[SQUEAKING]

[RUSTLING]

[CLICKING]

FRANK SCHILBACH: Welcome to lecture three. Today and on Wednesday, we're going to talk about time preferences and particular theory. We're going to talk a lot about a lot of applications, a lot of applications that are sort of close to your real world, including procrastination of problem sets, all sorts of other choices such as credit card debt, and so on, and so forth.

Can you be a little quiet? Thank you.

Think of the lectures today and on Wednesday building some framework and some sort of structure and how to think about these things. It's a little drier than maybe other lectures, in part because it's about theory, and about writing down a model, and trying to think about the world. Partially we're doing that to sort of try to explain behaviors that we see in the world, partially we do that because at the end, we try to think about welfare and how to evaluate certain outcomes-- is that good or bad-- certain policies and things to do, which later in the course we're going to talk about.

But for that you, need some structure how to think about some of those things. At the heart of it, a lot of this is about procrastination, about choices between the present and the future. Your problem set, in part, is also about procrastination. It will be posted later today, probably late. Please do let us know if you have any questions.

As I said, please be on time. Do the readings. There will be random pop quizzes. They will be at the beginning of the class, so you should be on time.

The laptop section is still over there. If you want to use your laptop, it should be there, ideally, in the front, in part because you're not going to bother others. I saw quite a few people using their phones in class in previous classes. Try to not do that. That's not good for you.

You will not be able to take away much from the class. Multitasking is very hard for people to do. Again, I'll show you some evidence on that.

As I said, the problem set will be posted shortly. If you have any questions, please do let us know on Piazza and help others answer them or answer them for others. I have office hours, usually Tuesday afternoons. Please sign up for them.

I'm very happy to meet you. It's very hard for me to meet people or get to know you in the large class otherwise. So please come to office hours. I'm happy to talk to you about anything you're interested in, ideally related to behavioral economics.

So let me give you an overview of this and the next lecture. We're going to talk first about exponential discounting. Why are we talking about exponential discount? This is the workhorse model of classical economics. This is how economists usually think about choices over time.

Second, we're going to identify some problems with this model, and try to think about why is this model perhaps not explaining things well, at least in some settings? And how could we improve on that? I'm going to propose an alternative model, which is the quasi-hyperbolic discounting model.

And then we're going to talk about sophistication and naivete, which is the idea that if you think you have different preferences in the present form in the future, then it becomes very important to understand. Do you actually know what's going on? Do you know that in the future you might be impatient, or do you perhaps think that in the future, I will be very patient, and then perhaps make some mistakes accordingly? I'll get to this in more detail.

So it's first important to notice that any choice, essentially almost any choice you make, almost always involves some choice over time. Essentially, some trade-off between the present, between some cost and benefit that you might occur in the very short run, and some costs and benefits that you might enjoy or incur in the future. What examples do we have? What choices over time do we face? Yes.

STUDENT: Savings versus consumption.

FRANK SCHILBACH: Uh-huh. And how do you decide how much to save?

STUDENT: Depending on your preferences and interests, right?

FRANK SCHILBACH: Right. So you have the choice, for example, if you think about should I save some money, let's say, for next semester or next year. So your choice is either to consume the money now in various ways-- eat food or whatever you would like to do with it, spend it on various activities. So if you save, if you make the decision to save, you have to give up some money now, and you get some benefits in the future.

The benefits in the future are determined by the interest rate, as you say. If you have a savings account or the like, you can essentially get some benefits in the future. And then you have some costs in the present, which would be essentially not consuming now, and some benefits in the future, which is getting that money in the future.

And then you need to somehow decide is that worth doing. There's some cost and benefit. We need to aggregate somehow, whether to make that choice. Any other choices you make over time? Yes.

STUDENT: Whether to go to college or not or start working right away and make some money or delay that income.

FRANK SCHILBACH: Right. So I actually have this example here-- going to school. It has some costs and benefits. And what are the costs and benefits of doing that?

STUDENT: You sacrifice four years or whatever right now versus supposedly a higher income later on.

FRANK SCHILBACH: Exactly. So you have direct costs of education, which is tuition in many cases. Sometimes that's sponsored, but often there's tuition. It's quite a bit of money. It's also the opportunity cost, which is often forgone wages. You could be working otherwise and make more money.

There's the joy of pain of going to school. Some might think it's positive. Some might think it's negative.

And then there's future wages, which in many cases, at least for you guys, tend to be higher from going to college. If you do a PhD, that might not be the case. I'm not sure if the TA's are here, but yes. I'm sorry for that.

And then you have to decide are you going to school or not. What do you need to do is you need to determine the utility, the value of each of these costs and benefits. And they occur in different points in time. You need to make some estimates.

And then, of course, there's risk and other issues involved. You might not have full information, and so on. But assuming that all away, suppose you knew all the costs and benefits of going to college.

Then you have to decide, is that worth doing? So somehow you need to aggregate these costs and benefits over time by putting appropriate weights on different periods in time, and decide, should I do this or not. OK. Yes, any other similar choices that people make? Yes.

STUDENT: [INAUDIBLE]

FRANK SCHILBACH: Right. For example, you could think about should I do a problem set? Should I come to class? Should I study for an exam, and so on.

Often, there's costs and benefits involved. Often, the costs are immediate. You have to work on the problem set. That might not be pleasant.

You have to study for the exam. That might not be pleasant. You could be doing other things instead that you can't do because of that. And then there's going to be rewards in the future, usually in the terms either through increased knowledge that might be useful for other things in the future, or through better grades, or whatever you might be rewarded from having more knowledge.

And then, again, there might be uncertainty involved because it could be that you might not fully know what the costs and benefits are. It could be that it's sort of risky. You might come to class or not come to class depending on whether there's a pop quiz or not, so there's risk involved.

But assuming that away, there's essentially benefits and costs in the present, and then benefits and costs, potentially, in the future. And again, somehow you have to aggregate these and weigh them in various ways. Any other choices? Yes.

STUDENT: Exercise.

FRANK SCHILBACH: Exercise, yeah, exactly. Exercise is a good one. Again, in the present, you might not enjoy it. Some people might actually enjoy it a lot. Somebody would tell me he was addicted to exercise-- that also happens.

But usually, people, at least in the short run, tend to not like exercise that much. But I think it's useful for them to do, in part because they feel better afterwards, in part because they have long-run benefits. Maybe they're in better shape eventually. Maybe the healthier eventually. Maybe they'll live longer eventually, and so on, and so forth.

And again, what you need to do is you have some costs and benefits. You have the costs of getting ready, getting out of the door, and getting yourself to do it. That often is costly.

There's the cost of exercising itself, which often is costly, maybe not. But then the benefits are often in the future, often really far away in the future. So if you really were eating healthier, often the same thing-- essentially, you might not like eating spinach and vegetables in the present. Some people, of course, love that, but often, then, the benefits come in the form of improved health many, many years out.

And again, what you need to do is you need to quantify somehow the costs and benefits of certain actions. And then you need to aggregate the costs and benefits somehow, to be able to make a choice. Is that a good idea or a bad idea? Do you want to do this or not?

A number of different examples-- here's another example of something that's very trivial-- purchasing an expensive software. You have to spend some money of doing it. That usually entails negative utility. People don't like to give up money.

Second, there's pain and frustration of learning the software. Again, that's often negative utility. And then there's mastery, which is positive utility from knowing or learning the software, until it becomes obsolete. So there's a stream of positive utility sometime in the future.

Now, how do you decide whether to purchase the software? Well, you determine the value of the utility of costs and benefits somehow. And we're going to talk about in some degree how to do that. And then once you have that, you need to weigh the costs and benefits, and try to aggregate, and try to figure out, is this a good idea or not.

There's another choice, which we're actually going to talk about when we talk about welfare and about policies. Overall, it's deactivating a social media account, in part because there's a very nice study that actually studies precisely that. So if you think about deactivating a social media account-- Facebook, Twitter, Instagram, whatever people are using-- there's different costs and benefits involved.

And you can argue about what those are. Part of that is the direct cost of deactivating the account. Often, that's a tedious thing to do. You have to figure out how to do it.

Often, companies try to not make it too easy for you to actually do that. You might want to archive some pictures, or whatever, and so on. Often, that's a tedious thing to do.

There's often a short-run adjustment cost, where you want to be in touch with your friends. Maybe it's harder to find out where the parties are, or whatever, whatever things are. So often, there's some adjustment cost, likely also negative.

And then there is some long-run impact on your social life, on your mental health, on your happiness, and so on, that could be positive or negative. Assuming that perhaps a positive, then again, you have to think about short-run negative costs and benefits. You have to learn about, think about what those are. Again, they might be uncertain.

But to the extent that you could tell what they are, then you have costs and benefits at different points in time. And when you make that choice, you have to figure out whether that's worth doing by aggregating them somehow to some point in time and, saying yes, I'll do it, or not. And we'll get back to this in, I think, something like lecture 20 or so, where there is a study that was encouraging people to, in fact, precisely do that, and look at happiness and other outcomes, mental health, and so on, among students.

OK, so what are other important choices over time? If you think about almost anything that you can think of, any choice that you make in your life, almost any of these involve some aspects of time. So if you think about investing, saving, borrowing, credit card spending, and so on, that involves choices over time.

If you think about education, often, there's costs in the present, benefits in the future. If you think about any sort of health investments-- eating healthy, taking your medication, brushing your teeth, exercising, and so on, if you think about sleeping, often sleep involves choices between the present and the future. You think about watching movies at night-- that's fun to do. But often, that comes out like pain on the following day in various forms.

Eating patterns as well, dating arguably involves sort of costs and benefits in the present and the future. People make different choices. Again, there's all sorts of other aspects involved as well, including risk, information, and so on. But what I'm pointing out is many choices that people make have some aspects that involve different points in time. And you have to figure out how to weigh these utility streams in some ways accordingly.

Now, here's a broad history of how economists have thought about this. And it's interesting to read, in fact. And this is what the Frederick et al. article talks about. In fact, economists sort of went full circle in some way.

So it started with a very complicated model of a production, the amount of labor allocated to the production of capital that depends on the effective desire of accumulation, which is a bit of a mouthful. But essentially, there was lots of rich psychological considerations involved in trying to explain how people make choices over time. People thought about self-control, self-restraint, the bequest motive, how much they think about their children, anticipatory utility-- people like to save because they like to think they'll be happy in the future-- and so on, and so forth. And it was a very complicated model of intertemporal choice that people had been thinking about.

At some point, then Bohm-Bawerk, who was an Austrian economist at some point realized or proposed that the interest rate, in some sense, is just a price. So if you think about doing something or saving some money from today until next year, it's really just like choosing between apples and bananas. When you choose between apples and bananas, there's a relative price, which is the price of apples divided by the price of bananas.

If you think about choices over time, if you think about consuming $1 today versus $1 next year, the interest rate or 1 plus the interest rate is the relative price of that. So for any dollar that I now consume, I could get 1 plus r dollars in the future. That's just the relative price of consumption now versus in the future. So you could think of-- the same way we think about apples and bananas and optimizing between those, the same way we can think about consumption in the present and the future, which are just sort of like different goods over time.

And so Irving Fisher, then, came up and said, let's just write down a two-good in difference diagram. This is exactly the indifference diagram that you've seen in like 1401 or other introductory Micro classes. Still, there were actually many psychological factors discussed, like personal factors that determine how much you save, and so on. But it was progress towards that.

Now, what is the Fisher diagram? The Fisher diagram looks something like this. This is what you should be familiar with from, again, 1401. What do we see here? What is this? Yes.

STUDENT: I guess it traces between [INAUDIBLE].

FRANK SCHILBACH: Right, exactly. So we have here choices between two goods, call them good a and good b. There's a consumption. c a is consumption of good a, c b is a consumption of good b.

We have a budget set, essentially, which is determined here by how much your budget's constrained, which is the triangle line that you see there. The slope of that budget set is determined by the relative price. That's essentially the p a divided by p b.

And then we have what's called an "indifference curve," which essentially is the curve that makes us indifferent between combinations of two goods. And we choose the point on the budget line that's the furthest out, that gets us in the furthest indifference curve. So that's 1401 that you should be all familiar with. In part, that's what was discussed in recitation on Friday.

Now, Fisher then pointed out when you think about choices over time, in fact, that's exactly the same thing. Think about it two periods, period one and period two. We have, essentially, a budget line, again, which is the budget set. Again, that's what was discussed in recitation on Thursday and Friday.

The difference here, of course, is then the price. The relative price is determined by the interest rates. So 1 plus r is now essentially the relative price, or 1 over 1 plus r, that determines essentially how much we can maximally consume. Again, the triangle that you see here is the potential set that you consume.

And then again, you have a indifference curve that tells us the sets of points that we are indifferent between, good one and good two. And we choose what's furthest out on the indifference curve. So essentially, we can apply any tools that we have from 1401 or any Micro class, from choices between apples and bananas to choices between period one and period two.

And so what we're sort of ignoring here is then in period one and period two, how are we going to spend the money? So we think of c1 and c2 as consumption bundles. Think about this like how much money is spent on certain consumption goods in period one versus period two, ignoring whether you buy apples or bananas, just how much money do you want to spend in period one, how much money do you want to spend in period two, ignoring how exactly are you going to divide it, assuming that you're going to get this right in terms of choosing within the period what's best for you. Any questions on that?

OK, so that gets us to the workhorse model in economics, which is Samuelson's discounted utility model. Paul Samuelson is a very famous economist who was at MIT for many, many years, one of the founders, if you want, of modern economics, and the MIT Economics Department as it is right now. And what Samuelson proposed was a non-graphical version of that, where he said, let's write down some math. Let's write down the representation. How should we think about utility maximization?

And what essentially he was proposing is to say at time t, people maximize their discounted utility, which is just the sum of discounted utility where there is a factor delta, which determines how much we care about the present versus the future. So we have, essentially, these instantaneous utilities, u t, u t plus 1, u t plus 2, and so on. This is your utility at each point in time.

Think of time as being discrete. In a sense, time could be years, time could be days, and the like. Think of them perhaps as years for now. There's your t, your t plus 1, your t plus 2, your t plus three, and so on.

u t summarizes, in some sense, how you feel in that year overall in terms of utility. That's your utility in that particular period. It could also be daily. It could be how you feel on a certain day, could be hourly, and so on. That's just a matter of definition.

And again, u t is a function of all activities that are going on in that particular year. That could be consumption, leisure, all the other things that are going on. That's sort of like in some sense, we abstract away what happens within that particular time period.

We're just summarizing all the things you're doing in that year yield to a certain utility. And now the question is, how do we aggregate these utilities? How do we decide between different options when the u t's differ across different options?

Now, what's coming in here, then, is the discount factor delta, which you see above, which essentially is telling you how much is util or an amount of utility, a unit of utility, worth in the future compared to the present. And so what you see here is a very simple functional form of doing that. Everything that's in the future is discounted.

Usually, we think of delta being smaller than 1. So delta could be something like 0.9, 0.8, or the like. So if you're in period t, period t plus 1 is discounted by 0.9. Period two would be then discounted by 0.9 to the power of 2, and so on, and so forth.

And so delta is essentially a very simple way of replacing a very complex psychology, how we think about choices over time, by saying let's just assume that people over time have a constant way of discounting the future. And it's taken on a simple mathematical form of exponentially doing so. Any questions on that? Yes.

STUDENT: Why was Samuelson's model adopted so widely? I mean, so it said in the reading that it was very simple and very pretty, but he's very much-- it seemed like oversimplified a lot of the research that had been done in the past. Why were people so quick, I guess?

FRANK SCHILBACH: Yes.

STUDENT: Was it, like, the fashion to have these [INAUDIBLE]?

FRANK SCHILBACH: Yeah, so I think one has to think a little bit about where things are coming from, in the sense that to start with, nobody had formalized some of these choices that people were making. In some sense, Samuelson was, like, OK, we have to assume something. So let's assume exponential discounting.

That's a simple thing to do. So let me just make that assumption as a first pass. He actually never thought this is the right model, or this is a normative model how people should behave, or the like.

That was all coming later. He was just proposing something that's tractable. And for tractability, he was proposing that.

Now, it's important to understand for a lot of behavioral economics, a lot of neoclassical economics, the traditional economics, simplicity is good. So usually, we like to simplify a lot of choices. And when things are simple, you can, in a tractable way, analyze things in the world.

And for many problems in the world, like for example, economic growth, or like how the economy evolves as a whole, and so on, some of these, the exponential discounting model might actually be the right model in some ways. Or if you think about how managers of firms, or whatever, et cetera, behave, in some ways that might be the right-- or the economy as a whole-- that might be the right model overall.

So in some sense, the answer is kind of like, A, some choices are actually explained reasonably well with exponential discounting. B, it was simple and easy to do, and you had to start somewhere. And then C, I guess people tend to stick to traditional things.

So in some ways, once you have written down a model, and people have written papers and invested their career in it, they tend to defend that, where in fact, maybe that's not the right thing to do, and become dogmatic about it. But that's now changing. And exactly as you say, there's problems with this model, and we're going to talk about those right now.

Now let me tell you a little bit about some definitions, just to be clear what we're talking about. So one is, what's a "discount function," what's a "discount rate," and what's a "discount factor?" So these are just definitions. A discount function essentially is when you have a stream of future utilities, u t, u t plus 1, u t plus 2, and so on, and so forth, you have to write down a function how to weigh these in the future.

So d of tau, as I'm calling it, is essentially giving you this discount function that specifies essentially all the weights that you're putting on future utilities and future periods. That could be that functional form. Could be anything. That's just a very general definition.

Now, what's the discount rate? It's essentially the rate of decline of the discount function. We call that rho and rho of tau, which essentially is just the derivative with respect to time divided by the discount function at that point in time. And the negative of that, because we think usually as positive as in the discount function tends to decline, as in stuff that's further away in the future you put less weight on than stuff that's closer to you or closer to the present. And so again, rho of tau specifies the rate at which value a util declines with delay.

And then finally, what does exponential discounting do? Exponential discounting specifies a specific functional form of the discount function. What does that mean? Essentially, we just take the discount function, d of tau, and what Samuelson was doing then was essentially just proposing a specific functional form, saying, OK, let's try that one. That's a simple thing to do.

Why do you choose that one? Well, it's delta to the power of tau. The discount factor now is delta. This is essentially when you think about two periods, how much weight do you put on each of those periods.

Let me just go back for a second. Here, when you think about going from u t to u t plus 1, you just add an additional delta. And going from u t plus 1 to u t plus 2, you add another delta, and so on. That gives you essentially the relative weights between two adjacent periods.

Now crucially, as you see here in that functional form, this is constant. So every time you have a time period, you go to the future, you add another delta. And that's an assumption.

So that's a very convenient thing to do. In part what it tells you, then, is also that the discount rate is constant over time. Again, so that you could do some math, and calculate the discount rate, if you do that, you'll find out that the discount rate is minus log delta, which is approximately 1 minus delta.

That is to say, not only is the discount factor constant, but also the discount rate is constant. And that's an assumption, again, that's made by Samuelson. So you can do that math. We can also do some of that in recitation in case you have questions.

Now let me give you an example on how does that help us think about how people make choices over time. Student Amy considers writing a term paper today so as to give herself a free evening in the future. So this is essentially the idea that the student now, tonight, has some stuff to do.

There's some opportunity costs right now. An outside option-- she could watch TV, she could meet her friends, or whatever, or she could write her a paper right now. The paper, if you write the paper right now, it comes at a utility cost of minus 1, costs 1 util because the other activities would be more fun to do it. She'd rather watch movies. However, if, instead, she also has some other stuff to do tonight, so she doesn't really have a free evening if she doesn't write the paper, but she just prefers not to write it right now.

Now, if she writes the paper right now, she will get a free evening sometime in the future in a few days from now. And that would be a lot more fun. She could go out. She could do whatever other things she likes to do.

She could go to the symphony or whatever she likes doing. The instantaneous benefit, the utility of getting a free unit, is 4/3 utils, so it's higher than the cost right now. But it's in the future, in some future evening.

Suppose Amy's daily discount factor is 0.9. Now, what does she do? How do we think about this now?

So the daily discount factor is 0.9. Is she going to do it if the free evening is tomorrow? Yes.

STUDENT: [INAUDIBLE].

FRANK SCHILBACH: And that's positive or negative? It's positive. Exactly. But it's exactly right. So you have to think about she gets the immediate costs right now, which is minus 1, the benefits of 4/3 on the future. Since her daily discount factor is 0.9, she's going to discount that by 0.9.

That's still larger than 1. So she decides to do that. That's how she weighs, essentially, the present and the future.

Now, in two periods, she does the exact same thing. But two periods are now further away in the future. So she discounts it by delta to the power of 2. And that gives her, again, something that's larger than 0, if I got the math right. So still she's willing to do it, if the free night comes two nights from now.

If it's in three periods, however, turns out then minus 1 plus delta to the power of 3 times 4/3 is, in fact, smaller than 0. So she will not do it. So essentially, when she thinks about costs and benefits, it depends a lot on how far away are the benefits in the future. The further they're away in the future, the more they get discounted, and the less likely she's doing something that will cost her utility now and yield benefits in the future.

Now, of course that's highly stylized. Yeah.

STUDENT: [INAUDIBLE]

FRANK SCHILBACH: Correct. Correct. So what I'm assuming here, I was not saying, when is the best time of doing that. What I was assuming is choice between today versus in a few days from now. There was no option of saying today, actually, I'd rather do it tomorrow.

We'll get to that. I was just giving you an example of a very simple choice between today versus sometime in the future, and then another choice between today versus tomorrow, today versus in two days from now, today versus three days from now, assuming that other days are not an option for now. We'll get to-- so procrastination, you need several days. We'll get to that later.

So again, the bottom line-- one second-- the bottom line is she will do it if the nice evening comes the next period or in two periods, but not if it comes later. Yeah.

STUDENT: Doesn't in all the periods she gets more utility if she rather gets a free day today and she switches the options, so she can [INAUDIBLE]?

FRANK SCHILBACH: Yes. Yeah, so what I'm assuming here-- and this is, again, an assumption-- is that the free night cannot-- so I was saying a little bit, but perhaps not clearly-- she has something to do tonight anyway, so she can't really have a free night. Maybe she needs to call her friends and so on. So that option is not available right now.

You're exactly right. If the free night came tonight, she would do that, and then do the stuff later, because she prefers the present over the future. But I was assuming that away for simplicity.

But in general, as it happens, many choices are often in the form of either current costs and future benefits, and then you'd rather defer those things. You only do that, essentially, if the benefits are sufficiently high. Other options are current benefits and future costs, and then the entire thing is essentially flipped.

So now, the next question, then, you might have is to say, well, how do we actually estimate delta? So we see people doing choices, but in some sense in the real world, we actually don't know what somebody's delta is. So how can we actually estimate people's delta over all?

Let's stick with the stylized example. What do we need to estimate delta in this specific example? Well, you would need several choices over time, and then essentially, you need to know what the costs and benefits of those choices are. And if you knew that, then you could learn about what delta is.

Let me just write this down for you. Suppose we didn't know Amy's delta, but we knew that u tau's for all periods for the different options that she has. So how could we estimate this from the above data?

So we learned, essentially, over here, suppose we see this behavior overall. What we get is several inequalities involving delta and involving u t's or u tau's that people choose in different points in time. So once we have these inequalities, then we can essentially just estimate what is delta. We just back out what delta is from these choices.

So what do we do? Well, we can just essentially do the math. It's very simple.

And what we'll find is, for example, if you see that the behavior that we just saw, which was essentially that she does it when the free night comes one day from now or two days from now, that gives us two inequalities, the first two inequalities that are written down, which is essentially delta must be larger than 3/4, delta must be larger than 3/4 to the power of 1/2, which is about 0.87. And then we have a third choice, where she doesn't do it if the free night comes three nights from now, which gives us another inequality, which tells us delta must be lower than 0.91.

So if you saw those choices, but if you knew the utility of a person, you could then back out what delta is. And delta in this case would be between 0.87 and 0.91. Does this make sense or any questions about that?

So all I was doing here is to say, suppose we didn't know delta, but we just saw the Amy's choices. What can we learn about her delta if we knew what the utilities are at each point in time? And if you do that, from this behavior we get these inequalities. And we can then back out what the delta is.

Now in reality, we actually don't know what the u tau's are. We don't know what utility is for different options from people. So if you see people's behavior, we can't actually estimate the delta from that. So what could we do instead, or what kinds of choices can we make or can we elicit? Yes.

STUDENT: If you can do it with money, there are different options. You have a chance to win [INAUDIBLE].

FRANK SCHILBACH: Right. And what additional assumptions do we need for that? So that's exactly right. That's exactly what people have done a lot.

So this is Rick Thaler again, a Nobel Prize winner who has done exactly that in 1981, getting people to start with hypothetical monetary choices. So say suppose-- this is kind of what I was asking you at the beginning in the first class. I was asking you different numbers, but what x makes you indifferent between $15 today and x dollars in a month, a year, and 10 years from now?

What do we need to assume for that now? Or what other assumptions do we need? How do we go from money to your utility?

STUDENT: There's an old study [INAUDIBLE].

FRANK SCHILBACH: Exactly. I need to assume something that's quite important. I need to assume utility is linear in money, either to say I'm just looking at that specific problem, u of X equals X. Or slightly more complicated, but in principle the same, marginal utility is constant over time. And that's sort of related. For our purposes, what we're going to assume for now is just to say your utility is linear in money. You have X equals X.

And then what you can do is if I give you an amount Y-- Y is $15-- and then I ask you what makes you indifferent between X dollars in, say, a month or a year from now? I'm just going to write down an equation, which essentially is to say u of Y, which is the utility of getting the $15 right now-- is you're indifferent between that because you just told me so, and u of X, which X is the amount that you just told me. And now I need to discount that by delta to the power of t, which is because it's in the future, you need to discount that.

Once I know that, I know essentially everything on the left-hand side and the right-hand side of the equation except for the delta. I can just back out delta from that. So what we're going to do is we're going to just use, then, the linearity assumption of the utility is linear in money, which is like u of Y equals Y, and u of X equals X.

We take logs on both sides and rearrange, and then get rho, which is, again, the discount rate, equals minus log delta. And that's log of X divided by Y and divided by t, which is the time period that I'm asking you about. That's a simple algebra and rearranging things.

We talked about a little bit in recitation and in the problem set as well. But is it clear what we're doing here? Are there any questions about that?

So just to summarize what I'm doing here, I'm just asking you between different choices over time. I'm assuming a utility function of money. So I'm imposing on you in some way-- and it might be a good or a bad assumption-- but I'm essentially assuming how you value money at different points in time. And with that assumption, then, I can back out from your choices over time how much you discounting utility in the future. And then the rest is just rearranging and doing some math.

So now, how do you do that? Here's an example of how to do that, then, for Y equals 15 and X equals 20. So if you told me that what makes you indifferent between $15 now and X in a month, if you told me $20, I can just write down the equation, and I get essentially a delta of 0.003.

The reason being that if you are indifferent between $15 and $20 right now, you're discounting, essentially, anything that's in the future by 3/4. Essentially $20 in a month from now or 3/4 as much-- or the money in the future is 3/4 as much worth for you than the money right now. That's the 20 versus 15 in a month from now.

And then I have to do this every month. So every month, it's 3/4 to the power of 12 will give you something like 0.03 as delta. So I'm just calculating the yearly discount factor using your monthly choice. Yeah.

STUDENT: [INAUDIBLE].

FRANK SCHILBACH: Right. So usually, what people do is yearly discount factors. So usually the delta is yearly. That's just a convention. You could also do it monthly, or daily, or whatever.

So what I'm doing is yearly discount factors, partially because I want to make them comparable across choices. But you could similarly also just do the monthly one, or whatever. And a lot of economic analyses, yearly is the frequency. When it comes to your problem set questions, it's going to be daily, because students tend to think in days, not necessarily in years.

STUDENT: [INAUDIBLE].

FRANK SCHILBACH: Right. So in some sense, this is what we're getting here in some ways in saying-- here I'm asking you about-- so you see the choice here, and these are actually real choices that people have made. When I ask you now between Y dollars, $15, right now and X dollars in 10 years from now, people tend to give different answers. And one constant finding there is that people tend to be more patient when it comes to longer run choices compared to shorter run choices.

I'm calculating the same discount factor. And what I just told you earlier is in the exponential discounting model, the discount factor delta should be constant over time. Should be the same whether you decide between today and tomorrow, between a year from now and a year and a day from now, or between any time in the future.

But what we find or tend to find in these kinds of choices is that people's discount factor is a lot higher in the future compared to in the present. I'll get back to that. So actually, your question is exactly on point. When eliciting choices between different days versus months versus years, you get a lot different answers depending on what you ask.

OK. So now, we can say-- and this is exactly what you're asking-- let's see. When you do this in different settings, what kinds of answers do you actually get. And what you see here is here's people's choices of delta and different types of experiments people have done. This is different years of publication.

But overall, what do you see is essentially, these estimates are all over the place. So you think we know what delta is. We think it's 0.9, or 0.8, or 0.95, or whatever.

But in fact, when you look at people's choices in different types of experiments, these choices tend to be all over the place. So that's not a good sign for a model, because you're trying to identify a parameter that fits many settings. Well, here, it seems to be that these choices are essentially all over the place, which tells you already maybe something is wrong in this model that we should try to fix.

Now, one thing I already said here is to say, when you look at short-run versus long-run choices, we tend to find that people are really impatient in the short run. However, people are patient in the long run. There's lots to learn from this experiment in various ways, in part about strategies to overcome self-control problems.

For example, a lot of kids are trying to manage their attention, are looking at, and looking away, and so on. But mostly, I think the key part you learn is how painful it can be to resist. In the short run, there's lots of essentially short-run discounting or essentially short-run impatience that we see in the world.

And if you think about it, often it's very hard in the short run to resist. Often when you think about in the future, it's much easier to do so. When you think about choices that you might face in your life-- be it marshmallows or something else-- would you rather have one marshmallow right now versus two marshmallows in an hour, you might say, well, maybe one marshmallow looks actually pretty good. Let's just take that one marshmallow right now. And a lot of these kids, I guess, opted for doing so.

When I ask you instead, would you like to have a marshmallow in a week from now versus two marshmallows in a week from now and an hour, it almost becomes ridiculous. Of course you're going to take two marshmallows in a week and an hour from now. What does it matter in terms of when exactly you get the marshmallow?

When I ask you the same questions about one marshmallow in a year from now versus two marshmallows in a year and an hour from now, it becomes very obvious that of course, I want the two marshmallows-- unless you think in a year from now, you might be on a diet. But the exponential discounting model has precisely that assumption. The assumption is that how much you discount an hour in this case does not vary depending on whether it's right now, whether it's in a week from now, versus whether it's in a year from now.

And the short-run discounting essentially tends to violate that assumption, in part because it leads to pretty absurd implications, as I'm going to show you in a bit. So what other evidence in the world do we have about short-run impatience, other than the marshmallows? Yes.

STUDENT: [INAUDIBLE] get concentrated.

FRANK SCHILBACH: Right. There's lots of-- I think among you guys, not that many people smoke, but lots of smokers would say, oh, I'd love to stop smoking in the future. I really want to quit. But then they find it very hard to do right now.

And maybe next time in the future, I will quit, and so on, and so forth. Lots of people try, and then fail, and so on. And in part, it's like the short-run impatience or short-run difficulty to do that compared to maybe the long-run desires of wanting to do so.

We'll get back to smoking, actually, at some point in the future. But that's exactly a great example of that. That's also true for other drugs, other addictions, and so on.

Actually, some of the social media, or computers, or phones, or whatever, you can also think of like that being sort of addictive in a sense. In the short run, it's very hard to get away from that. But in the very long run, it would be nice thing to do. Often, then, there's short-run impatience involved. Yeah.

STUDENT: Taking a break now versus [INAUDIBLE].

FRANK SCHILBACH: Yeah, so a break now always seems like a great idea. And then in the future, you're going to work really hard and so on. And then the future comes, and again, taking a break right now seems really appealing. Yeah.

STUDENT: Aggressive driving.

FRANK SCHILBACH: Oh, that's interesting. Can you say more?

STUDENT: In the short run, you're impatient. You're concerned about your [INAUDIBLE] so you might try to get to the destination faster. Or just in general, people try to get to the destination as fast as possible [INAUDIBLE].

FRANK SCHILBACH: Right. So of course, there's also other factors involved, including risk and the like. You might think-- you underestimate how risky it is, and you might think, oh, I might be overconfident, that you're never going to have an accident. But exactly as you say, in the short run, essentially there's some short-run benefits, which is like I could be there faster. It's kind of annoying to drive, and so on, and so forth.

The costs are in the future in some sense, so uncertain. You might crash and so on, and you might be impatient in the very short run. That's right. But I think that's a little tricky as an example because there's all these other factors. I do think, however, that short-run impatience is involved in that as well. Yes.

STUDENT: I think credit cards are also a good example. Like, you can buy this now with a credit card instead of saving to buy the thing.

FRANK SCHILBACH: Yes. So a lot of essentially choices of money over time, you can see the choices that I was asking you guys in class. That essentially shows some short-run impatience as well. There's perhaps even more salient payday loans that you might be familiar with.

So payday loans are essentially a very interesting phenomenon, where essentially, there are workers who get their paycheck by the end of the month or the beginning of the month, but then on the 20th of the month or sometime earlier, they would like to have some money earlier than that. So you can essentially just say, give me some money at a very high interest rate, and once my payday comes, I'm going to pay you back.

The interest rates are usually enormous. Usually it's something like up to 5,000 annualized compound interest, which is insane. These are huge interest rates.

It's also an enormous industry in the US. It's more stores than McDonalds and Starbucks combined, which I'm not sure how many stores there are, but I think there's lots of them. And people pay huge interest rates, and it's a huge industry of doing that.

What's kind of funny about payday loans, in some ways, is actually in some ways, it's an odd thing of the world-- that's sort of an aside-- as in workers have worked already for 20 days. In some sense, the employer owes them money. But instead, they're essentially taking loans from a salary that's actually, in some sense, theirs already anyway in various ways. But that's just an aside.

So that's a huge industry. You were saying something similar, which is credit card debt. Usually there, the annual interest rate is lower than that. It's something like 20% in many cases, sometimes also higher. There's lots of credit card debt in the US.

And you can think of this as like essentially signs of short-run impatience. What you see is people wanting to spend money now on various things. And they get the gains of doing that. The cost of that comes sometime in the future when you actually have to pay it back.

Finally, there's also some evidence of payday effects. These are often involved in things like people, for example, who get food stamps or any other monthly or other cash transfers-- that people get either food stamps or money at some point conditional/unconditional cash transfers at the beginning of the month. And then usually, there's these cycles in consumption or also expenditures, where at the beginning of the month, people live large and have lots of money.

Same is also true for graduate students on their stipends. The first weeks or months after getting your paychecks often is really great. And then it sort of declines over the course of that cycle.

The same is also true, by the way, for farmers and harvest cycles in India and other places. And then usually towards the end of the cycle, people either are hungry, or have low caloric intake, or are just not very happy. That's a very common phenomenon. And at the heart of that, there is some short-run impatience, in the sense of at the beginning of the month, you're really impatient, want to consume some stuff, and discount what's in the end of the cycle, what's further away, where the costs are coming, then, in terms of not having enough resources or money available anymore.

Here's some examples of payday loans. I was wondering what this woman-- this is from wonga.com. Apparently, they are advertising with grandmothers, because you wonder what this woman is doing there.

But what you see here on the right-hand side is essentially, the interest rates are something in the 1,000%. These are the annualized interest rates. These are enormous interest rates. Usually people take many loans of that.

They also take repeated loans. So it's not just as an emergency where people take a loan, but people tend to roll over these loans over and over again, and actually pay lots and lots of money to these companies.

There's often very high credit card APRs, which 20%, 25%, and so on are very common. Again, lots of people have lots of credit card debt. And often, it's again, not just to deal with shocks. You might say, well, if you have a health shock or some other shock in the family, if people get perhaps unemployed for a short period of time, maybe that makes sense to deal with that shock. But often, people tend to roll over this interest for many, many cycles, and keep paying these really high interest rates.

Now, in some sense, that's just empirical evidence. That's just a fact that these things exist. However, when you think that through, you get very absurd implications of this short-run impatience.

So what I showed you now is several pieces of evidence of short-run impatience. Now taking the exponential discounting model very seriously, we're going to think about some of these implications of what does the exponential discounting model say and imply from that. And one way to think about this is the money now versus later choices.

As I told you before, when you look at number one here, I was asking you about what makes you indifferent between $100 now and $X in two weeks. And the median student was saying something $120, $115. And you can think about what does that imply for the yearly delta.

Well, it implies for the yearly delta that it's about 5/6. So you're indifferent between $100 now versus $120 in the future. So that must mean the future is 5/6 as much worth as the present is for you right now.

Now, that's fine. Excuse me, that was the two weeks that was I was asking you about, $100 now versus X dollars in 2 weeks from now. So the two-week delta is 5/6.

Now you can think about what does that mean for your four-week delta. Well, it's 5/6 to the power of 2. So that's essentially you're indifferent between $100 now and $144 in four weeks from now.

You're also indifferent between $100 now and $11,400 in a year from now. And you're also indifferent between $100 now and I don't even know what that number is, but a very, very large number. So if you think the discount factor is delta, and you just roll that forward, you get essentially absurd implications, the reason being that we assume the discount factor is constant. And so that, then, essentially, if you are reasonably impatient between the present and any time in the near future, like two or four weeks from now, that must imply that you really, really don't care about what's happening in five years from now, and so on.

Now, that's completely unrealistic. The discount factor for two-week delays in the future must be, in some ways, higher than the discount factor for two-week delays in the present. And that's essentially what the quasi-hyperbolic, or the model I'm going to propose to you in the next class, is going to try and explain.

So why is that unrealistic? Well, we know for many situations in the world, people care a lot about the future. People save for retirement. People invest in education.

People exercise, often. People do problem sets. People brush their teeth. People eat healthy, and so on.

People invest a lot in the future, in stuff that happens four or five, six, seven, 10 years from now. So they care a lot about the future in some ways. Yet we find the short-run impatience. So now we need to find some model that can bridge this gap.

And so another way to put this is when you look at the evidence that we have in terms of my time horizon, when you look at discount factors conducted in studies such as the one that I just showed you, or using real-world decisions, what you see usually is that the discount factor in the very short run tends to be very small. This is what you see on the left-hand side of the graph.

When you look at further in the future, the discount factor tends to be higher. Or another way to put this is the estimated delta increases by time horizon. Again, that's a violation of the exponential discounting model.

So that's the first piece of evidence. The second one is preference reversal, dynamic inconsistency. What I mean by that is dynamic consistency is essentially the property that when you make a choice for the future between two future periods, and when the future then comes absent new information or any other things that have happened, you will stick to that choice.

A formal decision or a definition here is, the action a person thinks she should take in the future always coincides with the action that she actually prefers to take once the time comes. So if I make a plan to exercise tomorrow, or if I make a plan to eat salad tomorrow, I'm going to actually do that. I'm not going to be, actually watching movies seems like a good idea, or the potato chips instead look better.

I have perfect foresight in what I'm going to plan for the future. I know my future preferences. And my future preferences for what I want for the future coincide with what I actually want in the future, as well.

And so put differently, there's no intrapersonal conflicts. That is to say what I want for the future is also what my future self wants for itself. And so that's closely connected to the assumption of exponential discounting-- that is to say exponential discounting has the assumption that how much I care between the present and the future is always-- the weight is always determined by delta, and that delta doesn't change over time.

So when I think now about what I want in the future, between a year from now and two years from now, the difference between those or the discounting will always be delta. Once the future comes, the difference between a year from then and-- at the time, then, it will be like the present and a year from now-- will also be delta. So there's no difference there.

So what's the formal argument of the exponential discounting model? Well, it is essentially if at time 0, I prefer an action A over an action B, suppose there's different actions. There's action A and action B that I can do starting in period one.

Well, if I prefer action A over action B, on the left-hand side there's the utilities associated with that. There's u0 plus delta times u1 A of action A plus delta squared of u2 of action A, and so on. If I prefer that over action B, well, it must be that I prefer the stream of utility on the left-hand side to the stream of utility on the right-hand side.

But now that implies if I take away the u0, because they're the same on both sides, because I'm making choices for the future, and then divide by delta, what I get is essentially, again, an equality that at time 1, again, I still prefer option A over option B. That is to say, if I prefer option A over option B at time 0, that implies essentially that I also prefer option A over option B at time 1. So that essentially is another way to say it, is that the exponential discounting factor implies time and consistency. Any questions about that?

So what examples do we have that violate this property? We already talked about this a bit in the previous classes, but just remind ourselves. Yes.

STUDENT: The betting on how much weight you lose when you're on a diet. You make sure that you'll want to change your behavior.

FRANK SCHILBACH: Exactly. So dieting in general seems a great example of saying, I really would like to lose some weight, or have some target weight, or some target exercising, or a certain behavior of eating and exercising or combined. And I really would like to do that.

For now-- I mean, I think about the future. Often at New Year's or certain points of the year, our birthdays and so on, people think, OK, I'm going to do this. I have great plans and so on. They have certain preferences for the future.

But then the future comes a week or a month from then. People don't follow through. Exactly. That's essentially a clear example of a preference reversal, which is essentially another way of saying preferences are dynamically inconsistent. Any other example?

Yes.

STUDENT: [INAUDIBLE] say we should do something, kind of like this is, like, what we want our future to be. [INAUDIBLE].

FRANK SCHILBACH: Exactly. So that's true for, did you say exercising?

STUDENT: Yeah.

FRANK SCHILBACH: Yeah, for exercising, exactly. I'll show you some examples of people, for example, signing up for gyms that pay yearly membership fees, and so on, that tend to be very expensive. The idea often is then they think about they will go to the gym weekly, or daily, or whatever.

And then under that assumption for your preferences for the future, then it makes a lot of sense. But then if you then not actually go, or if your preferences are different, then it turns out to be different in the future, that's a pretty bad idea. Yes, you were saying.

STUDENT: So consider apples or bananas. If I'm choosing [INAUDIBLE].

FRANK SCHILBACH: Yeah, to be clear, if you just start eating apples because you had too many bananas in the past, that's not what we were talking about. So it's not about people's past choices affecting future choices through some form of habit formation, or people getting bored, or tired, or the like. But it's about if I today choose today I want bananas, tomorrow I want apples, and then tomorrow I'm actually saying, actually, I don't like apples, I really like bananas, then that would be a violation.

But it needs to be something that's essentially either new information or some new options or so on that become available. In the example that you're mentioning, there was none of that. So that's not quite what we're talking about.

More common is-- and there's a paper that does this, in fact, with Dutch employees by Read and van Leeuwen that essentially asked people about next week first. So it asked them about-- this is actually an actual company, where workers were asked, after lunch, would you like to have a snack? And what snack would you like to have? Would you like to have apples or chocolate?

When you're asked to do that today for next week, 74% chose fruit or apples, essentially. So lots of people tend to want to be virtuous in the future, eat healthily, and so on. When you ask them then the same question-- so then in the actual experiment, what they did is then they went back to the workers, and said, oh, I forgot your choice. Why don't you choose again. Let us know. That was a little bit cheating, but then essentially, 70% of people, when it comes for the same day, choose chocolate.

And here's none of that, in the sense of there's no habit formation, there's no people ate too many apples and now they really want chocolate. That was only one choice. And so now, when I make some choices for the future and the future comes, I should stick to that choice.

Similarly, there's movie choices. It used to be-- you guys are probably too young for this-- Netflix used to send you movies to your home. But often what lots of people had was this issue-- they had great plans of watching highbrow, or high culture, and often sad or deep movies in the future. There's really things they wanted to watch, be it *The Piano* or *Schindler's List* and so on, which by some category we might call highbrow. But instead, when the present comes, people often like to watch essentially lowbrow movies like comedies, and so on and so forth, for example, *Four Weddings and a Funeral, Speed,* and so on, so action movies or the like.

And then what would happen in Netflix often is you would get all these movies that you'd really love to watch in the future, but never in the present, then get stuck with them. And there's, in fact, an example or a paper who does this, which essentially elicits people's preferences for what they would like to watch in the present versus in the future. And what you see, essentially, is people tend to systematically pick for the present, for tonight, people tend to watch or want to watch lowbrow movies.

Action, rom com, or whatever sounds really good for tonight. When you think about what would you like to watch next week, people tend to pick highbrow movies instead. And there's lots of examples of that kind.

And so just to summarize, these preference reversals, again, these are not really possible in the exponential discounting model. That should not occur. That's by assumption not possible in that model, as I just showed you before, yet we see plenty of examples in the real world.

Now, the third piece of evidence is demand for commitment. That's really closely related to that. So one example here is demand for commitment is essentially when you know that your future preferences will be different from your present preferences, you might engage in commitment devices.

What does that mean? You might want to change the prices of your options in the future. And particularly, you might want to take away some options in the future. One example is Ulysses and the Sirens. Who knows that story or can tell me what it is? Yes.

STUDENT: So basically, there are these Sirens, and they're singing and [INAUDIBLE]. But [INAUDIBLE] but it's hard to tear yourself from [INAUDIBLE]. So he had [INAUDIBLE] tied to the ship so that he wouldn't be able to.

FRANK SCHILBACH: Yes, exactly. So here's Ulysses. I think he was on his way back from his long journey. He knew that the Sirens were going to come.

He knew that his preferences would change in the future-- that he would not be able to resist their power or their songs. And so what he did is he asked his crew to bind him to the mast so he would not be able to leave the ship, even if he wanted to in the future. And that's demand for commitment because he was taking away some options in the future, with a goal to change his future behavior, knowing that his preferences would change in the future.

If you wonder why the guys who are rowing are not leaving the ship. They had wax in their ears. I don't know why Ulysses couldn't use the wax either, but anyway--

So that's one example of a commitment device. There's another one, which is sort of financial advice that people often get, which is the following-- cut up your credit card and store the cards. If possible, get rid of all your credit cards or put temptation out of reach.

If you really can't do without a credit card, limit yourself to one. Put it in a tub of water, and stick it in the freezer. And so the idea here is if you really have self-control problems, well, when you want to buy something really quickly, when temptation sort of takes over, you have to limit your options in some ways. So in some sense, have you some cool down period. It takes a while to get your credit card out of the freezer.

I don't know. I asked my wife about is this a thing? And she was saying, well, haven't you watched "Confessions of a Shopaholic?" I have not. If you want to watch that video, you see, in fact, apparently that is, in fact, a thing.

But the idea of having some cool down period, which essentially is to deal with essentially short-run impatience, comes in many settings and many variations. In fact, for example, if you'd like to get married, often you have to go to some office and declare that you would like to get married, and then wait for another three days or something until you actually get married. Often, the idea is people sometimes come to their senses and it takes a few days.

So what do these examples show? Well, they show that people have a tendency for immediate gratification. And they tend to discount quite heavily in short-term decisions.

Now, what does the demand for commitment then show? It's we, in fact, tend to disapprove of this tendency beforehand. That is to say we know that in the future, we might be impatient. We don't like that. And because of that, we bind ourselves to the mast, or we freeze our credit cards, or some people, at least, do.

And so all of these decision makers are time inconsistent in the sense that when they make certain choices for the future, what they will want to choose in the future will be different. And knowing that, they will restrict their options. That is to say, different selves want different things.

So then what's the heart of the issue? Well, the heart of the issue is that there are conflicts rooted between short and long-run patience. What we want in the short run is different from what we want in the long run.

That is to say when we think ahead of the future, we tend to be very patient. There's all sorts of good things we want to do in the future. When the time actually comes, when we think about the present, we tend to be impatient.

Now the issue with exponential discounting, then, is the exponential discounting model has only one parameter which captures essentially discounting. But it can sort of-- by assumption, the discounting needs to be the same across all time horizons. That is to say, it can only match one of those two things, but not both.

It can only match either your short-run discounting, but then the long-run discounting is off, or you can try to match the long-run discounting, but then the short-run discounting is off. So what that tells us, we need two parameters to deal with that. So what we want, and I'll talk about this a lot more in the next class or in the next few minutes.

And then in the next class, we want a model that has greater patience for trade-offs in the future than for trade-offs in the present. And then we want another model. So one is we want different levels of patience over different time horizons, and we want a model that explains or helps us explain dynamic inconsistency.

So what is that model? So I just showed you before the exponential discounting model. That's just what I showed you before, but that's exactly the same, where essentially, your discounted or lifetime utility is essentially what's given here, where we have delta.

It's between 0 and 1. And delta is a short-term discount factor and it's a long-run discount factor. If I'm trying to decide between t and t plus 1, the difference between that is essentially delta. And if I decide between t plus 3 and t plus 4, it's also delta that regulates this factor.

Now, what does the quasi-hyperbolic discounting model do? It has another parameter. And this parameter is called beta. And beta governs, essentially, short-run discounting, while delta is the long-run discount factor.

What is that telling us? Essentially, beta discounts anything that's in the future. So essentially, if you look at the equation now, anything that's in the future, that's not period t, is discounted by beta. And then within any future periods, we have another discount factor that's essentially the long-run discount factor. That's delta.

Now, why does that help us? It helps us because now we can essentially separate short-run and long-run discounting. You can say short-run discounting is governed by beta and long-run discounting is governed by delta. And now we can match a lot of facts that we couldn't match earlier. Any questions on that? Yeah.

STUDENT: Yeah, I was wondering if the evidence [INAUDIBLE] was comparable to this. Because if you have a beta that really discounts any future consumption, would the commitment device [INAUDIBLE]. Because many [INAUDIBLE].

FRANK SCHILBACH: So you're asking two separate questions here. So one question is, can we explain, in theory, commitment devices? Can we explain essentially-- can we write down a theory that says you should be at least under some assumptions, under some parameters, willing to engage in commitment devices to demand for commitment? The answer is yes, depending a little bit on your naivete and sophistication, which we're going to get to.

But so you in principle, at least, can in theory write down a version of this model that predicts demand for commitment. You're asking a separate question, which is are these commitment devices actually going to help? So A, are some people are going to make use of these commitment devices, and B, are they going to help?

The answer is maybe. In many situations, in fact, no. The reason being often people then-- they might demand commitment but then not follow through in various ways, which can be then explained by people are sort of overconfident when it comes to their self-control problems. We're going to talk about this next time.

So the idea here is that people might understand that they have self-control problems. They might demand commitment devices. They might say, I'd like to have a commitment device to help me, but they might underestimate how bad their self-control problems actually are.

So then they demand a commitment device that's actually kind of helpful but not quite enough, that's not powerful enough. They demand that commitment device, but then they actually fail and do the thing they want to do anyway, and essentially have to pay money, or other things like that. We'll talk about that.

But that's not a theoretical problem. That's an empirical problem, in the sense of in principle, commitment devices should help. They might not be able to do so in practice.

Let me tell you a little bit more about specifics of the model. And then we're going to talk about this in more detail next time. So usually, we tend to assume that beta is lower than 1 and delta is close to 1.

So for example, we think beta is 2/3, or 3/4, or the like, and delta equals 1. So then your discounted utility becomes something like this. So relative to the current period, all future periods are worth much less.

So everything in the future, essentially, you discount by 2/3. And then within any future periods, you don't discount very much anymore. Usually, we think delta is 0.99, 0.95, or the like.

So there's some discounting in the future. You care more about stuff that's one year from now compared to 10 years from now or 30 years from now, but not that much differently. You care a lot about whether stuff is in the present versus in two weeks from now or in a year from now.

And so then similarly, if beta equals 1/2 and delta equals 1, then again, your discount function-- this is the d of tau that I was writing down earlier-- is essentially you care about the present 1, and then everything in the future is 1/2. So again, relative to the present, all future periods are worth less, weighed 1/2. And then all discounting takes place between the present and the immediate future.

So then again, what we can explain now is essentially short run impatience. I'm essentially impatient between the present and the future. Anything that's in the future is essentially far away or gets the weight of, in this case, 1/2 or 2/3 or the like. I can also explain long-run patience, because essentially across the years in the future, there's no discounting happening anymore. People tend to be relatively patient.

And so then, decisions, of course, are very sensitive to the timing of costs and benefits. We're going to talk about that next time. So as I said in the email I sent you, readings until Wednesday are the [INAUDIBLE] paper. We're going to discuss or finish the same set of slides that I've given you now. Let me know if you have any questions. Thank you.