Introduction to Economic Growth- I

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Lecture-18

So, we take a look at two tables now just to see how these numbers appear and, more importantly, what we can infer from an exercise like this. So, this is the development accounting exercise. Now, this is for the year 2005. Remember, this we can do only at a given point in time. So, these numbers that are appearing here on the screen right now is for the year 2005. Are we all good to go up to now? Now, in the year 2005, these many countries have been considered here that we see in the first column, US, Norway, UK, up to Cameroon, Zambia.

There is also another thing that I would like to draw your attention to and many a times when we are comparing data, it makes more sense to do this. We take a certain country's value as the benchmark and then we rescale everything else. So that we do not have to look at very big numbers all the time. For instance, here, everything is relative to US.

How do we know that? Because you see all the numbers for US, and what are all these columns all about? So there is output; by the way, this is output per capita. This P is again taken from Weil. So if you go back to Weil's textbook, so this is per capita output, per capita physical capital, per capita human capital, small h is human capital. The factors are K, the small k that is why represents the per capita capital. And H, small h is human capital, and A is productivity.

So, these are the columns. So, we were talking about how all values for the US that has been normalized to 1. What is the advantage of doing that? So that we do not have to look at large numbers, because here we are comparing. So, it makes sense to compare against a benchmark, right, and in this particular case US is the benchmark because all its values are 1. So, all other values that we see is relative to the US.

So, this is how we are going to interpret it. Say, for instance, the value of A that is productivity for the US is 1, whereas the value of productivity for South Korea we see is 0.63. So, what it means is the productivity of South Korea is 63% of that of the US. I hope it is clear now.

So similarly, in that manner, we can now compare. In most cases, these numbers they are all less than that of US, the productivity numbers. Another way of looking at the same you

know data will be that if the US and SK South Korea that is if they had the same levels of physical capital and human capital per worker, then the US would produce one over 0.63, which is 1.5 times as much output per worker as South Korea okay.

So, similarly, you can interpret the other numbers here as well. For Norway, this is marked in red because this is one value that is higher. Well, similarly, it is for Japan when we consider the factors column. Otherwise, in most cases, yes, in all other cases, all the values they are less than 1. So, compared to the US.

It is only Norway and Japan that is doing better or was doing better in the year 2005 when it came to the factors combined. So similarly here you can interpret for the rest of the numbers. So, maybe let us pick up one more number here, maybe the last one, let us see. So, Zambia, if we look at productivity, we see it is 0.

14. So, what does this indicate? This indicates that productivity in Zambia is only 14% of that of US, we should not forget comparison or to whom it is being compared to. The interpretation is not that productivity in Zambia is 14%. That is an incorrect interpretation. Zambia's productivity is 14% that of US. Because remember this is a comparison exercise that we are doing.

So, this was the development accounting exercise for the year 2005. This is for the same set of countries, I think couple of changes have been made here, but US still remains constant here and it is still considered as a benchmark. This is for the year 2009, as we can see here once again. Here we do see a change at least in terms of productivity, because now the productivity of Norway is actually higher than that of US. That was not the case earlier.

So, it was this productivity was 92% that of the US, so less than that of the US, but here now productivity in Norway and also productivity in the UK. They are both higher than US. So, it can mean two things, of course. One is that the productivity of these countries actually went up compared to the US, or because the US is the benchmark, then the values in the US itself might have gone down. So, both possibilities are there.

Of course, one has to look at other breakups as well. In fact, Japan, this is again marked in red, this is interesting. When it comes to physical capital and when it comes to the combined factors, it is doing better compared to the US. How do we know that? Because the numbers are greater than 1. So it's doing better compared to US.

But when it comes to productivity, its productivity is 70% that of US. So, here is the story that is emerging that in terms of productivity, Japan is doing worse compared to the US, but when it comes to the different factors of production they are more productive compared to that of the US. But since for output, we have to compare both the factors and productivity, for Japan, when we combine all these factors together, then its output per capita is about 73% that of the US, so it is less than that of the US. Okay, so these kinds

of, you know, pictures or these kinds of images, they emerge from tables like this, and as we have said that these are very good starting points. But you see here, for instance, again, what we had mentioned about growth accounting.

Now, looking at these numbers, we cannot, you know, ensure or we cannot figure out, say, for instance, you know, why did productivity in Norway go up? It was not like this earlier, it was lesser compared to US, but now it is higher compared to US. So, we do not have an answer to that based on this exercise, but clearly as we had discovered earlier as well, it is a good starting point. So, now, if we know that the productivity of Norway has gone up compared to the US, then we know in which direction we should start looking. So, a couple of caveats before we wrap up our discussion on development accounting as well. So, for both growth accounting and development accounting, they give us only proximate causes.

And what are proximate causes? As we had mentioned before, they will give us the broad causes, the broad sources, but they will not tell us, you know, the reason behind those sources. That is what should be remembered. Second, this measure of A or productivity. Or growth in productivity that is very crucial and for growth accounting, as we saw that this is treated as a residual, and you know, because it is treated as a residual. So, this kind of concern always remains that because it is a residual, whatever could not be accounted for by other factors, that has now become a part of A.

Maybe there are, it can be anything apart from productivity, also that has now become a part of A. And apart from the productivity measurement issue, there are also several measurement issues that have been pointed out regarding physical capital, how it is measured, regarding human capital, etc. So, one has to be very cautious while doing exercises like this, and most importantly, while making inferences based on exercises like this. So we finally now arrive at the last part of this course, where we talk about the emergence of new growth theories, also known as endogenous growth theories. So we have come a long way in the last few weeks.

We started with the introduction, and we started with the data because the disparity in terms of both income and growth rate is very obvious from the data itself. We also discussed the few you know methods of measuring economic growth, the caveats that are involved, the use of proxy variables, etc. Then we also went over a framework for analysis, that is, we went over a model, which is the Solow growth model, which we said is typically the starting point when one begins with the study of economic growth. And then, since so much of importance is attached to productivity, we spend some time trying to understand what is growth accounting, what is development accounting. And prior to that, while talking about Solow as an extension of Solow, we also tried to explore the concepts of convergence and whether the Solow growth model can answer questions like do poor countries actually catch up with rich countries? This catching up, is it in terms of per capita income or is it in terms of growth rate? So, we have come a long way since we had started

and in this last part, we would wrap up by talking about the recent research that is taking place in the area of economic growth.

So, what are the endogenous growth models? We are not going to talk of any specific model here, but rather here we would try and get a flavor of how things have changed since the Solow growth model and why was this change necessary and who all are the pioneers in this particular area. That is the objective of the last part of this module. So, the neoclassical growth theory, which is primarily the Solow growth model, which we had studied, this had evolved during the 1950s. Now, during the 1960s, it was very popular. We have seen some of its policy implications; it helps us understand what would happen if the saving rate were to go up, what would happen if the population rate, you know, were to change, etc.

But by the 1970s, the growth theories, or rather the growth theory which was primarily the Solow growth model that had become largely moribund. A tremendous revitalization, it occurred since the 1980s because it was mostly spurred by some of the shortcomings or limitations of the previous theories. Now, what were some of these limitations? Some of the limitations of the exogenous growth theories, we studied Solow, but there is also another model known as the Ramsey model where the primary difference between the Ramsey model and the Solow model is in the case of Ramsey, the savings is derived from an optimization problem wherein the savings rate was exogenously given to us. Now these theories could not give a very satisfactory explanation as to why growth rates and in particular the rate of technological progress that might change from one period to the other. So, this also became a very important question, why in the 1980s? This timing is again very important because we had also seen that earlier from the table that US was undergoing a productivity slowdown.

A few slides back, when we were talking about the growth accounting exercise, we did see that during the 1980s, productivity and the TFP growth rate had slowed down in the US compared to its previous decades. So, this became a major concern for macroeconomists, especially in the US that what might be the reasons for this slowdown. So, in this particular context, naturally, it was found that the Solow growth model, well, it is again a very good starting point. A lot of things can be understood from there, but also there are a few limitations and the biggest limitation being that, that the source of this growth in technological progress What is the source? Where will it come from? This was exogenous to the model. Remember that small g term that we had seen earlier.

So naturally people would like to know especially in the wake of a slowdown that how do we increase productivity? So, that kind of question was not answered in the exogenous growth models. So, the main focus of what is known as the class of new growth theory models, sometimes also known as endogenous growth models, is at the center, at the core, they all treat the same thing, which is all of them are trying to locate the source of

productivity growth. So, that is the common thread, that is the common theme. But what is the source of productivity growth for that different macro economists have different views about this. Before we move on to three important views that we will talk of and then we would be wrapping up.

This I have marked in red because this is very, very important because this is also a common point across macroeconomists who are working on new growth theories. That the crucial engine behind endogenous growth is the elimination of the assumption of decreasing returns to capital. Remember that entire dynamics of the Solow growth model we had, you know, drawn that dynamics as well. Remember, we moved from k1, then we did plus Δk, then we arrived at k2. That whole dynamics was possible because of the assumption of decreasing returns to capital, okay.

Now, in the new growth theory class of models, they do away with this particular assumption and this is what generates growth in such models. As we mentioned, there are different types of endogenous growth models, and we would be mentioning a few types here, just the major outlines so as to say. The first one is due to economist Paul Romer. He is a Nobel laureate in economics, and in 1986, his published paper in the Journal of Political Economy is considered a very important source of work. So, here what he did was compared to the Solow framework, where there is only physical capital, here the principal engine behind endogenous growth is ideas.

This is the big contribution of Paul Romer. So, the premise of his model is something like this, that ideas are non-rival in nature. And non-rivalry gives rise to increasing returns to scale. So we see how this assumption of decreasing returns to capital that has been eliminated by considering ideas. And with non-rivalry growth in income per person is tied to growth in the total stock of ideas.

This operates in a non-competitive market, and that is what leads to policy implication; that is why patents, patent protection etc is required. So, in other words, Paul Romer's model if we follow that. The driver of growth is generation of new ideas. And remember, we are always looking for a perpetual source of growth, something that does not die down, something that keeps on continuing forever. So, ideas can be generated almost infinitely, right? So, that is the driver of growth.

This is as per Paul Romer. Another school of thought that was initiated by Robert Lucas Junior and his emphasis was on human capital in the production function. So you look at the timing. So Paul Romer was 1986, his paper. And Robert Lucas's paper is in 1988. So, these timings are very interesting because as we have discussed earlier as well that you know all these theories come up in some context, okay.

People start thinking about certain questions, and that is when they can come up with answers, right? So, this was the decade of you know 80s where US had already started

experiencing a major slowdown in productivity. That is why economists, especially macroeconomists like Romer and Lucas, were looking into the source of productivity. So, in the case of Lucas, the source is, or the emphasis is on human capital. So, similar to the physical capital accumulation equation that we had seen before, do we recall that Δk is equal to s.f(k) minus Δk? Similarly, here is a human capital accumulation equation, okay? So, the growth in human capital comes from the time that individuals spend studying, okay? And in the theory of Lucas it is human capital formation itself that by non-decreasing marginal returns that creates endogenous growth. So again the idea is very similar like Paul Romer where ideas are infinite, ideas can be generated almost infinitely.

So here also human capital. Human capital is a source which unlike physical capital, it does not deplete per se. With time, physical capital only depreciates and depletes. Human capital is not like that. So here, the emphasis is on human capital.

It is still a capital Y. Because it generates returns, right? So, it is similar to physical capital in that sense because it generates returns but at the same time it is different from physical capital because it leads to non-decreasing marginal returns, okay. So, that is about it. Bob Lucas. So, both Romer and Lucas belong to one strand of new growth models that advocate ideas or human capital as the source of innovation that leads to sustained economic growth. There is also another third strand one can say in the economic growth literature, which is based on the Schumpeterian versions of innovation.

So, everyone is talking of technological progress or an increase in productivity, just that the sources might be different. Someone is talking of ideas, someone is talking of human capital, and someone is talking of it from the Schumpeterian sense. We have Philip Aghian here and Peter Howitt are the main proponents of this school that talks about the Schumpeterian version that is essentially creative destruction. You might have heard about terms like quality ladder models, etc.

So, either for creative destruction. So, either new products come in place entirely by replacing old products or it is the same product; its quality is enhanced over time, but essentially, it is in a Schumpeterian world. So, that is also another way of looking at the new growth theories. Well, overall, if we now combine the main takeaways that we have seen so far and where this all leads to, I thought that this quote by Peter Howitt is very relevant in our case. That is why this is the main takeaway. So here he says that much more work needs to be done before we can claim to have a reliable explanation for why economic growth is faster in some countries and in some time periods than in others.

But the fact that much of the cross-country variation in growth rates is attributable to differences in productivity growth rather than differences in rates of capital accumulation suggests that endogenous growth theory, which aims to provide an economic explanation of these differences in productivity growth will continue to attract economist's attention for

years to come. So that is why the current work that is taking place in this particular field is all geared towards one direction, which is in trying to uncover the sources of productivity growth, and that can be from new ideas, that can be from human capital generation. Or it can be in a Schumpeterian kind of sense, but this is where, at least theoretically, this is the current direction that the subject has taken. So with this, we pretty much come to the end of this particular course. And before we call it a day, a quick recap of what we have seen this particular week.

We had talked about the different concepts of convergence. There is unconditional convergence and there is conditional convergence. Much less evidence of unconditional convergence and there is some evidence of conditional convergence across the different countries of the world. And since productivity is such an important factor in productivity growth as well, so we did take a look at two accounting methodologies in trying to see how productivity growth can be measured or how far cross-country differences in per capita income what part of it we can attribute it to differences in productivity and what part of it can be attributed to differences in the factor accumulation. So, in that spirit we explored a little bit about growth accounting exercise and development accounting exercise. And finally, we talked about the emergence of new growth theories or endogenous growth models.

We talked about some of the proponents of this kind of model. This is a huge area in itself, and by itself, there are many models, many types of models. But the underlying factor or the main reason for the emergence of these new growth theories is due to the reason that the exogenous growth models, first the most important parameters you know for the exogenous growth model. They were all exogenous in nature. So they were not determined from within the system. And second, the source of productivity growth could not be pinned down.

And those were two main factors because of which it led to the emergence of new growth theories. So with that we come to the end of this particular course and what is it that we have seen in this course. So we had started with a short introduction to what is the area of economic growth all about and in trying to answer some of the stylized facts we tried to do that by combining data, figures and also some theoretical insights to uncover some of the explanations of some of the common observations regarding cross country differences in income and economic growth. But this search still continues, and that is why it is an elusive quest or an elusive search because there is no one single model or there is no mother model per se that can explain everything in one go. So, there are models here and there, different kinds of models, models of different flavors, and also a lot of empirical work is being done in this area to understand the differences in per capita income, differences in growth, sources of growth, etc.

And hence this particular search still continues. Well, with that, we come to the end of this particular course. I hope you enjoyed the lectures. Thank you very much for your attention and I hope to see you all in some other lecture, maybe some other time. Thank you.