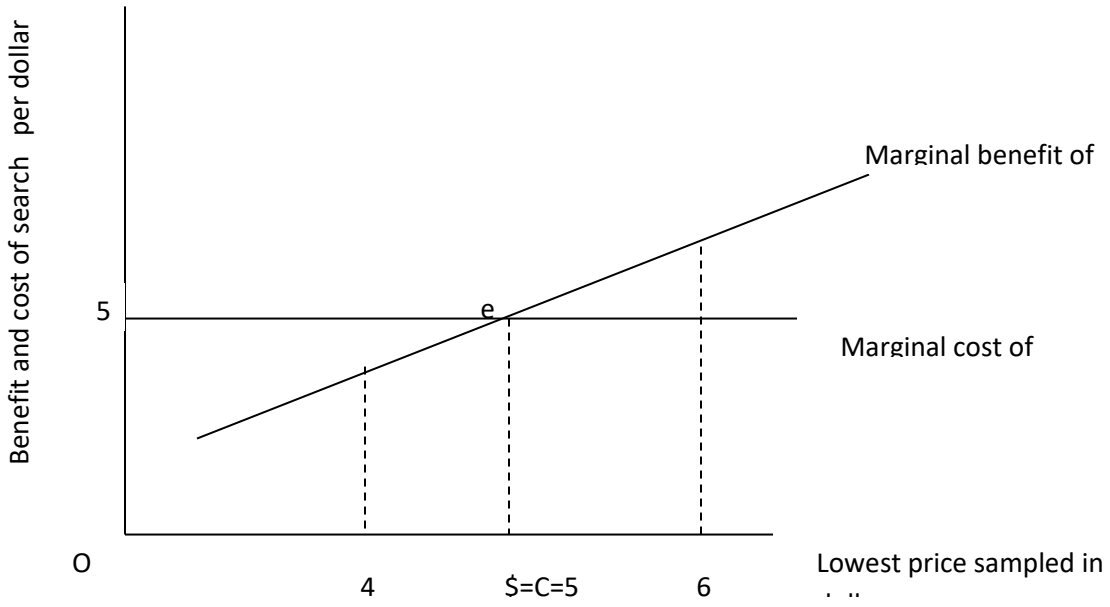


Figure 6.7: Optimal –Search Rule

We can apply the theory that consumers use a search -rule where marginal benefits equal marginal costs to predict the extent of price desperation on different products. The more resources devoted to searching, the closer will be the prices of homogeneous product sold at different stores. Information's cost can be minimized for consumers by organizations such as the consumers union, which tests products and sell the results in monthly magazine. Further more,

government can also reduce the cost by setting minimum standard and caring out inspections to ensure that standard is being observed. Advertising and other information sources can reduce the cost. It can reduce price for two reasons, firstly, it can increase competition by telling potential buyer about alternative sources of supply. Second, it enables firms to increase their out put and reap economics of scale.

6.5.2. Information problems: Asymmetric information

So far we have looked at situations in which information is available to everyone and can be obtained with an expenditure of resources. But not all situations are like this. For example, someone might have private information that may affect many economic transactions as what is available to one person is too costly for anyone else to obtain. Typical example may be your knowledge about your driving. You know much more than your auto insurance company does about how carefully and defensively you drive. Another is your knowledge about your work effort. You know far more than your employer about how hard you work.

Economic dealings between economic agents (individuals or organization) are governed by contract. One party to a transaction may know a material fact that the other party does not know about the good. For example, the seller knows the quality of his product whereas the buyer does not. When a good is purchased, the seller explicitly or implicitly guarantees that the good will work according to an expected performance standard. The more informed party many exploit the less informed party.

Economists use the term asymmetric information to describe situations in which buyers and sellers are not equally well informed about the characteristics of product or services. In these situations, sellers are typically much better informed than buyers, but sometimes the reverses will be true. This asymmetric information affects the behavior of market participants and explains a wide variety of phenomenon in modern economy lead to opportunistic behaviors which in turn lead to market failure, destroying many desirable properties of competitive markets.

Used Cares: An example of asymmetric information

The classic example of asymmetric information is the market for used cars-lemons Why is this not a surprise? Clearly, the seller of a used car generally knows a great deal more about its performance and deficiencies than the potential buyer. This asymmetry of information will

influence how the market works. How? Suppose that all new cars are either good or defective and that buyers find out which after they have purchased a car. If the owner then turns around and offers the car for sale, then a potential buyer of what is now a used car will not be able to determine (before buying it) whether it is good or defective, but the seller will know.

Under these circumstances, the equilibrium price of a used car would be less than the price of a new car. Note first that good and bad used cars should both sell at the same prices because the potential buyer cannot tell the difference prior to the sale. But this common price must be less than the price of a new car. If the prices of a used car were not less than the price f a new one, there would be no demand for used cars peoples buy a new car, and hence determine whether it is defective, and (if it proves to be defective) sell it and buy another new car.

"Lemons" (defective cars) would likely constitute a portion of the used cars offered for sale. Owners of good used cars could easily find the equilibrium prices of as used car to be so low that they would not be motivated to offer many of their cars for sale. On the other hand, owners of defective used cars would not feel similarly restrained. And this insight would make potential buyers even more inclined to be worry of entering the market for used cars and to offer relatively low prices for used cars if they did

The buyer of a used car would be willing to pay more than the equilibrium price if he or she were sure of getting a good one and the seller of a good used car would be delighted to agree to such a transaction. But the asymmetry of information across the market and the fact that only the seller knows whether the used car is good or defective makes it difficult for these sorts of transactions to occur. Faced with this situation, sellers of used cars try in various ways to signal buyers that their cars are good. They cite relevant facts concerning their cars. They encourage the buyer to have his or her experts inspect the cars before purchase.

We have said that economic dealing between individuals is governed by contract either implicitly or explicitly. When both parties to a contract (transaction) have no equally information, transaction is not efficient as information advantage leads to problems of opportunism, where by the informed party or person benefit at the expense of the person with less information. The opportunistic behavior or asymmetric information creates two problems:

A. Moral Hazard
B. Adverse selection

MICROECONOMICS II

A. Moral hazard problem

The moral hazard problem occurs when one party to a contract engages in opportunistic behavior after the contract is made. A Moral hazard problem exists when one of the parties to contract has an incentive to alter his or her behavior after the contract is made at the expenses of the second party to get benefit. It arises as it is too costly for the second party to obtain information about the first party's post contractual behavior and hidden action. Stating differently it is opportunism characterized by an informed person's taking advantage of a less informed person through an unobserved action.

Some examples are

- If Mr.-X hires Mr.-Y as a sales person and pays him a fixed wage regardless of his sales. Mr. –Y has an incentive to put in the least possible effort, benefiting himself and lowering profits of Mr. as the pay is not based on the volume of sales.
- An insured people find to take unobserved action (engage in risky behavior or take lesser precaution) that increase the probability of large claims against insurance companies. Individual will spend less on preventive health care and thus the probability or getting in to risk rises

But if a consumer can purchase car insurance on theft, then the cost inflicted on the individual of having his car stolen is less as he/she can report to the companies and get insured if the car is stolen. Similar analogy, applies to car damage/ collusion. Although it is unlikely that insured deriver would deliberately have collusion, such an insurance policy might give the deriver an incentive to alter deriving behavior. The deriver might be less cautious in parking lots and might generally drive less defensively than normal.

Such activities as failure to take care and reckless behavior reduce output or increase accidents, which show why market failures and hence harm society. These are moral hazard in which individuals have an incentive to do opposite to get advantage at the expense of contracting parties. The Moral hazard occurs in all economic activities where economic agents do not bear the full consequences of their action. In such instances the economic agents maximizes their own utility to determinant of others.

As opposed to competitive market where the transaction is determined by the condition that demand equals supply the marginal willingness to pay equals the marginal willingness to sell here is no smooth transaction up to the equilibrium in case of more hazard, hence no market equilibrium.

In our insurance case, for instances, has the property that each consumer would like to buy more insurance, and the insurance companies would be willing to provide more insurance if the consumers continued to take the same amount of care. But this trade won't occur because if the consumers were able to purchase more insurance they would rational choose to the less care.

Despite the pejorative name, not all moral hazard, are entirely harmful. For instances, pregnant women with health insurance make more prenatal doctor visits. Although the extra cost from these visits is a moral hazard to insurance companies, society benefits from healthier mothers or babies.

B. ADVERSE SELECTION

The adverse selection is other problem which arises prior to the making of the contract transactions between parties. It is the tendency for people to enter in to agreements in which they can use their private information to their own advantage and to the disadvantage of the less informed party. It occurs as the cost of obtaining the relevant information makes it difficult to determine whether the real is a good one or a bad one.

Some example may be:

In a shop or supermarket contract between the business man say Mr. X and sales person Mr. Y, if Mr. X offers sales people a fixed wage, she will attract lazy sales people, and hardworking sales people will prefer not to work for Mr. X because they can earn more by working for someone who pays by results. The fixed wage contract adversely selects those with private information (knowledge about their work habits) who can use that information/ knowledge to their own advantage and to disadvantage of the other party.

Suppose there are many producer of umbrella in which some produce high - quality product at with P_H prices and the others produces low- quality product at P_L. If the market is competitive, it has an incentive to produce only low–quality umbrellas as each producer has negligible effect on others. The Low–quality umbrella production has destroyed the market, for both qualities of good. That is, low quality item crowded out high quality items because of the high cost of acquiring information.

These adverse selection problems are more prevalent in insurance industry. Insurance companies face a different world; for instance good and bad car or derivers. If we assume Mr. G a good drivers low rate accident and Mr. F bad driver with high rate accident, unless the companies evaluate when they derive, it cannot differentiate between two drivers. Due to high cost of gathering information, the insurance company sells automobile insurances to both parties at the same rate, even though individuals within the group often differ sharply in terms of their likelihood of filing claims. Thus, buying insurance is attractive to those individual with the highest likelihood of accidents them good driver.

Similar problem arises with health insurances in which case those people with high incidences of health problems tend to buy health insurances at same rate with that of people with low incidences. The high risk people are better off because they can purchase insurances at rates that are lower than the actual risk they face and the lower people can purchase insurances.

Adverse selection forces insurance companies to raise their premium, which makes buying insurance even less attractive to low-risk individuals, which raises still further the average risk of those who remain insured. Income cases only those individuals faced with extreme risk may continue to find insurance an attractive purchase. Adverse selection create a market failure by reducing the size of market or dominating it, thereby preventing desirable transactions insurance companies have to change higher rates for insurance due to adverse selection or choose not to offer insurance at all.

6.5.3.MEASURES TO REDUCE INFORMATION ASYMMETRY

Up until know we have seen that asymmetric information result in inefficiencies due to moral hazard as well as adverse selection problems. How do these problems can be solved without shifting risk to people who hate bearing it or contracts at least reach a good compromise between

the two goals. Insurance companies, for instances, face trade-off between reducing moral hazards and the risk of insurance buyers as the company has a pools risk. It acts as through it is risk neutral. Similar trade-off may arise under adverse selection. Hence, how to solve these problems?

There are two main methods of solving adverse selection and moral hazard. These are:

A. restrictions opportunistic behavior or controlling opportunistic behavior and

B. equalizing information

A.CONTROLLING OPPORTUNISTIC BEHAVIOR

Adverse selection can be prevented if informed have no choice. For example, a government can avoid /reduce asymmetric information by providing insurance to everyone or by mandating that everyone buy insurance. Many states require that every driver carry auto insurances thereby reduce adverse selection that would arise from having a disproportionate number of bad drivers buy insurances. Similarly, firms often provide health insurance to all employees as a benefit rather than paying a higher wage and letting employees decides whether to buy such insurance on their own. By doing so, firm reduce adverse selection problems for their insurance carrier. Both healthy and unhealthy will be covered as a result firms can buy medical insurance for their workers at a lower cost per person than workers could obtain on their own. Insurance companies have responded to this problem by imposing limits on the amount to be insured. Particular policies many, for example, pay for no more than 8 days in the hospital for a person undergoing a gall bladder operation.

Furthermore, many insurance policies have a feature of **co-insurances** in which the companies cover some part so that the policyholder is obliged to pay the balance health insurance policies. Often have a 20% co-insurance rate, which implies that the insurance company pays 80% and policy holders pays 20% of any bill. Someone with a $500 medical bill would then pay 0.20 x 500 or$100. This 560 – insurance is to give the policyholder more incentive to hold down medical bills and to take pervasive care.

Insurance companies also respond to moral hazard by inserting **deductibles** in to the policies that they write. With a deductible, a policy maker has to bear part of the insured loss up to some

limit. For example, a medical insurance policy may stimulate that the patient must pay the first $200, of medical expenses that he or she incurs..

In some market it is possible to avoid from consumer ignorance through laws might provide protection against being selling lemons. Consumers might screen by collecting the information themselves, the government or others third party might supply reliable information. For instance, product liability laws protect consumers from being stuck with non-functional or dangerous products. Moreover, many states super courts have concluded that the products are sold with on implicit understanding that they will safely perform their intended function. If they do not, consumers can due the sellers even in the absence of product liability laws.

B. EQUALIZATION INFORMATION

Either informed or uniformed parties can eliminate information problems through:

Screening

Signaling

Screening is an action taken by an uninformed person to determine the information possessed by informed people. A buyer may test – drive (screen) several used cars to determine which one starts and handles the best. When the originally uninformed people obtain better information, they may refuse to sign a contract or insists on changes in contract clauses or on the prices of a good. Insurance companies, for example, try to reduce adverse selection problems by learning the health history of their potential customers; information on age and general health, individuals dangerous habit (drinking or smoking)…etc.

Consumer can avoid the lemons problems if they can obtain reliable information about quality. Consumers can buy information from experts or infer product quality from seller's reputation as it is easy to establish reputation in a market in which the same consumers and firms trade regularly. In some market, consumers learn of a firm's reputation from other consumers or from observation. If the mechanic can reliable determine the whether the car is lemon, the information asymmetry is limited.

Signaling is an action taken by an informed person to send information to a less informed persons. A firm may send a signal such as widely distributing a favorable report on its product by an independent testing agency to try to convince buyers that its product is high quality. In some

markets government agencies on non-profit organization such as customers unions also provide consumers with information.

Firm and individuals both engage in an activity called 'market signaling' to convey information about the quality of the products or services that they are offering. Companies usually, for example, are interviewing and giving exam to select relatively better workers from the labor market. Firm usually use education as an important indicators or signal of person's productivity when they are make hiring decisions as the more educated people, the more the productivity of the worker.

Similarly, the producers signal product quality through different mechanism such as issuing guarantee and warranties for customers implying their product is of high quality. The high quality product is also signaled through high prices for their goods. Furthermore, advertising and other market information give valuable result in this regard even through is persuade individual to buy a product or services.

Moreover, it an outside organization to provide believable information, it must convince consumers in that it is trustworthy. Some nonprofit organization, such as consumers groups, and non-profit organization publish expert comparisons of brands. To the degree that this information is credible, it may reduce adverse selection by enabling consumers to avoid buying low-quality goods. In some case there is also standardization and certification in which the government , consumer groups, Industry group and other provides information based on standard: a metric or scale for evaluating quality of a particular product. Consumers learn of a brand's quality through certification: a report that a particular meets or exceeds a given standard levels.

- Economic agents have constantly faces with problem of hidden information that result in moral hazard and adverse selection. The problems of moral hazard arise because those who have information advantages have incentives to change their behavior.
- The equilibrium out comes in these markets where hidden information problem there appear to be inefficient, but one has to be careful in making such a claim. The equilibrium in this case will always be inefficient relative to the equilibrium with full information.
- There are two main methods of solving adverse selection and moral hazard. These are: restrictions opportunistic behavior or controlling opportunistic behavior and equalizing information. In the first case the government or the concerned body restrict this behavior

by law or use different mechanisms such as standardization, certifications…etc. In relation to the second either informed or uniformed parties can eliminate information problems through screening and signaling

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Review questions

1. Do you think house rent or sale brokers in you surrounding has any economic role for the transaction activity under taken by the two major parties: buyer and seller? How and what do they do?

2. Suppose you want to buy Tape recorder as competitive market where is difference in cost of the product in different shops. How do you decide to by the good using the optimal-search rule criteria?
3. Someone, whose car is insured, may take less care to prevent from being stolen parking or/and damage while deriving as compared someone with no insurance. Why? What kind of problem is it? Is there any similar problem in you surrounding?