

PRINCIPLES OF BEHAVIORAL ECONOMICS

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Week 26

Lecture 26

Hello everyone, this is lecture 26 of the course on principles of behavioral economics. So, we are discussing prospect theory. We have discussed several anomalies that are observed with respect to prospect theory. Then, we discussed the editing phase. We are in the evaluation phase.

And in the evaluation phase, we have, in the previous module, discussed generally how the value functions are constructed with respect to one value scale and one decision weighting scale. So, here in this module, we are going to specifically discuss the value function. An essential feature of prospect theory is that the carriers of value are changes in wealth or welfare rather than final states. So, this basically refers to the concept of reference points that we have been repeating.

This assumption is compatible with basic principles of perception and judgment. Our perceptual apparatus is attuned to the evaluation of changes or differences rather than to the evaluation of absolute magnitudes. When we respond to attributes such as brightness, loudness, or temperature, the past and present context of experience defines an adaptation level or reference point, and stimuli are perceived in relation to this reference point. Thus, an object at a given temperature may be experienced as hot or cold to the touch depending on the temperature to which one has adapted.

For example in an AC room if I step out I will feel that outside is less comfortable or probably much hotter as compared to what I actually got adapted to or habituated to. The same principle applies to non-sensory attributes such as health, prestige and wealth. The same level of wealth for example may imply abject poverty for one person and great riches for another depending on their current assets. So for some individual by this we want to mean that maybe for some individual receiving a sum of one lakh rupees is life-changing.

while for there are several individuals or there could be some individuals for whom one lakh rupees deposited to their bank account does not even get noticed. Strictly speaking

value should be treated as a function in two arguments, the asset position that serves as reference point and the magnitude of the change that is positive or negative from that reference point the value functions are not identical they are likely to become more linear with increase in assets. However, the preference order of prospects is not greatly altered by small or even moderate variations in its asset position.

The certainty equivalent of the prospect 1000, 0.5, for example, lies between 300 and 400 for most people in a wide range of asset positions. This implies that to many people, if they are asked that, Would you like to have get into a bet where you win thousand rupees with 50 percent chance or win nothing? Or you would prefer a sure bet or sure prospect of 300 rupees or 400 rupees. Then most people would be indifferent.

In the sense that getting a thousand rupees with a 50 percent chance and getting 300 rupees for sure, they are indifferent between these two situations. Consequently, the representation of value as a function in one argument generally provides a satisfactory approximation. Many sensory and perceptual dimensions share the property that the psychological response is a concave function of the magnitude of physical change. For example, it is easier to discriminate between a change of 3 degree and a change of 6 degree in room temperature than it is to discriminate between a change in 13 degree and a change of 16 degree.

So, when things are at extremes or maybe it is concave in the sense when the temperatures are pretty much high then a change in 3 degree is less perceptible compared to a change from 3 degree to 6 degree. This principle applies in particular to the evaluation of monetary changes. Thus, the difference in value between a gain of 100 and a gain of 200 appears to be greater than the difference between a gain of 1100 and a gain of 1200. So the difference here remains only 100 rupees or say 100 dollars.

But this is actually—one can also say that from 100 to 200, it is double the amount of gain. But 1100 to 1200 actually gives us less happiness compared to increasing it from 100 to 200. Similarly, the difference between a loss of 100 and a loss of 200 appears greater than the difference between a loss of 1100 and a loss of 1200 unless the larger loss is intolerable for some reason or other. Thus, the value function for changes of wealth is normally concave above the reference point.

Again, we have discussed this functional form where concavity implies the second derivative of the value function with respect to the outcome x is less than 0 for any value x greater than 0. and often convex below it; that is, the double derivative is greater than 0

for x less than 0. That is, the marginal value of both gains and losses generally decreases with their magnitude. The value function, which is derived from risky choices, shares the same characteristics as illustrated in the following problems.

So, there are two problems. First of all, gamble A and B, where the number of participants was 68. The gamble is like you can win 6000 with a probability of 0.25. And you can win 4000 with a probability of 0.25 and 2000 with a probability of 0.25. So, ideally, you can see that this also gives a probability of winning 6000 with 0.25, but then they are broken.

Now, 82% preferred this over 18% preferring this one. Now, gamble C and D are like you are losing 6000 with a probability of 0.25. While there are two alternative losses in gamble D, in which, in one, you are losing 4000, and in another, you are losing 2000, both have an equal probability of 0.25. The number of participants was 64; 70% preferred losing 6000 compared to 30% who actually preferred gamble D. Now, from the gambles, we derive that, see, when we say that gamble B is preferred to gamble A, then this can be written as $\pi(0.25)v(6000) < \pi(0.25)[v(4000) + v(2000)]$, that is, the decision width.

$$\begin{aligned} \pi(0.25)v(6000) &< \pi(0.25)[v(4000) + v(2000)] \text{ and} \\ \pi(0.25)v(-6000) &> \pi(0.25)[v(-4000) + v(-2000)] \end{aligned}$$

If I go back to the functional form of the value function, the value function is written as $\pi(p)v(x) + \pi(Q)v(y)$. So here, I have only one outcome. So, $V(6000)$ multiplied by $\pi(0.25)$ is less than—it is less preferred. So, that is why this is less than $V(4000) + V(2000)$ multiplied by $\pi(0.25)$. So, since both have $\pi(0.25)$, they have been taken common out.

And from Gamble C and Gamble D, what we observe is that $\pi(0.25)V(-6000)$ is greater than—this is preferred to Gamble D—so greater than $\pi(0.25)V(-4000) + V(-2000)$. These preferences are in accordance with the hypothesis that the value function is concave for gains and convex for losses. Now, how this is possible—I am going to explain this using this diagram.

So, these are the gains: 2000, 4000, and 6000—I have hypothetically drawn them. Now, this is a concave function in the domain of gain—concave to the horizontal axis. You can see that this is the utility associated with 2000. This is the utility associated with 6000. Now, if I add this additional utility here, then the utility associated with 6000 would be something like this here, right?

If it hadn't been a linear function, then we would expect it to go through this point. But it is actually much less than that. Now, this what it was reflected here that $\pi^{0.25} V_{6000}$ is less than $V_{4000} + V_{2000}$. So, this is what it shows—the utility associated with V_{6000} . alternatively, from this expression you can see that we can always cancel out this $\pi^{0.25}$ and then accordingly from gamble A and B

I can write V_{6000} is less than $V_{4000} + V_{2000}$. Similarly by cancelling $\pi^{0.25}$ from both sides for gamble C and gamble D I can always write $V - 6000$ is greater than $V - 4000 + V - 2000$. So here you can see that V_{6000} , which is actually here, is less than $V_{4000} + V_{2000}$. If it is somewhere here, then it actually implies so. Similarly, in the domain of losses, this is where I have $V - 6000$.

This is where I have $V - 2000$; this is where I have $V - 4000$. Now, this is minus 2000; this entire is minus 4000, and this is minus 2000, right? So if I add this much of length to this much of length, I will be somewhere here. So $V - 6000$ ideally should be here if this is a linear function, but since this is convex from this angle, this is convex, and as a result, my $V - 6000$ is actually greater than $V - 4000 + V - 2000$. Now, these are in negatives, right? So which means that this is a larger negative, and as a result, this value is less than this value. Okay, so this is how convexity and concavity are explained in this context—any discussion of the utility function

for money must leave room for the effect of special circumstances on preferences. For example, the utility function of an individual who needs 60,000 to purchase a house may reveal an exceptionally steep rise near the critical value. Similarly, an individual's aversion to losses may increase sharply near the loss that would compel him to sell his house and move to a less desirable neighborhood. Hence, the derived value or utility function of an individual does not always reflect pure attitudes to money, since it could be affected by additional consequences associated with specific amounts. All that we are trying to say here is that the absolute amount of money probably matters less, and it is

other factors that impact the requirement for that money, the loss or gain that may explain the utility or the value function. So, as previously mentioned, 1 lakh rupees coming to someone's account could be life-changing for him or her, while it may go unnoticed for a super-rich person, right. So, in a similar fashion, we claim that Individuals do not always reflect pure attitudes towards money, which means the absolute value of money itself does not reflect much, rather, the sequential or the situational value is actually more important—

whether it is, you know, what the amount of wealth is to begin with, how much losses or gains a certain amount of money implies to an individual,

all these things matter. Such perturbations can readily produce convex regions in the value function for gains and concave regions in the value function for losses as well. Kahneman and Tversky propose that the value function is defined on deviations from the reference point. So here in this case the reference point is 0 generally concave for gains and commonly convex for losses and steeper for losses than for gains, so this point has already been discussed, and several times we have tried to prove that reference points matter. Now, on the second proposition, We say that it implies diminishing marginal sensitivity, which causes risk-aversion in the domain of gains and risk-seeking in the domain of losses.

The second proposition is that the utility or the value function is generally concave for gains and commonly convex for losses. So, as your amount of gains increases you become less and less sensitive to further gains. and as a result of which your utility or value function becomes concave. So, the additional gains are not actually generating equal amount of additional utility rather the additional utilities generated are much much smaller. Similarly, in the domain of losses what they say is that consecutive losses again make us immune to further losses

And as a result of which when we have several losses, the sensitiveness to further losses decreases and that is why the function or the curve becomes convex. Now, the third proposition says that steeper for losses than for gains. On proposition 3, KT claims a salient characteristic of attitudes to changes in welfare is that losses loom larger than gains. The aggravation that one experiences in losing a sum of money appears to be greater than the pleasure associated with gaining the same amount. This is actually simply talks about if you lose say 10 rupees or 100 rupees the pain associated with is much larger as compared to if you gain an equal amount of money say 10 rupees or 100 rupees.

Consequently most people find symmetric bets distinctively unattractive and the aversiveness of symmetric fair bets generally increases with the size of the stake so what it says is that a symmetric bet is one where the winning probability and the losing probability are same and the winning and the losing amount are also same so for example we get into a game where you you toss a coin if head turns then you win 100 rupees if tail turns out then you lose 100 rupees so KT says that since a loss pinches us more then and since both of them this outcome have the same probability

People will not generally be willing to play this game. Now, for smaller stakes—for example, 10 rupees—it's only 10 rupees, so you may still find some people who would be willing to play. If you increase it to 100 rupees, there will still be a few people willing to play. But if the stakes are larger—for example, if the stakes are, say, 10,000 rupees—then there will be hardly anybody who would be willing to play because you know, losing 10,000 pinches you more compared to gaining 10,000. So, as a result, they say that symmetric bets are distinctly unattractive, and the aversiveness of symmetric fair bets—that is, the willingness to avoid symmetric fair bets—

generally increases with the size of the stake. As the stake increases from 100 to 1,000 to 10,000, the aversiveness also increases. Now, what it tries to say here is: Let us consider two numbers, x and y , where both of them are greater than 0. This implies $v(y/0.5) - v(x/0.5)$ is preferred to $v(x/0.5) - v(x/0.5)$. So, basically, here, x is greater than y . This implies that if y takes a value of 10, then a symmetric fair bet with 10 rupees involved—where you win 10 rupees with a probability of 0.5 and lose 10 rupees with a probability of 0.5—is actually preferred to, say, an expected value of 100, which is preferred to a symmetric fair bet

where you win 100 rupees with a probability of 0.5 and also lose 100 rupees with a probability of 0.5, right? This is all it says. Now, this implies that $v(y) + v(-y)$ is greater than $v(x) + v(-x)$. See here we are supposed to if we write the value function then, of course, we are going to have one $\pi(0.5)$ here, $\pi(0.5)$ here, one $\pi(0.5)$ here, and another $\pi(0.5)$ here. Now, we can cancel them out—all of them get canceled—so we are left with this expression. Now, this can also be written as $v(-y)$. I take $v(-x)$ to the other side and $v(y)$ goes to the other side and

that is how I have $v(-y) - v(-x) > v(x) - v(x)$ and $v(-y) - v(-x) > v(x) - v(x)$. For y equals to 0, if I put y equals to 0, if you remember $v(0)$ equals to 0 and as a result of which for y equals to 0, I will be left with only $v(-y) - v(-x)$. and which is greater than $v(x) - v(x)$ and letting y approach x is $v'(-x) > v'(x)$ if v' exist where v' is the derivative of v this is the first derivative right so what does it imply it implies that when we are making losses then the loss function has a slope which is greater than the value function in the domain of gains So this proves that the value function for losses is steeper than the value function for gains.

This implies $v(y) + v(-y) > v(x) + v(-x)$
 Or $v(-y) - v(-x) > v(x) - v(y)$
 For $y = 0$, $-v(-x) > v(x)$ and
 Letting y approach x yields $v'(-x) > v'(x)$ if v'
 exists; v' is the derivative of v .

The proposed S shaped value function is steepest at the reference point which is 0. So again, I bring back that diagram, and here we have this value function, which is basically an S-shaped function. You can see that it is concave in the domain of gains. It is convex in the domain of losses. We also see that the slope of this value function in the domain of gains is less steep compared to the slope of the value function in the domain of losses.

Alternatively, v' minus y is basically steeper than v' x right so when I am making losses or v' minus x basically is greater than v' x so when I am making losses since losses pinch more the functional form is steeper compared to when I am making gains. And the last point I mentioned in the previous slide is that the value function is steepest around the reference point, which is 0. So this is the reference point of 0. And the value function is steepest here.

This may sound like a subtle tweak, but switching the focus to changes as opposed to levels is a radical move. Kahneman and Tversky focused on changes because changes are the way humans experience life. Consider Jane, who makes 80,000 dollar per year. She gets a 5,000 dollar year-end bonus that she had not expected. Now, how does Jane process this event?

Does she calculate the change in her lifetime wealth, which is barely noticeable? No. She is more likely to think wow, an extra 5000. So what it implies is that it is basically 5000 is compared with what she makes annually like 80,000. Now, what is asked is: Does she calculate the change in her lifetime wealth?

So, in her lifetime wealth, it can actually be a huge amount—say, 100 or 200 times more than what she makes annually. So, this is her total wealth, right? What the neoclassical says—we may come back to that point while discussing specifically mental accounting. We say that neoclassicals assume that whatever comes, whatever additional income is generated, that is basically combined with

The total wealth that an individual earns in his or her lifetime is then equally distributed. If this is so, then compared to the lifetime expected wealth, an additional 5000 is actually nothing, and accordingly, it is not going to give her that much pleasure. But if it is compared

with the current situation, then it gives her a lot of pleasure, and that's why she would consider it as, 'Wow, an extra 5000.' The main properties ascribed to the value function have been observed in a detailed analysis of von Neumann-Morgenstern utility functions for changes in wealth.

The functions had been obtained from 30 decision-makers in various fields of business in five independent studies. Most utility functions for gains were concave. Most functions for losses were convex. And only three individuals exhibited risk aversion for both gains and losses. With a single exception, utility functions were considerably steeper for losses than for gains.

With this, I come to the conclusion of the current module. We have talked here about the value function primarily. In the next, we are going to talk about the weighting function of the prospect theory value function. Thank you.