Lesson: Externalities and Public Goods

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1. Hal R. Varian: Intermediate Microeconomics, A Modern Approach, 9th edition.
2. C. Snyder & W. Nicholson: Fundamentals of Microeconomics.

Learning Objectives:

The objective of this chapter is to explain

a) How the presence of externalities and public goods may lead to market failure?

b) How government intervention in terms of well defined property rights can help in achieving Pareto optimum allocation of resources in the presence of consumption externalities?

c) How different legal systems can lead to different distributional consequences for relevant economic agents even if each system leads to pareto optimum allocation of resources.

d) How quasilinear preferences can lead to unique efficient amount of externality producing good or public good?

e) What are the methods to achieve Pareto efficiency in the presence of production externalities?

f) What are the problems in determining ideal amount of public good?

g) How private provision of the public good may lead to the problem of free riding?

1. Externalities and their economic cosequences

Whenever actions of economic agents (producers and consumers) have effects which are not taken care of by the market system through supply and demand forces, we say that externalities have occurred.

Externalities are of two types: Positive and Negative.

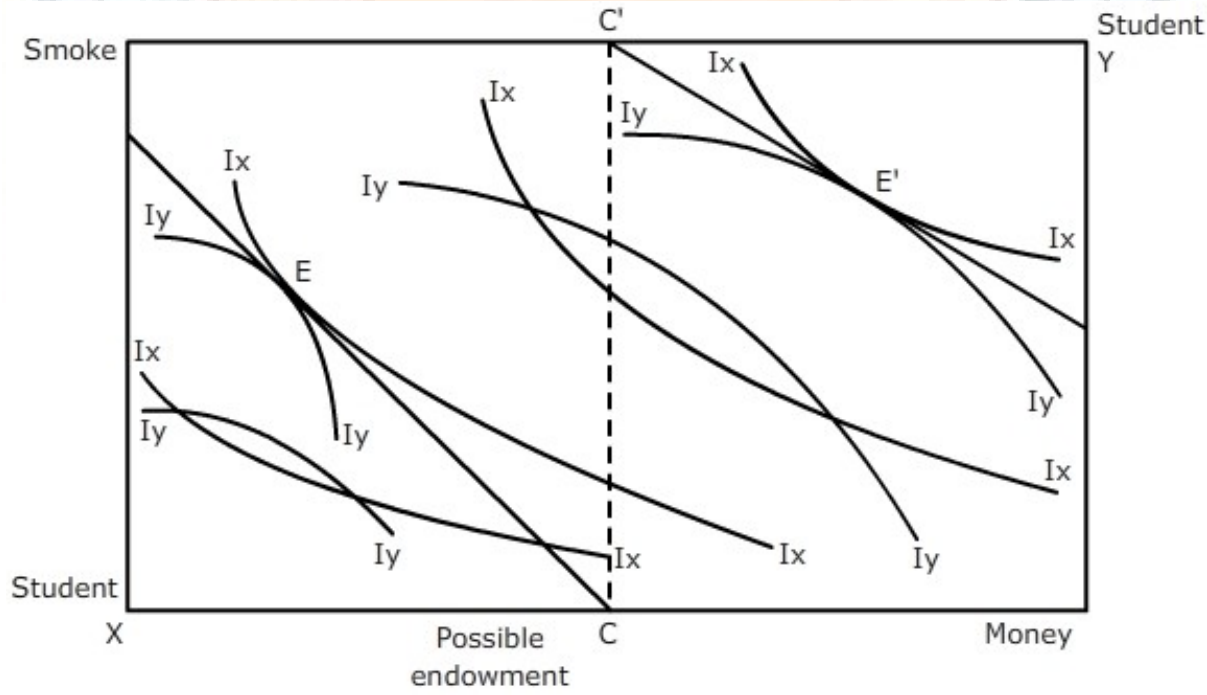
A positive consumption externality occurs if I do not have to pay anything and get some satisfaction from another person’s consumption e.g. I may enjoy looking at my neighbour's garden. Similarly, a negative consumption externality occurs if I am not being paid and get some dissatisfaction from another person’s consumption e.g. I may dislike the noise coming from neighbor playing loud music. The same type of positive and negative externalities can occur at the production level also.

Now having defined externalities we will try to explore the economic consequences of them. In the presence of externalities the market mechanism alone will not be able to achieve Pareto optimum (one person cannot be made better off without making the other worse off) allocation of resources. The government will have to intervene and supplement the market system to achieve Pareto efficiency. Now we will explain with the help of examples as to how Pareto efficiency can be attained through government intervention in the presence of externalities.

1.1 Consumption Externalities

Suppose there are two students X and Y sharing a room and two goods money and smoke. Assume that both X and Y like money but their preferences differ for smoke. X likes smoke but Y dislikes smoke.

Now we can depict the consumption possibilities for X and Y with the help of an Edgeworth box given below.



The length of the horizontal axis represents the total amount of money that X and Y have and the height of the vertical axis represents the total amount of smoke that can be generated. We have measured smoke on a scale from 0 to 1 , where 0 is no smoke at all, and 1 is smoke-filled room.

We measure X's money horizontally from the lower left hand corner of the box, and Y's money horizontally from the upper right hand corner. The total amount of smoke

is measured vertically from the lower left hand corner and the total amount of clean air (no smoke) is measured vertically from the upper right hand corner. The preferences of X are increasing in both money and smoke while preferences of Y are increasing in money and clean air.

Now after explaining the consumption possibilities and preferences of X and Y , we look at the initial endowments of money and smoke/clean air for X and Y.

The initial endowment of smoke/clean air depends on the legal rights of smokers and non smokers. It may be that X has a right to smoke as much as he wants, and Y just has to put up with it. Similarly, it could be that Y has a right to clean air and X just has to put up with it. Or the legal right to smoke and clean air could be somewhere between these two extremes.

Suppose Y has a legal right to clean air, then the initial endowment point will lie somewhere on the lower horizontal axis. Suppose it is point C, where X has (100,0) and Y has (100,0). It means that both X and Y have Rs 100 and there is no smoke. Now since Y has a legal right to clean air, so he also has the right to trade some of it for another desirable commodity that is money here. Now he will prefer to do so if his level of satisfaction increases after this trading. However for the trading to take place, X should also agree. He will agree if he also achieves a higher level of satisfaction by this trading. We can see that trading will take place until they reach the point E which is Pareto efficient as the marginal rate of substitution between money and smoke/clean air is same for X and Y at this point.

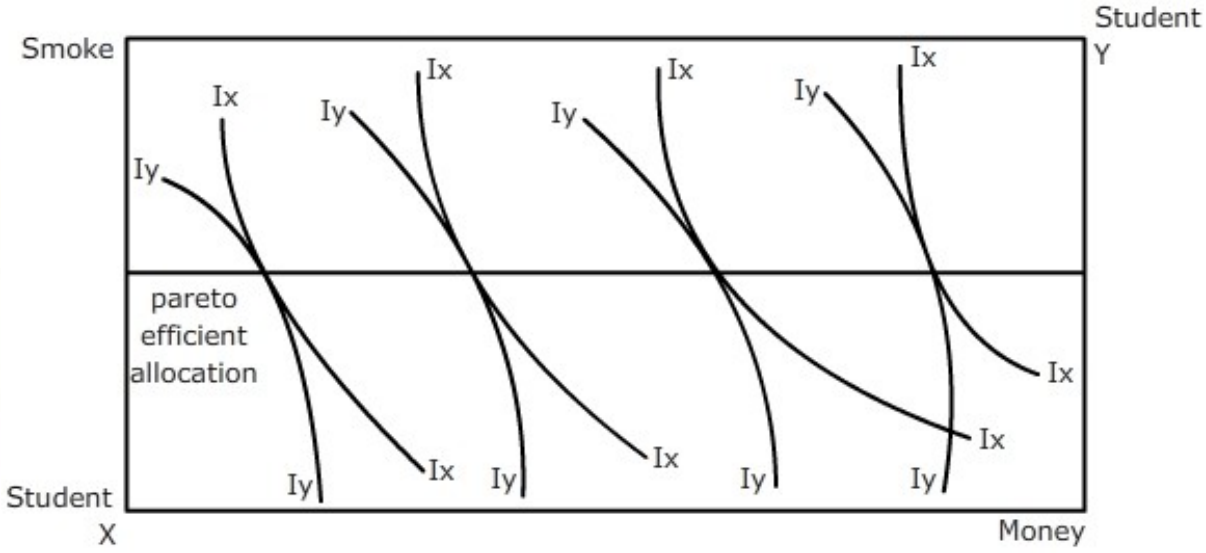
Now imagine another situation where X has a legal right to smoke, then the initial endowment point will lie somewhere on the upper horizontal axis. Suppose it is point C' where X has (100,1) and Y has (100,1). It means that both X and Y have Rs. 100 and there is smoke-filled room. Now X can trade some of its smoke for another desirable commodity that is money here. We can see in the diagram that trading will be beneficial for both X and Y until they reach the point E' which is Pareto efficient.

So depending on the prevalent legal system, we may have different initial endowment points of smoke/clean air which will lead to different Pareto efficient equilibrium points after trading has taken place. However, although both E and E' are Pareto efficient but their distributional consequences are different. X is better off at E' as compared to E and Y is better off at E as compared to E'.

In fact, there is no reason to limit ourselves to just these two efficient points. If there are well defined property rights – no matter who holds the property rights – and agents are free to trade both of these goods through price mechanism, they will end up

somewhere on this contract curve of Pareto efficient allocations of money and smoke.

Now we will show how quasilinear preferences can lead to unique efficient amount of externality producing good. Assume that the agents' preferences are quasilinear that is the demand for the good causing the externality does not depend on the distribution of money, leading to indifference curves which are horizontal translates of each other. In such a case every efficient solution must have the same amount of the externality i.e. the contract curve of Pareto efficient allocations of smoke and money will be a straight line parallel to the horizontal axis. The result that the efficient amount of externality producing good is independent of the distribution of property rights is known as Coase theorem. We can see in the diagram below that at different points on the contract curve we have different amounts of money being held by X and Y but we have same amount of externality producing good i.e. smoke.



Now suppose that property rights regarding production of externalities are not well defined, i.e. X believes that he has the right to smoke and Y believes that he has the right to clean air. In such a situation there will be inefficient production of externalities i.e. it will be possible to make both X and Y better off by changing the production of externalities i.e. smoke in our case.

1.2 Production externalities:

Now we will explain with the help of an example as to how Pareto efficiency can be attained in the presence of production externalities. Suppose there are two firms Iron and Fishery which we denote by 'I' and 'F' respectively. Firm I is producing a certain amount of iron which we denote by i and it also produces a certain amount of pollution which we denote by p. Firm I dumps pollution into a river which adversely affects the production of downstream located firm F.

Suppose the cost function of firm I is given by $C_i(i, p)$ where i is the amount of iron produced and p is the amount of pollution produced. Similarly the cost function of firm F is given by $C_f\ (f, p)$ where f is the amount of fish production and p is the amount of pollution produced by the firm I. We assume that pollution reduces the cost of iron production i.e. $\frac{\Delta C_i}{\Delta p} \leq 0$ and it increases the cost of fish production i.e. $\frac{\Delta C_f}{\Delta p} > 0$.Denote the price of iron by P_i,price of fish by P_f and price of pollution by P_p. Now firm I will maximize its profits by maximizing $P_i i - C_i(i, p)$ and similarly firm F will maximize its profits by maximizing $P_f f - C_f(f, p)$. It can be noted that firm I can choose the level of pollution that it will generate while firm F has no control over it.

Profits for firm I will be maximized when

$P_i = \frac{\Delta C_i(i^*,\ p^*)}{\Delta i}$

and $0 = \frac{\Delta C_i(i^*,\ p^*)}{\Delta p}$ i.e. $P_p = \frac{\Delta C_i(i^*,\ p^*)}{\Delta p}$

because price of pollution is zero from the point of view of firm I although it is negative from the point of view of firm F and from the view point of society.

Similarly profits for firm F will be maximized when

$P_f = \frac{\Delta C_f(f^*,\ p^*)}{\Delta f}$

In other words, profits will be maximized when the price of each good – iron , pollution and fish – is equal to their marginal cost. However, it will not be a Pareto efficient production plan since while making its production decisions firm I is ignoring the cost it imposes on firm F. The pollution created by firm I increases the cost of fish production and this increase in cost is a part of social cost of iron production which should not be ignored. So from the point of view of the society, firm I is producing too much pollution.

2. Methods to achieve Pareto efficiency in the presence of production externalities:

Now we will suggest ways as to how these two firms can achieve Pareto efficient production plan.

2.1 Mergers:

One way is to merge the two firms and form one firm which produces iron, fish and pollution. Basically, now there are no externalities as externalities have been internalized because this single firm will take into consideration all the interactions

between its different divisions and try to maximize the combined profits of all of its divisions.

The merged firm will maximize its profits by maximizing

$$P_i i + P_f f - C_i(i, p) - C_f(f, p)$$

In other words profits will be maximized when

$$P_i = \frac{\Delta C_i(\hat{i}, \hat{p})}{\Delta i}$$

$$P_f = \frac{\Delta C_f(\hat{f}, \hat{p})}{\Delta f}$$

$$0 = \frac{\Delta C_i(\hat{i}, \hat{p})}{\Delta p} + \frac{\Delta C_f(\hat{f}, \hat{p})}{\Delta p}$$

The last term indicates that merged firm will produce pollution until the sum of the marginal cost of pollution to firm(division) I and the marginal cost of pollution to firm(division) F is zero. This last term can also be written as

$$- \frac{\Delta C_i(\hat{i}, \hat{p})}{\Delta p} = \frac{\Delta C_f(\hat{f}, \hat{p})}{\Delta p} > 0 \quad (1)$$

because we have assumed that $\frac{\Delta C_f}{\Delta p} > 0$

It can be noted that when firm F and firm I were separate firms, then firm I produced pollution until the marginal cost of extra pollution to firm I was zero but after its merger with firm F it stops producing pollution when marginal cost of extra pollution to firm(division) I is less than zero. In other words less pollution is being produced after the merger.

2.2 Pollution vouchers:

Practically there will be more than one firm which will be producing pollution and dumping it into the river and it may not be possible to merge all the firms.Hence, even if we fix the total amount of pollution at some target level 'p', there still remains the problem of finding the most cost effective way to achieve the target since the cost of reducing pollution is usually different for different firms. Pareto efficiency can be achieved if marginal cost of pollution control is equalised across the firms. It can be shown that the market for emission permits will produce the efficient pattern of emissions automatically.

Assume that there is a large number of firms producing pollution in Delhi. Now initially we can fix a quota for each of these firms at e.g. 10% less than their previous

year's pollution level. Effectively we have given the right to pollute up to some fixed amount to each firm which it can use itself or sell. Obviously each firm will choose the profitable option. In equilibrium the market price of the right to pollute by a very small amount (marginally) would just equal the marginal cost of reducing pollution marginally as desired to achieve efficiency.

2.3 Pigouvian Tax:

Another way of achieving Pareto optimality in the presence of externalities is to put a tax of 't' Rs. per unit of pollution generated by firm I. Now to maximise profits, the firm will have to maximise

$$P_i\, i \; - C_i(i\,, p) - t\, p$$

Differentiating with respect to i and p respectively we get the following profit maximisation conditions:

$$P_i = \frac{\Delta C_i(i\,,p)}{\Delta i}$$

and

$$t \; = \; - \; \frac{\Delta C_i(i\,,p)}{\Delta p}$$

Comparing these conditions to equation (1) we find that if we set

$$t \; = \frac{\Delta C_f(\,\hat{f},\;\hat{p}\,)}{\Delta p}$$

we will be able to attain the Pareto efficient level of pollution. We call such type of a tax pigouvian tax. The problem with pigouvian taxes is that one must be knowing the optimal level of pollution in order to impose the tax.

2.4 Property rights:

Another way to solve the problem of production externality is to have well defined property rights for implementation of negative price for the output of pollution. Now suppose firm F has the right to clean water and can sell some of this right for money. Suppose P_p is the price per unit of pollution and p is the amount of pollution that Firm I produces. Now Firm I will maximize its profit if it maximizes.

$P_i\, i$ - $P_p\, p$ - $C_i(i\,, p)$,

And Firm F will maximize its profit if it maximizes

$P_f\, f$ + $P_p\, p$ - $C_f(f\,, p)$

The profit maximization conditions are

$$P_i = \frac{\Delta C_i(i\,,p)}{\Delta i}$$

$$P_p = -\frac{\Delta C_i(i\,,p)}{\Delta p}$$

$$P_f = \frac{\Delta C_f(f\,,p)}{\Delta f}$$

$$P_p = \frac{\Delta C_f(f\,,p)}{\Delta p}$$

Thus each firm is considering social marginal cost rather than private marginal cost while taking production decisions, so equilibrium will be Pareto optimum.

However, if iron firm has the right to pollute up to some amount '$\bar{p}$ ' say, then Firm I can maximize its profits by maximizing

$P_i\, i + P_p(\bar{p} - p)$ - $C_i(i\,, p)$

and firm F can maximise its profits by maximising

$P_f\, f$ - $P_p(\bar{p} - p)$ - $C_f(f\,, p)$

The profit maximization conditions remain same as in the case when firm F has the right to clean air. So attainment of Pareto optimality is independent of the assignment of property rights although distribution of profits will depend on the distribution of property rights. Firm F is better off when it has the right to clean water as compared to when firm I has the right to pollute up to some amount '$\bar{p}$ '. Similarly firm I is better off when it has the right to pollute up to some amount '$\bar{p}$ ' as compared to when firm F has the right to clean air.

3 **The tragedy of the Commons:**

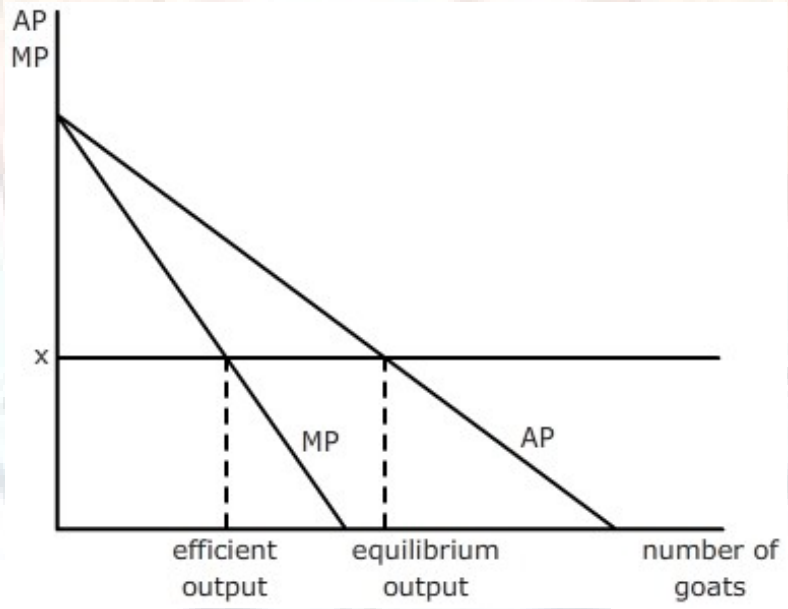
Suppose there is a common field on which the villagers graze their goats. Now we will compare two systems. One is that someone owns the field and decides how many goats

should graze there. Second is that the field is owned in common by villagers and access to it is free and unrestricted.

We denote the purchase price of a goat by x, the number of goats that grazed on the common by r and the value of the milk produced by r goats that grazed on the common by $f(r)$. So the average product is $f(r)/\ r$. Now the question is as to what is the optimum number of goats which should graze on the common land to maximize total wealth of the villagers. The answer is as usual i.e. one should equalise marginal product of a goat to its cost x.

Now if common grazing land were owned by someone who could restrict the number of goats, the above mentioned Pareto optimality condition will be fulfilled.

However, if the field is owned in common by villagers then the number of goats will increase up to the point where average product of goat i.e. $f(r)\ /\ r$ is equal to its purchase price x. This is fine from the point of view of an individual but not from the point of view of society as externalities are ignored. This argument can be explained with the help of following figure:-



The curve labelled AP is the average product curve. It is inversely related to the number of goats as we are assuming that output per goat declines as more and more goats graze on the common land. The curve labelled MP is the marginal product curve. Since AP is falling so MP will also fall and MP curve will always lie below the AP curve. So the number of goats where MP equals purchase price x will be less than the number of goats where AP equals purchase price x. So there will be too many goats to achieve Pareto optimality.

However, private property is not the only solution to achieve Pareto optimality. Government can form rules and implement them strictly to achieve Pareto optimality. For example, rules can be formulated and implemented about how many goats can be grazed on the village common.

4. Public goods and their ideal amount:

Now we will discuss a particular type of externality posed by public goods. Public goods are the goods which have both the characteristics of non exclusivity & non rivalry. A good is non exclusive if it is just impossible or very costly to exclude individuals from benefitting from the good once it is produced. National defense is a very good example of a public good. Similarly, a good is non rival if social marginal cost of consuming an additional unit is zero. For example the social marginal cost of one more car crossing a highway bridge during off peak hours is zero, because the bridge is already in existence and as one more car crosses, it requires neither additional resources nor reduces consumption elsewhere.

The biggest problem regarding public good is that everyone is provided with the same amount of good irrespective of one's preferences. Consider the example of national defence again. Once a particular level of national defence is established, every citizen is provided with the same amount irrespective of the fact that each citizen may value it differently. So although all citizens have different preferences and resources, they all have to reach some kind of agreement regarding the efficient amount of national defence.

Let us start with a very simple example. Suppose there are two colleagues X and Y sharing a room. They are trying to reach an agreement about the purchase of a TV. We will denote initial wealth of X by W_x, his contribution to TV by G_x and his money left over to spend on private consumption by C_x. Similarly, we will denote initial wealth of Y by W_y, his contribution to TV by G_y and his money left over to spend on private consumption by C_y. Now the budget constraints are following:

$$C_x + G_x = W_x$$

$$C_y + G_y = W_y$$

Next assume that the market price of TV is Z rupees, so in order to purchase the TV the following condition must be fulfilled:

$G_x + G_y \geq Z$

The utility functions of X and Y will depend on their private consumption i.e. C_x and C_y respectively and the availability of the public good(G) i.e. TV here. So utility function of X is given by $U_x(C_x, G)$ and utility function of Y is given by $U_y(C_y, G)$ where G will either be 1, indicating that TV is present, or O, indicating that there is no TV.

Now we introduce the concept of reservation price i.e. the maximum amount that a person is willing to pay to have a commodity and so is indifferent between having the commodity at that price and not having the commodity at all. It may be noted that a person's wealth will play an important role in determining the reservation price of each person. We denote by R_x and R_y the reservation price of TV for X and Y respectively. Then by the definition of R_x

$U_x(W_x - R_x, 1) = U_x(W_x, 0)$

i.e. the person is indifferent between having the TV at R_x with private consumption

$W_x - R_x$; and having no TV at all with private consumption equal to W_x. A similar equation holds true for Y i.e.

$U_y(W_y - R_y, 1) = U_y(W_y, 0)$

Now there are two types of allocations possible. One is ($W_x, W_y, 0$) i.e. there is no TV and both X and Y are spending their entire wealth on private consumption. The other is ($C_x, C_y, 1$) i.e. TV is provided and X and Y are spending $W_x - G_x$ and $W_y - G_y$ respectively on private consumption. Now an allocation is Pareto efficient if one person cannot be made better off without making the other worse off. If an allocation is Pareto inefficient, then we say that Pareto improvement is possible.

Now we will try to find out the conditions under which providing TV will lead to Pareto improvement. It will be a Pareto improvement if

$U_x(W_x, 0) < U_x(C_x, 1)$

$U_y(W_y, 0) < U_y(C_y, 1)$

Now using the definition of reservation prices R_x and R_y along with budget constraints, it can be shown that purchasing TV will lead to Pareto improvement if

$U_x(W_x - R_x, 1) = U_x(W_x, 0) < U_x(C_x, 1) = U_x(W_x - G_x, 1)$ and

$U_y(W_y - R_y, 1) = U_y(W_y, 0) < U_y(C_y, 1) = U_y(W_y - G_y, 1)$

Now since more private consumption must increase utility, we can conclude that

$W_x - R_x < W_x - G_x$

$W_y - R_y < W_y - G_y$

$i.e.\ R_x > G_x$

$R_y > G_y$

In other words, a necessary condition for purchase of the TV to be a Pareto improvement is that the reservation price exceeds the cost share for both X and Y.

Now, since $R_x > G_x$ and $R_y > G_y$ so, $R_x + R_y > G_x + G_y$ = Z. This is a sufficient condition for providing the TV to be a Pareto improvement. Since $R_x + R_y \geq$ Z, so we can easily find a payment plan (G_x, G_y) such that $R_x \geq G_x$, $R_y \geq G_y$ and $G_x + G_y$ = Z.

Now, we will show that distribution of wealth will play an important role in deciding whether or not TV should be provided. Since, reservation prices for X and Y depend on the initial distribution of wealth, it is quite possible that for some distributions of wealth $R_x + R_y <$ Z . Obviously in such a situation we cannot find a payment plan (G_x , G_y) such that $R_x \geq G_x$, $R_y \geq G_y$ and $G_x + G_y$ = Z. Hence, distribution of wealth will be an important factor in deciding whether or not the TV should be provided.

However, in specific cases the distribution of wealth may not be an important factor in deciding the provision of the public good. Suppose both X and Y have quasi-linear preferences i.e. their utility functions take the following form:

$U_x(C_x,G) = C_x + V_x(G)$

$U_y(C_y,G) = C_y + V_y(G)$

This means that marginal utility of the private good is always one, and thus the marginal rate of substitution between the private and the public good will depend only on the amount of G. In other words

$$|MRS_x| = \frac{\Delta U_x(C_x,G)/\Delta G}{\Delta U_x/\Delta C_x} = \frac{\Delta V_x(G)}{\Delta G}$$

$$\left|MRS_y\right| = \frac{\Delta U_y(C_y,G)/\Delta G}{\Delta U_y/\Delta C_y} = \frac{\Delta V_y(G)}{\Delta G}$$

However the level of the public good will be Pareto optimal if

$|MRS_x| + \left|MRS_y\right| = \text{MC}(G)$

where MC(G) denotes marginal cost of providing an additional unit of public good.

i.e. if $\frac{\Delta V_x(G)}{\Delta G} + \frac{\Delta V_y(G)}{\Delta G} = \text{MC}(G)$

It may be noted that this equation determines G without any reference to C_x or C_y. Thus there is a unique efficient level of production of the public good. In our case G will be either 1 if public good is available or 0 if public good is not available. We assume that $V_x(0) = V_y(0) = 0$. Now the definitions of the reservation prices become:

$U_x(W_x - R_x, 1) = W_x - R_x + V_x(1) = U_x(W_x, 0) = W_x$

$U_y(W_y - R_y, 1) = W_y - R_y + V_y(1) = U_y(W_y, 0) = W_y$

Hence, $R_x = V_x(1)$ and $R_y = V_y(1)$

implying that, reservation prices are not dependent on the amount of wealth so provision of public goods will also be not affected by the distribution of wealth.

Till now we have considered TV as a discrete good i.e. either have it or do not have it. Now we consider TV as a continuous good i.e. X and Y can have a better quality of TV by spending more money on TV.

Let G measure the quality of the TV and $c(G)$ denote the cost function for quality. This means that if X and Y want to buy a TV of quality G, they have to spend $c(G)$ Rs. to do so.

The budget constraint for X and Y combined is given by

$C_x + C_y + c(G) = W_x + W_y$

Now the quality of the TV will be optimal if the sum of the absolute values of the marginal rates of substitution between the private good and the TV for X and Y equals the marginal cost of providing an extra unit of the TV. However, when we considered TV as a discrete good, the efficiency condition was that the sum of the willingness to pay should be at least as large as the cost.

Now we can compare the efficiency conditions for a public good with that of a private good. Firstly, for a private good each person's marginal rate of substitution must equal the marginal cost while for a public good, the sum of the marginal rates of substitution must equal the marginal cost. Secondly, in the case of a private good each person can consume a different amount of the private good, but they all must value it the same at the margin while in the case of a public good, each person must consume the same amount of the public good, but they can all value it differently at the margin.

5. Private provision of the public good and the problem of free riding :

We have seen above that it will be Pareto efficient to acquire the public good i.e. TV here if the sum of reservation prices exceeds the cost of public good. However, it is not necessary that in a voluntary equilibrium they actually decide to acquire the TV. Acquisition of TV will depend on the particular method they adopt to make joint decisions.

If both X and Y truthfully reveal their preferences for TV then it will be quite easy to decide as to whether the TV should be purchased or not. However, in some situations X and Y may not correctly express their preferences for TV.

Suppose that for both X and Y the reservation price is greater than the cost of the TV. Now both X and Y may incorrectly reveal that their value for TV is zero thinking that the other one will unilaterally purchase the TV. This is the problem of free riding. We can explain it by attaching numerical values to our above example.

Suppose both X and Y each have a wealth of Rs.500, each values TV at Rs.100 and the cost of the TV is Rs.150. Obviously the sum of reservation prices is Rs.200 which is more than the cost of the TV which is Rs.150, so it is Pareto optimal to buy the TV.

However, in practice, it is very likely that the TV will not be purchased if X and Y independently decide whether or not to purchase the TV. Consider the decision of X . If he purchases the TV, he gets a benefit of Rs. 100 and pays a cost of Rs.150, implying a net benefit of Rs. -50.So he decides not to purchase the TV. Same holds true for Y.

Surely, if X purchases the TV and both X and Y watch it, then we can make a Pareto improvement if Y makes a side payment to X between Rs. 50 and Rs. 100. This is probably what would happen in this problem but situation becomes more difficult if there are more than two people involved.

In conclusion, we can say that in a voluntary equilibrium, the supply of public good will be less than the efficient level due to its characteristic of non exclusivity. So while we can depend on market mechanism for achieving Pareto efficient allocation of resources for private goods with no externalities, we will have to explore other mechanisms to achieve Pareto efficient allocation of public goods.

6. Mechanisms to achieve Pareto efficient allocation of public goods:

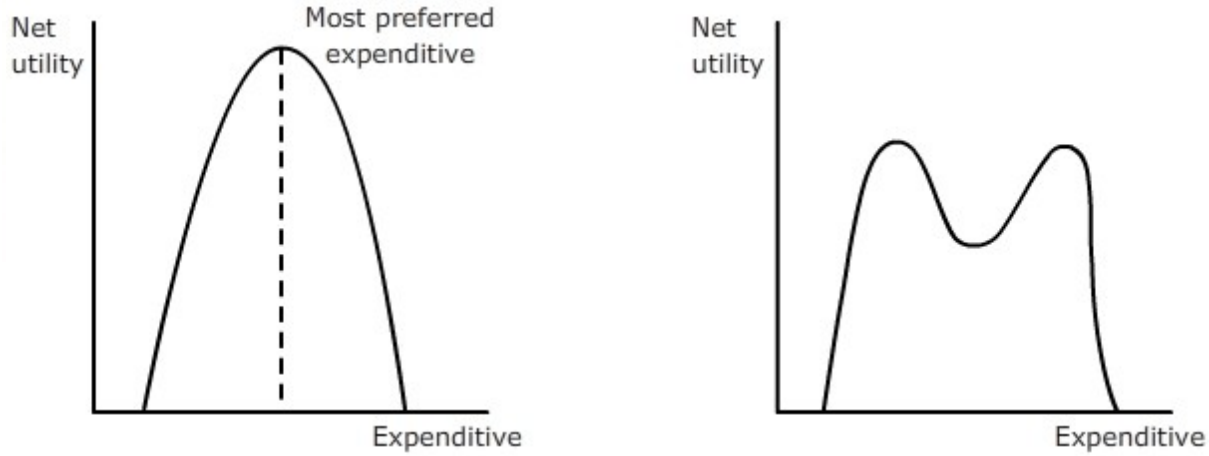
6.1 Voting:

Suppose there are N individuals and N is an odd number so there is no possibility of tie. These individuals are supposed to vote to reveal their preferences for different sizes of expenditure on some public good. We assume that each individual has a most

preferred level of expenditure and his ranking of other levels of expenditure depends on as to how close they are to his most preferred level of expenditure.

Now the first problem that may arise with voting mechanism is that preferences revealed by these individuals are non-transitive. Non–transitivity means that there is a majority of individuals who prefer A to B, a majority who prefer B to C and a majority who prefer C to A. Now we will show that it is possible to have any of the three outcomes by just changing the sequence in which alternatives are presented. Suppose we want C to be the outcome, then we ask individuals to first vote on A versus B and then on A versus C. Similarly if we want B to be the outcome, then we will ask individuals to first vote on C versus A and then on C versus B. Likewise if we want A to be the outcome then we will ask individuals to first vote on B versus C and then on B versus A. This type of possibility leads to manipulation.

To avoid non-transitive preferences, we assume that individuals have single peaked preferences i.e. net utility of different levels of expenditure on public goods rises until the most preferred point and then falls, as it does in Figure A; it never goes up, down and then up again, as it does in Figure B.



It can be shown that even if all individuals have single peaked preferences, even then the chosen level of public expenditure will not be necessarily Pareto efficient.

Voting will result in choosing the level of median expenditure i.e. an expenditure level such that 50% of the individuals want to spend more and 50% want to spend less but it does not say anything about how much more or how much less. However Pareto efficiency requires that this kind of information should be taken into account.

The second problem that may arise with voting mechanism is that individuals may not reveal their true preferences when they vote in order to manipulate the final

outcome. So there is a need to have some mechanism which motivates individuals to correctly reveal their true preferences about a public good.

6.2 Demand revelation:

Now we will discuss various methods that can be adopted for correct revelation of preferences by individuals with the help of an example.

Suppose neighbourhood association is considering developing a park. Assume that the cost of developing the park is Rs. 20,000. We denote the value that each person i places on the developed park by v_i. Now it is efficient to develop the park if the sum of these values is greater than or equal to the cost i.e. if

$$\sum_{i=1}^{n} v_i \geq 20{,}000$$

Now we will discuss various methods to decide whether to develop the park or not.

(a) One method is to ask each person as to how much they value the developed park, with the understanding that their share in cost will be proportional to their stated value, if the park gets developed. The problem with this method is that every person will have an incentive to free ride. As a result even if it was efficient to develop the park, the park would not get developed.

(b) Another method is not to relate money to be paid with the value that anyone places on developed park but just predetermine the amount to be paid if the park gets developed. Now we can show that everyone will have an incentive to overstate or understate the true value that one places on the developed park.

Suppose Mr X values the developed park more than the predetermined amount that he will have to pay if the park gets developed. Now Mr X will have an incentive to over state the value that he places on the developed park because that does not affect the amount that he will have to pay but increases the probability that the park will get developed. Similarly, suppose Mr. Y values the developed park less than the predetermined amount that he will have to pay if the park gets developed. Now Mr, Y will have an incentive to understate the value that he places on the developed park so that the probability of the park being developed gets reduced. In conclusion the ultimate outcome will not be necessarily efficient.

(c) The method that we will explain now was suggested by E. Clarke in the early 1970s. This method ensures that people will correctly reveal their true value for a public good using a kind of market or "auction" process. However, this method requires that preferences should be quasilinear, implying that there is only one efficient level of the public expenditure and the question is whether to supply it or not. In this method we ask each person about the value that he/she places on the

developed park with the understanding that he/she will have to pay a predetermined amount if the park gets developed. Let us denote the difference between person i's value 'v_i' and his or her cost 'c_i' by 'n_i' so that

$$n_i = v_i - c_i$$

Further let us use the term "pivotal agents" for persons whose reported valuations change the overall evaluation from negative to positive or vice versa. So any person might be pivotal. However, pivotal agents will have to pay a pigouvian like tax called Clarke tax. Now we will show the procedure to determine the amount of this tax.

When the social decision is changed, there will be some harm imposed on the other persons. Suppose the other persons wanted the developed park on the average, so that the sum of their net values was positive without person j, say, & person j made the sum go negative, then person j has imposed a total harm of

$$H_j = \sum_{i \neq j} n_i > 0$$

on the other people.

Similarly, if everyone else did not want the developed park on the average, so that the sum of their net values was negative, and j made it go positive, then the harm that j imposed is given by

$$H_j = - \sum_{i \neq j} n_i > 0$$

In order to give person j the right incentives to decide whether or not to be pivotal, we will just impose this social cost on him in terms of the Clarke tax.

The tax is not paid to the other agents- it is paid to the state. It does not matter where the money goes, as long as it does not influence anybody else's decision.

Problems with the Clarke tax:-

1. Clarke tax works only if preferences are quasilinear.
2. Clarke tax does not lead to Pareto efficient outcome because although the level of the public good is optimal, the private consumption gets reduced by the amount of tax collected from pivotal person which is not paid to the other persons.
3. Clarke tax creates the problem of equity and efficiency trade off. The Clarke tax ensures that Pareto efficient amount of the public goodwill be provided but it does not ensure the Pareto efficient way to pay for it i.e. a payment plan that makes everyone better off.

Practice Questions:

Q1. Define consumption externalities. Explain the economic consequences of consumption externalities with the help of appropriate examples.

Q2. Explain how government intervention in terms of well-defined property rights may lead to Pareto efficient allocation of resources in the presence of consumption externalities.

Q3. Suppose there are two legal systems with different property rights to solve the problem of consumption externalities. Show that both may lead to Pareto efficient allocation of resources but may have different distributional consequences.

Q4. Critically examine Coase Theorem with the help of an example.

Q5. What do you mean by production externalities? Critically examine any three methods to achieve Pareto efficiency in the presence of production externalities.

Q6. Explain with the help of an example as to how Pareto optimality can be achieved in the case of common goods.

Q7. Explain the role if distribution of wealth among relevant economic agents in deciding the ideal amount of public good.

Q8. How private provision of the public good may lead to the problem of free riding?

Q9. Critically examine voting as a mechanism to achieve Pareto allocation of public good.

Q10. With the help of an example show that Clarke tax will lead to correct revelation of preferences by individuals for public goods.