Energy Resources, Economics and Environment
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Lecture 11
Utility and Social Choice- Part 2

So now, the question is, individuals have different belief systems and then based on those belief systems they will have preferences and make choices. We now want to look at how we aggregate and make social choices from different individual values. So, what are the methods for making decisions about specific projects or regulations that have some adverse environmental impact, based on the individual preferences. Please remember, there are no restrictions on the individual preferences. Every individual can decide how he or she will choose between all the different options.

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So, let us put this in a set of different equations, let us say that there is N person society, there are N people okay, n people and let us say that there are, you know we talked of potatoes, onions, travel, air conditioning, a whole set of different goods, let assume a composite material good x, that material good has x1, x2, xm, different goods, good services okay, each individual is consuming all of this in addition to this.

So, there is an individual state of preferences, how many clothes, how much food, how much entertainment, all of this comes in this and then in addition to this will be e, e is the quality of the environment, this is remember this will actually have multiple attributes, we can talk about the air quality, we can look at particulate matter, we can look at global emissions in terms of CO2, we can talk about it in terms of the visibility.

So, it could be a the quality of water, the quality of the soil. Now, the idea is that this e, the x was dependent on every individual, so every individual would have a range of different values of x and would also have in the utility, some value for the environment, the environment quality is going to be common for all the n individuals, right. So, when we talk about the utility wellbeing of every individual.

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So there are two things, the composite good ‘x’, which has those m different components and the environment e and so each individual has a utility which is a function of xi and e. So, x1 e, x2 e and so on for each individual, there will be a utility function and then they will be n such utility functions okay.

Now let us look at when we look at, is it possible to substitute x for e, can we? If we consume more of x, if you are consuming more fossil fuels, there is going to be emissions, and so on. So, pure biocentrist will say that we do not want to have anything where any ecosystem or the species is getting, species biodiversity or any life is getting spoiled.

So, there will be no substitution for x for e. And in the case of extreme anthropocentrism, you would not want to give up anything in terms of your goods for the environment. So, you do not want to substitute any e for x, these are both extreme conditions, but in actual practice there will always be this trade off.

So, also remember, whenever we are talking of choices, we talked about the n individuals and their choices. However, the future generation and the utility that they will enjoy, right will also come into the utility function that means utility xi, e and the utility of future generations, where uj is the utility of person, j in a future generation and this is of course, makes it all that much more difficult.

And this is where now you have this whole situation where you have children coming up and opposing the governments in terms of the inaction related to climate change, you have Greta Thunberg telling world leaders that we need to think about the future and we do not have the right to spoil the choices for the future.

So, these are tricky things, but to in concept we think of, when we take the decision which is a long term decision, it is also the utility of future generations which is involved.

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So, we will now try to look at how do we choose between two bundles, there are two bundles of goods, two options A x dash e dash, where x dash is x1 dash, x2 dash, each of these x is x1 is for individuals one and it is the whole bundle of consumption goods that one, that that individual consumes and that has we said, it is a array of m different goods and services.

So similarly, so this is a composite good as we said, xn dash and e dash. This is one option, the second option is x double dash, e double dash alright, so the question is should we choose A or should we choose B? Should the society choose A or should the society choose B and what conditions should we choose? And the question is how do we generate a set of societal preferences over different bundles given individual preferences over the same bundles.

So, each individual will have a preference x1 dash and e dash, individual one has x1 dash e dash as compared to x1 double dash, e double dash, x2 dash e dash, x2 double dash, e double dash and here we are we will see under what conditions can we have a unanimous choice, under what conditions how will we have tradeoffs and what are the ways in which we can make these choices.

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So, this problem was first solved in a sense by Wilfredo Pareto, Italian economist who talked about the concept of Pareto optimality. And the idea was that we could get a situation where you cannot have an improvement where everyone benefits and so that become then you have the condition of Pareto optimality where there is no possible change where everyone benefits and everyone will be agreeable to it.

So, we look at the Pareto criterion is what he defined. This has found applications in many different fields and we will talk about it in the utility field.

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So, let us look at a situation, let us look at the graph, so what we have done here is we have simplified it, we talked about n individuals in the society, now we are looking at two individuals. So, we have A and B, and you have different combinations of in the case of W look at each point, each point is a combination of resources which gives us A's utility and B's utility.

There is a distribution of resources between A and B and this shaded region represents the feasible region of all possible combinations. So, when we compare W which with Z, you will find that A's utility for Z is greater than A's utility for W. So it is better off, A better off followed with Z, in the case of B also B's utility for Z is more, utility is more than that of W.

So, what we say is both A and B are better off and this Z is said to be Pareto preferred over W. Similarly, if you look at X and R, if you look at E and R, A's utility in X and A's utility in R are both the same, so as far A is concerned X and R are identical, but for B the utility for R is greater than the utility for X. So, for A is indifferent to this, but for B this is better so, this is also R is Pareto prefer to X.

When we now compare X and S, you find that A utility in S more than A utility, A's utility S is more than A's utility in X and Bs utility remains the same, again S is Pareto preferred similarly, Y, but if we look at this curve, you will find that this represents from this curve, there is no feasible solution of Pareto improvement. So, this curve represents the locus of all the best points which are Pareto prefer, this is also called the Pareto frontier. So, essentially we talk about Z being Pareto preferred to W and Y being Pareto prefer to X.

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So, in principle when we write this, we can talk about two consumption bundles, a dash being x dash and e dash and a double dash is x double dash e dash and the group of people i is equal to 1 to n with utility function defined over the consumption bundle.

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If for the group as a whole a dash is Pareto prefer to a double dash, that will mean that every individuals for every i, Ui of a dash greater than equal to Ui a double dash and for at least, at least one individual so, that means everyone is either better off or equal, it could be that all are equal, a dash is equal to a, a dash is equal to a double dash utility, at least for one individual the utility increases.

Then what we say is that a dash is Pareto preferred over a double dash, which means that everybody is at least as well off in terms of the utility and at least one person is better off with a dash then in a double dash, so the Pareto criteria will have unanimity, everyone will opt for a dash, everyone will opt for a dash, because they are either equivalent or they are better off.

So, this is the Pareto criterion and, of course, this is restrictive, it will be only in a very small subset of cases where you can have this where everyone is better off or they are in the equivalent situation and some are better off. So, for some it improves, no one gets affected, no one loses off in terms of the utility. There are many other situations where actually some lose and some gain and there is a modification which we try to do for which is called the Potential Pareto improvement.

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So, for instance in the case of X and if you look at X and R and we are moving from X to, if you look at the benefit that we are getting in terms of moving from X to Z, we are getting a benefit B's utility increases very significantly, A's utility decreases so, the question is the amount of increase that B has if B compensates A to account for the loss in utility that A has.

So that is compensated and based on that, this is equivalent at least equivalent for A then we can have a situation where A also okay with the new option and since B gets so much improvement in utility, they can transfer something back to A. So, that this is happening and this is the principle which is used for dams, when we talk about resettlement, we try to give compensation for to the people who are affected and with the result that the net

benefits outweigh the costs. And this is the whole concept of the potential Pareto improvement.

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So, in this what we do is we allow transfer of resources amongst the individuals to increase the unanimity of opinion regarding the option, so for instance, suppose 80 percent of the population prefer an option A to B, while 20 percent prefer B to A and according to the Pareto Criterion, we cannot say whether A or B is preferred.

But suppose the 80 percent can transfer significant resources to B and suppose the resources transfer is large enough so, that unanimously can be reached an option A. So, there is a compensation where B can agree that okay, we will go ahead and everyone agrees to do that.

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So, in order to do this, what we say is that in addition to x and e, we also have another resource y and this y could be something which is tradable, for instance money. So, that we are looking at a certain amount of y and we have transfers in y which are Zi that means, for instance, in the example that we had where A has a certain amount of money yA and B has an initial amount of money yB we transfers.

Since, A is getting, if you look at this graph, you remember sorry, B is getting most of the benefits. Let us look at this point when we look at B is getting most of the benefits, so what we do is B transfers money to A, so this will be Z. So, this becomes yA plus Z and this becomes yB minus Z. So, with the result that because now the initial thing was xA, e, yA now, it becomes xB, e.

The utility with this additional resource can be such that it is equal to the more than or equal to this. So, you transfer that much resource, so that these become equivalent and with the result that the utility of B is also increasing, even though it is transferring a certain amount of money, because it is getting so much additional benefit. So, if it is possible to do this such that the sigma of Zi is going to be equal to 0.

That means, there is no money or no additional resource coming from outside the system this resource is balanced within the system it is traded so that we compensate those whose utility is decreasing. And the individuals whose utility is increasing compensates this overall if you can do that, so that the utility of those who in the earlier case were not for the project, because their utility was decreasing.

Now their utility is remaining constant and it becomes after compensation, it becomes a Pareto preferred choice. So, then, that is the situation that we can look at. So, we look at the condition where we are comparing a dash y minus z is Pareto prefer to a double dash.

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We compare a dash y minus z to a double dash y and if a dash y minus z is Pareto preferred then we say that this is a potential Pareto improvement. So, this increases the options that we have and we compare two bundles as we said vector of transfers so that a dash y minus z is Pareto prefer to a double dash y then a dash is a potential Pareto improvement over y.

So, this is clear that we can compensate and in the compensation at the result of that, finally, every individual utility either increases or remains constant. Some of the individuals who had the utility increase more they transfer some resources, their utility, their part of that increase in utility shared with those who are losing out with the result that now there is unanimity. So, this is called the Potential Pareto improvement.

Now, the third situation is called the Kaldor Hicks Compensation Principle and this is a little controversial. This talks about the fact that if transfers could be made to achieve unanimity, that means if we can have a choice where we transfer from the gainers, some tradable resource to the losers, so that the losers utility remains constant with the result that there is a net gain and every single individual is okay with the project.

If that can be conceptually done, and it works, then the choice is socially desirable, even if the transfers are not equal actually meet. But this is highly controversial because in actual practice, when you look at individuals and societies, there is already a significant

amount of inequality and what is mentioned here is that if the project is such that it is possible to make these transfers then societally this project results in better utilities.

And the idea of equity compensation, links with the idea of equity is decoupled from determining whether the choice is a good idea or not, the choice is a good idea or not, if the hypothetically transfers could be made, and this would be then Pareto preferred even though the transfers are not made, so, this is a fine sort of argument, but in actual practice, this is what really happens in many cases.

We identify based on cost benefit, saying that compensation, even after compensation the profit, the project is profitable, but then we do not do the compensation. So, then there is this kind of issue and this is what often you know, this is the problem with the kind of economic, sometimes the economic calculations.

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Then another mode of choice is voting and voting means that every individual is asked to vote on the project and this rule does not need unanimity. So, it is more flexible than the Pareto condition but the majority rule cannot take into account intensity of preferences. So, often majorities may decide some things which may not necessarily be correct in terms of principles of natural justice. And so, now the next thing that we will look at is we will try to create some kind of a social indifference curve.

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We will look at the utility that we have for so, we would like to compare the society with a welfare function.

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Welfare function means there are n individuals. Each individual has its own utility u1, u2 to un, when we compare two different sets of preferences, where we look at two bundles, and a and b and we would try to see, we put a welfare function where we calculate the value of the utility for all the n individuals for a and the value of this utility for all the n individuals in b.

And if we say in comparing this, that this utility is greater than the you utility for b, then a is socially preferred to b, where W is called the Bergson Samuelson social welfare function. There are different ways of creating this social welfare function and there are many different function values.

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If you look at the Benthamite social welfare function, this is just a weighted average. So, we basically say, un we call this as theta 1 u1 plus theta 2 u2 plus and so on theta n un where theta i greater than or equal to 0, they are all positive. And we sum this up so, this is some weighted average, some weighted values, and we can decide what are these weights depending on this of course an Egalitarian function could be where we have equal weights.

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We can also try to see that we want to minimize the deviation from the, so you have this Egalitarian function which you can see here is the sum of ui minus ui minus minimum ui, so that the deviation from the minimum is we try to see that, we try to reduce the gap between the average value and the minimum value and this can be an Egalitarian social welfare function.

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John Rawls who was a philosopher and a thinker, said that utility function should be where we are maximizing the minimum utility of any individual so, the poorest individuals utility should be first maximize okay. So, with this we have, let us just take stock of what we have done, we have looked at this choices between environment and development.

We have looked at the philosophical basis and the perspectives, we looked at a few problems, few problem context and then we talked about the Pareto preference, the Pareto something being Pareto preferred and something where we can have a transfer and we can then use this with the transfer we can get a Pareto preferred option.

Then we looked at the Hicks Kaldur compensation principle. So these are three methods of choices Pareto prefer, Pareto compensation and then the Hicks Kaldur compensation principle. We then also looked at voting, after doing that, we then said that let us look at all the utilities and create a social welfare function where we get the welfare of the overall society.

Please remember, in actual practice these are all conceptual constructs by which we understand how we are making the tradeoffs. And it is difficult to construct some of these utility functions, but conceptually this is useful to us to understand what kind of tradeoffs and possibilities are there.

You may want to look at from your locality or your state or the context that you are familiar with, try to identify problems where we talk about energy and development and the environmental impacts, look at the kind of tradeoffs which are there, look at what kind of who are the stakeholders and how would you identify what are the kind of utilities.

And also think in terms of the value that we talked of e. How do we characterize and put one quantitative value to talk about the quality of the environment, that is a difficult task often, we are going to look at there is in the next module, we will look at the concept of Arrows theorem where he talked about the impossibility of social choice. We will talk about that and then we will move forward to define public goods and private goods.