Introduction to Economic Growth- I

Dr. Sohini Sahu

Department of Economic Sciences

Indian Institute of Technology Kanpur

Lecture-15

Hello and welcome to the last week for this particular course on Introduction to Economic Growth. So, I hope you have liked the lectures thus far and before we proceed with this week's lecture, let us do a quick recap from week 3 that is last week. So, we had first began by giving an introduction to what is economic growth and what is the motivation behind studying economic growth. And we did see some pictorial evidence, graphs, etcetera, the stylized facts, etcetera, that is what we had seen in the first week. And then in the second week, we had talked more about the data because what we actually come across in real life is mostly readings or articles based on the data. So, understanding this data is essential.

We also talked about that what if GDP data is not available for some reason or the other. Maybe as researchers we encounter such situations very often. Even as a general reader and that is why we did take a look at that newspaper article on night lights in the Indian context. Sometimes, if you would like to learn a little bit more about maybe places that are at a more granular level.

Their GDP data is not available then we can use proxy variable. So, in all those context we had talked about the data. After talking about data, we talked about a framework for analysis because, you know, it is one thing that yes, we do have the data, and we can analyze the data, and we can come to certain conclusions, but as policymakers, especially It helps if we have a model that is very handy to us, an economic model. So, for a framework of analysis as we had mentioned there are various kinds of growth models. There is no single growth model that makes our job very difficult so as to say, but you know, as students, we have a starting point typically, and that is the Solow growth model.

The Solow growth model is due to Robert Solow. We had discussed that model at great length. That model is also known as the neoclassical growth model. Sometimes it is also known as an exogenous growth model. Why? Because all the important parameters that we saw in the model that leads to a change in the steady state.

Remember small s, small n, small g. All these were exogenous to the model. So, that is why it is also sometimes known as an exogenous growth model. We had also discussed that how technological progress or rate of change in technology is a very very crucial factor

in ensuring growth especially growth at the steady state. So, for countries that have reached the steady state.

For them, if they have to keep on growing perpetually, then what is their source of growth and that source of growth is technological progress. That was the conclusion from the augmented Solow growth model. In while discussing the Solow growth model, we also said that all these various policy implications come out from there. For instance, what happens in an economy if saving rate increases? What happens in an economy if there is population slowdown? And what happens in an economy when productivity growth occurs? So, we can think of these as policy questions and those were also answered within the Solow framework. So, all these are the things that we had covered so far.

Today almost in continuation because convergence is a topic that is like an offshoot of the Solow growth model. So, once we are more familiar and we get more comfortable with the Solow growth model, now we can talk about questions like, does the Solow growth model tell us anything about this question that you know many a times we ask ourselves this question that would the poor countries ever catch up with the rich economies. This is known as the catching up because if we can recall one of the facts that we had seen under stylized facts of economic growth that nothing is forever in the sense that it is not like poorer economies will remain poor forever and vice versa. So, Is there a process by which poorer economies will catch up with the more affluent economies? Is there something that the Solow growth model talks about? So, convergence as the term suggests, the way we understand the term convergence in just the regular English language is something that converges. So, here in the same context we are going to talk about whether the poorer economies are going to converge to the economic status of the richer economies.

So, up to that I think I mean at this level this is the definition of convergence we will use gradually we will get introduced to more technical you know definitions of convergence, but I suppose the question the driving question behind convergence is are the poor economies ever going to catch up with the richer economies. And since technological progress or productivity growth, now this was also mentioned earlier as economists we use both these words interchangeably, they are very important. So, naturally now comes the question can we actually measure technological progress? We talk of technology all the time, but technology is intangible in nature. So, how is it that we can measure the growth in technology? So, to answer that question we will you know get into this framework of growth accounting. So, that comes within the broad area of productivity that is why productivity is mentioned here.

And similar to growth accounting, but not the same thing by the way is something known as development accounting. Which will tell us that what percentage of or when we are especially comparing across economies that how much of importance should be given to productivity growth versus how much of importance should be given to growth in factors.

Factors means labor capital etc. So, since these are two kind of related concepts, but not the same things, but they are related to productivity. So, we have clubbed them under this broad head of productivity.

And the final thing that we will be talking about this week is we will provide a background for the emergence of what is known as new growth models, sometimes also known as endogenous growth models. I have not written it here, but you know, sometimes you might hear the term endogenous growth models. I think the distinction is clear because, as we have said, for the Solow growth model. The most important parameters, they were all exogenous to the model that is one of the limitations of the model. So, now suppose if someone asks the question that we understand that technological progress is very important for growth going by Solow, but tell me where does this technological progress come from? What should I do to ensure technological progress? Now, that is not answered within the Solow framework.

Why? We will recall that small g, its value was exogenous, g was not a function of anything. So, we really do not know going by the Solow growth model that what is the source of that technological progress. And this is exactly what endogenous growth theory or the new growth models as we call them they address. So, they now go one step further and they look more into how this technological progress comes about, how can that be ensured, and what kind of environment do economies require to ensure that there is productivity growth. So, we will not be talking about any specific model that comes under the new growth models here, but we will kind of give an outline of the most important contributors to this particular theory, and with that, we will be wrapping up this particular course.

So with that let us begin with the first question. So we have to again get into that Solow mode once again. This is almost like a continuation of the Solow growth model and we are asking ourselves is there convergence that is why we see a question mark right next to it. Now, why is there a question mark? Because the Solow growth model it makes a very strong prediction. What is that strong prediction? Suppose countries in the long run, they do not display differences in rates of technological progress, savings rate, population growth rate and capital depreciation.

Then in that case, in all countries, the capital per unit of effective labour, they are going to converge to a common value irrespective of their initial capital stock. Now, does that hold yes or no? So, to understand this there are two concepts of convergence. One is unconditional convergence and one is conditional convergence. Let us look at it and I would also urge you that while I am drawing the figures here, please try and draw this as well, because not only is it a good practice, but you know every time we draw these figures, I think at least for me, the concepts become very clear.

So, let us begin. Let us ask the question slightly differently here because we are talking of convergence. So, convergence of what? So, let us say, suppose we are asking ourselves a question that do poor economies ever catch up with the affluent economies? To understand this, let us try and see whether we have an answer to this question based on what we have covered in Solow thus far. Now, possibly, I am not going to label everything here; I am assuming that we are already familiar with this particular figure. So, I will just draw those things that are required for us. Please label every diagram.

I am just trying to demonstrate how we might arrive at an answer to this question that we have asked ourselves here. So, we have the basic diagram in front of us. Let us say that this is the initial k for country A. let us say in the year 1960. This is a relatively poorer economy because there is also another country B and how do we know B is a more affluent economy? It is indicated by its position here; this kb is greater than ka.

Now, from the Solow growth model, what do we know? We already know the answer. So, what do we know from the dynamics of the Solow growth model? We know what is going to happen to this country, ka, which is originally it is here, kb is here, that is, country B is here in terms of K. What is going to happen to both these countries over a period of time? Over a period of time, Ka is going to move from here and this movement will continue until it reaches the point k*. We have gone over this entire dynamics before while talking about the Solow growth model. So, if you are still not familiar with this, I would urge you to please go back to those lectures and see how country A is going to move from its position, which is currently at ka 1960, to k* ss.

What is k*ss? This is a steady state. What is going to happen to country B? Country B is also going to move from its initial position here. And is going to reach k*ss. So, both countries then, over a period of time, we are not getting into the rate of convergence and how long it will take for the different countries to reach there. All those things can be calculated, and if you are interested, you should actually look up.

But the broad takeaway from here is. No matter where countries start from, they are eventually going to converge to this k*ss, right? Now are there some very strong assumptions that we are making or you know is there something with which we have to qualify then the answer to this question. So, then, if we go by this particular figure and we have asked ourselves this particular question, what is the answer to this question? Yes, then the poorer economies are eventually going to catch up with the more affluent economies. Is that the answer? Well, partially because there are some very strong assumptions that have been made here and I hope we could realize that while we were drawing this figure here. So, now let us point out what are those strong assumptions that we have made here. Now, the very fact that we had country A and country B in the same figure, what does that imply? It pretty much implies, remember where did we get all these curves and lines from? We had all these variables, parameters etc.

Now, if we have only one of s.f(k) curve and one of the n + g + δ curve and if we have placed both countries on the x-axis, then implicitly, we have made the assumption. That both countries have the same production function, they have the same values of s, n, g, delta, etc. So, yes, we have then made a very strong assumption here, and if we ask ourselves a question that well is this really the case when we look around us, especially when we are comparing poor economies and rich economies, the answer is no. So, then this answer is yes, provided there are many strong assumptions that have been made here. And what are those strong assumptions? The assumptions are the values of small n, δ , g, s, they are all the same.

The production function is also the same. You know, those are the strong assumptions that have been made. So, that is why we said that this answer is partial because, well, if this is the case, then as per the Solow prediction, they are going to converge where they are going to converge here. And they are going to converge in terms of their per capita income right? But then now before we proceed, so this is something known as unconditional convergence.

Why is this known as unconditional convergence? This is known as unconditional convergence because no matter where an economy begins, you can also have some other economy here, and we can have some other economy here. No matter where an economy begins from, if these assumptions hold then they are all going to converge to the same steady state. So, it is unconditional why because it is not conditional on the starting point. So, country A can have a lower starting point compared to country B, which has a much higher starting point because it is relatively closer to the steady state, but the starting point does not matter. It can only matter in terms of timing, but that is not what we are talking about here because when we say convergence, look at the question the question was are poor economies ever going to catch up with rich economies? So, this is the notion of unconditional convergence, because to draw this itself, now I have 4 countries, all 4 countries have been drawn using the same figure.

And that itself implies that we have made very strong assumptions here that for all four countries, they all have the same parameters; otherwise, we could not have drawn, you know, all of them here using the same figure here, right? So this is what is known as unconditional convergence. So, unconditional convergence then what does it tell us? It tells us that as long as we have these strong assumptions that we just mentioned, all countries are going to converge to a common same, or we can call it a common steady-state value. So, this is what unconditional convergence tells us. Now, if you are wondering that well these assumptions they are very strong and in real life does it hold? Possibly no, we have some or 200 countries around the world and if we are asking ourselves this question and if we make this assumption, I mean theoretically we can make this assumption. But when we go back to the data, as we said in real life, there is a high chance it does not hold, but again, there are some exceptions.

If the countries or if a group of countries are somewhat similar in nature. So, we can think of maybe the SAARC countries, right, SAARC or the EU countries, right, where they are more or less similar in nature. So, n value, s value, they will not be exactly equal to each other, but they are fairly similar to each other, maybe in those cases. So, for, you know, one can call them like groups of countries. Groups of countries with similar features, then for them this assumption is not so implausible.

So, as we said, if we are then looking at the SAARC countries or the EU countries and then asking ourselves this question, I think then this stands. Then we are good to go with unconditional convergence, and what we would say is irrespective of whether each of these countries, that is, the SAARC nations as we call them, where they start irrespective of their starting point, they are all going to converge to a common steady-state level. So, naturally you know whenever such predictions are made based on theory, you would like to test it with data. And this part that I am talking about here, this example, and the following graphs, are all taken from Debaraj Ray's development economics. So, there was a study that tried to test this.

So, one can test for unconditional convergence and this is unconditional convergence that we talked about here. And how are we going to test for unconditional convergence? Here, we could draw a figure and everything. With data, how we can test for unconditional convergence is we look at whether there is a strong negative relationship between the growth rate of per capita income and the initial value of per capita income. Why is that the case? Because as we know from the Solow growth model, further away one is from the steady state, the growth rate is going to be higher. The closer it gets, it is, you know, going to slow down.

So, there has to be an inverse relation between the starting point and the subsequent growth rates. So, this study what it considered, so now we are looking for as we can see from the title here. So, unconditional convergence evidence or lack of unconditional convergence question mark because that is what we will see. So, in this study these countries were considered and they have been ranked from poorest to richest, Japan, Finland, Sweden, Belgium, UK and Australia.

And this is the time period that was considered. So, the initial time period that was considered was 1870. So, the log of per capita income has been plotted on the x-axis. What is plotted on the y-axis? As we said that the growth rate over a period of time. So, here this is almost close to a century, you know this longer time has been considered. And what is found for all these 16 studies? This study was conducted by Madison, right.

And as I mentioned earlier this figure has been taken from development economics book by Debaraj Ray. So, what do we see here? So, this is a scatter plot. We were to fit a line here; it is a negatively sloped line. So, what does this indicate and what are we looking for?

If we are looking for whether there is evidence of unconditional convergence yes or no, this line should be negative. Is this what we find here? Yes, this is what we find here.

So, is there evidence of unconditional convergence based on this particular set of countries that was taken and they have been ranked as poorest to richest based on 1870. So, this is how they were ranked, the answer is yes. But now comes the next question and this is what we keep on doing in research is we try and see whether everything was covered for or is there some error that has been made. So, there is a major statistical pitfall in this particular study that was done. Now, this was Baumol's study; this was based on the data that was collected; we mentioned earlier that these are the countries that were considered.

Now, what was pointed out by Brad DeLong, who did an extension of this work. He said that the author had considered the countries that were rich ex-post, that is, countries that had similar per capita GDP levels in 1979. 1979 is the terminal year of this study. Now, it also strikes us and when we look at this set of countries here, these are all actually very rich nations in the current period. They were not all equally rich in 1870, but they are all rich now.

And they were possibly all you know rich during the time of 1979 when the study you know was conducted. So the argument that Brad DeLong is giving here is in 1870, with no knowledge of the future, what criteria would tell us to choose these countries ex-ante to test for convergence down the road? Ex-ante means before, and ex-post means after. So, in other words he is asking that well in 1870 we had no clue that these countries are all going to be developed countries 100 years down the line, right. They were all more or less similar in terms of their affluence only 100 years down the line, right? So, he is asking the question that on what basis these particular countries were chosen. So, that is why he is asking, well, if Japan has been chosen, then why not choose Argentina, okay? This is what is termed in econometrics, something known as a selection bias because hindsight is no substitute for forecast.

So, this is like saying that countries that were you know they were in different states earlier, but currently they have all converged because remember by the time the study was being conducted in 1979. All these countries they are pretty much similar types of countries already, right. So, you are already looking at cases where they have already converged because in 1870 we did not know what would happen to these countries 100 years down the line. So, ideally, what should be done or for a true test of convergence as it should look like, it should have a set of countries that ex-ante that is beforehand itself, they seemed likely to converge to high per capita GDP levels that came to characterize the richest nations decades later. So, what Brad DeLong did was that he addressed this question.

by adding countries like Argentina, Chile, East Germany, Ireland, New Zealand, Portugal, Spain, all these countries were now included in this set. He dropped Japan from this

particular set and this is the interesting question, what do we find after all these countries were now included? What do we find? What is the conclusion? What do you see? At least one thing I can clearly see from here that that neat negatively slope line that was there earlier, remember? And what were the earlier countries? These black ones were the earlier countries. These are the new countries. Now, if we consider the entire set of these new countries and the countries considered earlier, then looking at the overall plot at least I do not see a clear you know negatively slope line here, right.

This was the finding of Brad DeLong, okay. So, in fact, that is what has been found true for unconditional convergence; here we were talking of unconditional convergence. So, if we consider all kinds of countries together because this is what they were in 1870, and we did not know 100 years down the line whether they will converge or not. So, if we consider all kinds of countries at the same time. Then, we do not find much evidence for unconditional convergence, right? So, something that we saw theoretically was coming out from the Solow growth model, but here it is not turning out to be the same, okay.