[SQUEAKING]

[RUSTLING]

[CLICKING]

RICARDO CABALLERO: OK. Let's start. So the plan for today is to wrap up this growth theory section of the course. And I want to conclude by showing you what we can and cannot explain with the models we have looked up till now. And almost as a matter of accounting, I will tell you, what do we need to fill-- which gaps do we need to fill in order to explain the great dispersion we see in income per capita across the world.

But before I do that, I need to finish the previous lecture. And so let me do that. I had shown you this table. Remember, in the complete model-- the model that has a productivity growth, unemployment, and population growth, we concluded that in balanced growth, the following happened.

Obviously, if we pick the right normalization-- the right normalization, here, was effective workers. So the productivity times population or workers. And so if we normalize the variables by that, we get, obviously, zero growth. That's what it means to have a balanced growth, in which all the relevant variables are growing at the same rate.

So capital per effective worker will be a steady state. That's the diagram we plot. Remember, the diagram we plot was output per effective worker against capital per effective worker. And that diagram has a steady state. And that steady state-- at the steady state or the balanced growth point, then we have that the normalized variables grow at the rate of 0. Capital per worker has to grow at the rate gA because capital per effective worker is not growing. So capital per worker will be growing at the rate gA.

The same applies for output per worker. Output per effective worker is not growing. That's balanced growth. But therefore, output per worker will be growing at a rate gA.

These are the exogenous drivers-- output per worker, we assume-- well, sorry. Labor is exogenous in this model. And so is gN. Population growth is some constant we take. It's not something we try to explain within the model. But the two drivers of absolute growth will be gA and gN. And so capital in the steady state will be growing at the rate gA plus gN. Output will be growing at the rate gA plus gN. So that's balanced growth.

Now, let me give you an example so you can do-- suppose that our production function is this. We call that the Cobb-Douglas production function. K to the 1 minus alpha AN to the alpha. Does this function have constant returns to scale? Yes, the sum of the exponents is 1.

But-- so take the log of both sides. The change in the log is the rate of growth. And so you get that the rate of growth of output is equal to 1 minus alpha, the rate of growth of capital, plus alpha times the rate of growth of effective workers. So in balanced growth, gK will be growing at the rate gA plus gN. And therefore, output will also be growing at the rate gA plus gN.

OK, so that's what you have in the table. And if you want to look at a variable like this, capital per worker, then output per worker, then you need gY minus gN. So subtract the gN, and you can subtract on both sides. Then it's going to be equal to gA. And subtract gN from the right-hand side. This one and that one cancel, and I get gA on the right-hand side. So that's the way you use that expression to fill all these blanks. That's steady state.

So I think I stopped right before that-- this slide or at this slide, which is-- if I look at this, this table, gN is pretty easy to compute in most places. There are places in the world where we cannot even measure birth and death, so it's difficult. But in most places, you can measure gN, the rate of growth of population, quite accurately.

And the question we have, though, is, how do we measure technological progress? It's also easy to measure the growth in the stock of capital. It's investment minus depreciation. But how do we measure gA, the rate of technological progress?

And the first proposal on how to do it was also by Bob Solow. That was the second contribution he had in growth theory. Well, it was also growth measurement. How do we measure gA? It turns out that the only way you're going to have output per capita growing over time or output per person growing over time is due to gA.

So we might as well try to measure that since it's such an important variable for the growth of-- the growth of happiness. If you give one indicator of happiness is output per worker, well, such an important driver-- we need to be able to measure it.

And the basic idea that Bob Solow has is, is essentially something you could have taken from 1401. It's extremely simple. It says-- there are some assumptions behind this. But in the basic competitive model, you have that you can compute the contribution of each factor of production to output by the payment it receives.

So under this assumption, suppose that you're spending, in workers, $30,000 a year. So that means, in a competitive equilibrium in the labor market and so on, that the worker is contributing, to production, $30,000. I'm not going to deal with markups and things like that here. But that's the basic idea. You can adjust all these formulas to include markups. But let me not do that.

So that also tells you that if you increase employment by 10%, you're also going to increase output by 10% times whatever is the contribution of labor to output.

And that's what I have here. The contribution to output of adding workers is going to be that times delta N. I can divide, by Y, both sides, and here, multiply and divide by N.

And I get that the rate of growth in output due to a rate of growth in employment is equal to the labor share. That's called the labor share-- it's the wage bill, W times N divided by total revenue sales and times the rate of growth of a population or workers is the same here.

So I'm going to call this gYN-- is the rate of growth of output due to the rate of growth in population is equal to this labor share, which-- I'm going to call that alpha-- times Gn

I can do exactly the same with capital. And you can do-- if you have more factors of production, you can do the same for each factor of production. But in this simple example, we have only two factors of production-- labor and capital.

So I can do the same for capital. And I can say the contribution of capital growth to output growth is going to be equal to the capital share, which is the complement of the labor share. So it's total revenue minus the wage payment, the wage bill, divided by total revenue, times the rate of growth of capital.

So the contribution to output growth of the rate of growth of capital is 1 minus alpha, which is the share of capital, times the rate of growth of capital. So that means if I sum the contribution of labor and capital, I'm left with a residual, which is-- whatever is the rate of growth I have in output-- I know how much I'm getting from labor. I know how much I'm getting from capital. If there is any difference, it must be due to that thing I do not observe, which is technological progress. That's the logic of all this stuff.

Go back, for example, to this production function. I'm saying, I know the contribution that K has to output growth. I know the contribution that N has to output growth. Well, the only thing I'm missing is the contribution that A has to output growth, which I don't observe, but I observe output growth. I observe capital growth, employment growth. So I can solve out what is the technological progress-- A growth.

And thus, it's called the Solow residual, by the way. But that's the way, the rate of growth of A is measured. The rate of growth of the output minus the contribution to growth of employment, population and capital. Any question about that? Nope? Makes sense? Somewhat? OK, good.

So anyway-- so there's a huge industry of measuring these kind of things, of course. Let me give you an example on how to use this accounting. So China '78, 2017-- that's an episode in which China was growing very, very strongly. On average, China grew at over 7%, output-- over 7%.

Now, by the formula I showed you before, if I asked you the question, well, what was behind that growth? How much was the contribution of labor? How much was the contribution of capital? And how much was the contribution of technological progress?

Well, there are several things we can measure fairly well. Population growth during this period in China was around 1.7% per year. There was a massive amount of investment. The capital stock was growing at a rate of 9.2% per year. And the residual-- you can compute it using the Solow approach-- is around 4.2%.

So that's-- 7.2% is a result of the weighted average of these three things. So that's basic explanation of growth in China during that period.

Now, just looking at this-- don't look at the diagram. What jumps immediately? If you just look at this part. What jumps to you immediately?

Let me ask you differently. Does it look like balanced growth? Do you think that that's balanced growth? In other words, do you think that China had arrived to its steady state, and that growth is a result of what was happening in that steady state?

No. [LAUGHS] But what is it that looks-- that tells you that that's not the steady state? Balanced growth is when everything is growing at the same rate. Meaning all the endogenous variables are normalized, are growing at the same rate as the exogenous variables.

So what is it that it would merely jump to me here is that-- uh-oh, 7.2%-- that's less than the rate of growth of capital. So I know that there, capital over output was rising. So that's not a steady state. I know that.

I can see it in a different way. I know that in a steady state, in balanced growth, the rate of growth of output and of capital should be the sum of the rate of growth of population plus the rate of technological progress. That's 5.9%. But capital was growing at 9.2%, not 5.9%.

So I do know that that's a period in which. China was growing beyond its steady state or balanced growth rate of growth. And I know more than that. I know that the reason that was happening is because there was more capital accumulation than you would expect in the steady state.

When are you likely to see a situation like that in which capital accumulation is faster than the rate of growth of capital in the steady state and is faster than the rate of growth of output? That is, that's a period in which we have transitional growth being pulled-- growth above the steady state growth is being pulled by capital accumulation. When does that happen?

STUDENT: Two things come to mind. First is economies that are transitioning from command market economies, I believe? And also, the second thing that comes to mind is, potentially, countries recovering from war periods.

RICARDO CABALLERO: OK, that's deep answer. I wanted something simpler, which is-- I wanted to say-- so the economy is not in a steady state. That's clear. But what do we also know? We know that the capital stock is below its steady state level.

And that could be as a result of the things you described. You had a war, so capital stock was wiped out. Or you had a period in which saving rate was very low. And now you're going to a high saving rate. [INAUDIBLE] A lot of that is what happened in Southeast Asia, in particular. Actually, it was a fast increase in the rate-- a sharp rise in the saving rate.

But the bottom-- so what I had in mind is for one of these reasons, that's a situation where the initial capital stock was below the steady state. And so you have a period of transitional growth in which the investment rate is more than you need to do to maintain the stock of capital per effective worker. It's a positive gap between the green line and the red line. And that's what leads to transitional growth until you reach a steady state.

If things do not change, meaning population growth remain the same as in that period, and the rate of technological progress remains the same as in that period-- we know that the balanced growth rate of China is 5.9%. It's 5.9%, because it's 0.017 plus 0.42.

So that's 7.2% average that you are likely to see. And actually, this is an average that has numbers like 15% very early on to close to 6% or so on the last stage. So that would be a steady state.

Now, that, I think, is an overestimate because we know that the rate of population growth is declining very rapidly in China-- is turning negative. So for the rate of growth of output, China-- unless there's a big change in technological progress-- in the process of technological progress, it's going to be pretty difficult for China to grow a lot more than 5%, I think, going forward. And that creates some problems. But that's what it is. That's what this model tells you. You need to change something.

And the things you can change in this model are what? Well, you could induce higher saving rate. You could get more transitional growth out of that, more capital accumulation. That's costly. That means less consumption and so on. Or it could be some technological breakthrough, but that probably would affect the whole world, in any event. But that's the kind of things you expect.

Good. So the models we have developed here are quite good to explain catching up processes, catching up growth, and to understand where are the economists converging over time.

What I want to do next is-- I want to end up trying to explain-- remember, one of the plots I showed you very early on is that there's great dispersion in income per person, per capita across the world. And also, some countries are not catching up, especially in Africa and so on. And I want to try to understand-- so people have put lots of effort in trying to understand why do we have these differences.

And so I'm going to expand, a little bit, the model we have to show you a few things people have explored. And then I'm going to conclude that those things that people have explored sort of can't explain it either. And then I'm going to go back sort of to growth accounting. so the sort of thing I did for China there, and try to explain what seems to be behind these big disparities we have in the world.

So the first thing I'm going to do is just-- it's useful as an exercise, even. I'm going to modify the Solow model a little bit. So this is like the production function I showed you before. But rather than having N here, I'm going to have H. And H is just N-- our old N-- population, labor force over there, but it's scale up by this human capital factor.

So what this says is that human capital is really-- is the population times something that controls for the level of schooling of that population. So a big candidate for difference across the world is certain populations are far more educated than others. So this does exactly that. Size is an increasing function of the numbers of years of schooling.

And there is a big micro evidence-- literature trying to estimate what is the value of that side. What is the value of an extra unit of schooling for human capital and so on. And the estimate depends on what kind of schooling are we talking about-- primary, secondary, tertiary, or whatever. But on average, that's a number around 0.1.

So one extra year of schooling raises human capital by about 10% So the whole population increases, the average by one year. That adds about 10% to human capital. So it's as if you had increased population by 10%. So it makes a difference.

Now, it's pretty hard to raise, for a country, one year of schooling for the average. It takes a lot of time. But when you look in the cross-section, there is huge difference across the world between numbers of years of schooling. And that accounts for a big part of the difference in income per capita.

Anyways-- so let me do a balance growth exercise with this expanded model and see how far we can get. So the first thing I'm going to do is I'm going to normalize everything by effective work-- sorry, by workers. So I'm going to divide-- all the variables I'm going to show you are going to be divided by N.

Now, notice that I'm dividing by N, not by A times N or A times H. So there is a difference with the previous analysis. And I can always divide. The model we had-- I can always divide by whatever I want, all my variables. I divide it by effective workers because I wanted to have a diagram where the curves were not moving around. But I can divide by whatever I want. And I will divide by different things depending on the analysis I want to conduct.

Now, I know that once I divide by population only, not by A times a population and education, perhaps, I cannot draw my previous diagram-- the diagram with the saving, with output per worker, and so on, because those curves are going to be moving, so it's not very friendly. But I can divide by whatever I want.

But I want to divide, here, by just population. So little h will be simply big H divided by N.

Remember that big H was just e to epsi psi u times N. So that's that. Output per worker will be just-- will be K capital divided by N. And here is big H divided by N, which is little h. So all this, now, is measured as output per worker or per population-- per person.

Now, remember, what I can do here is-- then I know that the rate of growth of output per person is going to be equal to 1 minus alpha times the rate of growth of capital per person plus alpha times the rate of growth of A times the rate of growth of h, in which h is this years of schooling transformation.

Now, if you think about the steady state, it doesn't make any sense that-- gH, at some point, will become 0. I mean, we can increase education. But at some point, we cannot be all going to 150 years of education. Unlike capital and things like that-- you can increase, for a while, education. But at some point, there is a limit. I mean, you're not going to do a post post, post post, PHD, blah, blah, blah, blah.

So in a steady state, we know that eventually, in the long run, this gH is equal to 0. So this economy-- expanded to include years of schooling-- has the same sort of balanced growth characteristics of the economy I just showed you before. So in that economy, capital per person will grow at a rate gA, and output per person will grow at the rate gA. Output will grow at the rate gA plus gN. So exactly the same as we had before.

Up to now, adding human capital doesn't change our conclusions about balanced growth. It will change some conclusions that are important. So that's the reason I'm introducing this variable. But it doesn't change this conclusion. So this model, which is a little expansion of the previous model, we had, has the same balanced growth characteristics as the model I showed you before.

So let me do a little bit of algebra with it. So from the capital accumulation equation, I know that-- so let me-- remember, the capital accumulation-- now written in per person-- will be kt plus 1-- this is little k-- minus kt equal to s times yt minus delta plus m kt.

Wait, why don't I have a delta plus n minus plus gA there? Remember that in the previous model I have a delta plus m plus gA there. Did I make a mistake?

Actually, this is a useful exercise for you. You remember that I had a delta plus m plus gA there, no? What's wrong? I just told you that this economy, at least in balanced growth, is exactly the same. So did I make a mistake?

No. The reason I had the gA there is because I was looking at the change in capital per effective worker. I'm looking, now, at the change in capital per worker, not per effective worker. So I don't have that A in the denominator. So I don't need to account for the rate of growth of the denominator due to an increase in technology. I don't need that.

And so what I can do is divide both sides by kt-- that's kt. And this is the rate of growth of k, no? It's the rate of growth of k.

But in a steady state, the rate of growth of k, capital per worker, is equal to what? gA is the rate of growth of technology. So this-- in a steady state, this is equal to gA. And so what I wrote there is-- I think it should be exactly that. Is it? Yes, good. That's what I did.

And why did I do this for? Well, because now I can-- you know that I can measure delta-- I can measure delta. I can measure n. And I can measure gA.

So this implies that I can solve out, in a steady state, for what is the level of capital per effective worker. I can solve from this equation, and it's equal to this expression here.

Notice a few interesting things here. Capital per worker-- Each of them is divided by n, so I can also look at big K over A times big H. It's increasing the savings rate. That you already had in the model we discussed before. If the saving rate is higher, then you're going to end up with a higher capital per effective worker ratio in the steady state. It's decreasing in population growth. All these things you already saw before.

So now that I have this expression for K over H, I can go back to my production function, to this. And it's sticking there-- this value. And I get that output at time, t.

Once you are in the balanced growth path, it's equal to A (t) times h times k over Ah to 1 minus alpha. Just solve for that. And the point being is that now I can write this as y(t) is equal to a t times-- so human capital times this expression here.

So the point is, human capital doesn't affect the steady state growth, but it does affect the income per capita that you have. And it makes a big difference. I'll show you. So when people try to explain differences across the world, they notice that they were missing a big component. And that big component is education.

So let's compare. What I want to do next is-- I can do this for every country in the world. And I can compare it with the US. OK, I can do this for every country in the world. And I can compare it with any other country in the world. But just-- let's compare it with the largest country in the world in terms of output. That's the US. So let's see what we get.

So I'm going to take output per capita everywhere and divide it by the same expression for the US and then define that variable as yi hat. So for country i-- say, Singapore-- we take output per capita and we divide it by output per capita per person in the US.

Assume-- big, if. This is a huge, if. But you can do that for the US versus Singapore. Probably is not a crazy assumption to make. Assume that they have the same rate of technological progress and the same technology and so on. Well, the same rate of technological progress-- I'm going to assume that for now.

So then this yi hat-- you can write this-- it's just this for Singapore divided by this for the US. It turns out to be this expression here.

Solow did something like this and said, OK, assume that technology is the same across the world because, at least for major economies, technology can be imported. And we can have the same-- more or less, the same technology across the world.

So assume that this guy is equal to 1 and that both Singapore and the US have the same rate of growth. And so that means that countries that have higher savings rate will tend to have-- we know that as [INAUDIBLE] goes, we'll tend to have higher output per capita.

So Singapore has a higher savings rate than the US. That will tend to give Singapore a higher income per capita. If a country has a higher population growth, then it will tend to have a lower income per capita and so on and so forth.

And so the question is, well, suppose you make this assumption of equal technology and take the-- we can measure the saving rate in different parts of the world, the population rates in different parts of the world. And we're assuming that there's the same rate of technological progress everywhere. How much of of the difference we observe in income per capita across the world can be accounted by that?

So that was the first question, is-- well, suppose that technology is the same, but we measure all these other things-- saving rate, population growth, common rate of technological progress, common depreciation across the world, and so on. How much can we explain of the income disparity?

And the conclusion is the following. The conclusion of that experiment is that-- if the only difference behind income per capita were years of schooling-- sorry, a key thing that I forgot to measure is years of schooling. So if a country has more years of schooling, it will tend to have a higher income per capita and so on.

So if you try to explain the differences in income per capita across the world, using variables like years of schooling, difference in saving rate, difference in population growth, and so on, the world would be a lot more egalitarian than it actually is. It would look a lot flatter.

So this is how much you can account. Here, you put a bunch of lots of countries-- Africa and so on here. And if you just stick, in this equation, the corresponding saving rate, education levels, and so on, the world would be a lot more similar. There wouldn't be the kind of disparities we see between some African countries and Singapore, say. We're talking about Singapore.

But the world doesn't look like that. That's the point. So if you take all these things that make a lot of sense-- education, saving rate, and all that-- you're going to explain a small share of the differences in income per capita across the world. Sorry. In this plot here, L is our N. L, labor, is our N. So this is y over N. Our little y in this thing.

So we can get so far. We need something else. So what else do we need to add to really explain the amount of disparity we have?

Well, the answer is, again, the Solow residual. It turns out that the assumption that As are the same across the world-- that the level and the rate of growth are the same around the world-- is just a very bad assumption. The level of technology is very different across different parts of the world.

So the next step was to say, OK, let's measure the difference in technologies across the world. And it turns out that if you try to explain-- so if you go out there and you measure the level of technology across the world-- different places-- Zimbabwe, Singapore, South Korea, and so on and so forth-- well-- and then you plot that, the level of technology that countries have, vis-a-vis their output per capita, per worker-- you explain a big share of it.

So here is what you have-- is the relative A. So everything is relative to the US here. So the A that we measure-- the level of A that we measure-- I don't remember which year was this. I don't remember when it was. Doesn't matter.

So if you measured the relative level of technology in country I, relative to the US, and then you measure the relative output per capita in that country relative to the US-- and forget about everything else-- education and so on and so forth-- you can get a pretty good relationship between the two. So between one half and 2/3 of the difference in output per worker across different countries in the world can be attributed to the difference in technology level. So that's a conclusion that we have.

Now, let me revisit this issue of convergence. And so what you do is you take countries that have, more or less, the same A and that have more or less the same levels of education. And you look at the path of their output per capita. You get that the models we have been discussing here work extremely well.

So here, you see that they are, more or less, growing together. There are wars and stuff like that here. So there are great recessions and things like that. But on average, you see the countries that were behind caught up and so on. Big dispersion here. They were all growing together. And as more time passes, the closer they get to each other because they are converging.

These guys-- the US and the UK were already very close to a steady state, in the 1870s, while Japan was way behind. But it was sort of in the same class of countries in terms of technology and in terms of education levels and so on. So it works pretty well.

This is for more countries. And you plot per-capita income in 1870-- again, for countries that have similar As and Ks-- A's and h. And you look at the rate of growth, and you get exactly what you would expect. Countries that were further behind caught up. That's Japan. Very fast rate of growth. And you get this very negative relationship.

So this is the convergence model. It works extremely well, conditional on having the same A and h. So that's the contribution of this lecture. I already told you that this convergence model works quite well. The point is now that it works very well. And I had told you early on-- I think in the first lecture on growth-- that this worked very well for certain kinds of countries. But then when we put all of them together, there were some countries that were clearly off. And they were mostly in Africa, but you had countries that had low per capita income and they grew very little during that-- the sample I showed you.

So here, I'm refining that. I'm saying, OK, now I'm going to tell you a little bit more what I mean by countries being similar. And what I mean here is that they have similar A and h. So when I look at countries that have similar A and h, the models we have discussed work extremely well.

This is over a short period of time, so you have more fluctuations and more countries. But still-- you can argue that Mexico and Chile probably do not belong with many of these other countries, but you still get this negative relationship. It's quite clear.

Now, if you don't control by A and h and you put everything together, then the plot looks like the plot I showed you earlier. So if I control by A and h, the models work very well. If I don't control for A and h, then the models do not look that nice.

So this led to a literature, which is called the conditional convergence literature. And the idea-- it's almost accounting, but the idea is the following. So the question that-- what's behind this literature is, well, why is it that we have some countries-- say, here-- that have a very low income per capita and grow very slowly? That's the puzzle. How can it happen that we have that?

And the story-- but again, it's more accounting than an explanation, in my view-- is what is called conditional convergence. It says for some reason-- probably it has to be explained in terms of institutions, political instability, or whatever. For some reason, some countries have just lower steady state levels of technology, lower steady states because they have lower technologies, and they're stuck with lower technologies and so on.

So what this literature does-- it says, OK, let's compute the steady state. So let's accept that some countries will have lower level of technology. That's what it is. Maybe at some point, they'll flip from there. But they have been, for a long time, in the stack that let's assume that they have a different level of technology. So that means-- let's compute, for each country, its steady state, its own steady state, using its own technology and its own level of education.

So in particular, in this plot, I'm going to show you- take the values-- the value of A for 1970. That's the plot I'm going to show you. The value that each country has in 1970. Compute the steady state level of output corresponding to that A. A-- and over time, it will be growing at gA, whatever.

But take the A of 1970. Compute the steady state value of that. Compare it with the current output over that. If the current output is below that, that means that this country still needs to catch up-- not with respect to some universal steady state, but with respect to its own steady state, with its lower technology and whatever. And then look at whether we see convergence or not. And the answer is that you start recovering this downward sloping curve.

So what does this say? What is the big story telling us? It's saying, look, some countries, for reasons that are beyond this model, just simply have much lower steady state. Yep. They have lower technologies. They don't know how to use more complicated technology. I don't know. But that's what it is. They have lower technologies. And so they have their own steady states, which can be steady states with very low levels of income per capita.

Now, for those countries, it still applies-- and that's what this picture shows-- that if they are not at their steady state, they still have lower capital per effective worker than they need to have in their steady state-- that they will have transitional growth. So they will grow faster than their growth in their own steady state.

And that's what this picture shows. These are countries that grew very little. Look, we have Japan here together with Botswana. And maybe they won in the same place. So these are countries that still had lots of growth to do, relative to their own steady state.

And they did grow a lot. How do I know that? Well, because the output I compute-- the output I compute, relative to the steady state at the beginning of my sample, was much lower than 1. That means that you're not at your steady state.

So this variable here is the output you have at the beginning of the sample, relative to what the steady state-- your steady state is. How do you compute the steady state? Well, you input the level of technology. You input the saving rate. You input the population growth and all those kind of things.

So you have a number lower than 1. It means you still have catching up growth to do, not with respect to the global universal steady state, but with respect to your own steady state. And when you do that, you see that some countries that are in the total sample looked like they are not growing and so on and so forth. They are growing. They are just growing relative to their own steady state, which has little growth, and it has low levels of technology and so on. And so that's the conclusion of this conditional convergence literature.

Now, it turns out that the world has become very unequal, also, along this dimension over time. This shows you the ratio of GDP per worker of the 90th percentile to the 10th percentile country. And so you have not only big differences in technology across the world. But also, you have very different rates of growth in technology across different countries in the world. So this difference is sort of increasing quite dramatically. I don't know what happened here. [LAUGHS] These are the same.

So the world started with countries-- this is telling you it started with countries that were richer than others, and that distance has been rising over time that towards the end, we began to change here. I think that has a lot to do with China. That was a poor economy that grew very fast during that period. And it wasn't very large here, so it didn't matter as much. But then it began to count a lot. I think. I'm not completely sure. That's it.

Anyways-- but that's the state of knowledge in this-- obviously, there's a big literature around all of this, and very complex, even, literature. But there is-- we understand-- we know that we have good ways of explaining how a country converges to its own steady state, that we have very poor models, certainly, within economics.

Or within growth theory, per se, there is little institutions and stuff like that explain some of that. But we have very poor models, in general, to understand what gives rise to this big disparity in technology adoption and so on.

So that's all that I want to say about growth. The next topic is we're going to open the economy. We're going to go back to the type of models we had very early on, but now in the context of an open economy.