PRINCIPLES OF BEHAVIORAL ECONOMICS

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Week 42

Lecture 42

Hello everyone, this is Lecture 42. We are basically now discussing intertemporal choice models. In the previous model, we discussed Irving Fisher's two-period model. We started discussing the two-period indifference curve analysis, where we just introduced the budget constraint. In this module, we are going to discuss the optimal choice or consumption in the two-period model.

So, in traditional economics, a consumer is assumed to have exogenous and stable preferences for various combinations of non-negative consumption C0 and C1. Basically, they are denoted by C0 and C1, referring to two different periods. It is also assumed that the preferences are represented by a utility function. The consumer prefers C0, C1 that gives a high value of U, C0, C1. Hence, the consumer chooses the combination of C0 and C1 that maximizes the utility function U, C0, C1 under the budget constraint, which we already derived and discussed in the previous module.

$$C_0 + \frac{1}{1+r} C_1 \leq Y_0 + \frac{1}{1+r} Y_1$$

So, in the previous module, we basically derived this budget constraint, and the slope of this budget constraint is given by minus 1 plus r. On the same diagram, we are now superimposing some indifference curves. We assume that if C0 increases while C1 is constant, then the utility increases. So, this is one assumption of the classical utility theory analysis, where we assume that more is always better. So, as we hold the consumption in one period constant and increase the consumption in another period, then this point is actually expected to give us a higher amount of utility.

With these assumptions, the budget constraint should hold with equality when the utility is maximized. So first of all, when you are trying to maximize utility, what it says is that I must not be operating anywhere below the budget line. I will be operating on the budget line while utilizing all my money on consumption in the two periods. In this equation, if we set C0 equal to 0 to see what happens when all income in period 0 and period 1 is spent on consumption in period 1. Then we have C1 equals to 1 plus R Y naught plus Y1.

$$C_1 = (1+r)\ Y_0 + Y_1$$

So here we are just setting C0 equal to 0. If you remember, it was C naught plus 1 upon 1 plus R into C1. So now here this 1 upon 1 plus R is taken to the other side. Y1 also has 1 upon 1 plus R. So this cancels out and this is the expression we have. Now let us define A equals to 1 plus R Y naught plus Y1.

$$C_1 = A - (1+r)\ C_0$$

So this term is denoted by A. You are not consuming anything in period 0. This is the maximum possible consumption in period 1. And that is denoted by A in this diagram. So we take C0 on the horizontal axis and C1 on the vertical axis and draw the graph of the budget constraint equation. This graph has the slope of minus 1 plus R and its vertical intercept is A. So here we are having C1.

On the vertical axis, we are measuring the consumption of commodity 1. So, as a result, this point A gives us the maximum possible consumption when not consuming anything in period 0. And if we consume anything, then that would be measured along the horizontal axis. The slope of this line would be minus 1 plus R. This is because the budget constraint with equality can be written as C1 equals A minus 1 plus R times C0.

The reason is that A is the maximum possible consumption in period 1 if you are not consuming anything in period 0. But if you are consuming something in period 0, then subtract it from the maximum possible consumption in period 1 to arrive at the consumption in period 1. So that is how we derive the slope. See, we are measuring C1 on the vertical axis and C0 on the horizontal axis. So if I just compare it with any standard equation—

a linear equation like y equals mx plus c, where m is the slope. So here, minus 1 plus R is the slope, c is the intercept, and here A is the intercept. The graph expressing equation 4 is called the intertemporal budget line. So this is the intertemporal budget line. Let U1 be a level of the utility then the collection of C0 C1 such that U C0 C1 equals to Ui is called an indifference curve.

So at each point in time, the total utility depends on consumption in both periods. There are three different curves for three levels of utility. We have U0, U1, U2. These intertemporal indifference curves were studied by the economist Irving Fisher and are called Fisher's indifference curves. In economics, we assume that the shape of the indifference curves is convex to the origin, as shown in the figures.

This is the origin. These curves are convex to the origin. Because utility is assumed to increase when c1 increases while c0 is constant, we will have u0 less than u1 less than u2. As mentioned previously, if I consider a combination here and then suppose I increase the amount consumed in period 0, this point is not attainable. But suppose this point were attainable, then we could have the same level of consumption in period 1 but more consumption in period 0.

As a result, this would give me a higher level of utility. So, compared to U1, U2 gives a higher level of utility. All C0 C1 combinations that are on the line expressing equation 4—that is, the budget line—and all C0 C1 that are below the line satisfy the budget constraint. So, basically, as we mentioned, this is the feasible set. This is the area that the consumer can consume.

These are the combinations the consumer can consume. Among all C0 C1 combinations that satisfy the budget constraint, The one that maximizes the utility is the one at which one indifference curve is tangent to the budget constraint. So one indifference curve is tangent to the budget constraint. This is the optimal combination of consumption.

In the figure, C0 star and C1 star are the combination that maximizes the utility under the budget constraint. If C0 is smaller than income Y0, then the consumer saves the difference. So, basically, you are making some savings. If C0 is greater than income Y0, that is the initial period income, then the consumer borrows the difference. A patient consumer's indifference curve's slope is relatively gradual.

When present consumption increases by one unit, future consumption needs to decrease by a relatively small amount to keep the same utility level. Other things being equal, a patient consumer tends to have smaller present consumption and save more. An impatient consumer's indifference curve's slope is relatively steep. When the present consumption

C0 increases by one unit, future consumption needs to decrease by a relatively large amount to keep the same utility level. Let us try to draw it.

If these are the indifference curves, which we call steep indifference curves, then let us consider any combination like this: C01 and C11. So, current period consumption and future period consumption. Now, a steep line implies what it says is that when the current consumption increases by one unit—so if current consumption increases by one unit—then future consumption decreases by a larger amount.

So you can see that the increase is offset by the decrease in future consumption. So the drop is larger in order to maintain the same utility levels. Similarly, if I had begun from somewhere here, you can see that the changes are actually even larger. So these are the cases of impatient individuals. On the other hand, if my indifference curves are relatively flatter,

then when my consumption increases by one unit, future consumption actually decreases less than proportionately. Other things being equal, an impatient consumer tends to have greater present consumption and save less. So that could be understood if we actually introduce the budget lines here. Let me try doing that. If I have a budget line and these are my indifference curves.

So these are very steep indifference curves. So I can expect tangency here. You can see that the consumption pattern is actually heavily biased toward present time. Now again, I have a budget line, but my indifference curves are pretty flat. So in that case, I can expect a tangency point here.

So for patient individuals, the indifference curves are flatter, and they consume more in the future and less in the present time. Thus, the slope of the indifference curve is important for saving and borrowing decisions. The slope of the indifference curve is negative, and its absolute value is called the marginal rate of substitution or MRS, the rate at which present consumption is substituted by future consumption or vice versa. The marginal rate of substitution can be expressed by the ratio of the marginal utility of present consumption and the marginal utility of future consumption.

The marginal utility of present consumption is defined as The derivative of U C naught C1 with respect to C naught when C1 is kept constant which is also called the partial derivative and it is denoted by delta U C naught C1 upon delta C naught.

$$\frac{\partial U(C_0, C_1)}{\partial C_0}$$

So only when C naught is changing there is some change in C naught then how the total utility is changing that is denoted by the marginal utility of present consumption. In a similar fashion we also define the marginal utility of future consumption which is defined as the derivative of U C0 C1 with respect to C1 and C0 C1 when C0 is kept constant. So this is written as like this that only c1 changes how utility is changing.

$$\frac{\partial U(C_0, C_1)}{\partial C_1}$$

The marginal rate of substitution is defined as the ratio of the marginal utility of present consumption to the marginal utility of future consumption. So, the two expressions that we derived, we take a ratio of them that gives us the marginal rate of substitution, or MRS.

$$\frac{\partial U(C_0, C_1)/\partial C_0}{\partial U(C_0, C_1)/\partial C_1}$$

As shown in the figure, the slope of the indifference curve is equal to the slope of the intertemporal budget line when utility is maximized. So, at the tangency point, the slope of the budget line and the slope of the indifference curve are the same.

Therefore, the marginal rate of substitution evaluated at the optimal combination of present and future consumption is equal to the absolute value of the slope of the budget line, which is 1 plus r. The slope of the budget line is already mentioned here, and we have discussed that this is minus 1 plus r; the absolute value is 1 plus r, and the slope of the indifference curve is actually given by MRS, that is, the ratio of marginal consumption— present marginal consumption divided by next period's marginal consumption or marginal utility. So, this is the marginal utility from present consumption.

$$\frac{\partial U(c_0^*, c_1^*)/\partial c_0}{\partial U(c_0^*, c_1^*)/\partial c_1} = (1 + r)$$

This is the marginal utility from future consumption. The ratio equals 1 plus r. This is basically the condition through which we decide what should be the optimal combination of consumptions in two periods. This is an application of the utility optimization condition in microeconomics: that the marginal rate of substitution between two goods is equal to the relative price of the two intertemporal utility optimizations. And we have already mentioned also that the relative price of the intertemporal utility optimization is given by 1 plus r. The interest rate determines the relative price.

This condition is called the Euler equation. Now, let us take an example of an intertemporal choice. Adapting to chronic kidney disease. Well, this is a descriptive example, and we are not going to delve much into the derivations we have just discussed. Kidney disease affects about one in every nine adults in the United States and is always a life-altering condition.

It is actually prevalent in many countries, including India. Milder forms of kidney disease result in reduced kidney function. This generally requires patients to follow a strict diet, cutting out many desirable foods, counting calories, and limiting liquid intake. Additionally, patients must adhere to a strict exercise regimen. In the most serious cases, patients must undergo kidney dialysis.

This usually involves visiting a dialysis center three times a week and sitting in a chair for four hours while the patient's blood is processed outside the body through a dialyzer. Dialysis patients must undergo this treatment several times a week; otherwise, toxins quickly accumulate in the body, resulting in death. Dialysis patients are typically required to remain close to a home treatment center and cannot travel. Dialysis patients often report feeling weak or nauseated after treatment. In short, dialysis is an unpleasant treatment, but it is necessary to prolong life.

On the surface one would expect the quality of life to decline substantially as understandably if the kidney disease is severe enough to warrant dialysis. Thus, it should be no surprise that when perfectly healthy people are asked, they in fact believe that going on dialysis would significantly reduce their quality of life. So what all we wanted to say here is that since dialysis involves a lot of discomfort and actually the treatment is extremely undesirable, it has severe health implications and also gives a lot of discomfort to the patients before the treatment, after the treatment. So, a life where you have to be on dialysis for the rest of your life is actually not something which we look forward to.

So, if a healthy individual, suppose I am asked that how do you expect your life to be if you are on dialysis? Of course, anybody and I would also say that yes, life would be miserable. David L. Sackett and George W. Torrance surveyed 189 people about the quality of life they would experience should they contract various diseases. Participants in the study were asked to rate each disease on a scale in which one means the respondent is indifferent between living with the disease and being perfectly healthy. And 0 means the respondent is indifferent between living with the disease and dying.

So, if my response is pretty close to 0, say I say 0.1, which means I think living with dialysis is very much - instead I would probably prefer to die or it is as good as living a life or do not - it is as good as not surviving. On average people believe their quality of life would be 0.32 if they were required to visit a hospital to undergo dialysis for the rest of their life so you can see this was an average response which is pretty low at 0.32 If you have a healthy life and that is close to 1, then your desire to live is reduced by 70%. It's only 30% that you desire to survive or live.

Alternatively, when current dialysis patients were asked the same question, they rated the quality of life as 0.52 on average. So, you can see that for them, life was 50-50 bad when under dialysis. Although 0.52 is a long way from 1—meaning your interest to live has reduced by 50%—it is also a long way from 0.32. Why would dialysis patients feel so much better off than others might believe them to be? One potential explanation is that people with kidney disease use a different scale for their answers.

Perhaps when you have such a reduced quality of life, you cannot remember how good perfectly healthy life is, and thus your 1 is a healthy person's 0.6. So basically, as you understand, the perception has probably become distorted or has changed substantially. Well, this is still somewhat unlikely. Other studies have compared questions using a vague quality-of-life scale to one that uses a much more explicit scale and found that the

more explicit scale actually generates a wider divergence of values. In another study, researchers asked patients waiting for kidney transplants about the quality of life they would experience if they did or did not receive the transplant within a year. Then they tracked down the same patients after one year and found that they displayed a similar bias in predicting their own quality of life. Those who had not received transplants were better off than they thought they would be. Those who had received transplants were worse off than they thought they would be.

One reason people might perform so miserably at predicting the future well-being is that they give a knee-jerk judgment rather than reasoning through what life would really be like. So what all we can see is that broadly one thing emerges and that is we might not be great at predicting our future well-being or future state of well-being. So if something bad is, I am told that something bad is going to happen. How do you think you would be at that point of time?

So the analysis shows that we are very bad at predicting how bad I probably would be. Similarly, if I am told that how good you would be, My prediction could be bad in that as well. Peter A. Ubel, George Loewenstein, and Christopher Jepson found that if healthy people are asked to think about the ways that they might be able to adapt their life to kidney disease and dialysis treatment, their predictions of quality of life improves to something that is somewhat closer to the reported by actual patients.

Once people begin to consider their ability to adapt, they might realize that some of the things they enjoy most are still possible. People have a hard time predicting how they might adapt to future circumstances, which affects their ability to guess their future utility. So broadly, we see that there are some level of bias present in our understanding of how future is going to be. So this is what we are going to discuss further in the next module, what is this particular bias called and how they are going to impact our decision making.

These are the references used in this module. Thank you.