UNIT 2 WELFARE ECONOMICS AND ENVIRONMENT*

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2.0 OBJECTIVES

After reading this unit, you will be able to:

- distinguish between 'positive economics' and 'normative economics';
- define the concepts of 'efficiency' and 'equity';
- discuss the concepts of efficiency in 'consumption, production and product-mix' ;
- state the general form of 'social welfare function' with three of its major specific forms viz. utilitarian, Rawlsian and egalitarian;
- specify the efficiency conditions under which the social welfare function is optimised; and
- explain the criteria for 'policy evaluation' in terms of 'Pareto Improvement Criterion' and 'Kaldor-Hicks Compensation Criterion'.

2.1 INTRODUCTION

The previous unit presented a non-technical discussion of the links between the environment and economy. The unit also hinted towards the growing

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importance of applying economic analysis to environmental problems. Beginning with the current unit, we will undertake a more formal treatment of the links between the environment and economics. More precisely, we will try to understand the role of economists in designing environmental policy. In other words, we will explore the use of methods of economic analysis (by considering the concepts of welfare and micro economics), to identify and relate them to environmental problems for aiding the design of policies to correct or mitigate the same.

While we define 'welfare' more precisely later in this unit, for now, we shall use the terms welfare and well-being interchangeably. The purpose of all economic policy in general, and environmental policy in particular, is to increase social welfare. A course in environmental economics can thus be considered a course in applied welfare economics. With this background, we shall now turn to the field of welfare economics in this unit. Welfare economics, as defined by Baumol (1977), is the branch of economic theory which investigates the nature of the policy recommendations that the economist would make. Thus, several fundamental results from the field of welfare economics can be drawn upon while evaluating environmental policy decisions.

2.2 POSITIVE AND NORMATIVE ECONOMICS: DISTINCTION

Economics, and therefore economists, have two primary roles. First, economic tools can be used to explain the 'state of the world' or the happenings around us. In other words, economics answers the question of 'what is'? The use of economics to describe the state of world in the 'what is' perspective is known as *positive economics*. A key feature of positive statements is that they can be tested (in principle) using evidence. Alternately, economics can be used to explain 'what should be', or, how we wish the economy to allocate its resources alternatively for increasing the overall welfare. This alternate perspective is called *normative economics*. In other words, 'positive economics' is free of value judgement i.e. it is neutral in its approach. On the other hand, normative economics, attempts to *suggest* how the economy should function. It therefore inevitably involves defining what may be the 'best' way to do so. Hence, it entails making (often unverifiable) value judgements. These statements typically include words such as 'should', and 'must'. Often, normative statements can be rephrased to make them positive statements. For example, 'there should be a tax on pollution' could be rephrased as 'imposing a pollution tax would result in lowering of emissions'. The positive statement thus formed can be tested using economic theory and tools.

As stated above, environmental policy involves identifying the problem and correcting for environmental distortions. While the identification of the problem is in the realm of positive economics (i.e. in describing the problem), devising measures to rectify the problem falls into the territory of normative economics or analysis. The latter is because normative economics tries to answer what *kind* of government intervention would be required to achieve

the rectification of the problem. While different economists would typically arrive at the same conclusion regarding what the problem *is,* they may have diverse opinions on what the ideal solution *should* be, thereby offering different recommendations. In other words, positive analysis objectively observes, quantifies and characterises the behaviour of economic agents, while normative analysis identifies what policy should be pursued to achieve better welfare.

In general, an environmental problem can be viewed both from the positive and normative lens. For instance, a positive analysis of the climate change issue would entail measuring the effect of climate change on various sectors (e.g. agriculture and fisheries). More precisely, it could attempt the quantification of the observed losses in agricultural productivity and fishery yield due to climate change and also project under different scenarios value-neutral assessment of the problem. On the other hand, a normative evaluation of the issue would enable policy makers to answer questions such as: 'what action should be taken to mitigate the effects of climate change', 'when should the abatement policies be put into action', and so on. Normative analysis, thus, plays a significant role in spurring policy debates enabling policymakers to decide upon the future course of action. Policymakers (and, indirectly, the people who vote them into power) ultimately decide which policies to implement based on normative judgements. Some (hypothetical) examples of positive and normative claims surrounding environmental policies are presented in Table 2.1 below.

Table 2.1: Positive and Normative Statements

Concern	Positive	Normative
Human role in climate change	Human actions are largely responsible for climate change.	Humans should undertake mitigating actions to reduce the effects of climate change.
Cost of mitigating climate change	Abatement costs total nearly one percent of the forecasted global GDP in 2030.	The cost of mitigating climate change should be borne by developed nations.
Fertilizer subsidies	Subsidies for fertilizer use have resulted in poor soil quality over the years.	Fertilizer subsidies should be removed, and farmers should be encouraged to use natural manure.
Odd-even policy	The odd-even (road space rationing) policy has reduced pollution in Delhi.	The government is correct in introducing the odd-even policy on a permanent basis.
Petrol prices	If petrol prices increase, people will use more public transport.	Increasing petrol prices through a tax is a good idea.

2.3 EFFICIENCY

An allocation of resources is efficient if it is not possible to make anyone better off, without hurting at least one person in the economy. In simpler terms, an efficient allocation is a 'no-waste' allocation i.e. all resources have been fully employed such that any reallocation will necessarily involve the worsening of the position of at least one economic agent. Economic efficiency is characterised by efficiency in consumption, efficiency in production, and product-mix efficiency. These three conditions are discussed in this section of the unit for a two agent case for the reason that it permits a graphical analysis as is usually done to begin with in microeconomics. Its extension to multiple agent case could be made using methods like vector analysis which we shall keep outside the purview of the current unit.

2.3.1 Efficiency in Consumption

Given two individuals A and B, and their utility functions (assumed to be quasi-concave and differentiable), an allocation that satisfies the condition of consumption efficiency requires that the marginal rates of substitution for the two individuals be equal. That is, we must have: $MRS_A=MRS_B$. This means, in an Edgeworth box framework, the indifference curves of the individuals should be tangential to each other i.e. the slopes of the indifference curves must be equal at the efficiency points (as at point 'b' in Figure 2.1). If the condition is not met i.e. if the indifference curves are intersecting and not tangential, then it will be possible to increase one person's utility without hurting another person and such an allocation cannot be termed 'efficient' (point 'a' describes such an allocation in Figure 2.1). By drawing a line through all such efficiency points (i.e. allocation points where the above condition is met) we obtain the 'consumption contract curve' (the line CC in Figure 2.2) or the 'Pareto efficient frontier'. Further, by plotting the utility levels attained at the efficiency frontier, we obtain the utility possibility frontier (Figure 2.3). Note that the two points of origin viz. A_0 and B_0

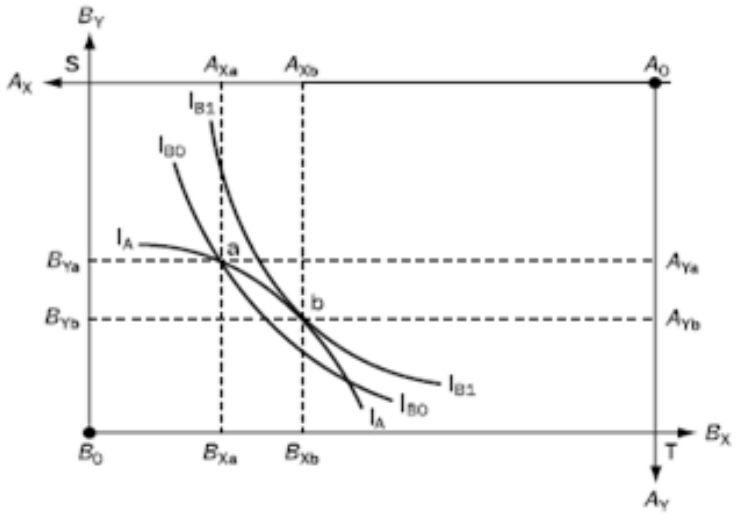

Fig. 2.1: Edgeworth Box and Efficiency in Consumption

Source: Perman et al., 2003 (page 107).

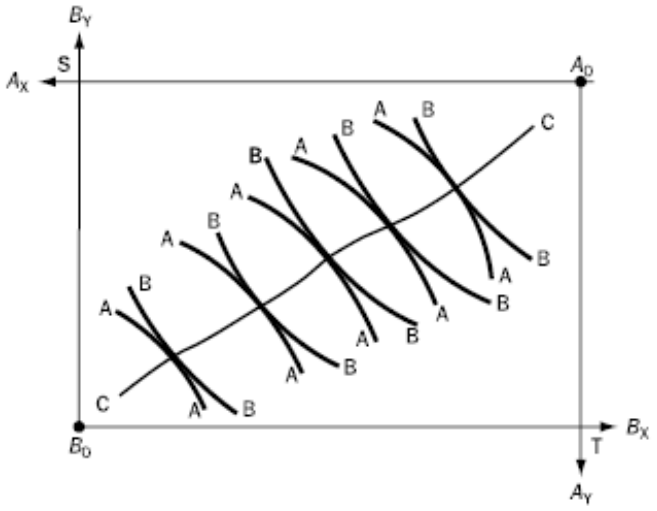

Fig. 2.2: Consumption Contract Curve

Source: Perman et al., 2003 (page 111).

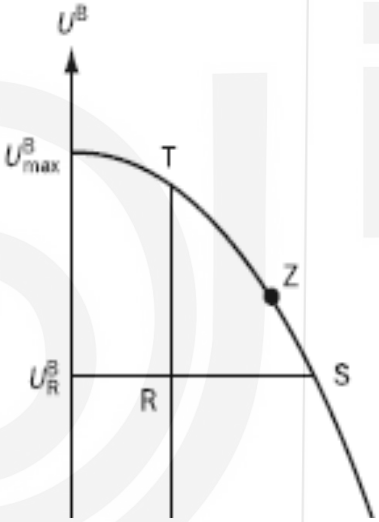

Fig. 2.3: Utility Possibility Frontier

Source: Perman et al., 2003 (page 111).

(in Figure 2.1) in the Edgeworth box lie on the contract curve. These are two special allocations, one where individual A has everything (A_0), and the other, where individual B has everything (B_0). Any reallocation from these two points necessarily makes one person worse off; hence these points are efficient.

2.3.2 Efficiency in Production

The condition for efficiency in production is similar to the one for efficiency in consumption (or exchange). Consider an economy which produces goods X and Y with a combination of inputs as capital (K) and labour (L). Efficiency in production requires that the marginal rate of technical substitution be equal in the production of both outputs. This means: $MRTS_X = MRTS_Y$. Graphically, we can again represent the condition as the point where two isoquants are tangent to each other in a production Edgeworth box. The production Edgeworth box along with isoquants and the

efficient allocation is illustrated in Figure 2.4. If the above equality condition is not satisfied, it would be possible to reallocate the inputs to increase the output of one of the goods, without reducing the output of the other good. The locus of all efficient allocations in the production Edgeworth box gives us the 'production contract curve', which if represented in the output space, is simply the 'production possibilities frontier' (shown in Figure 2.4 as the curve $X_M Y_M$).

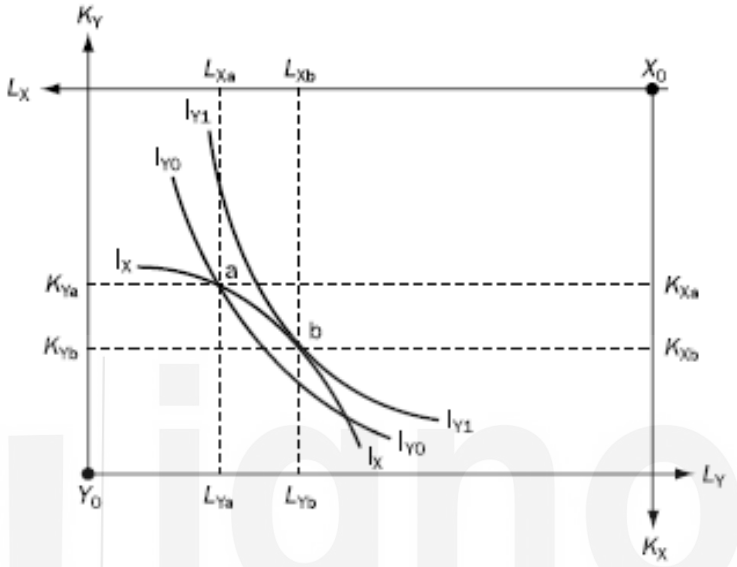

Fig. 2.4: Production Edgeworth Box and Efficiency in Production

Source: Perman et al., 2003 (page 108).

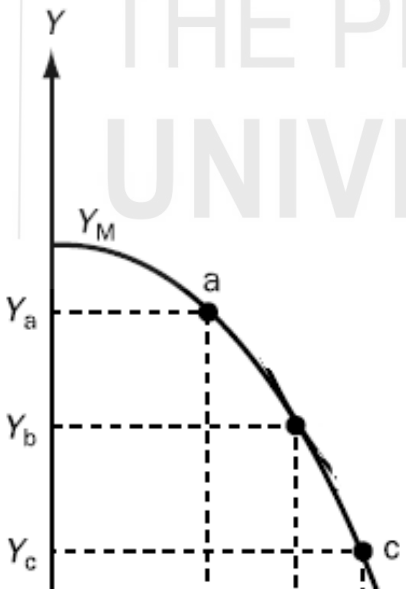

Fig. 2.5: Production Possibilities Frontier

Source: Modified from Perman et al. (2003), page 109.

2.3.3 Efficiency in Product-Mix

The product-mix efficiency condition is nothing but a combination of the above two conditions involving both production and exchange. Given the production possibilities frontier (PPF), the optimum allocation (i.e. the

product mix where the slope of the PPF equals the MRS of the individuals in the economy), is where we achieve product mix-efficiency. Let us define MRT_L as the increase in the output of Y obtained by shifting a small amount of labour from use in the production of X to use in the production of Y. Similarly, we shall define MRT_K as the increase in the output of Y obtained by shifting a small amount of capital from use in the production of X to use in the production of Y. Using these two quantities, the condition for product-mix efficiency can be specified as:

$$MRT_L = MRT_K = MRS_X = MRS_Y$$

At such an allocation, the economy is simultaneously satisfying the conditions for production efficiency, consumption efficiency and product-mix efficiency. This is called as 'a fully efficient static allocation of resources'. The allocation at which product-mix efficiency is being achieved is depicted at point 'b' in Figure 2.6. The locus $X_M Y_M$ depicts the production possibilities frontier where the slope is equal to the marginal rate of transformation (MRT) between goods X and Y. At the three points denoted by a, b and c (all points lying on the frontier in general) the production efficiency condition is being satisfied i.e. we have $MRTS_X = MRTS_Y$ at each of these points. The society's 'indifference curve' (denoted by the curve marked I in Figure 2.6), has a slope of $MRS^{A}_{X,Y} = MRS^{B}_{X,Y}$ at point b. Since the slope of the production possibilities frontier MRT can be rewritten as the ratio of the marginal rates of transformation of labour and capital, the above condition implies that at the point of allocation satisfying the product-mix efficiency, the slope of the production possibilities frontier (MRT) should be equal to the slope of the indifference curves of the agents (MRS).

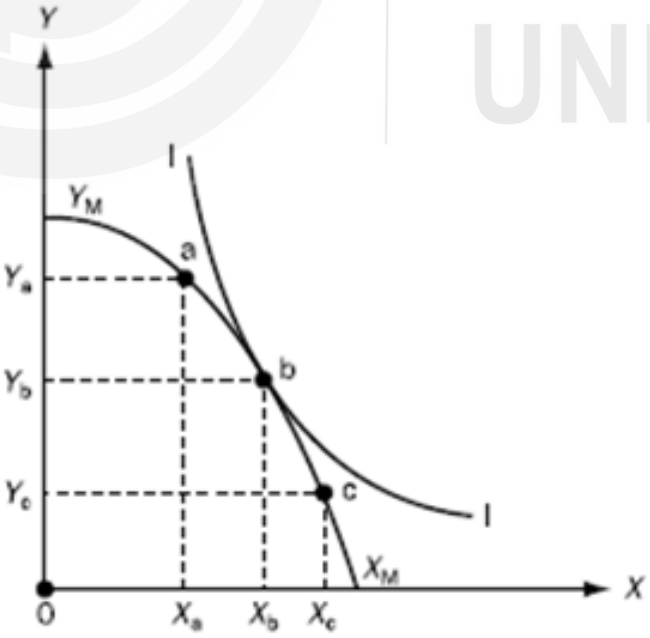

Fig. 2.6: Efficiency in Product-Mix

Source: Perman et al., 2003 (page 109).

Check Your Progress 1 [answer within the space given in about 50-100 words]

1) Distinguish between 'positive economics' and 'normative economics'.

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2) Illustrate the distinction in (1) above with an example.

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3) How is 'efficiency' defined? What are its three dimensions?

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4) How is a 'consumption contract curve' defined? Why is it also called 'Pareto efficient frontier'?

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2.4 EQUITY AND OPTIMALITY

In addition to efficiency, a desirable allocation of resources should fulfill the condition of *equity* as well. While no 'general' definition of equity exists, equity being a normative concept, it is often understood as 'fairness'. In the context of consumption and exchange, an allocation is considered equitable if no agent prefers another agent's bundle i.e. agent A does not 'envy' agent B's bundle. To take the simplest possible example, consider the two origins in the Edgeworth box. It was earlier explained that both these allocations are efficient. However, it is easy to see that these allocations are not equitable

because, at either of these two allocations, one agent has none of the two goods. Note that equity is not the same as equality i.e. an equal distribution of resources need not always be equitable unless the preferences of the two individuals are identical.

2.4.1 Optimality

Combining the two concepts of efficiency and equity we can get the notion of social optimality i.e. the maximisation of society's welfare. Naturally, if we are to maximise social welfare, we first need to define a function that represents society's welfare. This is clearly the 'aggregate social welfare function' representing society's aggregate preferences. Since due to Arrow's impossibility result this is not possible to achieve, to proceed further, we need the assumption that such an aggregation of preference is somehow possible. With this assumption, the social welfare function can translate the utility levels of all the members of the society to a number in such a manner that the welfare function gives higher values of utility to the more socially desirable functions (e.g. health and education). The social welfare function, $W = W(U_A, U_B)$ can take different functional forms, although the typical restriction on the function is that it should be non-decreasing in the utility of each agent. This means:

$$\frac{\partial W}{\partial U_A} \geq 0; \frac{\partial W}{\partial U_B} \geq 0$$

Some of the standard social welfare functions are:

a) Utilitarian (Benthamite): $W = \Sigma_{i=1}^{n} U_i$

b) Rawlsian: $W = \min \{U_1, U_2, U_3 \ldots U_n\}$

c) Egalitarian: $W = \Sigma U_i - \lambda \Sigma_i [U_i - \min_i U_i]$

The choice of a welfare function determines what the society considers desirable as the choice necessarily entail value judgments. Thus, given a utility possibilities frontier, the highest social welfare function that is tangent to it provides the social optimal (i.e. point 'b' in Fig. 2.7).

The locus WW is one of the 'level curves' of the social welfare function where its 'indifference curves' are assumed to be continuous and bowed inward. The tangency of the indifference curve with the utility possibilities frontier (i.e. the bowed out curve in Fig. 2.7) is at point 'b'. At this tangency, since welfare is maximised, all three efficiency conditions (i.e. consumption efficiency, production efficiency and product-mix efficiency) are satisfied. Further, the slope of the indifference curve and the utility possibilities frontier are equalised. Clearly, given the shape of the social welfare indifference curves, points 'a' and 'c' would not maximise welfare and hence are not optimal.

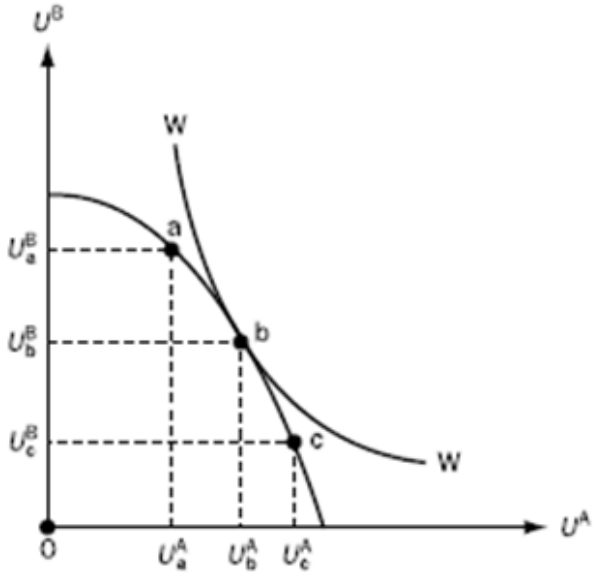

Fig. 2.7: Maximisation of Social Welfare

Source: Perman et al. 2003 (page 112).

2.5 ENVIRONMENTAL POLICY

The identification of the social welfare function (SWF) and the optimal allocations meeting the efficient conditions, ensures that the allocations are made in accordance with the social welfare values where a higher ranked allocation is chosen over a lower ranked one. This procedure, although is theoretically sound, pose problems in practice. First, as mentioned above, the construction of aggregate preferences is not straightforward. In addition, the choice of the specific form of the social welfare function being normative, guided by value judgements, one is prone to use methods of alternative allocations avoiding the need of referring to a SWF. In other words, in such situations, we would need criteria for evaluating alternative allocations. Towards this end, the present section discusses two criteria.

2.5.1 Pareto Improvement Criterion

The most well-known normative criterion, proposed by Italian economist Vilfredo Pareto, to judge whether a social change is 'welfare improving' is derived from the notion of Pareto efficiency. Recall that a Pareto efficient allocation is one where all mutually beneficial exchanges have been exhausted i.e. no one can be made better off without making someone else worse off. We can, therefore, define a 'Pareto improvement' as a change in which at least one person benefits with no one else losing. In Figure 2.3, a move from point R to point T, Z or S is a Pareto improvement since all these movements increases the utility of at least one agent without hurting anyone else. An important lacuna of this simple but restrictive criterion is that it is of limited practical use. Virtually all proposed reallocations would involve some 'gainers' and some 'losers' i.e. it is usually impossible for a policy to benefit everyone and hurt no one. In other words, the very need to evaluate policies arise from the fact that there will be always be 'winners' and 'losers' whose

relative gains and losses are exactly what is needed to be weighed and compared.

2.5.2 Kaldor-Hicks Compensation Criterion

The Kaldor-Hicks compensation test is a better approach which tests whether the total social benefits exceed the total social costs. It thus lays the foundation for the cost-benefit analysis methodology widely used in policy evaluation. The Kaldor-Hicks evaluation criterion, also known as the compensation principle, identifies *potential* Pareto improvements and postulates that a given change is welfare-improving as long as the winners (i.e. those who gain from the change) could, *inprinciple*, fully compensate the losers, and still be better off. The potential compensation (or transfers) from the gainers to losers need not *actually* take place. In other words, even hypothetically, if these potential compensation payments are transacted, they would leave everyone at least as well off as before, while some agents would be better off. Such compensations would therefore be 'unanimously better', and hence yield a Pareto improvement. The following example illustrates this concept.

Consider an economy with a factory (i) and a fishery population in a downstream to the factory location (j) ($j \neq i$). Let us say that currently factory 'i' is creating pollution by releasing toxins in a nearby river which is affecting the life of fishes or the profits from fishing. The government decides to impose a tax on the factory to incentivise it to reduce its effluent discharge. Suppose factory i loses profits amounting to x due to the tax, while all other fisheries ($j \neq i$) gain by this same policy (since the reduced pollution will allow the fisheries to earn higher profits). Evaluating such a change through the lens of Pareto optimality would lead to the conclusion that this policy should not be implemented. However, if the gain of all fishery agents ($j \neq i$) is *greater* than x, then these agents could (collectively) transfer the amount x to the factory 'i' leaving all the agents better off. This is thus a potential Pareto improvement and is called as the Kaldor-Hicks test. An important limitation of the Kaldor-Hicks compensation test is that considerations of fairness are not necessarily addressed. For instance, consider an illustration as in Table 2.2 where two alternative allocations, 1 and 2, of goods X and Y are shown with both the agents A and B having the same utility function $U = \sqrt{XY}$. The move from allocation 1 to 2 reduces A's utility and increases B's utility.

Table 2.2: Compensation and Fairness

Agent	Allocation 1			Allocation 2		
	X	Y	U	X	Y	U
A	100	25	50	100	16	40
B	25	400	100	225	256	240

In allocation 2, B can potentially transfer 9 units of Y to A making A as well off as in allocation 1, and leaving B better off. Such a move would therefore pass the Kaldor-Hicks compensation test. Note however that the actual

compensation need not take place and this reallocation has hurt the poorer of the two agents viz. A. In other words, the hypothetical compensation doesn't imply fairness and thus this evaluation criterion ignores the concern of distributional equity.

Check Your Progress 2 [answer within the space given in about 50-100 words]

1) What is a typical restriction on the 'social welfare function'? Why is it impossible to aggregate requiring us to make an assumption on this to proceed?

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2) Why is it generally difficult to pursue allocation option indicated by 'social welfare function'? What options are followed in such situations?

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3) What is meant by Pareto Improvement Criterion? What is its limitation?

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4) How is Kaldor-Hicks criteria superior to Pareto's Improvement Criterion? What is its limitation nonetheless?

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2.6 LET US SUM UP

Beginning with a distinction on the 'positive' and 'normative' concepts of economics, the unit introduces the concepts of 'efficiency, equity and optimality'. In the context of environmental policy considerations, since value judgements are involved and making a choice between alternative allocations is always involved (since adhering to the theoretical social welfare optimum is simply not possible in practical life), the concepts of Pareto Improvement Criterion and Kaldor-Hicks Compensation Criterion are discussed.

2.7 KEY WORDS

Welfare Economics : The branch of economic theory which investigates the nature of the policy recommendations that the economist is entitled to make.

Positive Economics : The use of economics to describe the world. It is a value-neutral analysis.

Normative Economics : The branch of economics that can be used to explain 'what should be'. It entails making value judgements.

Efficiency : An allocation of resources is efficient if it is not possible to make anyone better off, without hurting at least one person in the economy.

Equity : It is a normative concept, often understood as 'fairness'.

Optimality : At an optimal allocation, society's welfare is maximised.

Pareto Improvement : It is defined as a change where at least one person benefits, and nobody loses.

Kaldor-Hicks Compensation Test : This criterion postulates that a change is welfare-improving as long as the winners (those who gain from the change) could, in principle, fully compensate the losers, and still be better off.

Arrow's Impossibility Theorem : Arrow's result shows how aggregate preferences will be 'well-behaved' (i.e. complete, transitive and reflexive, and independent of irrelevant options), only under a dictatorship. In other words, the desired properties of a social welfare function cannot be achieved under a democracy. 'Aggregation' of individual preferences to construct social preferences is, thus, not a straightforward exercise.

2.8 SOME USEFUL BOOS AND REFERENCES

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2.9 ANSWERS/HINTS TO CHECK YOUR PROGRESS EXERCISES

Check Your Progress 1

1) It is difference between explaining a situation on a 'what is' basis (i.e. positive economics) and explaining the same in terms of 'what should be' basis, the latter an ideal or efficient situation (i.e. normative economics) for which policy intervention to rectify the anomaly or imbalance is required.

2) If the environmental distortion on account of loss to marine life is limited to its quantification and explanation, it amounts to limiting the approach to making an assessment on environmental damage. If the approach is advanced to indicate what mitigating steps should be taken to reverse the damage to establish normalcy or stability by a policy intervention it becomes the solution by a normative economist or a normative evaluation.

3) In simple terms, efficiency means using the available resources optimally. This means, no other economic agent can be made better off without making at least one other economic agent worse-off. The three

dimensions of efficiency relates to efficiency in: consumption, production and product-mix.

4) In a two person's case, the consumption efficiency is attained at the point where the indifference curves for the two individuals are tangential to each other. By drawing a line through all such efficiency points, the curve we get is what is called as the 'consumption contract curve'. It is also called as the 'Pareto efficiency frontier' because, at these points 'one person's utility cannot be increased without hurting the utility of the other'.

Check Your Progress 2

1) Typical restriction is that 'aggregation of preferences at the society level' is possible. The impossibility restriction comes from the Arrow's impossibility theorem which states that: the desirable features of a social welfare function are inconsistent with a democracy. In other words, individual preferences cannot be aggregated in a perfect manner to construct one social preference.

2) Firstly, construction of aggregate preferences is impossible. Secondly, due to normative judgements involved, one is compelled to seek alternative allocation options. In such situations, evaluation criteria becomes useful.

3) The criterion requires that one's improvement should not be at the cost of the other. But in practice, this can rarely happen as all allocations makes some to gain and some to lose.

4) Kaldor-Hicks criteria is better since it considers the 'total social benefits' exceeds the 'total social costs'. It considers the compensating potential of gainers to the losers even if the actual compensation does not take place. A limitation is that consideration of fairness or distributional equity is not met.

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