ENGINEERING ECONOMICS ASSIGNMENT

TITLE : “MONOPOLY”

SUBMITTED BY:

NAME: ZISHNENDU SARKER

ROLL: 2K19/CO/450

BRANCH: COE

BATCH: A6

SUBMITTED TO:

JAPJI KAUR MAAM

ENGINEERING ECONOMICS

Delhi Technological University

Computer Engineering Branch, A6

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Introduction of Monopoly:

What is Monopoly ?

~ " Pure monopoly is represented by a market situation in which there is a single seller of a product for which there are no substitutes; this single seller is unaffected by and does not affect the prices and outputs of other products sold in the economy. " - Bilas

A monopoly is a specific firm or a person who is the sole seller of a particular commodity (which does not have any close substitutes) in its market. The word monopoly has been derived from the combination of two words i.e., 'Mono' and 'Poly'. Mono refers to a single and poly to control.

Like this, monopoly refers to a market situation in which there is only one seller of a commodity. There is only one producer in the market. So, he has complete control over the market. There are no close substitutes for the commodity it produces and there are barriers to entry. The single producer may be in the form of an individual owner or a single partnership or a joint stock company. In other words, under monopoly there is no difference between firm and industry.

A monopolist can determine the price at which he would sell the commodity but he cannot determine the quantity that would be sold at this price. The quantity sold would depend upon the market demand at the price he chooses.

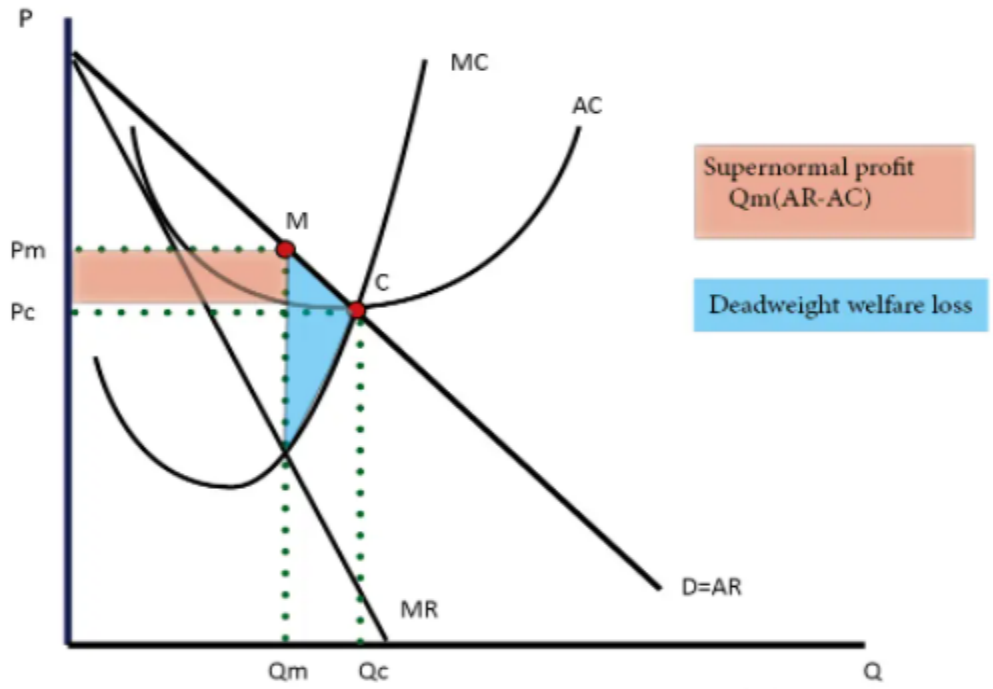

Fig: Monopoly Diagram

Features of Monopoly:

1. **Only one seller:**

   The monopolist's firm is the only firm. The monopolist is the only seller in the commodity. He has control over the market and he sets his own product's price.

2. **Large number of customer:**

The number of customers is assumed to be large. As there is only one seller or industry in the commodity, that's why it will have a large number of customers or buyers.

3. **No Close Substitute:**

There shall not be any close substitutes for the product sold by the monopolist. The cross elasticity of demand between the product of the monopolist and others must be negligible or zero.

1. **Shape of the AR curve of Demand Curve:**

In the case of monopoly, one firm constitutes the whole industry. The entire demand of the consumers for a product goes to the monopolist. A monopolist can sell more of his output only at a lower price and can produce the sale at a higher price. The downward-sloping demand curve expresses that the price goes on falling as sales are increased.

2. **Barriers of Entry:**

There are either natural or artificial restrictions on the entry of firms into the industry, even when the firm is making abnormal profits.There are strong restrictions on any firm or other producer producing the product/ service which the monopolist is producing.

3. **Price Discrimination:**

Price discrimination means charging different prices for the same commodity . there are three types of price discrimination. There are three types of price discrimination . They are: personal discrimination, price discrimination, trade discrimination.

4. **Super Normal Profits In the Long Run :**

In the short run a monopolist may earn supernormal profits, normal profit or may even run into losses, but in the long run the monopolist would choose such price and output combination that it would end up with super normal profits.

Barriers to Entry (In Monopoly):

Barriers to entry form an obstacle to businesses when entering a market. This can come in the form of high start-up costs, strongly branded competitors, or high import duties. For instance, car manufacturers require high start-up costs and face competitors that have high brand trust and loyalty. If trying to start a new company to enter the market – it would be extremely difficult. Therefore, as a result

of barriers to entry, new firms do not enter the market – thereby reducing the level of competition.

- A barrier to entry is something that prevents or deters new businesses entering the market - this may come in the form of high start-up costs, regulatory requirements, or, brand loyalty among others.
- There are 4 main types of barriers to entry – legal (patents/licenses), technical (high start-up costs/monopoly/technical knowledge), strategic (predatory pricing/first mover), and brand loyalty.
- Barriers to entry are important as they can prevent free competition which reduces price and increases choice for the consumer.

Fig : Barriers to entry

Why Does Monopoly Arise?

Why do monopolies arise? There are many different reasons, but all of them have to do with barriers to entry in the market. The reasons for these barriers are the reason for arising monopoly.

- **Structural:** There are properties of the market that automatically shut competitors out:
    1. **Economies of scale**: .When businesses get larger they benefit from reduced input prices. For example, supermarkets can negotiate lower prices for bread and milk, whilst small stores will struggle to negotiate with suppliers.This makes it difficult for new entrants because they already come into the market at a disadvantage. Big stores can charge lower prices due to their size, which means new entrants are unable to effectively compete. If there are economies of scale, large-scale advantages, the size of the firm is crucial for average cost. A situation can then arise in which only one firm can recover its costs. This is called a natural monopoly and an example of this is railroads

    2. **Cost advantages**: If the monopolist has access to a cheaper way of producing the goods, for instance if she has a patent on a cheaper technology, she can push competitors out of the market. The technology of a firm may be such that the production of a good by that firm may exhibit decreasing marginal and average costs over a wide range of output levels (reaping the benefits of the economies of scale). The decreasing marginal cost with an increase in the volume of production and large initial cost required to set up the business serves as an advantage to the firm over its possible competitors. Decreasing costs enables the firm to reduce its prices to such an extent (lower than the operating cost of its competitors) that it would make it difficult for other firms to enter the market.

- **Strategic limitations**: The monopolist can create barriers to entry. There are some facts that come under strategic limitations like predatory pricing, heavy advertising, fast mover (those who came/come first in any sector) etc. An example is limit pricing, where the monopolist sets the price so low that it becomes unattractive for competitors to enter. The first-mover advantage is another example of a barrier to entry. For example, eBay and Amazon are both two notable cases. The first-mover benefits from a greater brand image. If we want to sell something, we can easily go to eBay and for many, it’s the

first point of call. To change that decision-making process in people's minds is an incredibly difficult barrier to entry to overcome.

- **Licence:** When any firm wants a license to provide a commodity or provide a service , then at first they have to take permission from the government. Licenses and permits are another government granted barrier to entry. These are usually issued by the government to maintain quality, but reduce the level of competition at the same time. As a result, new businesses or individuals will find it hard to enter. For example, in the US state of Arizona, a license is required for a hairdresser to be able to blow dry hair. It takes over 1000 hours in order to obtain such a qualification. This dis-incentives would be hairdressers as it makes it unnecessarily difficult for them to enter the market, thereby reducing the level of competition. That's why individuals with a good investment are involved in monopoly for a long run in the business.

- **Cartel:** When a number of firms get together and collectively decide on a common price of and quantity of the commodity. This results in the creation of a virtual monopoly. Under Cartel, some firms retain their identities but coordinate their output and pricing policies to set themselves as a monopoly. The firm agrees among themselves to restrict their output to the level that maximizes their joint profit. The most famous example of Cartel is the Organization of Petroleum Exporting Countries (OPEC).

- **Political or Government:** The government may decide to grant a firm a monopoly in a certain market. A common example is for pharmaceutical goods. So, getting Licenses is another government granted barrier to entry. These are usually issued by the government to maintain quality, but reduce the level of competition at the same time. As a result, new businesses or individuals will find it hard to enter. But as there the competition is less , so, for a long run it will be very beneficial . That's another reason why monopoly arises. Many times, monopolies emerge due to legal barriers imposed rather than due to economic conditions. The government may assign intellectual property rights, including patents and copyrights, giving a firm exclusive control over production and sale of certain goods for a specific period of time

Sometimes, the government may award exclusive rights to a particular firm to serve a market. Such rights are awarded in the cases of public utility services, post offices, communication services etc.

- **Patents and exclusive rights**: Patents are a tool that the Government uses to promote innovation as companies should be more willing to create new products if they have monopoly power over the products. If a firm has a patent on a certain good, other firms are shut out during the life span of the patent. It is also possible to have exclusive right to extracting, for instance, oil or metals.

Nature Of Demand Curve in Monopoly:

Under monopoly, it becomes essential to understand the nature of the demand curve facing a monopolist. In a monopoly situation, there is no difference between firm and industry. Therefore, under monopoly, a firm's demand curve constitutes the industry's demand curve.

Since the demand curve of the consumer slopes downward from left to right, the monopolist faces a downward sloping demand curve. It means, if the monopolist reduces the price of the product, demand of that product will increase and vice-versa.

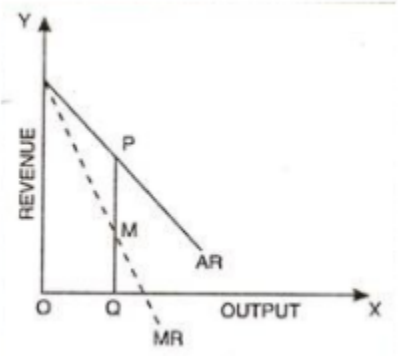

Fig: Revenue and Demand graph

In the figure above, the average revenue curve of the monopolist slopes downward from left to right. Marginal revenue (MR) also falls and slopes downward from left to right. The MR curve is below the AR curve showing that at OQ output, average revenue (= Price) is PQ whereas marginal revenue is MQ. That way AR > MR or PQ > MQ.

Price and profit determination

Price Determination :

Monopoly pricing is a pricing strategy followed by a seller whereby the seller prices a product to maximize his or her profits under the assumption that he or she does not need to worry about competition. In other words, monopoly pricing assumes the absence of competitors being able to garner a larger market share by charging lower prices.

As already discussed, a monopoly refers to a single seller operating and selling a good in the market of a large number of buyers. Since there are no other sellers of such good in the market, the entire demand of such good is enjoyed by the one seller and as a result, monopolies become able to make a considerably massive amount of profits through their sales in the markets.

The goal of a monopoly in developing a pricing strategy is to maximize profits. The market price is determined by demand for goods or services. The monopoly wants to set the highest price possible and still be able to sell all goods manufactured. A monopoly must determine the correct level of output to maximize profits. A monopoly has an advantage over other market structures in determining prices in that consumers cannot easily exchange their product for a comparable one

from a local provider. For example, there is not a comparable substitute for electricity.

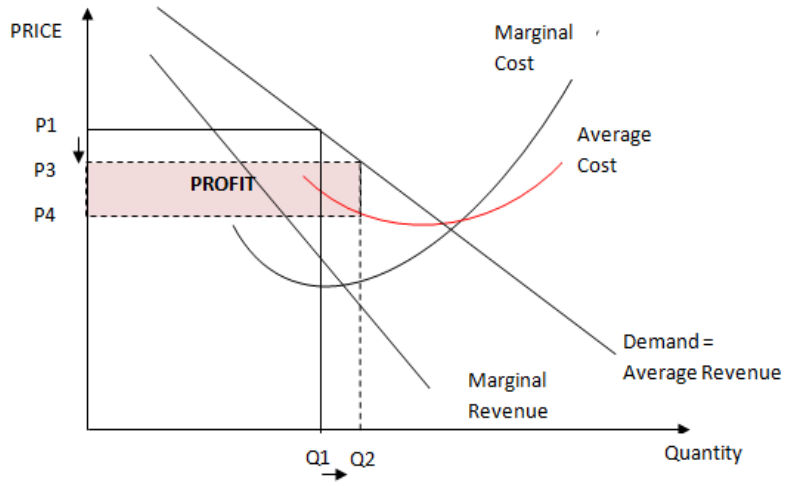

Fig : Price Determination

Monopoly pricing requires not only that the seller have significant market power, possibly a monopoly or near-monopoly or a cartel of oligopolists, but also that the barriers to entry for selling that good are high enough to dissuade potential competition from being attracted by the high pricing. In particular, monopoly pricing is infeasible in contestable markets.

Maximum Profit:

The monopolist wants to maximize her profit. She does that by producing the quantity, Q*, at which MC = MR:

$$MC\left(Q^*\right) = MR\left(Q^*\right)$$

Fig: maximum profit

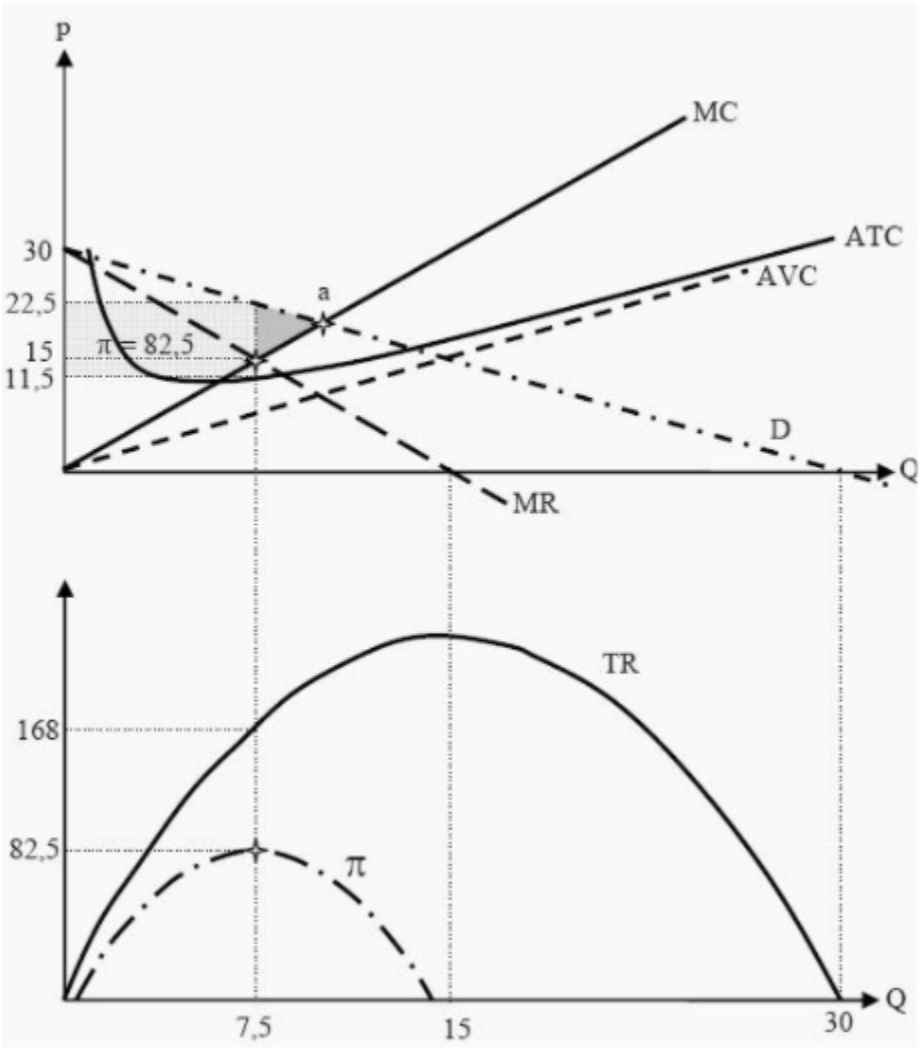

Fig : Max profit graph

In the above figure, this corresponds to the quantity 7.5, where both MR and MC equal 15. To see that this choice maximizes the profit, think of what would happen if she would produce more than that quantity. If she would produce one more unit, she would get paid MR but also incur a cost of MC. Moreover, since MC > MR, the cost is larger than the revenue and she would reduce profit; similarly if she would reduce the production. The profit at a quantity of 7.5 is, according to the lower diagram, 82.5. The price the monopolist will charge is the

one that the consumers, according to the prepared to pay when the total production is 7.5, i.e. 22.50. The corresponding ATC is 11.50. In other words, the monopolist makes 22.50 - 11.50 = 11 per unit sold, totaling to 11*7.5 = 82.5. This corresponds to the grey rectangle in the upper part of the figure. Similarly to the firms in a perfectly competitive market , the price must also be above the average variable cost, AVC. If it is not, it is better to produce nothing at all. In the long run, the firm must also cover its fixed cost, and then the price must be above the average total cost, ATC. In the above figure, we have also indicated where total revenue is maximized. This occurs at the quantity Q = 15 and corresponds to the point in the upper part of the Figure where MR = 0. Note that this point does not maximize the profit. In the example, the firm makes a loss at that quantity.

Price discrimination under monopoly

What Is Price Discrimination?

Price discrimination is a selling strategy that charges customers different prices for the same product or service based on what the seller thinks they can get the customer to agree to. In pure price discrimination, the seller charges each customer the maximum price they will pay. In more common forms of price discrimination, the seller places customers in groups based on certain attributes and charges each group a different price**.**

Types of Price Discrimination:

Price discrimination is a common pricing strategy' used by a monopolist having discretionary pricing power. This strategy is practiced by the monopolist to gain market advantage or to capture market position. There are three types of price discrimination, which are :

i) Personal
ii) Geographical
iii) On the basis of use

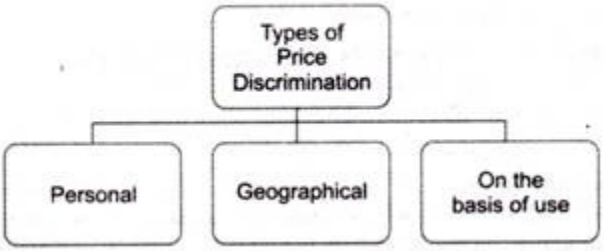

Fig: types of price discrimination

now , let's discuss the brief:

i. Personal:

Refers to price discrimination when different prices are charged from different individuals. The different prices are charged according to the level of income of consumers as well as their willingness to purchase a product. For example, a doctor charges different fees from poor and rich patients.

ii. Geographical:

Refers to price discrimination when the monopolist charges different prices at different places for the same product. This type of discrimination is also called dumping.

iii. On the basis of use:

Occurs when different prices are charged according to the use of a product. For instance, an electricity supply board charges lower rates for domestic consumption of electricity and higher rates for commercial consumption.

Figure given below shows the degrees of price discrimination:

The three degrees of price discrimination are : first degree , second degree and third degree price discrimination

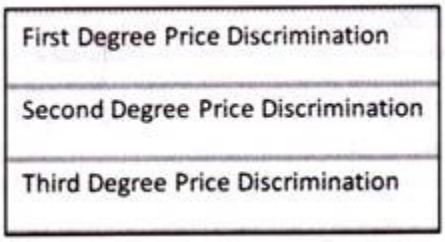

Fig: Degree of Price Discrimination

i. First-degree Price Discrimination:

Refers to a price discrimination in which a monopolist charges the maximum price that each buyer is willing to pay. This is also known as perfect price discrimination as it involves maximum exploitation of consumers. In this, consumers fail to enjoy any consumer surplus. First degree is practiced by lawyers and doctors.

ii. Second-degree Price Discrimination:

Refers to a price discrimination in which buyers are divided into different groups and different prices are charged from these groups depending upon what they are willing to pay. Railways and airlines practice this type of price discrimination.

iii. Third-degree Price Discrimination:

Refers to a price discrimination in which the monopolist divides the entire market into submarkets and different prices are charged in each submarket. Therefore, third-degree price discrimination is also termed as market segmentation. In this type of price discrimination, the monopolist is required to segment market in a manner, so that products sold in one market cannot be resold in another market. Moreover, he/she should identify the price elasticity of demand of different submarkets. The groups are divided according to age, sex, and location. For instance, railways charge lower fares from senior citizens. Students get discounts in cinemas, museums, and historical monuments.

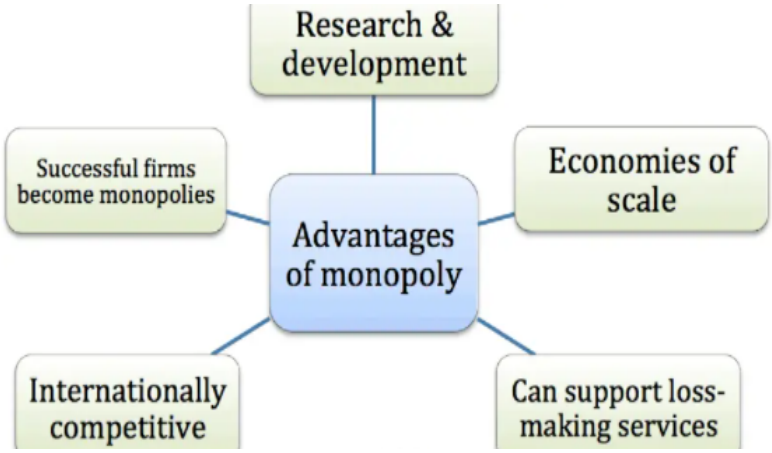

Fig : Advantages of Monopoly

What Are the Advantages Of A Monopoly?

Monopolies are commonly thought to be negative for all parties except shareholders in the monopolistic company itself. However, there are a small number of benefits that can positively affect everyone in a monopolistic marketplace. They are:

- Stability of prices. In the absence of competition, there are no price wars that might rattle markets. Other companies and end-user customers who do business with a monopolistic company may enjoy certainty at the prices they will pay.
- The ability to scale up. Monopolies can lead to large economies of scale. A company that holds a monopoly on a certain type of product may be able to produce mass quantities of that product at lower costs per unit. Depending on the ethics of the company, those low prices may be passed along to the consumer.
- Budgets for research and development. A monopoly that feels confident about its market standing is more likely to feel safe investing in research and development. This can lead to new products and manufacturing efficiencies that may benefit consumers down the line. The pharmaceutical industry offers an example of this.

- saving drugs. It also gives drug companies an incentive to push pharmaceutical treatments rather than much cheaper solutions to promote good health and avoid poor health in the first place.
- Research and development. Monopolies can make supernormal profit, which can be used to fund high-cost capital investment spending. Successful research can be used for improved products and lower costs in the long term. This is important for industries like telecommunications, aeroplane manufacture and pharmaceuticals. Without monopoly power that a patent gives, there may be less development of medical drugs. In developing drugs, there is a high risk of failure; monopoly profits give a firm greater confidence to take risks and fund research which may provInnovation. Without patents and monopoly power, drug companies would be unwilling to invest so much in drug research. The monopoly power of patents provides an incentive for firms to develop new technology and knowledge that can benefit society. Also, monopolies make supernormal profit and this supernormal profit can be used to fund investment which leads to improved technology and dynamic efficiency. For example, large tech monopolies, such as Google and Apple have invested significantly in new technological developments. However, this can also have downsides with drug companies able to charge excessively high prices for life-e futile.

Disadvantages of Monopolies

1. Higher prices than in competitive markets – Monopolies face inelastic demand and so can increase prices – giving consumers no alternative. For example, in the 1980s, Microsoft had a monopoly on PC software and charged a high price for Microsoft Office.
2. A decline in consumer surplus. Consumers pay higher prices and fewer consumers can afford to buy. This also leads to allocative inefficiency because the price is greater than marginal cost.
3. Monopolies have fewer incentives to be efficient. With no competition, a monopoly can make profit without much effort, therefore it can encourage x-inefficiency (organisational slack)
4. Possible diseconomies of scale. A big firm *may* become inefficient because it is harder to coordinate and communicate in a big firm.

5. Monopolies often have monopoly power in paying a lower price to suppliers. For example, we can see farmers have complained about the monopoly power of large supermarkets – which means they receive a very low price for products. A monopoly may also have the power to pay lower wages to its workers.
6. Monopolies can gain political power and the ability to shape society in an undemocratic and unaccountable way – especially with big IT giants who have such an influence on society and people's choices. There is a growing concern over the influence of Facebook, Google and Twitter because they influence the diffusion of information in society.

In the late nineteenth-century, large monopolies like Standard Oil gained a notorious reputation for abusing their power and forcing rivals out of business. This led to a backlash against monopolists. But, in the Twenty-First Century, there are new monopolies which have an increasing influence on people's lives.

Initiation in India :

In economics, the idea of monopoly is important in the study of management structures which directly concerns aspects of economic competition and provides the brief for topics such as individuals organisations and economics of regulation. There are four basic types of market structure in traditional economic analysis such as perfect competition, monopolistic competition, oligopoly, monopoly.

A monopoly is a structure in which a single supplier produces and sells a given product. If there is a single seller in a certain market and there are no close substitute for the product. Then the market structure is that of a " Pure Monopoly". Sometimes, there are many sellers in an industry and there are many cl;ose substitutes for the goods being produced, but nevertheless companies retain some

market power. This is termes Monopolistic competition , whereas in Oligopoly the company interacts strategically.

In general, the main results from this theory compare price-fixing methods across market structure, analyze the effect of a certain structure and very technological demand assumptions in order to assess the consequences for an abstract model of society. Most economic hardworks follow the practice of carefully explaining the perfect competition model, mainly because this helps to understand departures from it.

The boundaries of what constitutes a market and what does not are relevant distinctions to make in economic analysis. In a general, equilibrium contract a good is a specific concept including geographical and time-estated characteristics. Most studies of the market structure sellar use a little of their definition of a good. Allowing for more feasibility in the identification of substitute goods.

Case study Of Apple (Brand)

In 2005, even with more than one player in its market segment, Apple was able to sell a more expensive product and achieve 63% control of digital music players and 83% control of the legal digital music download market. Such an achievement was made through leveraging on its ITunes store and stylish status of iPods.

In charging high prices, Apple built a premium and exclusive status for its products. Over the long term, this will create a cult-like following for its products as long as the firm can keep on developing digital music players with better technology than that of its competitors.

This will require massive investment in idea and technology generation and development. Low sales numbers can easily lead to the company being bankrupt. In conclusion, charging high prices is a risky but highly rewarding option (Manikw, 2008)

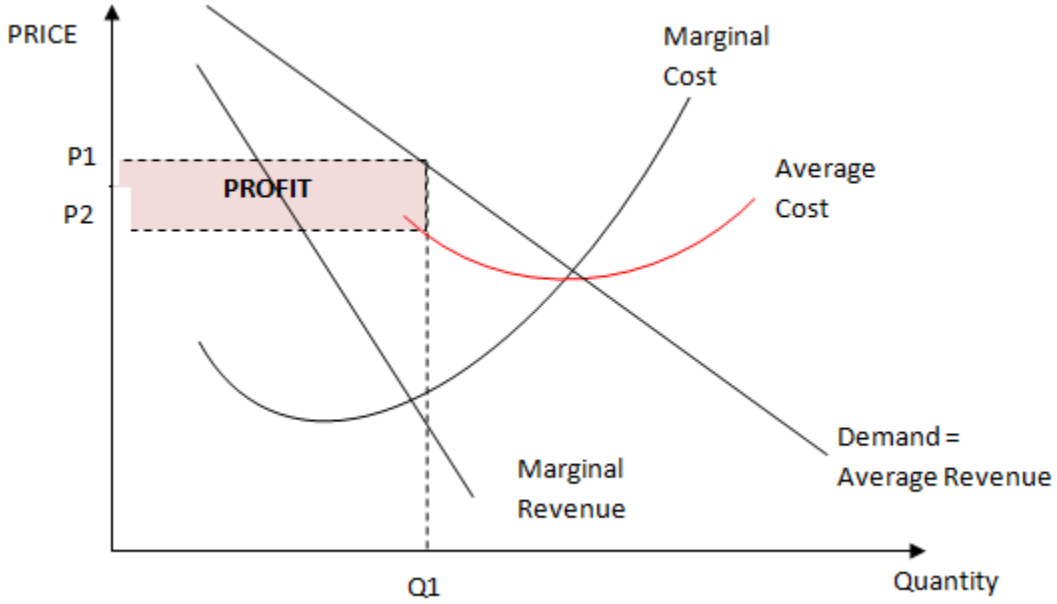

Fig 1 : Monopoly abnormal profits

Fig 1 represents a monopoly market. A monopolist is a price maker because the company does not face any competitors in such a case. Thus, there is a price inelastic demand where marginal cost meets marginal revenues, which represents the quantity for profit maximisation.

Extrapolating the output up to its maximum to meet the average revenue and cost curves, we arrive at the prices P1 and P2. The total cost of production is P1Q1, while the total revenues are P2Q2; the difference is the supernormal profit.

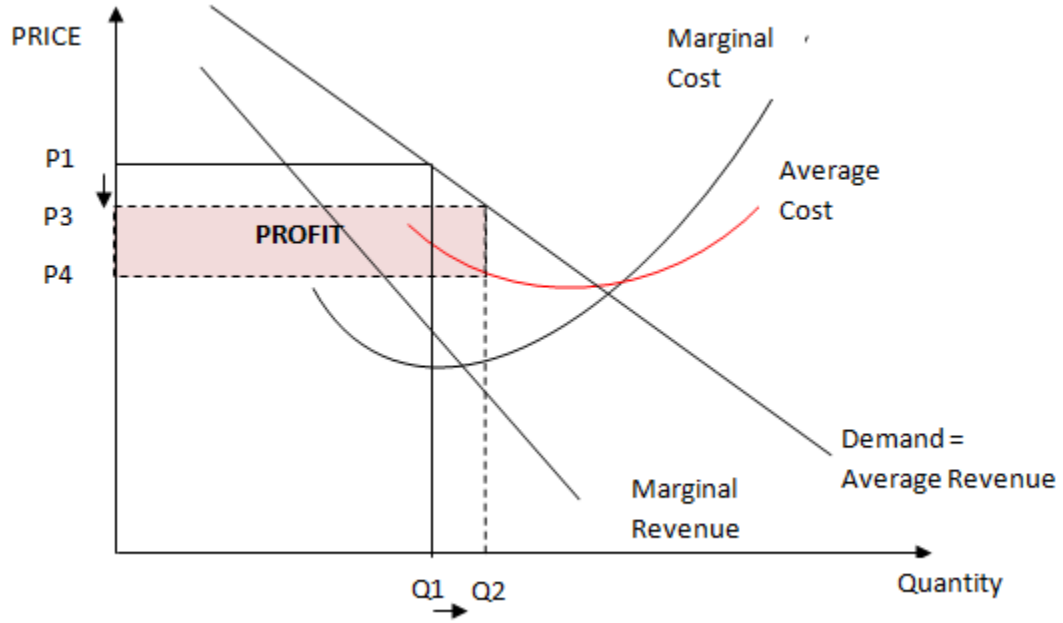

Fig 2 : Price Discrimination

Considering Fig 2, prices decrease from P1 to P3, while quantity sold has an increase from Q1 to Q2. This is due to a different demand pattern brought about by different demographic and physiographic population factors, while a different cost pattern brought about by a change of the tax regime affects the cost pattern resulting in a different price maximizing output and different prices.

First, for price discrimination to take place, it must be performed in different geographical markets. Secondly, market segmentation is based on different demographic and physiographic population factors. Thirdly, inelastic price elasticity of demand ensures the advantage of price discriminators (Manikw, 2008).
Monopolies and oligopolies are vital firms in a country especially if they can work competitively to bring new products to the market, while providing job places.

Secondly, they accumulate large amounts of capital for the benefit of the economy. However, consumer and labor groups have no trust in monopolies and oligopolies achieving this economic function without government oversight.

Arguments for intellectual property rights include giving the right of intellectual property to its owner, who can use it for financial gain. The right to own an intellectual property is a result of hard labor and investment in creating it.

Thus, development to humanity would not occur from private entities but only from the government. The socialist and economic growth would follow the government's agenda. Margins for firms would be thin since it is a price market (Dwivedi, 2002).

Every industry deserves to obtain its intellectual rights, especially considering the economic significance of motivating capital and expertise investment. In such areas as healthcare, its importance to ensuring human rights observance and proper solutions to human health problems is significant. For such markets, additional control by government authorities is necessary to balance morality and intellectual rights (Perloff, 2009).

Numericals

Question 1

Assume a monopolist has MC = 10 and no fixed costs. The monopolist faces a demand curve of P = 100 - 3Q. Find the equilibrium quantity and price.

Revenue = $P \cdot Q = (100 - 3Q)Q = 100Q - 3Q^2$

Marginal Revenue = 100 - 6Q

Setting MC = MR:

10 = 100 - 6Q

=>Q = 15

Question 2 :

Assume a monopolist has MC = 10 and no fixed costs. The monopolist faces a demand curve of P = 100 - 2Q. The government imposes a tax of 10 dollars for every unit sold. Find the equilibrium quantity and price.

Answer : To find the equilibrium quantity, we can simply assume the consumer absorbs the tax (the equilibrium quantity is the same whether the tax is shouldered by the firm or the consumer). The demand curve is then:
$P + T = 100 - 2Q$
$\Rightarrow P = 90 - 2Q$

Revenue $= P \cdot Q = (90 - 2Q)Q = 90Q - 2Q^2$
Marginal Revenue $= 90 - 4Q$
Setting MC = MR:
$10 = 90 - 4Q$
$\Rightarrow Q = 20$
$\Rightarrow P + T = 60$
$\Rightarrow P = 50$

Question 3:
Assume a monopolist has MC = 20 and no fixed costs. The monopolist faces a demand curve of $P = 100 - 4Q$. Calculate the deadweight loss.
Answer:
Revenue $= P \cdot Q = (100 - 4Q)Q = 100Q - 4Q^2$
Marginal Revenue $= 100 - 8Q$
Setting MC = MR:
$20 = 100 - 8Q$
$\Rightarrow Q = 10$
To find Q*, find the intersection of P and MC.
$100 - 4Q^* = 20$
$\Rightarrow Q^* = 20$
The deadweight loss is simply the area between the demand curve and the marginal cost curve over the quantities 10 to 20. The deadweight loss is thus 200.

Question 4 .

A monopolist has the cost function $TC(y) = 200y + 15y^2$ and faces the demand function given by $p = 1200 - 10y$. What output maximizes its profit? What is the profit-maximizing price? What is its maximal profit?

Answer:
We have TR(y) = (1200 - 10y)y = 1200y - $10y^2$, so
MR(y) = 1200 - 20y.
Also
MC(y) = 200 + 30y.
Thus any output at which MR is equal to MC satisfies
1200 - 20y = 200 + 30y,
or
50y = 1000, or y = 20.
We have MR'(y) = -20 and MC'(y) = 30, so MC'(20) >= MR'(20).
The price associated with y = 20 is p = 1200 -(10)(20) = 1000, so the firm's profit is
(1000)(20) - 200(20) - $15(20)^2$ = 20000 - 4000 - 6000 = 10000.
Since this profit is positive, the optimal output for the monopolist is the output we have found, namely y* = 20. The price is 1000 and the monopolist's profit is 10000.

Question 5.

A monopolist's cost function is TC(y) = (y/2500)(y / 100)^2 + y, so that MC(y) = $3y^2$/2500 - 4y/25 + 5. It faces the inverse demand function P(y) = 4 - 4y/100. Find its output, the associated price, and its profit.

For MR = MC we need
$3y^2$/2500 - 4y/25 + 5 = 4 - 8y/100,
or
$3y^2$/2500 - 8y/100 + 1 = 0,
or
$3y^2$ - 200y + 2500 = 0,
or
y = [200 ± root(40,000 □ 30,000)]/6 = [200 ± 100]/6 = 50 or 100/6.
Thus there are two outputs at which MR is equal to MC: 50 and 100/6.

We have
MR'(y) = -8/100 and MC'(y) = 6y/2500 - 4/25.

We have MR'(50) = -8/100 = -0.08 and MC'(50) = -0.04,

so that MC'(50) >= MR'(50).

Also we have MR'(100/6) = -8/100 = -0.08 and MC'(100/6) = -0.12,

so that MC'(100/6) < MR'(100/6).

Hence the slope of MC is greater than the slope of MR only at $y = 50$.

For $y = 50$ the price is $P(50) = 4 - 200/100 = 2$, so the firm's profit is (2)(50) - TC(50) = 100 - 100 = 0.

We conclude that the outputs of 0 and 50 are both optimal for the firm.

Question 6 :

A monopolist's cost function is

$$\mathrm{TC}(y) = \begin{cases} 0 & \text{if } y = 0 \\ 100y + F & \text{if } y > 0. \end{cases}$$

It faces the demand function $p = 300 - 5y$. How much does the monopolist produce (as a function of F)? What is the price? What is the monopolist's profit?

- We have $\mathrm{TR}(y) = (300 - 5y)y$, so $\mathrm{MR}(y) = 300 - 10y$; $\mathrm{MC}(y) = 100$. Thus for $\mathrm{MC}(y) = \mathrm{MR}(y)$ we need $y = 20$.
- We have $\mathrm{MR}'(y) = -10$ and $\mathrm{MC}'(y) = 0$, so the condition $\mathrm{MC}'(y) - \mathrm{MR}'(y)$ is satisfied.
- For $y = 20$ the price is $300 - 5y = 200$, so the profit is

$\mathrm{TR}(20) - \mathrm{TC}(20) = (200)(20) - 2000 - F = 2000 - F$.

Thus the optimal output is

$$\begin{cases} 0 & \text{if } F > 2000 \end{cases}$$

$y^* = 20$ both 0 and 20 if $F = 2000$

$y^* = 20$ if $F < 2000$.

- If the firm is in business then the price is $p^* = 200$.

Notice that the optimal output is independent of F if $F > 0$.

Now suppose the firm has to pay a lump sum tax of T. Then its cost is

$$TC(y) = 100y + F + T \text{ if } y > 0$$

so that its marginal cost is exactly the same as before: $MC(y) = 100$. Thus the the output it chooses is not affected so long as the tax T isn't so large that the firm is better off shutting down---in this case, so long as $2000 - F - T > 0$, or $T < 2000 - F$.

Now suppose that the firm has to pay a fixed percentage tax on profit. Then it maximizes $(1 - t)pai(y)$ instead of $-(y)$, where t is the tax rate. Since t is a constant, the solution of this problem is exactly the same as the solution of the original problem of maximizing $-(y)$. Thus this tax has no effect on the monopolist's behavior.

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