Health Economics

Dr Pratap C Mohanty

Department of Humanities and Social Sciences,

Indian Institute of Technology Roorkee

Week – 06

Lecture 28- Prospect Theory

Welcome, scholars. Thank you for attending our course on health economics as part of the NPTEL. Here, we discuss the important aspects of behavioural economics chapters, specifically prospect theory. I am just recapping what we did and what we are targeting to do. We started the basics of behavioural economics in the previous lecture, and here we will discuss prospect theory, initially developed by Kahneman and Tversky in 1979. We will also emphasize the problems with the expected theory and the origin of this and their framing, certainty, reflection, and loss aversion effects. We will also discuss the editing and evaluation phases of the choice process.

We will also emphasize the discussion of value and weighting functions, and we will also discuss in-dominate status quo biases, as attached to existing theories. So, considering the work of Kahneman and Tversky on the aspect called prospect theory, both of them introduced the prospect theory in 1979; their famous paper was called Prospect Theory and analysis of decision on the risk, and it is also known as loss aversion theory because it points out that the fear of loss is greater than the satisfaction from profit. So, this theory criticizes the EUT, the expected utility theory that provides an alternative model and accounts for bounded rationality by relaxing the assumption of complete transitivity and independent preferences, which is used to take in the EUT theory or the expected utility theory. Choices among risky prospects exhibit several pervasive effects inconsistent with EUT theory's basic principles.

Prospect theory in psychology suggests that people will think about gains and losses and prioritize the potential value of losses and gains rather than the potential outcome while choosing from the possible alternatives. We are just comparing here the EUT and the PT, prospect theory and the expected utility theory and we mentioned already that the EUT is based on the rationality assumption and the rationality is again bounded as mentioned by Kahneman and Tversky and bounded rationality, which means that people with cognitive limitations and unable to make decisions consistent with completeness, transitivity and independence and that is discussed in the previous lecture. The prospect theory mentions that irrational human behaviour is influenced by various biases like risk aversion and risk-seeking behaviour, even at the same time. Three main biases are noted while understanding the PT or the prospect theory: certainty, reflection, and loss aversion. Then to count the

contribution of this theory, Daniel Kahneman received the Nobel Prize in 2002.

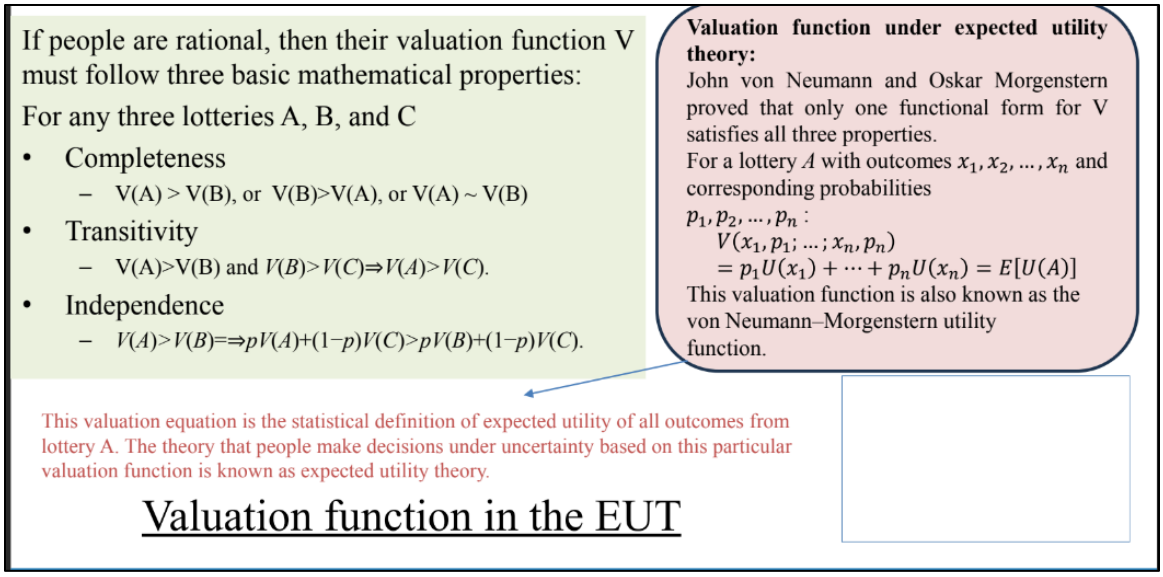
Unfortunately, Tversky passed away before 2002 and could not own the prize. So then, what is a prospect? Prospect is carrying with the probabilities with the choice function, and prospect is indeed a contract that yields outcome x_i with probability p_i, whereas the sum of the Pi should be equal to 1.

$$\sum p_i = 1$$

Then, the prospect theory, where the extent of risk is explained, and then what a riskless prospect is to be explained. What is riskless? A prospect that yields x with certainty and is donated by only x, whereas the risk prospect and decision-making under risk can be viewed as a selection between prospects or gambles or lotteries. So, prospect theories are presented through the valuation functions, how people value their contracts or the prospects.

So it is exactly mentioned as maybe for a lottery L, the value of L is equal to the value of those possible outcomes with their probabilities. So, if people are rational, then the valuation function, V, must follow the basic mathematical properties such as completeness, transitivity, and independence. So completeness as I told you primarily emphasizes or clarifies the extent of independent decisions, and that is basically when A is preferred to B or similarly, B is also preferred to A when a combination of prospects with their value or the value function which combines the prospects of A is preferred to A or the value of the prospect of B over A that means these two are independent that is called completeness of preferences. Transitivity, I think, need not be clarified, and so far as independence is concerned, once any prospect and the valuation is preferred, their combination is also preferred over or the expected value of those is also preferred over the other basket of choices. So, this is largely called the valuation function and the valuation function under expected equity theory is what is presented to you.

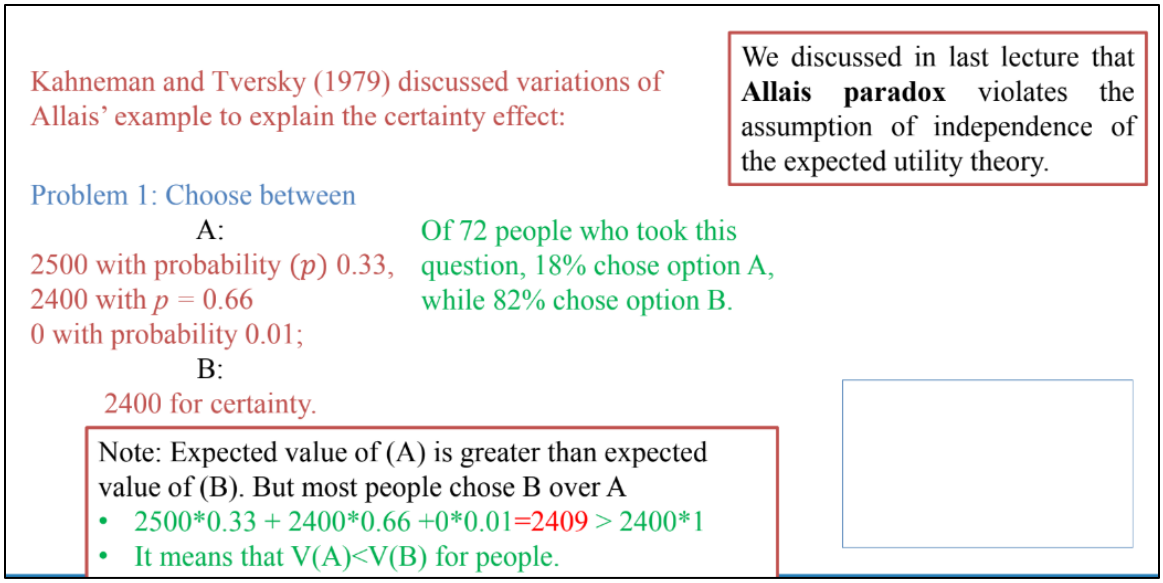
So, Neumann and Morgenstern proved that only one functional form for V satisfies all three properties we have just mentioned now, properties like completeness, transitivity and independence. This valuation function, which we have just said V is a function of this combination of or function of their individual outcomes with their respective probabilities when we say this and this through the typical Neumann and Morgenstern approach of presenting the expected utility theorem, this valuation function is also known as Von-Neumann-Morgenstern utility function. This valuation equation is the statistical definition of the expected utility of all outcomes from Lottery A, the theory that people decide on or on something based on this particular valuation function in the expected utility theory we have already discussed.



Some evidence that people make choices contradicts the EUT, which we already started discussing in the last lecture. Here, we discuss the contradictions based on the possible prospects. We will also clarify each of them with some examples, starting with misjudging probabilities, then framing, then loss aversion, then within misjudging probability, there are two maybe overvaluing certainty that means certainty effect is noted or overhauling small probabilities. I will clarify just now. Other categories in the case of loss aversion are endowment effect and importance reference points we will clarify. We will start with the overhauling certainty, which we have just said. So, overvaluing certainty is where the irrational decision-making might be due to a misestimate probability of risk.

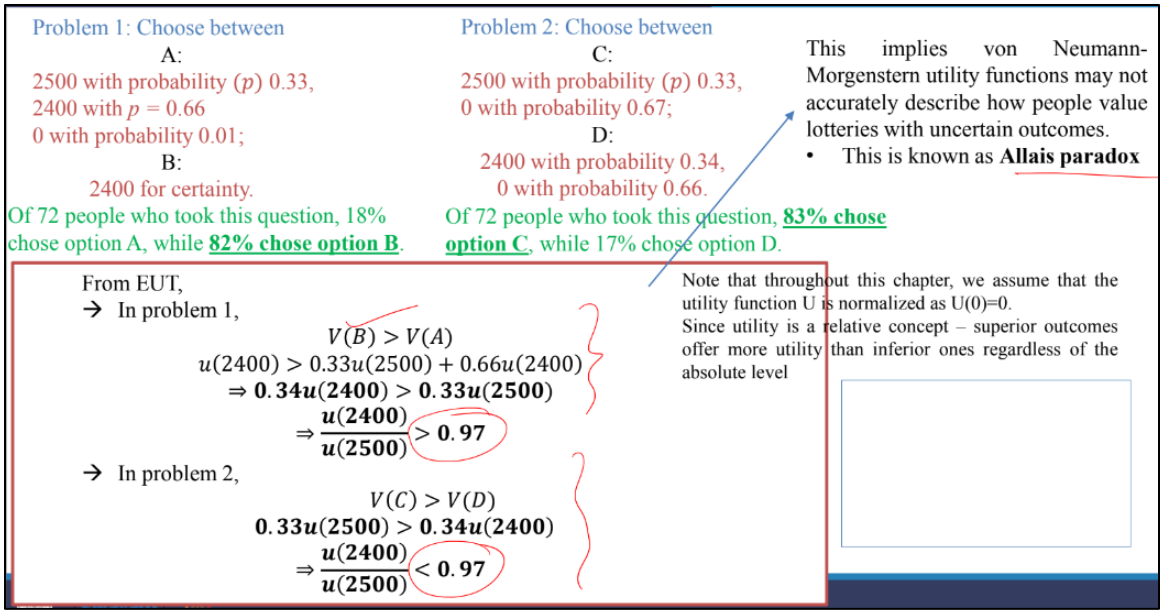
Kahneman and Tversky show that people's stated preference violates rationality even if true probabilities are known. Overvaluing certainty is where people may overweight outcomes that are certain to uncertain outcomes. So I will also give you examples like the two cases where the certainty is there, but the expected outcome is even higher than that, but still people prefer the certainty ones. So, that indicates certainty effect. This is a best-known counter-example to the expected-equal theory that explored the certainty effects, as we mentioned for the case of Allais's 1953 example.

We can also revisit and explain. You can just see it here. This is where we are going to explain the Allais paradox as well. Kahneman and Tversky discuss variations of Allais's example to explain the certainty effect. So here in the problem 1, there are two cases.



One is in case A, you will see 2500 is the outcome with a probability of 0.33 and another 2400 outcome with a probability of 0.66 and 0 with a probability 0.01. In case B, we have 2400 certainty, and the outcome with certainty is 2400.

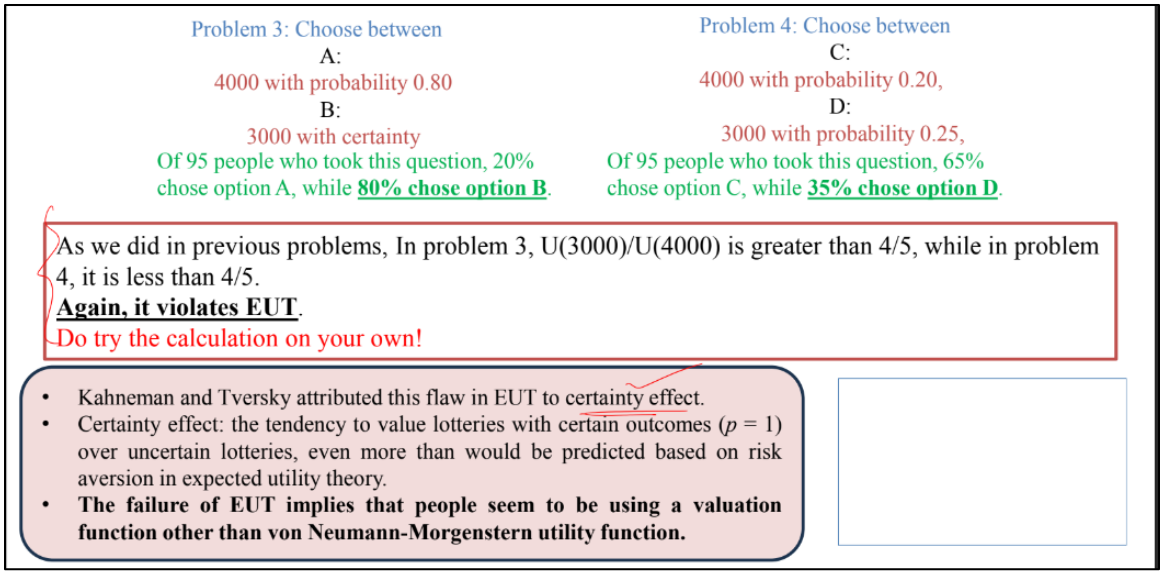
It has been observed that out of 782 people who took this question, only 18 percent chose option A while the 82 percent chose B because of the certainty. You can just see what really happens so far as the expected utility is concerned. In the first case which is case A, the expected utility is even higher which is 2409, which is higher than that of case B, but in the case B it has certainty indications that it has no probabilities or the probabilities 1. But because of the certainty effect, the preference is higher for case B. This means that the valuation for A is less than that of B, which the people value. Even if the expected utility differs, we present another case 2. In case 1, we have already said that 82 percent chose option B. We present another problem where both cases are attached with certain probabilities. So far as the return is concerned, in the case C, you will find 2500 with a probability 0.3, whereas in case D it is 2400 with probability 0.34. So, however, if you just check this, out of the 72 people 83 percent choose option C as against only 70 percent for D. So, I will just calculate the valuation function based on Tversky and Kahneman. You will see what really happens.



And then the problem 1 case, we have already mentioned the valuation is higher for the case B. This is what we mentioned. In problem 2, the reverse is noted. Even if the respective utilities ratio are the same in both cases, the choices are different, just the reverse. Here, C is preferred with less probability, and D is against it.

But you just see what happens when we take; we just we need to note that throughout this chapter we assume that the utility function, we need to first note that the utility function is normalized throughout; otherwise, it is difficult to compare different contexts. And since utility is a relative concept, superior outcomes offer more utility than inferior ones regardless of their absolute level. From this example, and we have seen that the expected utility function may not accurately describe how people value lotteries with uncertain outcomes. So, with uncertain outcomes, people are highly confused, and their views do not signal how the reverse preferences are taken in a general context. So, this is how is called partly discussed for case A is even if this is higher than this is greater and this is lesser, but the choices are different.

This is precisely called an Allais paradox. Here in problem 2, another two problems we are just citing for your reference, we are just mentioning you can calculate and explain. These kind of questions might be there in your assignment. So, I am just keeping for you to go through. However, I am just giving you directions.



Kahneman and Tversky attributed this flaw in EUT to the certainty effect which we have started explaining. That means people have a certain rigidity in mind when going for the outcome with a certain degree of certainty. The failure of EUT implies that people seem to be using a valuation function other than the expected utility function as proposed by Neumann and Morgenstern. So, we have already mentioned these details in the previous lecture as well as per problem 3 and problem 4, you can just see I am not explaining much. We have already said that this violates EUT.

You can try on your own. So, coming to problem number 5, another case is the case of overvaluing small probabilities. That is very interesting to note, identified rightly by those authors as part of the explanation of prospect theory. They compare with what is called the actual probabilities as against the perceived probabilities. There are some tendency of the people to perceive the probability differently. Like when we have zero probability, you see like in this example, 5000 with probability 0.001, which means the outcome is with certainty is there, the probability is very less and zero with the probability with surety is there that is 0.999. You will get a zero outcome, which means you will get an outcome with a higher probability. Another case is like 5 with certainty. People choose largely with case A or option A which is 721 only because this has a guarantee, which has given a higher guarantee with very small probabilities.

Problem 5: Choose between

A:

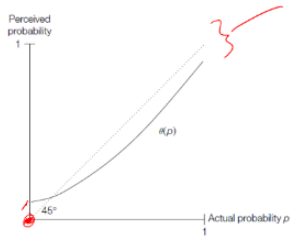
5000 with probability 0.001

0 with probability 0.999

B:

5 with certainty

A is chosen by 72% people and B by 28%



Perceived probability and actual probabilities according to Kahneman and Tversky (1979)

People seem to systematically overweight very low probabilities and underweight medium and large probabilities.

- Schoembaum (1997): **light smokers overestimate** their mortality risk; **heavy smokers underestimated** their risk.

Misjudging Probabilities: Overvaluing small probabilities

So, when the actual probabilities are close to zero, you can see from the 45-degree line that the actual probability is very close to zero; people do not put it as zero. People say that it has a higher probability because when it is zero, as if the probabilities will be very low and surety is there, they take the risk. So, people seem to systematically overweight very low probabilities and underweight medium or large probabilities. Once it extends a certain level of probabilities, they start giving higher value or giving underweight sorry, underweight, over at the lower probabilities and underweight the medium and large. And this diagram clarifies the difference.

At the zero level, it is higher; at other levels, you will feel the difference. One typical example is given in the context of the person who used to smoke. The chances of smoking and its outcome is expected to be catastrophic. Those who have just started or at the beginner level or just taking very few time frequency of smoking usually overestimate the probability of this event happening or the mortality or the risk. So maybe those who are starting with this or the light smokers overestimate their mortality risk, whereas the heavy smokers, once they are habituated, in between they might have derived a certain perceived understanding.

Since this is not creating any trouble, they also predict that with heavy smoking it is not going to create any problems. Hence, heavy smokers underestimate their risk. This is another example I think you can apply in our work. So, this was referred to by Kahneman and Tversky, the original writing in 1979, differentiating perceived probability and actual probabilities. This is precisely called overvaluing small probabilities.

Another is called framing. In expected utility theory, final outcomes are all that matter. What frame you make and, finally, what you get really matters. In prospect theory, however, it is presented differently. It is presented as how a final state is reached that really matters. I mean state and the process really matter.

Like in EUT, expected utility theory, if you are given 50 dollars directly or first given 100 dollars then taken back 50 dollars, both ways give equal utility. In this framework, these two situations are equivalent. However, in the case of prospect theory, these are not the same. Framing of a problem can affect the perception of how valuable is choice. Giving and taking are not the same activities or do not have the same choice or preference function so far as prospect theory is concerned.

Another is called to explain this; it is called isolation effect. How far the things you have already perceived and possessed are getting isolated from you, you might give higher importance to that position. Different decompositions of a pair of prospects into common and unique components can result in varied preferences. This phenomenon is known as the isolation effect. This highlights how diverse decomposition may yield different outcomes.

The isolation effect implies that the contingent certainty of the fixed return enhances the attractiveness of this option relative to a risky venture with the same probability and outcome. So, the isolation effect occurs when people are presented with two options with the same outcome, but different routes to outcome are important. In this case, people are likely to cancel out similar information to lighten the cognitive load, and their conclusions will vary depending on the options they have been framed. So, others are like representation, whether through a standard representation or a sequential representation.

We are presenting here a problem. Here is a problem called problem 4 through a two-stage game. So, the first stage has a probability of 0.75 to end the game without winning, and the probability is one-fourth or 0.25 to move to the second stage.

If it is there, it has a sequence. If the sequence follows with other probabilities, like in the second stage, we have a probability of 8 to win 4000 or 0 with 20 percent probability, or there are two sequences; the first is this, and the second is to win 3000 with certainty. In this two-stage game, winning 4000 has what is the probability then? You can just see in the first stage, the second stage, we started with backward counting, like 4000 with 0.8 probabilities. Since the person has opted for the second stage, the person who might have taken the game must have entered the first game; the probability of ending the game without winning means 0.75 person has closed in the first case. So the person has entered the second stage with the probability of this, which means this has to be taken. So this is included 0.25 times 0.8, so 0.8 is here. So, the joint probability is 20 percent to win 4000. And to win 3000 again, 0.25 is there, and the second stage has no probability. So that means 0.25 times 3000, the second one is 0.25, and the second stage has probability 1. So, 0.25 times 1 to get that 3000.

Representation: Standard and Sequential

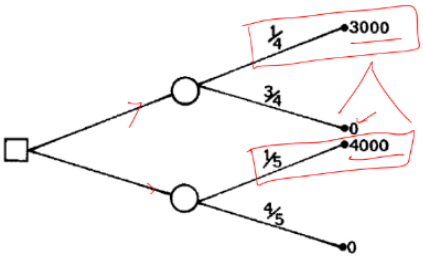
Problem 4*: Consider a two-stage game (from problem 4).

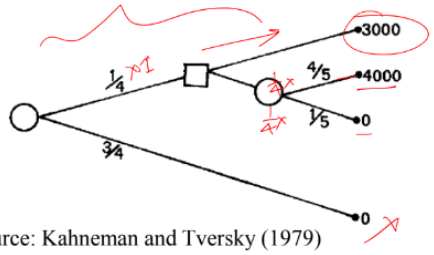
- Stage 1: probability (0.75) to end the game without winning anything, and a probability (0.25) to move into second stage.
- Stage 2:
  - probability (0.8) to win 4000 or 0 with prob (0.2)
  - Win 3000 with certainty.
- In this two-stage game, winning 4000 has (0.25*0.80 =0.20) probability to win.
- To win 3000, there is chance of (0.25*1=0.25)

- This shows how choices may be altered by varying the representation of probabilities.

Hence, for the second case, the probability is 0.25. This shows how choices may be altered by varying representations of their probabilities. Here, we are just presenting the sequential aspects. As it follows, you can see the nodes present differently, giving direct possibilities to the second phase, whereas this has a choice function. In the first one, again, to get 3000 as the outcome, you have one-fourth probability and three-fourths probability or 0.75 probability to get 0 as the outcome. And whereas in another case, you have a one-fifth probability, that is 20 percent probability of getting 4000, and a four-fifth is 0. So, decision-makers face a choice between these two prospects. Two prospects are independent to each other. In problem 4, most people choose 20 percent probability of getting 4000 as the outcome because it is very clearly paying more because this is the one, whereas 25 percent probability to get 3000 is not one rather, this is preferred in this. Coming to the sequential formulation in another form is how if one-fourth, there are two stages.

This is actually with surety 3000 received in the second stage, which means one-fourth of 1 to get this or to this is, in any case, is not obtained since 0 is the outcome. So, one is actually following this. If this is the case again in the second stage, this time one-fourth times this or to get this and or one-fourth times one-fourth to get this. So, by comparing all these possibilities, one will conclude. So, two prospects are, in this case, actually dependent.





Picture Source: Kahneman and Tversky (1979)

Standard formulation of problem 4

- Decision maker faces a choice between two risky prospects
- Two prospects are independent
- In problem 4, most people chose (4000, 0.2) prospect

Sequential formulation of problem 4

- Decision maker faces a choice between risky and riskless prospect
- Two prospects are dependent

Certainty advantage → choses (3000) prospect

So, the decision maker faces a choice between risky and riskless prospects, and two prospects are dependent because the probabilities on the first and the second are actually dependent on each other. So, yes, the certainty advantage is there in the case of the choice function. So they chose 3000 with certainty, and then we also presented how certainty is usually preferred in our previous case. So another aspect is called loss aversion. So far as we assume, people are either less risk-averse or less seeking or neutral.

They are both at the same time they might be risk averse as well as they might be risk-seeking. So, it has a link with their endowment and status quo. So, if it connects to the endowment, the tendency of people to attach greater value to a loss of a given amount than to an equivalent gain. If they are losing something, they give more because they have an endowment effect and have already been attached to that product. So, if you are still giving an equivalent amount, people may not give more weightage.

Status quo, where effect suggests a tendency of people to prefer the current situation and to be resistant to the change. So whatever was there they already perceived, they already reached, and they prefer to reach that level only. That is part of the status quo. Reference points are necessary to discuss utility gains and losses as outcomes may differ with changes in reference points.

Of course, it matters where you start. So, the way it is presented or represented matters. So, there are two ways of presenting the prospects. One is called a positive prospect and a negative prospect. Like if you present the persons with their positive effects, they are getting the returns in; positive, they are actually preparing the certainty 80 percent of the people out of the 95 people in total prefer certainty without any with this is probabilities and probability attached with case A as against case B.

So they prefer case B, where positive values are given. If the reverse is just given, then you

are supposed to get an outcome with a loss of something against another loss. So people prefer just the reverse if another case C and case D are presented but the presentation is through a loss. So you can just compare this as against this.

	Positive Prospects			Negative Prospects	
Problem 3:	(4000, 0.80) < (3000)		Problem 3':	(-4000,0.80) > (-3000)	
N = 95	[20%]	[80%]	N = 95	[92%]	[8%]
Problem 4:	(4000, 0.20) > (3000, 0.25)		Problem 4':	(-4000, 0.20) < (-3000, 0.25)	
N = 95	[65%]	[35%]	N = 95	[42%]	[58%]

The preference reversal happens between negative prospects and positive prospects. *(Reflection of prospects around 0)*

→ **Reflection effect**

It is just the reverse. So they do not want to lose certainty. They are least preferred if there is a certain amount of loss somewhere. Similarly, this one is 65 percent preferred in other cases, whereas just the reverse is noted here in case of negative prospects. I think I have already discussed this, and this is also called a reflection effect when something is reflected or presented in a mirror image, but the choice function just gets reversed. And the replacement prospects are around zero, so zero means from positive or negative sides.

So, we have already discussed this. I think you can go through and find out how some people are both risk averse as well as they are seeking from the example as well. Coming to the prospect theory in terms of some phases, it is called the editing phase or evaluation phase. Hence, decisions are taken accordingly. The editing phase consists of a preliminary analysis of the offered prospects, which organizes and reformulates the options so that the prospects are considered to be different and choices are accordingly taken. Usually, the marketing guys follow those rules and strategies to attract customers.

And in the evaluation phase, edited prospects are further evaluated, and prospects of the highest value are chosen. In the editing phase, you can see that in the first one, they start with the coding of the preferences or the choices or the outcomes and that individuals view results as gain or losses in relation to the reference point, and they make combinations of the prospects for simplification purposes. As you can see, if this is the probability, we are attached 25 percent to get 200 in other cases, and the choice is there. If they combine these two choices, there is a 50 percent probability of getting 200.

So, combining models is going to be more prepared and accordingly chosen. Similarly,

segregation is when we segregate the riskless component from the risky component. So, like you can see here, this as against this, then this can be decomposed into a simplified version of segregation called only minimum 100 is guaranteed with at least in both the choices 80 percent is there to receive 100 as the outcome or gain. So, in this case, what we see out of the prospect of these two cases, A and B, is decomposed into a sure gain of 200. And the risk prospect is, in this case, still there is a risk component called 100 with 80 percent probabilities.

But 200 is the surety of gain when we segregate them correctly. Another is cancellation when repetition of the common constitutes is present in the choice function or in the choice basket. So, the common constitute can be avoided and can be cancelled. So, discarding the common constitutes like this is what we have highlighted in this case; this is for one, this is just avoided, and we just compare other options. So, a sequence of editing really matters, and that really helps create a better prospect.

So another is called the valuation phase, which we have said is the evaluation phase. So, that is called the evaluation phase, where the valuation function is important and carries the better weighting functions of those value functions we have already started discussing. The valuation function under prospect theory is analogous to the expected utility theory. This differs from the EUT because the EUT function evaluates absolute income only, whereas the PT value function is calculated relative to a more important reference point. Hence, prospect theory's value function evaluates changes in their income and health rather than the absolute level of the states.

The value function can model loss aversion as well. So, for a given value of X, the value of this one should be at least less than that of the minus of that level. So, the value function is presented in this illustration. We just see that it follows in the positive part, it follows a convex function, sorry, it follows a convex, sorry, in the positive side, secondary derivative since it is going to be negative, so it follows a concave function whereas in the negative side of it or in the other side of the value, we have a convex function. So because of this, you will see one another interesting aspect: when the negative side of it is being evaluated, you will see that the changes are very sharp. The value function is, therefore, steeper for the losses than for the value function of the gains.

Value Function

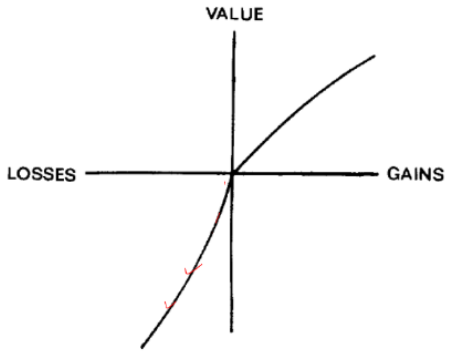


FIGURE 3.—A hypothetical value function.

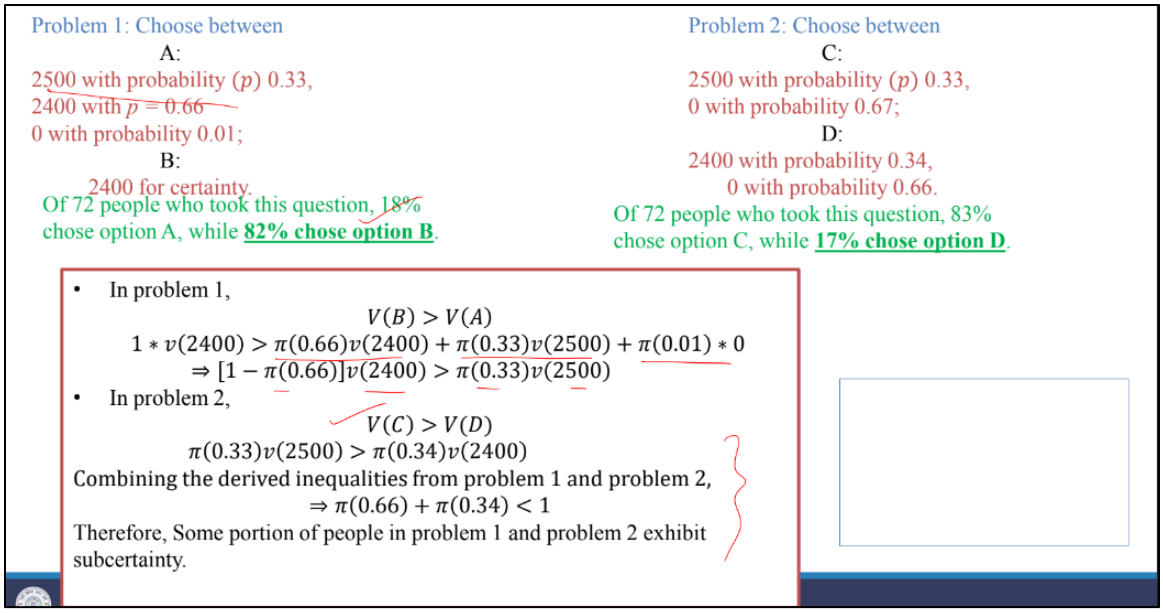
- Value function is defined on deviations from the reference point.
- The value function for changes of wealth is normally concave above the reference point ($v''(x) < 0$, for $x > 0$) and often convex below it ($v''(x) > 0$, for $x < 0$).
- Value function for losses is steeper than the value function for gains.

This is steeper; this downward side is steeper than the gain side. There are different characteristics of value functions. I think you may go through it in detail, I am not presenting. This follows an S-shaped curve and reflects diminishing sensitivity. I have already mentioned how people give different values at different gains as against losses. Our diagram has already presented positive prospects as against the negative prospects side.

Here, when you go for the negative addition of something, your diminishing utility is different from that of the rate of diminishing utility of the positive side. So, it does not depend on the wealth level and solely depends on gains and losses relative to the reference point, which also corresponds to the origin. Similarly, you can see the point of origin that compares with the loss of aversion we have already discussed. Since we are running short of time, I am not mentioning much, I am just clarifying the basic details.

Similarly, in this prospect theory, you will see decision weights and how they matter. Decision weights may look like probabilities. They affect how much each outcome is considered. The decision weight of an impossible event is also 0, just like probability, and its weight is 1 for certain events. I think these we have discussed. However, the decision weights diverge from their associated probability, and some of the decisions do not always add up to 1 and are often less than 1.

That is another interesting aspect. This property is known as sub-certainty; it is not 100 percent certainty. This is to be noted; you might see some of the questions in the assignment or the final exam. So, you see, there are, we have to clarify these, you can also cross-check. So, the sum of the value and these weights will not necessarily be 1 in this case. So, given this example, the value function as presented for problem 1 and problem 2, you will see that 82 percent choose option B because of certainty, and in the C and D cases, more people preferred C.



And this also clarifies from our prospect function that the value of B is greater than that of the value of A, and in this case, problem 2, the value of C is greater than that of the value function of D. So, you can just see how it is calculated. We have given the steps for each of their probabilities; accordingly,

In the other case, it is also defined step by step. So, this is what we already discussed. So, like the endpoint behaviour, it is also important. So, the event is guaranteed. So, decision weight is one, and people misperceive very low probabilities, which were already discussed and came in a 1979 paper, and we will discuss all these things in detail. So, one implication of these for health economics is emphasized in the Rand health insurance experiment. You will see that I will just take another 2-3 minutes to wind off that the EUT, the expected utility theorem, finds that the families with similar incomes and risk of illness would demand similar levels of insurance regardless of what type of coverage they had during the experiment.

Rand's experiment, which we have also discussed in other units. Whereas in the case of prospect theory, families who were assigned to have less insurance coverage during the experiment were willing to pay much less than the families with broader insurance coverage for a new insurance plan after the experiment. It is how these two are different. You can just have a check. So this shows that there is some inertia in plan choice for consumers that gains and loses asymmetrically, not symmetrically. The plans held are more highly valued than equivalent plans that have not been purchased.

It affects the status quo as well as endowment bias. Some others have also discussed this. However, in health insurance and covering only losses, people make people act risk-loving. Using prospect theory, the authors explain both over-insurance for cars and electronics and under-insurance for health, showing how this theory applies to different types of

instrumentation. So, you can just go through this case, and it will be interesting to read. So, we have just the end. We want to emphasize one case based in India by those topmost authors; we have cited their work and explained the low takeoff of microinsurance in India from behavioural economics. The prospect theory is largely discussed, and they have cited the case of Yeshasvini cooperative farmers' healthcare schemes, which are largely self-funded schemes based in Karnataka, India.

Prospect theory says that individuals are risk-averse towards gains but risk-loving towards losses. Because health insurance covers losses, individuals should act as risk lovers for their health insurance demand. Similarly, hyperbolic discounters are more willing to buy insurance. It's not just a linear approach; there is also hyperbolic context, which is also noted. So, finally, the results provide evidence of the adverse selection as households with a higher ratio of risk members are more likely to purchase insurance.

The behavioural explanation for low uptake is also given. So even we will discuss these details. In addition, there are some aspects to be noted, such as health technology assessment. In unit number 8, we have already discussed the theory and principles of economic evaluation. We will study the methods to quantify the benefit of medical treatment, such as standard gambles and time trade-offs. The two methods, etcetera, are discussed. The author, Bleichrodt 2002, explained the disparity between these two, standard gambles and the time trade-off, emphasizing the probability weighting, loss aversion and scale compatibility. So they also derived the explanation for the expected utility theorem and the prospect theory and its implications you can just go through.

I am sure it will be interesting. Prospect theory also suggests that small interventions or nudges can also have outsize effects. You will find out some things, especially the status quo effects, as part of the Rand-HIE experiment. Similarly, other aspects, like the school cafeteria, are examples we discussed, and we will also discuss Nudge theory in our other lecture. So next lecture particularly emphasizes the time inconsistency theory of behavioural economics.

These are readings for your reference. I hope you will be interested in studying, as there are so many things in between. We are just giving you the fundamentals to behavioral economics. That is all for today. Thank you.