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**ESTHER DUFLO:** Welcome again, everyone. Very nice to see you. And also, thank you very much for doing the readings, and putting the comments, and putting the comments on the notes. I have my notebook here, where I wrote down your points, which I'm going to cover as we go along.

One small note, some of them appear fully anonymous. So I don't even know who wrote them. But many of them have at least the name is visible to me, so two points. I think if you're not shy, you can feel totally free to share with your classmates. Because a lot of your thinking is useful, and elaborate, and it's fun. So unless you have a reason not to, you should feel free to make it open. We can establish that as the default social norm.

At the very minimum, I would appreciate seeing your name on the signature, just to know. So what we are going to do today is to talk a bit about the Dasgupta and Ray paper. Someone asked, does anybody even know that paper? So that's like a modern classic, just so you know. That's why we are teaching it, and also because it's a good paper. But it's a paper that probably every development economist has read at a point or another.

And I think some of it is actually lost, because what's very nice in this paper is the whole general equilibrium use of the capacity curve, the S-shaped capacity curve. And in a lot of the future zeitgeist of the use of the capacity curve in development or the S-shaped curve, we think about the dynamic thing, and we are kind of done with the use of the S-curve, whereas they have a richer use of it.

But this is really a very, very well known, very important paper, which is something common to the whole culture of the field. So thank you for reading it carefully, and for commenting on it.

So we'll go through it relatively rapidly. So it starts with our friend the capacity curve. The capacity curve relates to this income into to today's work capacity. So that in itself, where does that function even come from? Why do we have a relationship between today's income and today's work capacity?

Erin?

**AUDIENCE:** Because of biological necessity you need money to buy food, and then to have calories to work.

**ESTHER DUFLO:** Right. And before that even, it's already a composite function in a sense. Implicit in the assumption is that you eat what you have, or at least there is not much of a choice there. Maybe people have to have some amount of money for their house, and for their clothes, and everything else is being consumed. That choice is not really modeled at any point.

So there is a relationship between how much income you have and how much you get to eat. And what is of most interest to them is the relationship between how much you get to eat and how productive you are. And that curve is interesting, because it starts increasing, but maybe mildly. And then what happens after at some point to this curve? If I were drawing on the board, where would I go? [INAUDIBLE]

**AUDIENCE:** It would go up.

**ESTHER DUFLO:** It would go up in a steeper way. So it has a steep section. And then it flattens again. So what's the kind of mechanism behind that that I have in mind and for this particular paper?

Zoey?

**AUDIENCE:** I think it's nutrition, like what you have in [INAUDIBLE], having more money doesn't help in the work capacity.

**ESTHER DUFLO:** Precisely so the idea is that initially the first few calories are needed, maybe the first 1,200 calories or so are needed, just to keep your body functioning. And it's only after these basic needs that doesn't make you particularly productive, it's only after these basic needs are met that the future calories are being translated into work capacity, physical capacity in their case. They have in mind people harvesting bushels of maize.

So at the beginning, like I give you just a little bit of money. You can't go very far. Then eventually you are fed enough. The maize is translated into energy that you can devote to the maize harvesting. And then it flattens again, as you have eaten enough. And then maybe too much or for Thanksgiving dinner or whatnot.

So many of you have asked, OK, this particular people is about nutrition. But could we think about other source of that S shape coming from other things?

And that's an excellent question. And the answer is, of course, yes. And many papers, either explicitly or implicitly in development, that are searching for poverty traps or a persistence of poverty, or under-investment, try to build up a reason for an S-curve. Sometimes the S-curve is a little bit simpler than that you could just have, which would work just as well, is a segment that is like this, then a jump, and then another segment that's there. It doesn't have to be that.

So for example, can you come up with any domain where you might see a relationship between someone's cash in hand, I'm saying cash in hand because it could be a person or it could be a farm, someone cash in hand, and how productive they are? Can you think of another example where we could see this type of shape reasonably come up?

**AUDIENCE:** I mean, maybe they need to purchase an expensive piece of equipment for their--

**ESTHER DUFLO:** Precisely. So you could imagine, for example, a small business. They're starting their small business. They're making clothes, say. So they're buying some clothes. They are sewing, and they are not very productive, sewing by hand. And then they only have two hands. So after a while, it stops. And then comes a time where they could either hire second person, they have to hire them full-time. That would be a fixed cost. Or they could buy themselves a sewing machine.

And then if they managed to get to this point, then they would find themselves at a much higher level of investment. So that's another place where you would find something that wouldn't necessarily have this S-curve, but you would find themselves there. We'll see example in education, for example, where let's say adding a dynamic dimension to it. But parents who themselves is highly educated might find it much easier to help their own children at home, and impart human capital.

So that also creates a moment where if you have a secondary education yourself, the cost of providing a basic education to your child goes down, and therefore the returns of any investment in that education goes up. So that would create such a jump as well. So that's why this S-shape is something that is, of course, very central, and a lot of what's done in development. As opposed to other fields, where we try to avoid non convexity. They make everything a little bit more complicated. But of course, in this case, that's the complexity we want you to embrace.

At the moment, everything is static. There is no dynamic yet. But I'll go back to dynamic interpretation of that curve very soon. And that's going to give you the term, poverty trap, which was actually absent completely in the paper, someone observed.

Now what else we can put on this graph is what's that line? It doesn't have to be a 45-degree line. It looks almost 45-degree line. But what's important is that it's a straight line. What is it representing in their world? Aaron?

**AUDIENCE:** Is this a-- it's a wage.

**ESTHER DUFLO:** Right. That's the wage. So the idea in the world is that the wage is a piece wage. So if I wanted to get a higher wage, do I move this way or that way?

**AUDIENCE:** You move towards the x-axis.

**ESTHER DUFLO:** You move toward the x-axis, because the wage is the other way. It says for every single possible work capacity, how much income you have. So we are reading it the other way. Does that makes sense? And so here is a lower wage, and here is an interesting wage. So generally, when there is a tangent in an economics class, we are trying to optimize something. But here, I'm not optimizing anything.

What's interesting about this particular wage and why does it turn out to be relevant?

Aaron?

**AUDIENCE:** This is where average equals [INAUDIBLE] for capacity.

**ESTHER DUFLO:** I wouldn't characterize it quite that way. Yeah?

**AUDIENCE:** Because it only intersects your capacity for every two points at the origin, at that tangent point. It means that everyone eventually is going to [INAUDIBLE]?

**ESTHER DUFLO:** Yes, and in particular, what happens if the wage is any lower or any higher than this? So if the wage becomes any higher than  $v^*$  star?

**AUDIENCE:** Then you're going to get even more.

**ESTHER DUFLO:** You're going to get-- you're in the zone where you are working quite a bit, earning quite a bit. If the wage is any lower than this  $v^*$  star?

You are earning nothing. So that  $v^*$  star is interesting, not because it represents any optimality or anything, but because it is the smallest possible wage at which people in this economy can perform meaningful work.

I wouldn't interpret the zero as pure starvation. But it could be very, very minimal work. I met a guy in Indonesia who described themselves as being there. I don't know whether he was. And I don't know whether it was. But he gave me this whole theory, explaining to me that he was so weak that he couldn't really work in the fields.

So it was mostly staying near the pond, and catching fish from the side, which is a low effort energy. He could catch some fish. And then he would bring them home to his brother, and his brother would feed him in exchange. So that's kind of the idea of it's not just minimal work which gave him minimal feeding in exchange, which hardly sustained them. So that's the sense of that  $v$  star.

So now we are armed with that. This is every single person. We can think about how the labor supply is going to look like. So if I had one individual, and I can say how much does one individual work as a function of what the wage happens to be. And that  $v$  star would be here. And the point is that if the wage is any lower than  $v$  star, labor supply is 0, or close to 0, nobody can really do any work.

If the wage becomes any higher than  $v$  star, then we have a proper usual labor supply curve. As the wages increase, people work more. That's the right side of the slide. And then what happens at  $v$  star? For an individual person, if the wage happens to be  $v$  star, what would people be able to do? And maybe like to do, or do utilities a bit in the background here, but implicitly in this world would prefer to do if the wage was exactly  $v$  star?

Yeah? Sorry, go ahead. You had started, sorry. And what is your name?

**AUDIENCE:** Tollin. If you're at  $v$  star, then you're not working--

**ESTHER DUFLO:** Yeah, nothing different. It's not a matter-- you are capable of working. So every single individual who would like, it's possible, is working there. I think utility is a bit far from that world. But I think in the background, they mean that people would prefer to work and eat, than to be like half dead. So they are not indifferent. But they are capable of working. So everybody who is capable of working, and then if the wage is below, then they are not.

The question is, where they are going to be. So if the wage that's now labor demand, so the labor demand is completely classical in this world. If the wages goes up, you want less labor. Or if the wage go up, you-- so something shifts the labor demand. What could it be in this agrarian economy that shifts the labor demand, up and down? Yep?

**AUDIENCE:** [INAUDIBLE]

**ESTHER DUFLO:** Well, no. Understood.

**AUDIENCE:** Say those educational shocks, workers are more productive.

**ESTHER DUFLO:** Yeah what could make workers more productive in this agrarian world?

**AUDIENCE:** More appropriate training, more [INAUDIBLE]?

**ESTHER DUFLO:** Yeah, or simply the productivity of the land. So it could be just a different economy with better or worse land. It could be the climate. It could be past investments. Right now, there is no past, but there might be a past. So something moves the labor demand but up and down. We have a quite normal equilibrium where everybody is working.

And what happens if the labor demand is there, causes that dotted line? What happened to aggregate labor supply? What does it have to be? Yep?

**AUDIENCE:** It would be zero, no one works.

**ESTHER DUFLO:** So if it were zero, if labor supply was 0, then wages would be very high at that labor demand, because I have to continue that graph. So if there are very, very, very few workers, then wages would be very high. So that's not an equilibrium. So it's not zero.

Yeah, Erin?

**AUDIENCE:** Would you have to ration the balance to the [INAUDIBLE]?

**ESTHER DUFLO:** Right. So it has to be here. That's the only thing that's in equilibrium. Because if it's any lower, the wages a bit higher, then more people would be working. That would lower down the wage. If it's any higher, than the wage would go down, and then nobody can work at that wage, that is slightly lower. Therefore, it has to be exactly here. That's the equilibrium.

But of course, in this world, people either work or they don't work. There's no smooth labor supply. And therefore, the way it's obtained is that some people work, and some people don't. So here on this graph, roughly what fraction of people have to work in order to make this an equilibrium? Is it one third or is it 2/3?

**AUDIENCE:** 2/3?

**ESTHER DUFLO:** 2/3. So 2/3 of people have to work, and one third don't work. Right? So that's involuntary unemployment, a situation where you have exactly identical people. But the only way to sustain an equilibrium is you have to draw a lottery between them, where some of them work, some of them don't work. And then, of course, that continues the sentence in the paper that you've read. It said, and one is distinctly better off as a result. So that better off is slightly loose, because it's not that they gave us a utility function. But they have this idea that it's better to work enough and be productive than to just be half starving. Right? So that's involuntary unemployment.

That's our first result. Our second result has-- yes?

**AUDIENCE:** Does that mean that a prediction is that if there's demand shocks in this kind of economy, like wages should just stay the same?

**ESTHER DUFLO:** Exactly. So in this, as long as we are moving, as long as we are moving in that zone, the wage will stay the same. And the impact will be felt on unemployment. Even though there is no wage rigidity imposed by anybody, it's not that there is a minimum wage. But it's a minimum wage that you have to pay in order to get a day worth out of the people you are hiring.

So the minimum wage is a product, not of institution, but of that peculiar a capacity curve, exactly. So that produces that. So changes in labor demand produces changes in employment.

So now where we get to the poverty trap idea, is when we add some heterogeneity between people. And in particular, with non-labor income. So non-labor income comes, for example, from owning some of the land that is being worked by people. So people, let's say, don't have an equal share of the land. And then when you own the land, you're getting some rent from the land. And that's your non-labor income.

And what does non-labor income does to the capacity curve? If I have more-- so you have here a first person that has a bit of non-labor income, if I give them more non-labor income, where does the curve move?

Now that relates employment income to work capacity. Yeah? Can you remind me your name?

**AUDIENCE:** Wesson.

**ESTHER DUFLO:**Wesson. Can you?

**AUDIENCE:** A shift left, you require less employment income for the same--

**ESTHER DUFLO:**Exactly. So we can shift left, because we can first eat what comes out of the non-labor income. We'll have that. That will contribute to maintain our basic metabolism. And then we're good to go with a bit less. So that moves that curve there. Which means that the  $v$  star is now not an economy wide parameter. It's an individual wide parameter. It depends on the person. It depends on how much non-labor income they have at their disposal.

So there you can see we are getting to a poverty trap in a sense. Because the inequality in non-labor income are being magnified by the inequality in labor income. And some people pointed out in the comments that without anything like eagerness to work that would go in the other direction, which is very much the classical phenomenon. Which is if you're rich enough, you don't need to work as much to earn your living. So maybe you are going to not work as hard.

The poor people their incentives to work are very high, because they need the money more. So we'll get to that angle. But here, notice it's got nothing to do with eagerness. You cannot work if you don't have enough to sustain your basic metabolism, which means that the standard mechanism that we have operating in a lot of our neoclassical world, which kind of tends to bring to convergence between people, is not operating at the lowest level of income in this economy. Right? Hence, the exacerbation of pre-existing inequality via the labor market.

So now is once we have that in place, we can say, well, let's rank people by how much land they own. And so people are ranked here from the poorest person in the economy to the richest person in the economy. The first m people, let's say have no land whatsoever, or a tiny, tiny minuscule bit. And then they are ranked. So they are richer, and richer, and richer, and richer. Does that make sense? That's a very summarized, nonstandard way of representing a distribution of wealth, but it's quite effective.

And now what we can say is, well, let's plug the  $v$  star as a function of how much people land have, and therefore I'm still this is the same axis as before. But now I'm representing the minimum wage at which people are willing to work. So that's the reservation wage. Right? So which one is which? Which is the reservation wage that comes from the capacity curve idea?

It's the high curve that goes like this, Or the low curve that goes like this? Wesson?

**AUDIENCE:** Higher curve.

**ESTHER DUFLO:**Yeah, higher curve. Why?

**AUDIENCE:** Because once you have some land that you own, you have non-employment income to live off of.

**ESTHER DUFLO:** Exactly. So that's the v star we started from in our very, very first graph. And here, what happens is that I'm moving the capacity curve to the left. Then I move it, and I move it, and move it, which lowers the v star. So that's that part. Now this is what we have here is the eagerness to work as a function of how much non-labor income you have, which is your classical thing that someone thought was missing. In fact, it is there. But it only kicks in at some point.

Well, it's there from the beginning. If you're very, very poor, you'd love to work. So your reservation wage is very low. You're desperate. You really want to be doing something.

And then as you become richer, you already have some non-labor income to go by. You're not as desperate anymore. So that's a reduced form of some utility function, where you also value leisure somewhere in the background. So maybe you're not working if the wage is not at least this amount, and then this amount, and then this amount, and then this amount. And this might go up.

So this side of it is your standard individual labor supply curve. Working, as everything else equal, you prefer to slack, if you can. And then of course, you need to be both willing and able to work in order to work, which gives you your effective reservation, which as the thick curve, which is the highest of both. You need to be at the same time willing to work, and at the same time able to work. Does it make sense?

So that's where we are now. And now we can do the same exercise we did before, which is to transform this curve of reservation wage to a labor supply curve. So write your standard aggregate supply, aggregate demand curve, as a function of the piece rate. So I have my demand curves. They are like before, nothing special about them. We can also play with them in the future. But right now, we are happy with them.

And then we are looking at what happens at various possible equilibrium. So when the wage is very low, very few people can work, because for most people, the reservation wage is low. When the wage increases, we can start bringing people. Once we get at that point, we have a flat moment where here when the wage is super low, none of your landless can do any work. The wage is too low for them. So it's not happening.

As we reach to that level, this is the case we did in detail at the very beginning, where we're going to have some people among the landless who are working, and some who are involuntary unemployed. So we have a flat segment here. And then once the wage is any higher, only the standard the labor supply phenomenon kicks in. So that gives us this kind of funny curve.

We have a zone here if the labor demand is in this zone, we have a zone here where you have unemployment, involuntary unemployment, as defined in the first part of the paper, which is strictly identical people get to work or not to work by lottery.

When we are here, he still wants to call that involuntary unemployment, although they are not strictly identical. Because one person is slightly richer than the other. But truly the person who is slightly poorer would very much love to work. And then you could give them-- they are almost identical. You can give them just a little bit, and they would be working full time, and they are unable now. Right? So that completes the description of that world.

So now we can do some little policy experiment. So the first one is imagine a land reform to taking some land from some people and giving to some other people. Can you think of one land reform that will increase production and reduce unemployment? And on depending which place you are in? Choose your level of-- yes, Salome?

**AUDIENCE:** And maybe one that gives land from the very rich to the poor, to the very, very poor.

**ESTHER DUFLO:** Yes. So for example, who do you want me to-- so I'll just-- you want me to take the land from whom?

**AUDIENCE:** The [INAUDIBLE] ones.

**ESTHER DUFLO:** From these guys.

**AUDIENCE:** Yeah.

**ESTHER DUFLO:** Yeah, so I could take it from them. That would not do anything to their labor supply. But who would you give it to?

**AUDIENCE:** Move it to the left.

**ESTHER DUFLO:** To the left? So suppose I'm in this equilibrium. If I give land to them, and I give it to them, does it necessarily increase production or reduce unemployment? It depends how much I have to give. But I could, for example, if I take some from the quite poor, I push them below their reservation wage. They are too poor to work. They really want to work now. And I give it to them, and then that makes them willing to work.

I took that. I take that land away from them. That makes them willing to work. That increases the labor supply. I give it to them. That makes them able to work. That increases labor supplies as well. It's not going to make this guy happy at all. But that's a possibility. Or I could take land from here, as Salome suggested. And instead of give it to the very poorest, I could give it to the people who are just on the margin.

Or I could take a lot of land from them, from these guys, redistribute sufficiently that nobody even at that labor supply has a reservation rate, which that that's too high for the current equilibrium wage.

So you might have this type of reform, where the classical trade between equity and efficiency isn't there anymore. Because by redistributing all to increasing productivity. And that's something which that is also a theme that in many of the classes we're going to find again, but in this case, coming straight from there.

So is it a Pareto improvement to do that? So you're going to remove it from the graph. Is it a Pareto improvement to increase in this way aggregate production, reduce unemployment. Is it Pareto improving? Yeah?

**AUDIENCE:** Isn't the economy efficient already?

**ESTHER DUFLO:** Yeah. The economy is efficient already. And you can see it in this case, that it's not tied to improving, because you've made someone unhappy. They were perfectly happy with their land. And the result in their second paper that I didn't ask you to read and is a bit obscure, is to show that the economy is Pareto efficient. But the intuition for why the economic is Pareto efficient is no market is missing.

You can introduce any market, you'd like here. It's not going to make any difference. In particular, what if I introduce a credit market? What if you could borrow? What if the poor people could offer to borrow from the rich people? Would that work? Would that help in this particular setting?

Why using that-- so Salome thinks that it would help. Why do you think it would help?

**AUDIENCE:** Because in that case, the rich people would get it back. So they wouldn't be angry, and the poor people could work and produce more.



**ESTHER DUFLO:** So how would they get it back?

**AUDIENCE:** What do you mean? They're borrowing with the poor people?

**ESTHER DUFLO:** Yeah. But how? From where? You are borrowing. But in this particular model, the way it's set up, where would the poor pay back from?

**AUDIENCE:** From being able to be employed.

**ESTHER DUFLO:** Yes in order to be employed, what do they need to do? They need to eat. Therefore, they cannot reimburse. There's nothing they can do. You open the credit market. Nobody's going to want to lend, because nobody can reimburse. This is a bit of an extreme situation, of course, because this is a static setting where you can't really invest in yourself.

But in this world, the credit market is open. It just turns out that nobody wants to lend, because nobody can reimburse. Because if you are able to work, it is by eating everything that you earn. And therefore you have to eat it. And it's not there anymore to give it back. That's why that's the sense in which the economy is already efficient. It is not nice. But it's already efficient. That's the best we can do. So that's a very powerful result.

Because in many cases, where we have an inefficiency in an economy, that's because some market is missing somewhere. We can shut it down, or we can open it up or something. And in these cases, the market is out there. Everything is there. But we can't make it happen, in a better to improving way. Of course, it doesn't matter. Maybe we don't try-- improvement is not the only criteria by which we want to go. But this is worth pointing out.

Similarly, if you wanted to do a cash transfer, instead of redistributing land, you could. That would get some people to work. And that is something that, again, is our instinct is if you give people cash, they are going to stop working. But of course in this world, the poorest people get empowered by getting cash. And that is, again, something which is true with nutrition. But maybe we should hold this thought, because there could be other reasons why very, very poor people could be empowered by getting cash.

So instead of making people lazy, a cash transfer would empower people. And this, it would be true if it's high enough. But again, the cash transfer needs to be financed by something. And here, it's going to be financed either by taxing, or by redistributing, or something else. Yes?

**AUDIENCE:** Can I think of this all with a national minimum wage [INAUDIBLE]?

**ESTHER DUFLO:** Yes, exactly. So it's creating a minimum wage, which is not-- the capacity curve is leading to a minimum wage, which doesn't come from institution, but is an efficiency wage.

**AUDIENCE:** It does lead involuntary unemployment.

**ESTHER DUFLO:** Exactly. It does create involuntary unemployment in the same way that in the Mortenson Pissarides type labor papers that you may have seen, if you've done labor or macro. You have an efficiency wage not coming from that mechanism, but coming from people who need to be motivated by working. And you have an involuntary unemployment in those models as well.

The mechanism is different. But the idea that the wage cannot fall beyond some level, which here could be variable across people, or was already in these models before it got into Mortenson Pissarides.

**AUDIENCE:** Is the purpose to explain why there is involuntary unemployment even though in an economy with zero friction?

**ESTHER DUFLO:** Exactly. So that's the purpose the purpose of the model is precisely to explain why there can be involuntary unemployment even in economies with zero friction-- no minimum wage, no institutional constraint, perfect market.

**AUDIENCE:** Thank you.

**ESTHER DUFLO:** Now someone pointed out-- so I should say something about this modeling approach, because a lot of you in your comments had very well taken comments about, oh, what if this market was missing, and that market was missing, and then there was some other imperfection? And coming back to the discussion that we were just having, what is remarkable about this model is you have in terms of writing paper strategy, is to produce the maximum number of reserves with the minimum number of assumptions.

So as an editor, for example, I'm not a theorist myself. But sometimes I have to judge theory paper. And my benchmark is to try to see if the papers deliver more results than assumptions. It's generally not the case. So that paper has more results than assumption. And you really try to go to the minimum, minimum assumption, and then you deliver powerful results, which you very nicely summarized.

But now that we have that framework, we can play with it. We can add things to it. And one of the things that you suggested in some of your comments is intrafamily gender issues. So suppose now that you have a family of two. How might they share resources?

So, I'm sorry. I don't have a graph. That's a cue for you to answer that question. If you are a family of two, how might they share the resources in the family? Yes?

**AUDIENCE:** One could be tempted to try to feed the person that's working the most amount of food, so that the other one may end up undernourished, because they're giving the food to the one that's actually going out to work to bring food to the family.

**ESTHER DUFLO:** Yes.

**AUDIENCE:** Instead of dividing it equally.

**ESTHER DUFLO:** And one might not only be tempted, but that might be the only way to do it, because depending on how much income there is in the family, if you try to shared equally, you might end up with not enough for anybody to work. And someone pointed out that that becomes a gender issue maybe, because the person who is more likely to go out might be the man leaving the woman behind undernourished. And then in that same comment, is like maybe if there is any money left, then it will go to the kids, which means that you could have in the same family a pretty well-nourished man, and currently with children, very, very undernourished female.

And then if you push that a little bit further, that reasoning, you end up to people who are not able to work much. So in a family who would that be? That even if you fed them enough, they couldn't walk much besides the kids? Yeah?

**AUDIENCE:** The older people.

**ESTHER DUFLO:** The older people, exactly. So one temptation or maybe one only surviving strategy, would be to starve the older people. And there is a paper from Ed Miguel about Tanzania where he shows that in periods of drought, so when you can think of a period of drought in the context of this motor or something that moves the labor demand down, putting some family under a strain. You start seeing a lot of witch killings.

So people suddenly discover that they have a witch in their midst. The witch, being usually an old woman who cannot really work more for the family. And they cast out the witch, or they kill the witch, et cetera. So it's a possible explanation for the resurgence of witch killings in bad times.

And of course, it is convenient, because you can also blame the witch for the drought, and then everything is squared, and you have some rationale for what you are doing. But that would be an explanation in the context of this model.

Another thing, another paper that also linked to the gender dynamic, which has happened to all the women, another thing that is true in the context of these gender dynamics is a paper from India that looks like in normal times, the probability of survival for boys and girls once they are born are relatively similar. But in drought time, the mortality of girls shoots up compared to that of boys.

And so the fact that they are similar in normal times suggests that maybe the family is OK with keeping the girls around now that they are born. We'll discuss gender in a minute-- not in a minute, in a few months-- we'll get to gender. There are a lot of issues about selective mortality, and selective abortion, and mortality right at birth. But once the girls and boys are around, conditioned on being born, their survival probability normally is low. But when you get these extreme cases, that's when you say, OK fine. I'm not even going to try with that girl.

So the entire family issue can be interpreted in the context of those models. This paper is entirely static. And what Srinivasan's first critique about this very static framework? When you think about, well, it's like saying basically involuntary unemployment is not such a big deal in this world. Why is it not such a big deal in this world?

**AUDIENCE:** Because normally contracts are one way. So over many periods, technically if you had the involuntary unemployment, everyone would end up working. Like you say, 60% of people work on a given day, then everyone would end up working 60% of days.

**ESTHER DUFLO:** Yeah. So it's not even-- I don't know if it's a fact that normally contracts are daily. But he's saying suppose contract could be daily. Then fine, you're just working every-- you're working two days out. It's not that a particular person is unemployed most of the time. It's that everybody is unemployed from time to time. If you've seen *On the Waterfront*, a very classic American movie against a union mostly. Very interesting for anybody interested in labor or in development.

Anyway, *On the Waterfront*, every day there is a lottery for who-- not really a lottery but people show up to get work. And then some do some don't. But it's every day. So maybe it's just kind of works itself out.

So here, of course, if we introduce some dynamic to the model, then that argument, that criticism will break down. In particular, suppose that how productive you are tomorrow is a function of how much you eat today. It's not a crazy way of thinking that you use your body. By not eating, you're putting under stress. You become more fragile. Then the capacity curve with different nutrition history moves also left and right, and a bit similarly to the impact of having land or not having land.

And so for example, for someone who is better nourished, their capacity curve moves to the left. So the person who got the job yesterday is also more likely to get the job tomorrow, and so on, and so forth. So you get persistent in this world. And of course, where we need to really introduce this dynamic consideration, and many of you pointed out in your comments, is children investment.

Where investment in utero nutrition, and nutrition of the young child is something that is going to have impact for potentially for their full lives. For example, a paper by Ed Miguel and Michael Kremer, and a bunch of co-authors followed up kids that they had dewormed when they were little. They were not even infants. They were primary school children.

They were part of an experiment when they were kids, where they were dewormed. So dewormed is a way of giving nutrition to people, because the worms are fighting for your food.

So while in their first paper, they showed that the one children are less likely to have anemia, and their weight for height had increased, suggesting something as if they had eaten a little better. And in some sense they had, because more nutrients would be available to their body. So that's kind of paper one. They showed that. They also showed that kids were absent in school less often.

Then fast forward 10 years. They surveyed these people again. And they found that they're making 23% higher wages if they had been dewormed two years instead of one. Because by time everybody got into the deworming school. So we're comparing two years of effective deworming versus one, 23% higher wage. Now yeah?

**AUDIENCE:** From the perspective of the previous model, it would be just like they all take jobs from someone else, the average wage.

**ESTHER DUFLO:** Yeah, so this is wage. Wage, that's income. It could be wage or it could be income. And they have various form of things. But in often the case, they are still in the area. So they are either doing agricultural work, or they are doing a little business, working in small business, that kind of thing.

**AUDIENCE:** But I mean like as long as labor demand doesn't change.

**ESTHER DUFLO:** Yeah.

**AUDIENCE:** In this particular example, there's nothing changing in labor demand.

**ESTHER DUFLO:** Right. That's correct. So it's like you would say, well, the wage is a wage. They cannot-- so think of it-- it's the-- remember, it's the-- it's the hourly wage. So their productivity has gone up, is the way of measuring it. That's a good point. In the pure context of my model, there's no space for an increased wage. But think of them as increasing more, working more hours.

So the impact is, the upshot is that this intervention has a very long-term effect. Because it's 23% more productivity in every single-- presumably, in every single year moving forward. So those are large increases. So this is really about moving the capacity curve left permanently. Yeah?

**AUDIENCE:** Did the efficiency results [INAUDIBLE] in the [INAUDIBLE]?

**ESTHER DUFLO:** Yes, absolutely. So once you have dynamics, then the credit market becomes essential. Because then, if you can borrow, and if you can somehow commit to reimburse, then you can invest in your own capacity and move that forward, or someone else could invest in your own capacity and move that forward. So certainly we are exactly in this world, where once there are dynamics, then things can be done in order to reap these benefits, and institutions start to matter.

So for example, so you said about borrowing. So you could borrow to invest in your own capacity. But the labor market could also try and invest in a worker now. Now it becomes profitable for an employer to take someone who is undernourished, feed them up, move their capacity curve to the left, and eventually reach a point where at the current efficiency wage of the economy, it's worthwhile employing them, continue to move them, and eventually get something back.

In a casual labor market, do they have any incentive to do that?

**AUDIENCE:** Maybe not [INAUDIBLE].

**ESTHER DUFLO:** Exactly. They don't, because they are not going to recover the person. So Debraj Ray has an excellent undergraduate textbook, really wonderful, and I actually would encourage any of if you are interested in development to at some point read it. It's really just an excellent book. And he has an anecdote about his mom, who was working with always the same rickshaw puller, and the rickshaw puller was very thin. And it was very difficult for him. So she fed him, and et cetera, and then the rickshaw puller just moved out. So that's the tale of what would happen in a casual labor market.

So you have the borrowing. The difficulty is that, and we'll talk about that a lot, is the limited liabilities. You cannot take someone's last bowl. Of food away. And therefore, you might not be able to get the money back. Or you get into this long-term contract, legal or illegal. So we talk now there is a lot of work in international institutions about modern slavery, which is itself a reincarnation of bonded labor.

So some kids, for example, it's an arrangement, labor arrangement that is frequently found in Nepal, where parents literally sell a kid to an employer, who is feeding that kid enough when they are little in order to then be able to employ them. And slavery is a particularly egregious form of that arrangement. So there is a book by Fogel, an economic historian at Chicago, a Nobel Prize winner, who points out that the slaves in the South we're actually better fed than the workers-- first of all, than independent workers in the US, and also then boys in London, poor boys in London.

And the argument being that they were seen as worthwhile investing by their employer. And that again would not be true in a static model. Because you invest in the person. He needs to eat. He's going to eat, but is not going to be able to work. But in an area where you can actually build that person's capital to reduce their  $v$  star, it might be worth it. Yeah?

**AUDIENCE:** Just to clarify on Ahmed's point, so I think credit markets become important when feeding someone actually increases their productive capacity, rather than so much as the curve shifting.

**ESTHER DUFLO:** Exactly. Where you can move the capacity curve to the left. So someone whose minimum reservation wage was below what would sustain them to work, becomes able to work when they were not before.

**AUDIENCE:** Don't they then get paid less and then it's still just feeding everything [INAUDIBLE].

**ESTHER DUFLO:** Yes. So you need to find a way. So you continue to move it, move it, move it, move it. And then there is some scope, right? You have some-- think of the curve that we had. You have some scope above the reservation wage. So in a market, it wouldn't work. Because in a market, they will be paid whatever is the going wage. But if you have a bonded labor situation, you can take away what you give them, as long as you give them enough that they can work. They can work the minimum amount at that level.

**AUDIENCE:** OK, so would you hit that new range where--

**ESTHER DUFLO:** Yeah, you hit that trench, for example, where someone is sufficiently healthy that you hit that range where you are in the usual labor supply labor demand framework. And then you're doing to them what I was doing, in my mental land reform exercise, of taking a little bit away from the--

**AUDIENCE:** Thanks.

**ESTHER DUFLO:** So central to this work, of course, is the S shape. And what I really like about that paper is to really use it in the context of a market, very simple framework. Make it work as best. But what a lot of people have done with the S shape is to think of it a bit differently, and to think of it as now a mapping between income today and income tomorrow, or an asset today, and an asset tomorrow.

And you could, of course, do the same thing with the S shape. You could say, well, I'm putting income today. Someone is going to eat that income, work, get a wage. That wage is going to multiply the income that they made. And then they are going to have income tomorrow. So that creates a mapping between income today and income tomorrow. And now if we look at the possible mapping, so this is in terms of assets that could just work with income.

You have the mapping between asset today, asset tomorrow, or income today, income tomorrow. That's the first possibility where this is your neoclassical situation, where you have this other dynamic implied. Which is if you start here, tomorrow you have this. Then this move to here, day after tomorrow, you have this, this move to here, et cetera. We did that exercise at the end of last year.

So here is like your change in this case, assets, as a function of how much asset you start with. And the change in the assets goes up if you start poor enough. They go down if you start rich enough. So that there is only one point at which it converges. Now, that's your standard evolution, if there is nothing particular.

Now our capacity curve situation was one where because of that fact that people eat all their income, but the income doesn't make it as productive, doesn't make them as productive at the beginning, the evolution depends on where you start from. So there is a low steady state, a medium steady state that's unstable where unless you start exactly here you're going to move from it, and a high steady state.

And this possibility of multiple steady states is what people loosely call as poverty traps, a situation of poverty traps. Now so that's one setting. That's our capacity curve. So this is-- think of our capacity reinterpreted.

Someone starts their day with some income  $y_t$ . They eat breakfast. They go to work. They are paid. That gives them  $y_t$  plus 1. And then that's that. So this is the dynamic version, not dynamic in the sense of there is investment in the capacity curve. But it's like from today to tomorrow, to today, to tomorrow relationship.

Here is another example that will produce something quite similar. This is the one we saw with the small business, for example. Now what is a necessary condition for multiple steady state? Which is met in two of the graphs and not in the other one. Yes?

**AUDIENCE:** [INAUDIBLE] and then the convex part and then--

**ESTHER DUFLO:** And in particular, what's-- so for example, suppose that I'm doing something like this-- chook, chook, chook. I have a convex part, and I will have a poverty trap, if I do this? No. Why? Sara, why don't I have a--

**AUDIENCE:** [INAUDIBLE]

**ESTHER DUFLO:** Yes. So the necessary condition is that the curve needs to intersect the 45 degree line from below. So either like this in real, or like this by the jump. But then it'll be an intersection of the 45 degree line from below. You're going to find that's kind of the name of the game in many papers, to find whether that exists or not.

So it is not necessary or sufficient to have a convex part. And in particular, we could always be below. We could always be above. But sorry. It is not sufficient. But it's at least necessary at some point the 45 degree line is intersected from below.

So then that's where we get to the Srinivasan second critique, which is well, fine possibly. Why not? But is it empirically true, that we are in situations as far as nutrition is concerned where it's not enough to have a mapping between income today and income tomorrow, or asset today and asset tomorrow, to create a poverty trap. And I will warn you this is a mistake that people always make.

So for example in the World Bank, they want to say that treating women poorly makes country poor. And the argument is that women who are better treated, takes care of their kids better, and countries where kids are treated better there is more growth, and more welfare for everyone.

Maybe these two parts are correct. But it is not sufficient for this to create a poverty trap, because both relationships have to be strong enough that this mapping actually has that convex shape at least at some place. And in a sense, this is the heart of the Srinivasan critique is to say, fine, people own money. They use some or all of that money to eat, and then that makes them more productive.

But I'm agreeing that they are this relationship. So income tomorrow is a function  $f$ . That's the capacity curve of a function  $g$ . That's the decision to consume curve. Of  $y_t$ , income today. But is this curve such that not only it exists, but it is convex in a part? So it needs to intersect the 45 degree line from below. What does it mean the slope needs to be at that point of the curve, at the point where it intersect this 45 degree line from below?

It needs to be greater than 1. So it needs to be that when  $y_t$  is equal to  $y_t$  plus 1, this convolution has a slope of greater than 1. So you can do some very simple calculation to convince yourself that this is going to happen if the product of the two elasticity, the elasticity of the  $g$  curve and the elasticity of the  $f$  curve is greater than 1.

Because when  $y_t$  is equal to  $y_t$  plus 1. The derivative of this function is the product of the elasticity of the  $f$  function, and the elasticity of the  $g$  function. So now we have an empirical testable implication, which is the product of these two elasticity greater than 1? And what Srinivasan tells us is that can't be true. Why?

He's making an argument about one function mostly, and a little bit the other one. What it's main empirical argument for why he doesn't believe? Yeah.

**AUDIENCE:** Something about how the amount of money required to purchase a sufficient number calories is actually quite small compared to the pretty large wages. So we shouldn't really expect there to such a strong relationship between--

**ESTHER DUFLO:** Exactly. What he's saying is that food is super cheap. So the  $g$  function cannot be that steep. Because to get enough calories, you don't need that much money. So the  $g$  function is not that steep. That's his argument, that money is making that. Now he's making some argument about the  $f$  function, which is based on this homeostasis argument that as people get used to not eating, they become actually productive, while not eating. Which I think is a bit of nonsense.

But so he's trying to make arguments on both sides. This is not done in this paper. But that's what he has in the back of his mind. Is let's look at the product of these two elasticities. And only if the product of these two elasticities somewhere, ideally it needs to be at the intersection, so when  $y_t$  is equal to  $y_t$  plus 1. But let's remove even that thing, and let's look at the elasticity of nutrition with respect to income, and then of income with respect to nutrition. Can we show that it's greater than 1?

And the good thing is if you put it this way, well then you can look. You can just as many of you have told in your comment, well, the data is now much better. We don't need to argue this on first principle. We can look at these elasticities directly.

So we now need to pay attention quantitatively to the elasticity of the relationship between nutrition and income, and between income and nutrition. While keeping in mind that this, by definition, these things are endogenous to each other. So we'll need to be looking a little bit carefully how we do that.

So that's basically the three arguments he's making, and this one is an argument about the  $g$  function. This one is an argument about the  $f$  function. So now let's spend the next 15 minutes that we have delving into the empirics of the nutrition productivity relationship.

So it's actually-- I'm not as I said, the Dasgupta and Ray is the modern classic. So a lot of people have tried to look into it. And therefore, looking at this relationship between nutrition and productivity, it's a literature that's used to be extremely active in the '70s and '80s, and then actually came back recently. So the best descriptive evidence comes from Angus Deaton and Subramanian looking at using the NSS, national sample survey detail to look at calories in India.

What and it's worth looking at skimming the paper, because it's a difficult exercise to know how much people eat, what the advantage of the National Sample Survey data is that they have a very, very, very detailed food questionnaire, so very, very, very detailed. Why is that? If the questionnaire is not very detailed, you get into the problem, which I'll show you in a minute, that people as they become richer, not only eat more calories, but more expensive calories. And unless you capture that, you're going to mix up the two.



So here they are pretty convinced that they are able to really, they have so much detail, like what type of rice, and what type of things that they can calculate, use nutrition table to calculate how much calories is in what people consume. And then they run a regression. This is a nonlinear regression. It looks linear. But it's actually a locally linear regression.

So think of each of these points as the predicted from an OLS regression that's run very closely to that point, with weights that are decreasing as you move along. So this is a non-parametric function. Remember, this is entirely descriptive, because they are not bothered at all about the fact that your expenditure might be endogenous to how much calories you have. They are basically buying this Srinivasan argument. This was Subramanian. They are buying this Srinivasan an argument that food is cheap, and therefore they are saying we are not going to worry about endogenous. Fine. We'll keep that for now.

And they run this regression. And it's pretty precisely estimated. You have a function. You have a line that's quite clear. Where do we read the elasticity of per calorie capita, as a function of per calorie. This is expenditure. We'll think of it as income for now to simplify things. How do I read the elasticity?

I'm not asking you what it is. But how would I find out what it is if you had a ruler? So here is something you can keep for your life, very useful if you're going to learn only one thing from this class. In the log-log relationship, the coefficient, the slope, is the elasticity. You can prove it for yourself. I make my undergraduates do it. But I think you can do it as your own homework.

So the slope of that relationship is the elasticity. And that's about 0.35 maybe. So that's not nothing. It is elastic. But that's not one. And also it's not very different from different places. So if I want my product of my two elasticities to be 1, it better be that the relationship between food and productivity is super steep. We are not in a good shape now. So that's the first one.

So this is the elasticity now. So what they are doing here, is that they are-- so the nice thing of doing this locally linear regression is that as well as coefficient, you are estimating a slope at each point. So then you can plot this slope directly. And then you have the elasticity. You can see the elasticity is mildly decreasing as people become richer. But it's relatively constant. And it's about 1.4. I was exaggerating with my point 0.35.

So the relationship does not appear to be nonlinear, or non [INAUDIBLE], at least in this range, despite the fact that it's probably another estimate, due to the fact that they didn't take into account reverse causality.

I mentioned that we need to be careful with not using very aggregated food data. Because as people become richer, they will eat more expensive calories. And they find that here. They calculate the price per calorie as a function of expenditure. And the elasticity is about the same. The elasticity of price per calorie and the elasticity of number of calories is about the same. So if you sum the two roughly as people become 10% richer, they eat about 0.7%, 0.8% more on-- or they spend 8% more on food. And this 8% is again shared roughly into 4% in more expensive calories, and 4% in more calories.

Prima facie, that success that can't be feeling the burden of that poverty trap based on nutrition that strongly. Because otherwise, within the same budget, they would have the ability to eat at least 8% more calories, and not 4%. So that doesn't look too good for that basic argument in the most static level. Does that make sense?

So I'm a little bit restating the Srinivasan point, but based on more data on what we observe. So that's that. And over time, in India, so then they do the same thing with linear relationship, and they make the argument that I made. And then very interestingly, they use a bunch of NSS in another paper. They use a bunch of NSS that's Deaton and Dreze, to look at what happened to this relationship over time.

And what they find is that the angled curve, which the angled curve is the curve that links how we call this elastic curve, the curve that links how much calories in a household consume with how much capital expenditure they consume. Over time, it falls down. And in a rural area, it's larger than urban areas. That makes sense if you think that rural people make more physical work. So then they need more of the calories.

And over time, it goes down, and down, and down. Which has the consequence that basically people are swimming upstream in terms of how many calories they eat. So even though in India people are still many people are still undernourished, as the country becomes richer and as there are fewer and fewer extremely poor people, but the calorie consumption has not really gone up. And why?

It's because people move up. People move down an angle curve to the right, and then they move up that angle curve at the same time. And the two things combine which means that people are not really getting out of where they were in the first place.

And that's still a bit of a mystery, why that is the case. But again, that suggests that there is no desperation, or if there is desperation on food, there are other things that are even more desperate.

There is an experiment in China that is even more extreme, and for a while it had me thinking that maybe, if we did this properly, the elasticity goes even the other way. So a paper by Rob Jensen, which looks at an experiment, it's a randomized experiment where they decide to subsidize the staple food. So in one case it's rice, and in one case, it's wheat to make noodles. So they do that in two places.

After that, what they do is that they look at what people consume. So we start from a situation where a big part of their food budget and a big part of their budget, it's a pretty poor household, was rice and wheat. And then we subsidize that to a large extent. And what happens when they do that is that people are eating less rice, not more rice. That's what they really wanted to show. Because that makes rice the example of a Giffen good.

And this is kind of fun to find a Giffen good. Because maybe Giffen goods don't exist. And here they find one. So that was their main kind of a game. So you subsidize rice, and people eat less rice. Why? Because there is an income effect, which is large enough, since rice is such an important part of their budget that it more than compensates for the substitution effect, which is that rice is cheap enough that you want to have more of it.

OK, so that's the game. And then what you're seeing is that what people eat instead is more seafood, for example. But then where it becomes even more striking is that, overall, people are in one region, they end up eating fewer calories in the places where they are given a subsidy on the staple rice in Hunan, and in the other region it's positive, but insignificant.

So what-- Yeah?

**AUDIENCE:** Was is there any employment or wages impact of this experiment? Because if they are any poverty traps, and they are reducing their calories with this experiment, they should be-- [INAUDIBLE].

**ESTHER DUFLO:** Yeah, so exactly. So that does suggest that they can't have been funding themselves in poverty trap based on nutrition argument. Otherwise they wouldn't have done that.

**AUDIENCE:** Maybe they are making mistakes.

**ESTHER DUFLO:** Or they they are making mistakes, and then they top working altogether. But that would have-- it would have to be something else. So people would have to be either completely wrong, super irrational, or they're actually not starving, and they are happy to eat something else. What would that imply? That would imply that the elasticity of food consumption with respect to income is extremely low.

And so for a while, after seeing this paper, I was waiting to see a more experimental result on the impact of income on nutrition. Because it has to be that the income effect on nutrition is negative. As always it couldn't be that nutrition behaved like this Giffen good that when you make it more expensive, people eat less. It has to be that income effect is negative, and not just lower than we thought.

Now there is a lot of caveat with this experiment. It was very short term. People were given vouchers for rice. And so maybe a long term increase would have had very different status. Maybe they used the windfall to have good food for a while, and then they would go back to this-- so going back to your maybe they are making a mistake. Maybe they are not making mistakes, but they are taking good advantage of the temporary decrease in the price of rice.

But when I saw this paper come in, and the Deaton rice paper coming with the elasticity falling, I was like, OK. Is it the data-- is it just a food aspect of caloric consumption with respect to income is really that low? And then a bunch of papers came up which had the possibility to just answer this question directly.

And in particular, a paper that you're going to see again when Ben talks to you about cash transfer, which are experiments based on the program Give Directly, where people are simply dropped cash into their laps, either as regular income, or as a big lump sum that's given to either men or to women, and it's given in larger amount or smaller amounts, et cetera.

The point is that that's an experiment. That lasts for a longer period of time. So the lump sum is a lump sum. But it's important the two people are supposed to smooth it out. The other was there is a monthly income for a year. And so that's really the ideal experiment to answer this question. We can see how much this transfer, perhaps some of it was saved, some of it was consumed, how much to calculate the elasticity, I'm going to look at the impact of this transfer on overall consumption, regular consumption, not durable, like day to day consumption.

And then I'm going to look at the impact of this transfer on calorie consumption. Now it's not perfect. We don't have calorie consumption. They had a very broad category. So it's going to be food consumption. So you're going to have the sum of the quantity of calories, and quantities of calories. But we are in a great situation, because we can now-- this is each type of consumer.

There is a different version that people got. This is how much their consumption-- their day to day, the regular consumption of non durable goods increase. This is how much their food expenditure increased or enlarged. And so the ratio of these two gives me the elasticity. And they all lined up, so that the elasticity are pretty much all the same.

In blue and in red, it's just the standard elasticity calculated exactly like in Deaton and Subramanian or Deaton and Dreze by the calorie regression. For all of the things I told you about elasticity being androgynous, it seems like so similar, what you're getting, the slopes you're getting by using the various treatment effect, the ratio of their consumption. So you could draw a line coming from this point. It would be pretty well aligned with the simple OLS lines that is simple OLS regression of consumption, or food consumption, and overall consumption.

And that gives us the elasticity. So the OLS elasticity is the equivalent of the descriptive work in Deaton and Subramanian. And then the IV elasticity, think of it as the ratio of the proportional increase in food consumption to the proportional increase in overall non-food consumption. And now you get here very similar results. And elasticities of food consumption at about 1.8.

Again, it's food consumption. So it doesn't take into account the quality increase. So maybe you want, and you've seen the same thing here that the meat and fish has larger elasticity. So people substitute to meat compared to cereals. Cereals, if you look at the IV, cereals has the elasticities at well below 1. So people seem to be moving a little bit, presumably the substitute within calories as well.

So you can think about this 1 divided roughly in two, half-half. So we are back to number of looking like Deaton and Subramanian. It's not that people are not consuming in form of food the transfer that they are getting. But it's not an enormous elasticity either.

So to complete the loop, I would need to give you more on the impact of food availability and productivity. And the sum of that is that at the daily level is not that high. It's not zero. But there are experiments on that where you feed t worker and they produce t. But it's not enormous at all. So it is quite unlikely that this mechanism itself that is highlighted in the Dasgupta and Ray phenomenon is that pertinent on the ground.

But we haven't lost our time. Because there is so many more potential sources of this S-curve. So what we are going to do last time is to take another tack. There are basically two ways in which you could test for poverty trap. The first one is to take your particular mechanism. So here it's the food. And then I'm going to look at the effect of income and food, and food on future income, and take the product of the two.

Or you could say, well, let me be more a reduced point. And look directly at the mapping from income to income, or from asset to asset. And what we do next time is that go back to the report. And then if we do there find an S-curve that interacts in the right place, and you already know that we are going to find that, because I showed you that curve. Then we'll have to go back and think, but where is it coming from. It is not from food. Which opens up all sorts of interesting possibilities, including the behavioral one that you alluded to.

Thank you very much. And then we'll see you on Wednesday.