14.01SC Principles of Microeconomics, Fall 2011
Transcript – Lecture 4: Preferences and Utility

PROFESSOR: We've been talking so far about basically overviews of supply and demand relationships and understanding how markets work. Now we're going to step back and get behind the supply and demand curves and understand where those curves themselves come from. So we talked about, given that we have supply and demand curves, how they interact. Now we're going to get behind that and see where these curves actually come from.

Thank you, by the way for coming down. I appreciate it. So what we're going to do is, we're going to start with the demand curve, and we're going to spend the next few lectures talking about consumers and how consumer preferences are ultimately what leads to the construction of the demand curve. Then after that and after the first exam-- that will cover what's on the first exam-- after the first exam, we'll start talking about firms and what determines the firm supply curve.

So today we'll talk about consumers and we're going to talk about where the demand curve comes from. And where it comes from, and where all consumer behavior coming from in economics is from utility maximization. That's where everything with consumers starts is with utility maximization. That's the basic building block of consumer behavior. And basically, utility maximization-- that's what this lecture will be about, describing it.

But basically, an overview is, we posit some type of preferences. We posit consumer preferences, what consumers would like. We posit some budget constraint, what resources consumers have to get what they'd like. And then we do a constrained maximization problem that says, given your preferences, given what you'd like, subject to the resources you have available, what choices will you make?

And in particular, we're going to ask, the term we'll use is we'll ask what bundle of goods makes you the best off? Given your preference, given your constraints, what bundle of goods? So think about consumers choosing across a set of goods. Typically, we'll think about two goods because graphs are easier to think about two dimensions than more. So we'll typically think about trading off two goods. So think about consumers with preferences across two goods, some budget they can allocate, and how they make those choices.

But this basic framework applies to the multiplicity of choices we all make along many, many dimensions. So doing two dimensions as one of the simplifying assumptions I'll talk about. But that's just a simplifying assumption. So basically what we we're going to do is we're going to go through this in three steps, not just in this lecture, but over the next few lectures.

Step one, is we're going to talk about what assumptions we make about preferences. So I'll talk today about preference assumptions. So the axioms that underlie how economists model consumer preferences. We'll then talk about how we translate these preferences assumptions into mathematical tractability through the use of the utility function, which is basically a mathematical representation of underlying consumer preferences.

So we'll talk about how we basically take these preferences and translate them into something that we can work with here at MIT by making it mathematical, by making a utility function. And then finally, we'll talk about budget constraints. And armed with these three things, we'll then be able to model how consumers make decisions.

Now, importantly for today's lecture, we are not dealing with budget constraints. So this is not happening today. So today we're not going to worry about the budget constraints. Today we're in a world where we're just going to talk about what people want and we're going to put out of our mind whether or not they can afford it. So just talk about people want, and we'll put out of mind for today. We'll come back next time to whether they can afford it. We're just going to think about unconstrained preferences for today's lecture.

So let's talk about our preference assumptions. So, to model consumers' preferences across goods, we're going to impose three preference assumptions. Three preference assumptions. Assumption one-- now once again, let me remind you from the first lecture, this is getting to some of the harder material. I'm going to write messily and talk quickly, so stop me if anything is unclear. And if you don't stop me, I'll just go faster and faster until I explode. So basically, feel free to interrupt and stop me with questions and such.

Three assumptions on preferences. The first assumption is completeness. The first assumption is the assumption of completeness. When comparing two bundles of goods, you prefer one or the other, but you don't value them equally. OK when comparing two bundles of goods, you prefer one or you prefer the other, but you're not indifferent. Completeness is the same as no indifference.

So what we're saying is whenever I offer you two bundles of goods, you could always tell me what you like better. Now it could be infinitesimally better. I'm not saying you have to have strong preferences. But you cannot say I'm indifferent. You can never be purely indifferent. There always at least some slight preference for one bundle of goods over another. That's the completeness assumption.

This is an assumption we make. Now in reality, oftentimes we are indifferent. Well once again, this is one of these simplifying assumptions that will make the model work. And in fact, in reality if forced, you can always decide whether you like one thing better than another, we just often follow heuristic rules which say we're roughly indifferent. We're just going to say, more precisely, you are never purely indifferent.

So, I'm not sure is not an option. You can never say I don't know, I don't know which I prefer, I'm indifferent. I'm sorry, let me back up. I'm using the wrong word. Forget I said indifferent, because we'll want to use that word in a different context later.

You can't say, I'm not sure. You can't say, I'm not sure. You can't say, I'm not sure, can't say I don't know, I don't know how I feel about that. Scratch what I said a few minutes ago, because I want to use indifference differently. Completeness is not about not being different, we're going to use that. What I'm saying is it's about not being sure. You've got to value every bundle of goods. You've got to be willing to value every bundle of goods that's given you.

So you can't say that I don't know, I don't know how I feel about that. You've got to have some feeling about stuff. You can't say I'm not sure. You've got to have a complete set of preferences over all bundles of goods that are given you. OK, that's completeness.

The second is transitivity. Which is something we've been learning since kindergarten about transitivity, right? And also, it's a different context. That's just if you prefer x to y, and y to z, you've got to prefer x to z. OK, you guys should do transitivity in your sleep by now. OK, so the standard transitivity we always assume in math class, we're going to assume here as well. OK, that should be pretty noncontroversial.

OK, and then finally, and probably most controversial, is we're going to assume non-satiation. Or the famous economic assumption that more is always better. OK. More is always better, that is, you never would turn down having more. Now we're going to talk later today and tomorrow about why you might not like the next unit as much as you like the current unit. But you'll always like it greater than zero. You're always happy to have more.

You never say, I've had enough, I literally value at zero the next unit. You may value it as epsilon, but you'll always value it as greater than zero. That's the non-satiation assumption, more is always better. Now, this is the most controversial. And obviously we can think of many contexts in which that's not true. But if we don't allow for this assumption, the modeling gets a lot trickier. So once again, let's put it out of our mind.

Realistically, we know once we've eaten a certain amount, we literally do not want any more. OK, so we're going to put that aside. Assume we're always in a space where we can always eat a little bit more. OK, we'll call it the Jewish mother space. OK, you can always eat a little bit more. OK, you can always eat a little bit more. We're just going to assume we're in that space for now. OK.

And so, for large ranges, we can see it is not an unreasonable assumption. Although, I think in extremes, you could see this becomes unreasonable. OK, so those are assumptions. Completeness, which once again, I screwed up in describing. Come back to the second way I described it, which means you can't say you're not sure. You always have preferences over things. That doesn't seem unreasonable. Transitivity which we've been living with since we were kindergartners. And non-satiation, which could be a little controversial, but we'll live with it for now.

Now given these, we're going to talk about the properties of what we call indifference curves. This is why I screwed up before. Of course you can be indifferent between things. That's the whole point of economics. I don't know why I got that wrong. I haven't taught this course about six years, so I lost track of things.

Properties of indifference curves. So indifference curves are our name for what you could also think of as preference maps. In economics, we like to be able to describe everything, as I said, three ways, intuitively, graphically, and mathematically. Preference maps are the graphical representation of people's preferences which we do through graphics that we call indifference curves.

So now let's go to the example I'm going to use that I'm going to use throughout these next couple lectures of a decision you have to make. Now I tried to think of a cool way to make this example cool, and I just couldn't. So its going to be a boring example. It's going to be, imagine your parents gave you some money and you had to decide whether to buy pizza or see movies.

I tried to make it at least a little bit relevant even if I couldn't make it cool. You've got to decide whether to buy pizza or see movies. That's your decision. That's the trade-off you're making. We're in a world with only two goods, pizza and movies. And you're deciding how to allocate the money your parents gave you over pizza and movies.

Now let's say we're going to consider three choices of pizza and movies. So go to figure 4-1a. We're going to consider, you could have two pizzas and one movie, that's point A. You could have one pizza and two movies, that's point B. Or you can have two of both, that's point C. That's just three choices you're facing.

Once again, we're ignoring paying for them. Budget constraints is next time. Now we're just saying I'm giving these three choices. Well how do you feel about them?

Well let's assume that you're indifferent-- and this is why you can be indifferent. What I said before, just strike. Let's say you're indifferent between two pizzas and one movie, and one pizza and two movies. Let's say, if you had two pizzas and one movie, or one pizza and two movies, you pretty much feel the same about them. But clearly you like two pizzas and two movies better than either of the first two combinations.

Then what we can do is we can draw what we call indifference curves. And that's in figure 4-1b. These are maps of your preferences. An indifference curve is the curve showing all combinations of consumption along which the individual is indifferent. And I'll say that again, very important concept. An indifference curve is a curve showing all combinations of consumption along which an individual is indifferent.

So you have an indifference curve. I said you were indifferent between A and B. So you have an indifference curve that runs between A and B. That means that all, and I'm assuming that all combinations along this curve, you're indifferent. So you're equally happy getting two pizzas and one movie or one pizza and two movies.

But point C, which is two pizzas and two movies is on a different indifference curve. You're not indifferent between point C and points A and B. You're indifferent between A and B-- I'm just assuming this, I'm not saying you are. But I'm just assuming, let's imagine you are. But you clearly like two pizzas and two movies better than one of one and two of the other. Yeah?

AUDIENCE: Does that break the completeness rule for the--

PROFESSOR: Does that break it? Why would that break it?

AUDIENCE: Do you prefer pizza over movies or movies over pizza?

PROFESSOR: No. Because this is my screw up before. Completeness just means you know how you feel about everything. So strike from the record my initial description. Completeness means you just know how you feel about everything. You're allowed to be indifferent. Completeness just means you can't say, I don't know, I don't know how I feel about pizza. You've got to have feelings for pizza. OK. You've got to know how you feel about stuff. That's what completeness is.

So armed with those assumptions, there are four key properties of indifference curves that we have to keep track of. Four key properties of indifference curves. The first is that consumers prefer higher indifference curves. So you prefer higher indifference curves. Prefer higher indifference curves. What I mean by that is, the further out the indifference curve, the more you prefer it.

And this comes naturally from the non-satiation assumption. Given that we've assumed non-satiation, you must always prefer an indifference curve that's further from the origin because it's more, and more is better. OK so given non-satiation, you will always prefer an indifference curves that are further from the origin. That follows directly from non-satiation.

The second point is that indifference curves are always downward sloping. Indifference curves are always downward sloping. Indifference curves are always downward sloping. And that, once again, comes from non-satiation. To see this, let's look at the next figure, an upward sloping indifference curve.

Why does an upward sloping indifference curve, someone tell me, violate non-satiation. Yeah?

AUDIENCE: Because you're indifferent to getting more.

PROFESSOR: Yeah. Because this would say you're indifferent between (1,1) and (2,2). It's not quite drawn right. We ought to just have this go through to point (2,2). But basically, this would say you're indifferent between getting one pizza and one movie or two pizzas and two movies. You can't be because that violates more is better. So indifference curves can't be upward sloping, they've got to be downward sloping by the non-satiation assumption. OK, that's the second property of indifference curves.

The third property of indifference curves is indifference curves cannot cross. Indifference curves cannot cross. Why can't indifference curves cross? Well here I forgot to have Jessica do a pretty diagram, so you'll have to deal with my ugly handwriting here. So why can't indifferent curves cross?

Well imagine a situation where you have your pizza and your movies. And imagine a situation where you have one indifference curve that looks like this, and one indifference curve that looks like this. OK, two indifference curves. And you've got, let's label these points A, B, and C.

Now could someone give me, based on the properties of indifference curves that we talked about over here, given these three properties, can someone tell me why this is a violation? Yeah?

AUDIENCE: Because A and B are on the same curve, meaning you're indifferent between A and B. A and C are also on the same curve because you're indifferent between the two. But that means you're also indifferent between B and C which can't be true because more is better.

PROFESSOR: Exactly. So transitivity says I must then be indifferent between B and C through the logic you just laid out. But I can't be indifferent between B and C because B dominates C. B has a basically the same number of movies, but more pizza, so I must like B better. So by the combination of transitivity and non-satiation indifference curves can't cross.

And finally, completeness, which is the most awkward of these assumptions, it simply means you can't have more than one indifference curve through a point. So basically, the idea of every possible bundle has one indifference curve. You can't have two indifference curves through it sayin, I'm not sure which indifference curve I'm on. I'm not sure how I feel about this. You know how you feel. There's one indifference curve through every bundle. There's not two indifference curves through a bundle.

So this is the way we think about preference maps which is the sort of core building block of utility theory. Now I was an undergrad here, took this course, but I never really understood indifference curves until I had a year off with a grad student who was trying to decide where to take a job and he did it through just showing me an indifference map.

He said look, I'm trying to decide where to take a job, and I care about two things. I care about how good the place is and where it is. So he said here, he had location and he had academic rank. And he said look, I'm indifferent between Princeton which has a shitty location but a wonderful academic rank. I'm from New Jersey, but it's still a shitty location. OK, and Santa Cruz. And Santa Cruz which has not such a good academic reputation, but a pretty awesome location.

And he said here's my indifference map. And where did he end up going? He ended up going to the IMF, the international monetary fund in DC which had a better location than Princeton-- worse than Santa Cruz, but a better reputation than Santa Cruz and worse than Princeton. So he decided he was indifferent along this map, and he ended up choosing a point in the middle.

But indifference curves are just a way of representing two dimensional choices. Now very few choice in life are really two dimensional, but that's a nice example. Question in the back?

AUDIENCE: I was wondering if IMF, the point would be actually not on the curve, but further out?

PROFESSOR: If it were further out. A great question. So imagine if IMF were here. What should he have done? Definitely go to IMF. Here he was indifferent. He could flip a coin and be equally happy at all three. But if IMF were out here, and maybe it was because that's what he chose. That's a good point. I don't know if IMF was here or here.

The fact that he chose IMF, it can reveal it wasn't anywhere in here. It's a very good point actually. It can reveal it wasn't anywhere in here. That we know. But I can't tell if it was on the curve or outside the curve. It could have been on the curve because he's indifferent, so who knows, he could have flipped the coin. Or it could have been outside the curve because it's better. We can't tell that. That's a good point. All right. So that's a preference map. That's indifference curves.

Now let's step from indifference curves, which is a building block of preferences, to utility. Now everything you need to know about preferences is represented in those indifference maps. The problem is they're pretty awkward to work with when we need to actually prove theorems and solve and understand how people make decisions. That's a lot easier if we have a mathematical representation of those preference maps. And that's the utility function

So the utility function is a mathematical representation of preferences. That's all it is. You're going to be hearing this term in your nightmares for the next semester. Utility functions. But remember, it's just a mathematical representation of people's underlying preferences. Don't be scared of it.

And the key thing is that we assume individuals have these well-defined utility functions, and by maximizing those utility functions we can tell what choices they're going to make. So for example, suppose that I said that your utility function over pizza and movies was the square root of pizza times movies. That's a utility function. I'm going to say, what the hell does that mean? Well, it doesn't mean anything, it's a utility function. It's your preferences. It's a mathematical representation of your preferences.

What does that mean? What it means is-- it doesn't mean anything inherently, but it tells us about your preferences. What it tells us is that your preferences can be represented. If you flip back to figure 4-1b, it tells us those are your preferences because you're indifferent between two pizzas and one movie and one pizza and two movies. Of course you're indifferent. They both give a utility square root two. But you prefer two pizzas and two movies because that gives a utility of two.

So this is a mathematical representation consistent with those utility indifference curves. Not the only one. There's other mathematical representations that could be consistent with those indifference curves. But let's posit that this is your utility function. This is a mathematical representation of your tastes.

Now what does utility mean? Utility means nothing in the sense that it is not a cardinal concept. It's only an ordinal concept. So if I say to you that you get two utils from two pizzas and two movies, that doesn't mean anything. It just means that you get more than from one pizza and one movie. And we can even get the ratio that you get square root of two more, than you get from one pizza and two movies.

We can do ranking and ordinality, but we can't assign cardinality. I can't say how happy you are in some abstract absolute sense from two pizzas and one movie. I can't give a cardinal form preference. But this is an ordinal ranking of preferences. I can tell what you like better than what else. That's why utility function is a representation of indifference maps. They're just a mathematical tool for comparing bundles, they're not some inner answer to the value of your soul or something like that. Don't imbue these with too much magic. They're just mathematical ways of representing preferences.

The key concept, the single most important concept, for consumer theory for understanding how consumers make decisions is the concept of marginal utility. We'll talk a lot this semester about marginal this and marginal that. And this is our first example. Marginal utility.

That is how your utility changes with each additional unit of the good, or the derivative of the utility function. If you want to do it in calculus terms, marginal utility is the derivative of your utility function with respect to one of the inputs. But if you don't want to put it in calculus terms, it's as you add each unit of one of the elements of the utility function, how does utility change

So to see this, let's do an example of marginal utility. Imagine for a moment that you have two pizzas, p equals two. You've got two pizzas, they're there. Your roommate's got them or something. OK, now I want to ask, how does your utility change as you see additional movies? And to show that, let's look at figure 4-3 which isn't here. Whoops. There's no figure 4-3. Do you got that figure 4-3?

AUDIENCE: There was never any figure 4-3.

PROFESSOR: There was never any figure 4-3. So let's go to 4-5. So basically--

AUDIENCE: Figure 4-4?

PROFESSOR: No but-- actually fine. 4-4. So basically what this is showing, what figure 4-4 is showing, is it showing how-- no actually, let's go to 4-5. They're out of order. Let's go to 4-5. What 4-5 is showing-- no, that's not going to work. OK, back to 4-4. What figure 4-4 is showing, is it's showing how your marginal utility for movies evolves, how your utility evolves as you get more movies.

Given that you have two pizzas, this is the evolution of your utility as you get more movies. So each additional movie increases your utility. The slope is positive. By more is better, we know that. Even if it's some date movie, it still improves your utility. So it still improves your utility, but at a diminishing rate. And that's the key is that we assume diminishing marginal utility.

The key assumption underlies everything we'll do for consumers is diminishing marginal utility. We assume that additional movie increases your utility, but at an ever diminishing rate. So basically, we can actually graph your margins. And that's what figure 4-5 is, is a graph of your marginal utility. So basically, when you have two pizzas and one movie, utility is square root of 2, right?

Now what I'm saying is if you get one more movie, your utility is going to rise from square root of 2 to 2. So the marginal utility of that next movie -- is that right? Two movies. 1.4. Yeah, it's going to rise by the square root of 2. You're going to multiply your utility by the square root of two, so your marginal utility-- you're going to go from the utility of square root of 2 to utility of two. So utility is going to increase by the square root of 2. Utility is going to increase-- I'm doing this wrong, hold on. One second. From one movie.

I see. I see. So, I'm sorry. This isn't the delta, this is the level of marginal utility. So I'm graphing the actual level of marginal utility. Back up. OK, so I'm graphing the actual level of marginal utility. So when you have two pizzas and one movie, your marginal utility, your actual utility-- I see, that's what this is. This is the actual utility I'm graphing. So I told you a minute ago, we can't measure utility as a cardinal concept, but actually here I'm doing it anyway because it's to illustrate marginal utility.

So your utility, OK. When you have one movie is 1.4, square root of 2. That's your utility. Now when you move from one movie to a second movie, your utility goes up from square root of 2 to 2. Your utility goes up by 0.6. So the marginal utility of that second movie is 0.6. Utility was 1.4, was a square root of 2. Now it's increased to 2. So the marginal utility of the first movie is 0.6.

Now let's say you add another movie, you go to three movies. What's your utility now? It's the square root of 6. So it's gone from 4, to the square root of 6, which is 2.45. So your marginal utility of the third movie is 0.45. This graph is messed up because the first one is an actual utility level. So the first one I say, for one movie, you have a utility 1.4. And then for the second movie, I give the marginal utility, the third movie marginal utility. So, this graph sort of-- yeah?

AUDIENCE: It shows the marginal utility of the very first movie.

PROFESSOR: Yeah, I guess that's right because you're zero. You're zero movies. OK, right. You're right. OK, so the first one is the marginal utility of the very first movie, you're right. So the very first movie gives you marginal utility of 1.4 because you go from 0 to square root of 2. That's right. My bad. So you go from 0 to square root of 2 to get a marginal utility of 1.4 for the first movie From square root of 2 to 2, you get 0.6 the next movie. From 2 to square root of 6, you get 0.45 for the third movie. For square root of 6 to square root of 8, you only get 0.38 from the fourth movie, and so on.

So the key point is that these marginal utilities are ever decreasing. Each additional movie gives you less incremental utility. And if you stop and think about it, it's kind of intuitive. Just stop and think, think about the movies you want to see right now. The four movies you want to see. Presumably whichever you ranked first would give you more utility to see than whichever you ranked second. And if you think the movies that are out right now are pretty crappy like I do, by the time you get to the fourth movie, you're not getting much utility from it at all. Thinking about movies that are out now, you're getting a lot of utility from that first movie you see. Marginal, extra utility from the first movie you see. But each additional one is giving you less and less.

And that's the idea of diminishing marginal utility. Likewise with pizzas, if you haven't eaten all day, that first pizza can give you a very high marginal utility. The enjoyment you get from eating that first pizza can be very large. But the second pizza, not so much. You're already pretty full. Third pizza, even less. And then fourth pizza would probably violate non-satiation. So that's the basic idea. Yeah?

AUDIENCE: I have a question. Do we assume that the goods are homogeneous. Is it the same movie watched four times? Or different movies?

PROFESSOR: Actually, that's a great question. And you have to specify that as part of the problem. I haven't specified that here. Obviously it can't be the same pizza eaten four times. It could be the same kind of pizza eaten four times. But do you see the same movie? I haven't specified that here. So there's not a general assumption about that. It depends on how I define movies. Did I define movies as-- I don't know. God, I'm terrible. All I know that's out now is the Guardians of G'ahoole because I've got a little kid who is interested in it. Whatever movie's out.

Do I define movies as Guardians of G'ahoole, or do I define movies as seeing a movie? And I didn't specify that. Implicit in my examples, I specify movies as seeing a movie. But you have to specify that to be more precise if you're actually trying to figure out-- it depends what you're maximizing over. If you're maximizing over seeing any movie or maximize over seeing the same movie. And I didn't specify here.

AUDIENCE: It can work in both cases.

PROFESSOR: It would work in both cases. Clearly you could imagine, actually it's a very good point, where do you think your marginal utility would diminish more? Seeing the same movie. So what your example points out is that different goods will have different rates of diminishing marginal utility. OK, so marginal utility will always be diminishing, but at very different rates for different goods.

So the general principle is that they'll be generally diminishing marginal utility. But at different rates for different goods. So after all my mess ups, let me just review. Marginal utility is diminishing because each good is worth less to you. It's always positive because of non-satiation. And this graph represents the marginal utility you get from each movie you see conditional on having eaten two pizzas. Marginal utility is the increment from the next unit consumed.

Now let's get back on track here. Now let's go to thinking about-- now that we have this concept of utility and marginal utility, let's now bring utility back to preference maps. Let's ask, given what we know about utility, what can this teach us about the shape of preference maps? What's the linkage between utility and preference maps?

And that linkage comes through something we call the marginal rate of substitution. The marginal rate of substitution is the mathematical concept that links preference utility with preference maps. The marginal rate of substitution technically is the slope of the indifference curve. It's delta P over delta M. The slope of the indifference curve is the marginal rate of substitution.

That's what it means graphically, but here's what you have to understand at a deeper level. What it really is, it's the rate which you are willing to trade off. The rate at which you are willing to trade off the y-axis for the x-axis. The rate at which you're willing to trade off pizza for movies. So that's what it means intuitively.

The slope of the curve tells you that you're indifferent. Remember, you're indifferent between any points along with this indifference curve. You're indifferent between four pizzas and one movie, you're indifferent between two pizzas and two movies, and four movies and one pizza. You're indifferent along all those combinations of figure 4-6. The MRS is the slope of that curve telling you the rate at which you're willing to trade off pizza for movies.

Now just a side note here, you're never, of course, actually trading. There's not some market where you bring a pizza and get a movie. So I didn't say trade, it's not like baseball cards. I said trade off. What I mean is ultimately you have some budget, and you have to allocate that budget. So if you decide to allocate it on pizzas, you can't allocate it on movies. Or the more you allocate on pizzas, the less you can allocate on movies.

So there's always a trade-off. Remember, I said, economics is always about trade-offs. Given your limited budget, there's always a trade off. And the rate at which you're willing to trade off is your marginal rate of substitution. Given that you're going to have to trade off-- and we haven't got a bunch of constraints yet, we'll get to that next time-- the rate at which you're willing to is your marginal rate of substitution. Yeah?

AUDIENCE: Is that rate usually related to the price?

PROFESSOR: Ultimately no. I'm sorry. The marginal rate of substitution purely comes from your preferences. Ultimately to decide how much you actually consume, you'll need to bring in the price. So remember, I haven't talked about prices here, we haven't talked about that here. But this is a preference concept. This has nothing to do with prices.

But you're getting ahead of us. We'll see next time, to decide how much you actually consume, you're going to relate the marginal rate of substitution to the prices you face in the market. And that will decide how much you consume. This is just a utility concept. Yeah?

AUDIENCE: Did you say it was the y-axis or the x-axis? That would be negative?

PROFESSOR: It's negative. Yes. Of course. Right, of course. The point is how many movies are you willing to give up to get another pizza? How many pizzas are you willing to give up to get another movie? MRS, it's very hard to remember what's on the top, what's on the bottom. Be very careful on this. But that's why I said remember it's the y-axis or the x-axis. It's how many pizzas you're willing to trade off to get another movie.

Basically remember when I say trade off, here, this is not that you're literally trading, it's that ultimately you're going to have to make that trade-off. Ultimately when we come to the next lecture and face a budget constraint, you're going to have to decide how do I want to allocate my budget across pizzas and movies? The way you're going to decide that is by the relationship of how you feel about trading off one for the other. Now here's the key feature of the MRS which is the MRS is yeah? Question? Yeah.

AUDIENCE: That and exchange rates are always changing depending on how much you happen to be trading.

PROFESSOR: Exactly. The MRS is diminishing. Technically when you go to grad school, you realize that marginal utility isn't actually technically always diminishing. I said it is. For this course it is. But if you want to get mathematically correct, really what's always diminishing that you prove is the marginal rate of substitution is always diminishing.

So we have diminishing marginal utility for the purpose of this course, but the really important concept is you have diminishing marginal rate of substitution. The rate at which you're willing to trade off pizza for movies is going to fall as you have less pizza and more movies. So to see that, look at this graph, and let's compute the marginal rate of substitution along each segment.

So let's localize. Imagine the segments were linear, imagine we had two linear segments between these points. We don't. But imagine for a second we did. So the marginal rate of substitution from the first point, four pizzas and one movie, to the second point, two pizzas and two movies, the marginal rate of substitution is -2. You are willing to give up two pizzas to get one movie. This is the same graph, figure 4-6. This isn't on the graph, you have to write it on.

So going from that first point to that second point, you're willing to give up two pizzas to get one movie. So that rate of marginal substitution is -2. However, when you're at two movies and two pizzas, and I say OK, how about giving up one more pizza to see movies? Now you say, wait a second. To give up one more pizza, I need to see two movies. My marginal rate of substitution on that second segment is -1/2.

The marginal rate of substitution on the first segment is -2. The marginal rate of substitution on the second segment is -1/2. Once again, assuming they're not linear, so it's actually changing everywhere, but if they were linear, that's what it would be. Can someone tell me why? Why is the marginal rate of substitution falling? Why is the marginal rate of substitution lower on that second segment than on the first?

AUDIENCE: Because marginal utility increases the fewer of something you have.

PROFESSOR: Exactly. So go ahead, flesh it out, the fewer of somthing you have, so tell me in terms of the trade you're willing to make.

AUDIENCE: You value it more, so you want to trade more of something else for it.

PROFESSOR: The point is when I have four pizzas my marginal utility of that last pizza is not very high. And I'm fine to give up two pizzas-- and plus I'm only seeing one movie, there's a second movie I really want to see. So you say to me, look, I've got four pizzas, I'm seeing one movie.

You say hey, there's a second movie out I know you want to see. I know you don't really value four pizzas. At the end, you're totally full. Would you be willing to give up two pizzas to see the second movie? And you're like, sure why not?

Well once you have two pizzas and you've seen two movies, you're not that interested in a third movie and you'll be hungry if you have less than two pizzas, so then you say, wait a second. If you want me to give up another pizza, you've got to give me two movies. Because my marginal utility of pizzas is rising, my marginal utility of movies is falling. And that's why the marginal rate of substitution diminishes along the indifference curve.

So that allows us to write mathematically the definition of the marginal rate of substitution is the negative of the marginal utility of movies, or more generally what's on the x-axis, over the marginal utility of pizza, or more generally what's on the y-axis. The marginal rate of substitution, the first key formula you need to know for this course, the marginal rate of substitution is equal to the ratio of marginal utilities.

Now this is tricky. Maybe you guys don't find it tricky, it's the kind of thing I find tricky. Which is I defined it as delta y-axis over delta x-axis. And yet, when I defined here the marginal utilities, I flipped it. I did the marginal utility of what's on the x-axis over the marginal utility of what's on the y-axis. Why is that? Can anyone tell me why that is? Why is it flipped when defined in terms of marginal utilities? Yeah?

AUDIENCE: It's a denominator. So utility over movies--

PROFESSOR: Well, let me try for slightly more, how does marginal utility relate? Yeah.

AUDIENCE: Marginal utility is delta P over P. So it gets flipped. Because of--

PROFESSOR: OK. Yeah, you're giving the same answer, which is technically right. What I was more looking for but it's the intuitive version of that, marginal utility is a negative function of quantity. Marginal utility is a negative function of quantity.

So the fact that it's a ratio of the quantity of pizza over the quantity of movies is the same thing as the marginal utility of movies over the marginal utility of pizza. Because marginal utility is a negative function of quantity. The more quantity you have, the lower is your marginal utility. And that's the key to understand.

So it's the slope of the indifference curve which is the ratio of the marginal utilities, but it's the marginal utility of movies over pizza. Because what that's saying is that as you get more movies, you care less about each additional movie and ditto with pizzas. Let's just look at this for a minute, think about it intuitively for a minute. We've seen it graphically, we're seeing it mathematically, let's make sure we understand it intuitively.

What this is saying is that as you get more movies-- so let's relate this to the graph. As you get more movies and less pizza, as you move down that curve, more movies, less pizza, what's happening? What's happening to the marginal utility of movies as you move down that curve? What direction is it heading?

AUDIENCE: It's decreasing.

PROFESSOR: What?

AUDIENCE: It's decreasing.

PROFESSOR: It's decreasing. Because you're getting more movies and marginal utility is a negative function of quantity. Likewise, the marginal utility of pizza is increasing because you're getting less pizza so you care about each pizza more. And that's why the marginal rate of substitution diminishes. That's why it diminishes because as you move down that curve, the numerator is falling, the denominator is increasing. And that's why we have everywhere diminishing marginal rates of substitution.

So another way to think about this is imagine for a moment what life would be like if we didn't have diminishing marginal rates of substitution. And once again I'm going to try, once again Jessica, next year we'll let you make this pretty. But I'm going to try to draw it crudely here. Let's do pizzas and movies again. Let's do pizzas and movies again. Movies and pizza. And that's one, two, three, four. One, two, three, four.

Now let's imagine that instead of diminishing marginal utility and instead of indifference curves being convex to the origin, imagine if indifference curves were concave to the origin, which is what increasing marginal rate substitution would imply. So that would be something where you'd be indifferent between four pizzas and one movie, between three pizzas and two movies, and between one pizza and three movies.

So your indifference curve would look like that. Not quite to scale, but you get it. It would be concave to the origin instead of convex to the origin. In this case, marginal rates of substitution would be everywhere increasing. That is, basically I'd be willing to give up one pizza to get one movie. But to get that next movie, I'd give up two pizzas.

But as you can see, that doesn't make sense. It doesn't make sense that given that as long as you're ranking movies, or even more in the example of seeing the same movie over and over again, it's maybe more compelling. That basically what you can see is that if you're willing to give up one pizza to see that movie a second time, why would you possibly give up two pizzas to see it a third time? That makes no sense at all.

If you only like it so much you only give up one pizza to see it a second time, why would you possibly give up two pizzas to see it a third time? You wouldn't. It doesn't make sense. And that's why marginal rate of substitution has to be everywhere decreasing, it can't be increasing. Yeah?

AUDIENCE: Could it remain constant?

PROFESSOR: It could actually remain constant. Yes, that's right. You can be indifferent. My indifference curves-- how many of you guys have seen Toy Story 3? I think it's one of my 10 favorite movies of all time. The greatest children's movie ever made. I've seen it three times. My indifference curve is virtually-- I've enjoyed it the third times as much as the first-- it's virtually flat with respect to Toy Story 3. I could see it 10 more times and feel pretty much the same. So that's certainly possible that it would be constant, that I'd be willing to give up whatever I pay-- $10 a shot to see it. It's possible.

So basically, almost always, inequalities will be greater than or equal to, or less than or equal to in this course. It's more fun to talk about the not equal to case, the non-linear case. But linear cases will exist as well. It's just a can't be can't be opposite sign. You can't have an increasing marginal rate of substitution. Another question over here?

AUDIENCE: What about addictions? You could want it more the second time.

PROFESSOR: That's interesting. So how would addiction work? so basically--

AUDIENCE: Well it's not really decreasing. You need more the second time, right? So it has to--

PROFESSOR: That's very interesting. I mean in some sense. So you give up one pizza for the first shot of heroin. And then, you're hooked, so then you'd be willing to give up two pizzas for the next shot of heroin. Yeah, I guess so. I guess that's right. I guess we're going to have to stay away from addiction in this course. I guess an addictive good could look like that. That's a very good point. Other questions, comments?

So what we're doing is we're going to stop here, understanding that we're going to have-- leaving this example aside-- we're going to have diminishing marginal-- yes one more question?

AUDIENCE: [UNINTELLIGIBLE]

PROFESSOR: Basically, we're assuming by non-satiation that ever happens. So once again, that would violate the non-satiation. The problem with the addictiveness example is the reason it wouldn't work in this course is eventually you'd violate your budget constraint because you'd want more and more and more. Maybe not. But in any case, we're going to ignore that example, assume diminishing marginal rate of substitution, and we'll come back next time as I put this together with a budget constraint to actually dictate your choices.