Week 2 Transcript

I'm lucky.
Yeah.
Oh.
Okay, we're going to get started.
Hello.
Okay.
Good afternoon everyone.
Welcome back.
Uh, s1 b5.
Today we're going to talk about inequality around the world.
Um, after the first two lectures of Real foundations, we
looked thoroughly at what counts as GDP.
Uh, how to measure GDP, how to think about real
income, nominal income.
We're going to actually use it to think about these
building blocks, to apply for really important macroeconomic questions, such
as why do countries grow faster than others?
Why is there so much income inequality around the world?
What explains, uh, country differences?
Uh, all those for all these insights that we have
about the world that you've observed, how can you map
it onto a theory, uh, of growth to understand about
income in the long run?
Now, given that we know what GDP is, you know,
an aggregate of economic activity, it's not a perfect proxy.
It's not perfectly measured, but it is a good way
of capturing economic activity, good way of capturing standards of
living, general, uh, welfare.
Now we want to compare it across countries.
Now we're going to see the problem.
How do you actually compare standards of living across countries
in places where their different exchange rate, their different prices
of goods and so forth?
To have an accurate understanding of GDP across countries or
income differences across countries, and also income inequality.
Now, in the last ten years or ten years or
so, I would say, starting with President Obama, uh, there's
been a lot of increase on the focus of I'm
going to try to walk around today with my mic,
um, on income inequality.
As most of you know, right now, a lot of
this emphasis has been on income inequality within cities, between
rich and poor groups, within a place, within a country.
And lots of there's been a whole debate about how
inequality has risen so dramatically, to the point that there's
a lot of civil, sorry, social angst and politically charged
motivations.
But one really interesting pattern in phenomenon is that income
inequality across countries have actually declined in the last 20
years or so.
So income differences have shrunk across countries, even if they
have risen within countries.
And of course here we're going to talk about cross
country comparisons.
We're not really as studying.
This is not a study of rich and poor, but
this is one of the key ideas that we'll be
exploring, right?
Why is there so much income inequality, but also why
has it shrunk over time across countries?
So we have to have also a good concept of
measuring these income across countries, which is a key concept
that we're going to highlight today.

Uh, we're going to talk about something called the aggregate production function.
You know, I'm sure all of you have some views about why countries grow faster than the other.
You know, think about it for a second.
There are lots of countries that have caught up to the advanced economy frontier South Korea, Japan, Israel, Korea, Taiwan, economies, Hong Kong, etc. East Asian tigers.
While some have actually fallen behind, um, not only, uh, growing slower than even the US, uh, but falling further and further behind, uh, loss of a few a few countries like Rwanda, even Guatemala, countries in Latin America and Africa.
There's some countries like Brazil, who is just as rich as it was in 1960, basically did not grow in relative terms.
Uh, there is a concept called the middle income trap, which is very relevant, which is, you know, these are all related concepts here since 1960.
Out of 100 countries that were in middle income country in 1960, only ten of them, okay, a handful of them have managed to escape that trap and become rich countries.
That includes countries like Israel, Spain, Greece, uh, Japan, Korea and some of those that we have mentioned.
Right.
So clearly we want to have a view and this is a long run view of the economy.
Now when we measure GDP last time, the demand driven GDP of expenditure based consumption, investment, government spending, etc., that doesn't give you a long run view of income, right?
That just tells you over a period of time what what are the key components that determine GDP.
But what about growth in the long run?
And here when we talk about growth across countries or cross country comparisons, we are talking about a long run view of growth.
And so for the next three lectures we're going to have that growth theory being a long run.
And then we're going to shift to short run macro, which is a very different aspect in here of government policies play a role.
So when we talk about the aggregate production function, it's extremely useful because it can summarise all these important factors that determine a long run income of a country.
Okay.
We're going to talk about that.
And then we're going to try to decompose that.
That aggregate production function is going to tell us a few really important factors that make some countries richer than others.
And we're going to explain why, again, you want to start thinking in your view, you know, why do countries differ in their productivity and their income levels in their many aspects.
Right.
And can you map these theories that you have onto our theory and therefore have a framework to think about these issues?
It would be a goal accomplished for this, for this course.
Now this just shows you the inequality around the world.
Um, let's not think about measurement per se for now, but this is gross national income, GNP, if you will, or GNI, sometimes it's called it's measured by P.
We're going to get to that.

But this is an idea of what it looks like
of income distribution around the world.
Uh, hotter areas or cooler areas being the richer ones,
hotter areas being, uh, the poor ones above $55,000.
This is a 2020, obviously, in North Africa, uh, North
America, Europe, Australia, and then smaller than $5,000 per year
per capita, uh, in in much of, uh, parts of
sub-Saharan Africa and uh, and other Asian countries.
Right.
So a wide distribution of income, I mean, if you
think about it for a second, what makes this so
different?
We do all have access to knowledge, right?
Knowledge is, in most sense of the word free.
We know how physics works.
We know how math work.
That's pretty much all there.
Now, it's true that we might not all have access
to the same kind of technologies, but it's not impossible
to get right if it's just a matter of getting
the right technology to produce then poorer countries.
Well, the world Bank and other institutions can just lend
money for these poor countries to buy up the technology
that they need.
And boom, that should solve both.
Right?
So what makes this so different now that we have
globalisation, we have all these advancements in technology and all
this, you know, access to capital because it's not just
a your own country, you have access to international capital.
If that were just the answer, then there should not
be such a big difference between $5,000 per year and
$55,000 per year.
And actually, the richest countries today are more than 100,000
per capita GDP today.
Right?
So that is in some sense a puzzle that we
want to we want to answer, um, now.
Before we get to, you know, some of the measurement,
I just want to point out that apart from some
of these economic factors, there has been quite a group
and an important contingency led by the likes of Jared
Diamond and his, uh, book guns, Germs and Steel and
others who argue that geography is really important.
People like economists like Jeff Sachs.
I'm not sure how many of you have read guns,
germs and steel.
It's an interesting book, not an economics book.
Um, but his argument is that, you know, civilised.
Some places were bound to have a head start in
development and growth because of geography.
And that includes things like the availability of certain plants
and animals, uh, which influenced the development of agriculture, which
then led to the organisation of societies, taxation, centralisation of
bureaucracy and so on and so forth.
Um, and, and this is, you know, a geography view.
I don't think it explains the whole spectrum of why
countries are richer than others today.
But it is an interesting thing to think about and
how it maps on to some of the things that
we're going to, uh, discuss today.
But first things first, let's start to measure.
Okay.
Measure GDP per capita or income per capita so that
we can compare across countries.
Now we're going to use GDP per capita income per

capita sorry interchangeably okay.
It's the same thing as we mentioned before the circle
of flow, the three ways of measuring GDP means that
income and GDP should be the same in principle.
Right.
So we're going to have a proxy that's directly measured
by something that's very available not income but GDP to
to measure these things.
So GDP per capita by definition is GDP divided by
total population.
Okay.
But there's something also wrong with that.
You know, many people could be not working right.
Uh, children going to school or, or or so forth.
And whether that should be counted or not, it depends
on what we're talking about in terms of measuring the
average income or standard of living per person.
This is a good measure.
Okay.
Uh, let's look at United States in 2019.
Uh, very easy GDP 21.43 trillion USD divided by population
of 329 million persons.
Uh, that amounts to $65,134 per person GDP per capita.
Okay, I'm going to use 2019, not the latest figures
because we'll see.
To make it comparable, there's going to be another adjustment
factor that's most recent data is 2019.
But you can again you know if you like these
things go play around with it.
You know go to world Bank data or the data
Bank.
And first of all from what we have learned last
time, understand what's the difference between real GDP per capita
and nominal GDP per capita.
And one is using current exchange rates or current prices,
and one is using constant prices from a base year.
Remember remember that distinction between real nominal and you can
play with it.
And you can look at different countries and how they
compare with each other and how they compare with the
rest of the world.
Uh, let's just take another example.
Country.
Let's say it's Peru, uh, 7757 billion, uh, nuevo SOS.
It's in its own domestic currency with a population of
33 million people.
GDP per capita 23,287.
Sales per person.
Okay, so how do we compare these two?
Who's richer?
Who's richer.
Obviously us would be richer, you know, as a as
a so who's richer between us and Switzerland.
Maybe you don't know that answer.
Right.
So but Swiss is in Swiss francs.
US is measured in US dollars.
Can you how do you measure them?
Well, you think that you probably want to use the
exchange rate and then convert it into the same currency,
whether it's dollars or soles or or whatever it is?
Now let's just look at Norway, another country, um, uh,
GDP per capita, uh, is uh 600, uh 59,873 kroner
per person.
Uh, and sorry.
So GDP divided by the number of people we have

this per person.
Right now, the exchange rate is $1 to 8.8 kroner.
Okay.
And so if we convert it to the same currency
dollars.
Okay.
So one one um, one thing, if you get confused,
one trick, make sure that the units are right.
Okay.
So this is obviously kronor right.
And then exchange rates dollar per kroner.
So when you multiply kroner by dollar per kroner, you
get dollars, right.
Exchange rates often get confused.
Which way is it around.
But you can see that um, uh, see this this
numerator uh cancels out with the denominator and you're left
with dollars so that then you make sure that you're
correct.
Right.
So that's equivalent to around $75,000 for Norway.
Now Peru using the same idea.
Remember it was 23,000 souls per person.
The exchange rate.
The nominal exchange rate.
And you can go on these, um, data banks and
find out what is the official exchange rate.
So $1 is equivalent to 3.34 sol.
And that gets you almost $7,000 per person.
Okay, so that seems like the easiest way to compare
income across countries, correct?
We're using some exchange rate.
Of course the question becomes what determines the exchange rate.
Right.
Why is it $1.
Sorry £1 to $1.3 now.
And you know before ten years ago was or a
little 15 years ago was $1 a £1 to $2.
Right.
What makes that.
Now this is not a course about international macro or
international finance.
And we're not going to talk about what determines exchange
rate.
But the idea is it's a little bit arbitrary.
Is it something that, you know, it's really we should
be used to be comparing income differences across countries and
standards of living.
So that's one measurement.
But using this most common measurement let's look at exchange
rate sorry GDP uh per person.
Now in terms of 2009 the richest country was Luxembourg,
the second richest country was Switzerland in 2005.
Well, they've moved up the ranks since 2009.
Ten years later, um, from fifth place to second place
and second place to first place.
Now.
Third place in 2019 was Ireland.
Okay, not sure you consider Ireland among the richest country
in the world, but that's what it says.
Um, but again, this is why it's going to be
interesting to look at whether some of these measurements are,
are right.
And it was eighth in 2009, United States, interestingly enough.
Well, it has a lot of people 300 million.
It's not the richest country in the world, but one

of the richest, even though it has the most advanced technology.
But again, it's big, right?
So anything that's big divided by a really, really big number.
Let's not discuss China and India.
Massive numbers, massive number of people.
Um, it potentially is smaller.
Uh, China moved up the ranks.
Now it's 10,000, uh, dollars.
If we use official exchange rate from 121 22 to 82.
Right.
So again, not a middle income country and Peru about the same.
And the poorest countries still remain the poorest countries ten years later, Malawi, Burundi, Somalia, etc..
And how much are they living on per year?
$100 of GDP per capita.
Okay, so less than a dollar a day now by world Bank standards.
Um, you are below the poverty line if you're living less than a dollar per day.
Now, I think that they have moved up that that dollar up to something else because there's been inflation.
There's been other things.
Right.
But think about the vast differences we're talking about, you know, 100 times difference in income across countries.
Okay.
So that's what we did.
Um, convert GDP into US dollars and then using current exchange rates.
But let's think about it for a second.
Okay.
Is this a good measure.
Of standards of living because we're we're pretty much trying to compare standards of living across countries.
What can your income how much does your income get you?
Obviously, again, we don't know what this official exchange rate means, right?
It's just a number.
It's a ratio.
But think about it this way.
Think about the fact that, um, we can buy a basket of goods in this country.
Okay, let's say this basket of goods we talked about the basket of goods, um, last time as the deflator.
Right?
Uh, GDP deflator or the CPI.
And just imagine that this basket of goods cost £10 in this country.
But the same basket of goods cost, let's say, um.
Uh, ten soles in Peru.
Okay.
Just for for sake of argument.
Now, that can well be the case because as we know, in poorer countries, things are cheaper, right.
If you go for.
Well, so the classic example, the economist index, the economist has what's called a Big Mac index.
Okay.
So I don't know how many of you heard of that, but let's think about a hamburger.
And you guys have travelled around the world of course.

And Big Macs cost different um, or have different prices across countries.
I think Scandinavia has the most expensive big maps, Big Macs, but I have to check again.
Um, and in countries like India and China, they were very, very cheap, right?
There could be a difference of $1 of equivalent $1 Big Mac in China versus, you know, $5 in Scandinavian countries.
Okay.
So the general observation is that in poorer countries things are going to be cheaper.
What we really want to understand is how much purchasing power does that income get us correct.
And you can't use exchange rates to do that.
Official exchange rates.
So let's just say that that basket costs £10 in UK and ten soles in Peru.
What does that mean?
Well, the equivalent of a purchasing power is actually 1 to 1.
Right.
Ten gets you that basket.
Ten soles and £10 get you the same thing.
So if we take the exchange rate of a commonly comparable good, that exchange rate is actually one.
That's the idea behind purchasing power parity will be more specific okay.
So what is purchasing power parity.
It's the relative cost of a basket of goods that's comparable.
That's in two different locations because that tells you what you can buy.
You can have all this income in Norway.
But if prices are double the prices in America, then what you're effectively half is rich, right?
In terms of the actual stuff you can buy, you can only buy half of it.
So that's the concept of purchasing power and it's an exchange rate.
You can think about it as an exchange or an adjustment factor, if you will, in the textbook that can be used to compare standards of living across countries.
Um, so let's just take one.
Good.
Okay.
I talked about a basket of goods.
Let's say that it's a bag of rice in the same units and that cost a dollar, sorry, $3 in the US and one sold in Peru.
Now, the relative price or the PGP for that particular good is simply three, $3 per soul, right?
That's not the official exchange rate, right?
The official exchange rate is something else.
This is the relative price of that.
Good.
Now imagine that it's a agglomeration of individual goods in that basket.
And you measure relative prices that way.
And you construct an index.
And so aggregate PGP by the data banks that, you know, that construct it.
Penn World table is the the database that you should look at to look at PGP adjustment factor.
They found that the aggregate or the basket is 5.85 sold per dollar.

In other words, $1 buys you the equivalent of what,
5.85 can buy.
Okay, so that's actual purchasing power.
It's not the exchange rate, it's a purchasing power parity.
So we're going to use this factor to convert GDP
per capita across country so that we can better compare
living standards across countries.
Okay.
And now obviously this adjustment factor is different from the
official exchange rate.
Okay.
$1 you can exchange for 3.34 but actually $1 you
can buy what 5.85 soles bought.
Okay.
So then you think about what that means for real
income per capita.
So then let's just look at the per capita GDP
for Peru starting with the nominal GDP which is 23,000
sole per person.
Not multiplied by the official exchange rate.
But by the PGP.
Okay.
Bye bye.
So this was remember.
Remember the units.
This is 5.85 soles per dollar.
So dollar per sol is one over that.
Okay.
So so you use $1 per soul or.
Sorry.
Sorry one.
So how many dollars per soul.
That's 0.171.
You multiply that and guess what.
You get about $4,000 of income.
What did Peru have before?
7000.
So actually once you use PCP conversion.
Peru can actually buy less than what the official exchange
rates suggested.
Okay, so that means on average, Peru is more expensive
than other countries.
Right.
If that basket of goods, if the income per capita
actually fell rather than risen.
Now, this is actually not the case for most developing
countries.
Most developing countries basket of goods cost a lot less
than it would in advanced economies.
Once you convert it into the same currency and therefore
developing countries income tend to rise.
When you use PGP adjustments.
So again, even if you have, let's say, you know,
10,000, uh, you know, even if developing country has a
certain amount of GDP per capita, it can buy a
lot more.
So that rises.
So let's just take a look at, at some other
countries.
So first of all, Norway, what was it before Norway
was um 75,000.
Now using PGP adjustment factor.
Not much change okay 77,000 okay.
So let's now look at the rankings again uh, based
on PGP.
Okay.

So first of all Luxembourg doesn't change anything.
You know, it's just average prices, average income.
Switzerland is about the same.
Now remember who was number three?
Ireland.
But using PGP it became Iceland and Iceland, which had much lower per capita income than 95,000.
Had 95,000 a per capita income when using PGP adjusted factor.
So a lot richer than what it actually was.
And this is just comparing to its 2009 ranking.
Well, actually, 2009 was a great financial crisis, and actually Iceland had a big dip.
So that was a problem for per capita GDP.
Now if you look at developing countries, uh, first of all, um, let's see if we have a um, yes.
So this is, this is comparing sorry, this is comparing 2009 to 2019.
Let's just look at the comparison between exchange rate ranking and ranking.
Now if you look at China, if you use the official exchange rates ranked 82, but you climb up the ranks to 75 if you peep.
Why?
Because things are cheaper in China.
So for all the income per capita that China has, you can buy more stuff than what the official exchange rates suggest.
Okay.
Um, and Peru also goes up in the ranking.
Actually lots of developing countries going up in the ranking.
Not much difference from Malawi and Burundi and Somalia just because you know, well they're they're just very, very poor.
So their ranking stays the same.
Okay.
Any questions so far.
Okay.
Everybody understand pptp adjusted factors.
So this is using nominal exchange rates okay.
And when we say international dollars at 2017 prices this is 2021.
What does that mean.
Is this nominal GDP or is it real GDP.
This is real GDP, right?
Because it has a base year of prices 2017.
Okay.
When you go look at the data this is going to tell you current prices means nominal constant 2015 prices or 20.
Whatever it is means real.
Okay.
That's the concept that we talked about last time.
That's very important.
So this is the income distribution using nominal exchange rates in 2021.
And this is going to be the one using 2017 constant dollars real but PCP adjusted.
Does much change.
No, the distribution of income is still.
I mean, if you look at the shaded areas, I know that it's very difficult to to to look at this.
Obviously the green parts become less green.
Um, the difference is not large, but you can see that the income inequality, even by P standards, is still large.

Even though they're reduced somewhat, they are reduced somewhat because poor countries, by virtue of having lower prices, means that it boosts up their income per capita and therefore reduces the inequality across countries measured in P, but it doesn't change that much.
All right, so what causes, um.
Income differences, what we're going to explore next.
You'll see that economists will talk about capital stock productivity, human capital.
There's a view about institutions which countries have better institutions.
Some believe that democracies are good for growth.
All of these things can be tested in principle, empirically.
Um, and I'm not sure that there are some really consistent factors outside of the basic views capital, productivity, human capital that give us a good, um, of good understanding of growth.
It does give us a good understanding of growth, but it doesn't solve the growth puzzle.
But we're going to try to appeal that one layer by one layer to explore that further.
Okay.
So productivity.
Um.
One key.
Theme or theory is that countries defer an income because of differences in productivity.
Okay.
That kind of kind of makes sense.
You're more productive, you know, if you take, um, I don't know if the numbers are correct, but in 1990, apparently one American worker.
Were the same equivalent to four Indian workers.
Okay, after 20 years, India's productivity grew so much so that one American worker was equivalent to two Indian workers.
So what happened there?
You didn't have to change anything.
You didn't have to change the number of people.
You didn't have to change capital stock.
You didn't have to change anything.
And India is twice as rich.
Okay, so productivity seems like it's important, right?
Think about it.
You guys can either choose to work hard and not be very productive, or work little and be very productive and get scores.
Which would you rather be?
Obviously the productive type, right?
But the question is what determines productivity is something that will be, um, a key thing that we want to explore.
Now, first of all, there are many kinds of productivity.
I've listed three, not two, three types of productivity.
That's a that's a typo.
The first, um, let's start with a simple one.
Let's start with labour productivity.
Labour productivity is just measured as GDP divided by hours worked okay.
How many hours were contributed into the process and GDP divides that.
So output versus input.
And that measures how much output you have every additional hour you work.
So that's one measure of productivity.
And that's called labour productivity because labour represents how many hours worked.
You could also divide this by GDP.

You can also GDP can also be divided by per
worker.
Remember that GDP per capita was so far uh measured
as GDP divided by total population.
Right.
But lots of people in this total population are not
working for a variety of reasons.
Some countries females don't work okay.
So obviously you have to divide it by the number
of people who are actually working.
That's another measure.
Same number of workers or hours worked.
Not too much difference.
So that's a measure of labour productivity.
Every additional worker.
How much can additional GDP does it contribute to now
capital productivity is similar for capital okay.
For every additional unit of capital how much additional output
do you get?
Now let me just first note three things here.
Sorry two things.
What is these?
All these?
The labour and capital.
They are inputs.
What's the output?
Output is GDP.
Okay.
So the two inputs capital labour.
You can say that in the old production.
Uh, structures.
There was an additional really important input in the past.
What was that?
Land.
Okay.
But land is so far less important because agriculture accounts
for a small share of GDP.
So we're going to ignore that.
So let's say there's only two inputs capital and labour.
And that produces the output which is GDP or income.
What's left.
What's left is called total factor productivity.
Okay.
If you subtract all the inputs that you put in
the capital labour use, and we're going to talk about
measurement later on, whatever cannot be explained by the inputs
used in that production process.
It's called total factor productivity.
In other words it's a black box.
It's a black box measuring our ignorance.
But that's that's what we're going to call productivity.
Okay.
TFP it's a solo residual because it's the residual from
output taking out the output growth.
That's not due to the two inputs which is capital
labour okay.
It's going to be much clearer when we actually have
some numbers and production functions and so forth.
But for now these are the three types of productivity.
How productive your labour is, how productive your capital is
and everything else that's not explained.
So first of all this we've seen its GDP per
capita.
This is GDP per worker.
This is labour productivity.
Do you see any difference here?

They look very similar.
What does it mean is that productivity and income are
very correlated.
Right.
The richer countries tend to be more productive.
That's what it says because you can't really tell the
difference between the two.
Right.
And why?
Why that has to be the case is something that
we want to explore further.
Okay.
So now if we compare GDP per capita versus GDP
worker, remember this is a measure of productivity.
Then we can see that Luxembourg is super productive.
Um, United States is more productive than GDP per capita.
Well, obviously this is going to be higher than the
this column because, you know, this is total top population.
This is just the number of people who works.
Right.
So obviously this is going to be higher.
But this is very productive.
Like Luxembourg is very very productive, much more competitive than
us.
Everybody increases their productivity.
But across the rankings, um, there is not that much
of a change.
Uh, if we look at the rankings.
So again, this tells you that income is very positive,
related to productivity.
Richer countries are more productive.
In other words, we want to understand why are some
countries more productive than others?
Let's look at labour productivity, uh, measured by GDP per
hour per hours worked okay.
There's not much big difference between per worker.
But this is going to help you compare across, um,
a number of countries.
This is too small for you to see.
But basically among the OECD countries, uh, this is in
2015.
Sorry, this is 2022.
Mexico has the lowest labour productivity.
Ireland.
We talked about specifics about Ireland, why it's a special
economy, but it has the highest um and labour productivity
is actually very high in some of the countries that
you didn't imagine, like Korea, Bulgaria, Turkey, Poland and, and
so forth.
Okay.
Um, so high labour productivity could be a number of
reasons, including how much capital you are using, including how
good is your human capital.
Um, but this is a measure of GDP per worker.
Now let's look at total factor productivity.
When we talk about productivity in general we're talking about
total factor productivity okay I mean if you step out
of economics where this classroom people are not very precise
about these things, but what you want to measure is
total factor productivity, because that captures the overall efficiency of
your economy.
Right.
Labour is just labour efficiency.
Now think about it for a second.
You had three people working before okay.
And there were only three machines.

Now you have the same number of people three worker
and you gave them more machines.
Six machines.
What happened?
Well they produce more, so they're more productive.
But are they inherently more productive or efficient in the
way that we think about these, this concept, or it's
just that they had more capital to work with, right?
A lot of these developing countries saw rapid growth in
labour productivity, not because the people were getting better and
more competent and smarter and more efficient, but they had
more stuff to work with.
Okay, so TFP is a is a better measure because
you're taking out all the inputs involved, everything that's left.
And TFP embodies things like technology.
When we talk about TFP, we're mostly talking about technology,
but we're going to expand on that.
So access to technology, um, access to advanced technology, how
efficient you are.
Knowledge.
Uh, knowledge.
Knowhow.
Organisational.
Managerial.
All that which is not explained by how much capital
labour you put in the process is explained by how
productive you are is called a peak.
So just to take a look at this, um, this
is TFP growth, uh, between 2006 and 2022.
Uh, let's just compare for rich countries Japan, Korea, UK
and US.
Uh, if you look at, um, the, uh, the US,
what we see is that actually TFP growth has been
pretty low compared to the likes of Japan and Korea,
especially in later stages.
And uh, UK, UK has been following very similar trends.
And by the way, this is the pandemic.
So there was a huge fall in productivity.
Um.
Think about what that y y that is, right.
I mean, here we're really talking about fluctuations.
Why did why was there a productivity drop in 2020.
If we measure it the way we measure taking out
the capital and labour and all that.
Well, um, first of all.
If, uh, if somehow your capital is not utilised.
Right.
Uh, you know, you have all this stuff in your
factories and you have all these people that you have
not fired, okay?
All of them are still around.
And think about a recession.
Now in a recession, obviously, the definition of recession is
that your output falls, right?
So your GDP falls, but you have not adjusted your
capital and labour yet.
Why?
Because you can't fire people.
That.
You can't, you know, your capital stock.
You're just not using as much of it as you
realisation is low.
So what happens is that when you have a GDP
fall but nothing of the input changes, then all of
that is attributed to a fall in productivity.
Okay.

So again we're going to be more specific when we
see the production function.
But just at this point I just want you to
recognise that first of all, a few interesting, uh uh,
interesting, um, uh, pattern is Korea, despite being already a
rich country, has a high or a relatively higher productivity
growth levels higher than the US, which means that it
has an ability to keep on growing.
And despite the advancement in technology in US and UK,
uh, TFP growth has been averaging 1%.
That's not very, very high.
Okay.
And lots of other developing countries, 4 or 5%, sometimes
even higher.
So this is TFP.
Um, but now that we've seen that there's a comparison
of per capita GDP.
What we do know is that it is positive correlated
not only with productivity, but also a number of things
as we measure the standards of living.
One is absolute poverty rate.
We can see that this is income per capita.
And this is the percent of population living less than
$1.25 a day.
This is probably the poverty line, official poverty line.
And you can see that the richer you are, obviously
the the lower the less poverty you have, right?
There's almost zero poverty in all these countries.
And by the way, we'll talk about this a little
bit more.
But look at the scale here okay.
It's proportional scale obviously 500 to 2000.
This is the same distance between 2000 and 8000 right.
Obviously not true if it's totally levels.
But this is a proportional scale.
This is so that we can properly compare things when
there are exponential factors.
Anyway, we're going to talk about this next lecture.
And there's a there's a paragraph about this in the
book.
But just to, just to keep in mind this that
this is you know, every time you quadruple you have
the same distance.
So 500 to 2000, 8030 2000.
And so you can see that poverty obviously falls.
And that's a negative relationship.
Life expectancy.
The richer you are the longer you live.
However in countries like the United States you can see
this is below the line.
Right.
So in the US, for a given its income level,
its life expectancy is actually lower than what it should
be.
Um, and some in some cases a life expectancy is
higher than what it's income, uh, per capita relationship suggests.
But this tells you that, yes, the richer you are,
the less poverty you have and the longer you live.
Okay, human human development index also this is, I think,
from the United Nations, a very clear picture that on
all levels, whether it's, you know, education, schooling, access to
health and all of that, you're doing better if you
are richer.
Okay.
So.
Now let me just jump first to the production function,

because I think it makes sense to talk about this
first.
Okay.
Why is this useful?
Now we talk a lot about a lot of things,
okay.
Income differences.
Productivity.
Now, I mentioned to you that the true institute.
Right.
Capital.
And labour.
Now.
What's a production function?
Production function is something that summarises the production process.
If you had the inputs, you get the output.
The output is Y, which is income.
The inputs is capital.
No voting and labour.
Usually labour is denoted by L.
If you were going to say if h was H.
H measures human capital.
So first of all.
This is the production function.
You multiply by an efficiency factor.
That is what we call TFP.
And you get income.
Okay, so think about this for a second.
Let's let's pause and think about these various factors.
Capital stock we know what that is.
Equipment machines buildings so on and so forth.
Remember that depreciation of capital is very important.
But we don't measure that in GDP okay.
Labour is how many number of people are working.
But is that a good proxy for inputs.
No because it misses a critical factor which is the
quality of the labour inputs.
And so we tend to talk about this as the
efficient unit of labour.
How efficient that labour is.
So we call it human capital.
Human capital is denoted as H.
Now there are various ways to measure human capital.
Lots of debates.
About how to.
Measure human.
Capital.
But for instance, you can measure the.
Quality of labour force by the years of.
Schooling.
Or the years of secondary education, or some more sophisticated
measures that are potentially better measures to capture that one
unit of labour is not equivalent, another unit of labour,
if this person is more educated, more skilled.
Right.
So H is human capital.
Um, F is just a functional form.
Okay.
We'll see that you can write this production function down
in a way that's convenient.
But basically this means that increases in capital will increase
your Y, increases in your human capital will increases your
increases your income and increase in efficiency.
Eh, increases your output.
So the idea is let's turn to this first okay.
The idea is that this is income.

How do how what's the relationship between income and capital
stock.
First of all, note that it's increasing.
If you raise if you increase your input, you increase
your output.
Correct.
But what's really interesting, what's really fundamental, the most fundamental
concept behind growth is what's called the diminishing marginal returns
to capital, or the curse of diminishing diminishing returns.
What does that mean.
When you increase one unit of physical capital stuff here
you raise your output, but further increases in capital.
Your incremental output is smaller.
How do we see this on the graph?
Well think about it this way okay.
This is one unit of additional capital stock.
Right.
Where does income go from from point A to this
point okay.
This vertical difference is the additional Y you get from
increasing your capital stock.
Correct.
Now let's take a higher level of capital stock and
increase that by one unit.
What happens to output you raise from you go from
point B to this point here.
And the vertical distance measures the additional output you have
when you increase your unit of capital stock.
And guess what.
This is smaller.
So that's called the diminishing returns to capital stock.
It makes a lot of sense.
You had 100 in the sheets.
Would you say uh you know a thousand widgets.
Now you have 200, you know, and you increase it
by ten more machines.
You increase output.
By the time you get to 200.
You add ten more machines.
At that point, that's going to make you less of
a difference.
Okay.
This is why.
Economies slow down.
The more you invest, the less the less impact it
has on output.
And so you slow down over.
Time is why we see advanced economies having slower rates
of growth.
Okay.
So that's called the law of diminishing returns.
And this is true for efficient efficiency units of labour
as well.
Right.
The same concept.
You increase your labour.
But at a certain point there's diminishing returns that that
kick in.
Now let's look at what happens when you increase technology.
Okay.
So here it.
Tells you exactly how what role that A plays right.
So this is a curve that uses less advanced technology.
This is the curve that uses more advanced technology.
Now let's say that you have exactly the same input
of capital stock on the x axis.

What happened.
If you have a higher a.
You have a higher output.
Okay.
So this higher efficiency actually pushes out the production function.
Remember that you want to show you want to.
This is a thing classic thing that people get confused.
Are you moving along the curve or are you expanding
or shifting the curve.
Right.
When you increase k or h, you are moving.
Along the curve.
From this point to this point.
When you're increasing A, you're shifting out the curve because
again, one more time holding constant the input, you get
more output.
That means you're shifting the curve.
So what does all this mean in principle.
Right.
Adding the production function really is very a good summary
of everything that goes.
Into the production process.
Right.
Capital labour.
You increase capital.
Or you invest more, build roads, build infrastructure.
As we know from our GDP accounting.
What does that mean?
That increases you.
You increase labour, the number of people, working people participation.
You increase the education of your labour.
What happens to output?
You get higher output, right?
So input turns into more output.
But a is tricky.
A total factor.
Productivity is ways in which you can efficiently, more efficiently
use your inputs, right?
If A is higher.
That means that even if you exactly the same number
of people in the same number of machines, you're going
to get more outputs.
That's the efficiency concept.
And y could be organisation.
It could be better technology okay.
It could be, you know, things like.
The best, the most optimal use of your inputs.
Now.
Uh, let me just conclude by saying think about developing
countries.
Right.
Developing countries.
And we're talking we'll talk about the cross country comparison.
Um, uh uh, next, uh, next lecture.
But a lot of developing countries obviously have low inputs,
right.
Capital stock being lower, labour being lower.
If you look at countries like India or China, um,
what is their physical capital stock as a share of
us?
Uh, 9% Afghanistan, 3.7%.
China only.
Only 15% of physical capital stock.
Human capital.
Average schools have years of schooling.
Same thing.

Right?
Low inputs.
But guess.
What?
A massive difference is.
Also in productivity.
In TFP, something like 50% of the income differences of
our countries is actually explained by differences in politics.
How do you explain that?
What's productivity?
Right.
That's the black box.
But a very interesting thing in developing countries is that
it's not.
Just about advanced.
Technologies and innovation.
And, you know, all that.
It's simply about reorganising the economy for its most productive
use.
Okay.
To give you one example.
You are a very productive entrepreneur, but you simply don't
have access to start up funding.
You have another entrepreneur much less productive.
Maybe it's connected.
He has a rich parent or whatever.
Much less connected.
He gets the capital.
That's a misallocation.
I'll simply take that capital and give it to you.
Guess what happens to economy?
You are richer.
And so that's misallocation factor also comes into play with
respect to a.
So when you go back I like you to think
about your various observations of growth and how it maps
onto these three factors.
A, k and h.
And that would explain a lot of the income differences.
See you on Thursday.
Yes.
Hi.
Much more than I understand.
I hope it stays that way.
I hope it stays well.
It doesn't let me know.
Okay.
Oh, yeah.
Oh, yeah.
Yeah.
He was.
Right about.
So.

No no no.
I.
Yes.
Okay.
Good afternoon.
Good afternoon everyone.
Um, we're going to get started.
Okay.
So let's just, um, let's just remember what we, we,
we learned from last time and how it continues into
today.

And the next lecture.
So last lecture, we started the series on growth.
Right.
The important thing to remember is that theories of economic growth is about theories of the long run economy.
And you'll see why that's going to matter.
And theories of the long run of why countries grow faster than other, or why countries are richer than other, is subsumed by this one equation.
Sorry.
This is from the last, last lecture.
Okay.
We're going to come back to the today's lecture.
This is income.
And by writing income as output as a function of inputs, we can basically categorise all the most important factors that go into determining why some countries are richer than others, right?
Because this is just telling you its output.
Times technology is equal to technology times a function of our inputs, which is capital and labour.
In other words, countries are richer than others because either they're more efficient and or they have more capital and or they have more human human capital or labour labour force times efficient labour units, whether it's education or skills, is H.
Right.
So now basically when you ask yourself and we're going to do this exercise at the end of lecture, you know, why do you think countries are richer than others.
It basically falls under these three things.
I mean, we'll test it later.
But you can think of any theory and I can tell you that it goes into either a k or h.
Part of the reason is that a is the unexplained factor, which means it can really be anything.
Right.
But you know, usually we want to think about a as being efficiency productivity again a we we rushed through this last time.
But we're going to talk more about today as an index of technology.
But it's not just innovation.
Innovation obviously matters.
Chips Moore's law and all this um, technology, biotech, all the things that you can imagine.
But it's also the efficiency of production, organisation or production.
As I gave you the example last time, uh, if economy is highly distorted or mis allocated, that's a low efficiency.
You give capital to the more productive people.
And less capital, less productive people.
Rearrange.
Then you actually get higher efficiency.
So that's very important for developing country, which is not just about access to the high tech and cutting edge technology.
It's about how efficient that production process is.
And, um.
This is something that we did not talk about, but we're going to get to that more today.
So this is an assumption of a production function, right.
It says output is equal to a technology times capital stock times efficient labour.
So what this tells you is that if you raise

capital stock it increases output.
Same thing with efficient labour sources.
Same thing with technology.
But guess what.
This relationship with why the the relationship between A and
why is linear right meaning a 1% increase in a.
Leads to a 1% increase in Y.
That's not going to be true for K and H.
Right.
A 1% increase in K is not going to lead
to a 1% increase in y y.
What is the law that we spoke about?
Diminishing returns to capital.
Right.
So more one additional units of capital.
Guess you gets you less than 1 to 1 additional
units of Y because of diminishing returns to capital.
And we saw that with this graph.
This is the graph that is, you know, that shows
you that that function can be graphed as the following.
One additional unit of k doesn't get you one additional
unit of y.
We saw this with these, um, these these graphs here.
Right.
This increase in Y is going to be greater than
this increase in Y.
The more capital stock you have.
Now just think about this for a second.
What does this tell you.
It tells you that if developing countries were able to
raise their capital stock, they're going to increase their income.
Right.
But the more you raise, you can't do this indefinitely,
because the more capital you invest in, the smaller effect,
an additional effect on income there is.
Right?
So that's a diminishing.
But that's not true for a.
Okay a here is proportional.
You can indefinitely grow or increase your income through technology.
It doesn't have this diminishing returns.
And mathematically you can see this because on the exponent
it's not something less than one okay.
Here is less than one.
Which means that 1% increase in k leads to one
third percent increase in Y.
This is 1% increase in H leads to two thirds
percent increase in Y, but here a 1% increase in
A, it leads to a 1% increase in Y.
Okay.
This is getting a little bit just a tiny bit
of math.
But this helps you a little bit.
Understand um, better uh, you know, the concepts that are
that are involved.
Okay, so now we come back to our lecture.
Uh.
This time and this lecture handout for.
And so what is?
What is the relationship between what we're talking about today
and last class?
Well, first of all, last class, we're talking about why
countries are richer than others, right?
This production function tells you the level of income.
And you can compare the levels.
Today we're going to talk about growth, which is something

over time.
Income differences across countries is something in the same time period across countries.
Right.
But it's going to be very related concepts obviously.
So the first thing to note is that this is the definition of growth between period t and t plus one.
Okay.
So again one is a cross sectional or cross country element which we discussed last time.
Why are countries richer than other.
Today you're going to be asking why are you richer than your great grandparents.
Okay.
And that's a cross time element.
So but it's again it's still income.
It's still GDP.
So definition of growth I don't need to explicate that.
This is just the definition of growth 3% growth 5% growth 10% growth etc. and kind of growth in anything.
Why is any variable.
Okay.
And here we're going to look at when we talk about growth, as I mentioned in the first lecture or second lecture we're talking about real.
We're referring to real GDP per capita.
When we talk about this country grew at 2% this year.
We're talking about real GDP growth per capita or otherwise specified.
Now growth is exponential.
Okay.
Um, if you if you are not familiar with these concepts, I'd say open up your Excel.
Uh, start with some number.
And look at growth rates.
Okay.
Say that this variable grows by 5% or 10% or 3%.
Have a feel of what that curve looks like.
And this is exponential growth, which is different from just exponential growth, is basically something that grows at approximately constant proportion of growth rate.
Okay.
Every year you grow at 3% or 4%.
Doesn't matter.
Just roughly constant proportion of growth rate.
What's what's growth.
What's what's exponential growth in your life.
Well, um.
If you invest money, right?
That's exponential growth.
If you put in £100 today, if you earn 10% this year, that gets you 110 by the end of the year.
Right.
If you put in £10,000, that gets you £1,000 per year, not £10 per year, right?
A thousand.
So that increment is proportional to your base, right.
Whether it's 100.
Worth 10,000.
That's your base.
It's proportional.
So it's either £10 or £1000.

If you invest a £10,000 and you earn £10 this
year, that's not you're not doing very well here.
Right.
So investment tends to be exponential growth.
Okay.
It's proportional.
Your grades are not exponential growth, right?
You get 80 out of 100 this term and you
get 90 out of 100 next term.
That's obviously not not exponential growth, right?
Population growth is exponential, right.
Population tends to grow well let's say 1 to 2%
per year okay.
So think about what that means in which variables are
exponential and not.
But new growth builds on past growth and its effect
compounds.
The compounding is the key here right.
It's compounding.
And you'll see why it's important.
So this is not compounding.
This would be the wrong answer.
So suppose that Y is growing at 10% each year
since 2000.
What would be the value of y in 2015.
So you earn 10% per year.
Total increase would be 10% times 15 equals 1.5.
So it would be 1.5 times your original value in
2000.
Wrong okay.
Wrong.
That's not that's multiplicative.
It's not exponential.
So what should it be?
Again, for many of you this is familiar.
But just a just to get make sure that we're
getting this correct.
So you grow at 10% per year.
So that's 2000 times 1.110.
And then it builds on past growth.
So 2000 oh one times 1.1.
So everything is built on the past growth.
But this growth already this number already subsumes the growth
from the previous period.
So it's exponential.
So by the time you get to four years later
it's times one not four times 1.1 but 1.1 to
the fourth power okay.
So that's compounding.
I think it will be for those who are not
that familiar, who doesn't have a good feel of it.
Just take the Excel and look at, you know, play
around with this to get a feel of this.
Obviously, by the time you're compounding, you're not get 1.5.
You're not getting 1.5 times your original value.
Um, after 15 years, you'll get four.
You're getting more than four times.
So 4.18 multiple, not 1.5 because of compounding.
So I mean, the power of growth builds on this
idea of compounding growth.
Don't underestimate growth of 2%.
Growth of 1%.
Okay.
If you can have constant growth over many years that's
enormous.
So when people talk about the power of economic growth,

it's just that if you can continue that, you're going
to be a lot richer than you were when you
started out.
And we're going to see this.
Um, so just for for the sake of illustration.
Uh three countries per capita GDP, let's say in 1810.
That was $1,000, right?
Roughly.
That's actually your rich country.
If you had $1,000 per capita GDP in 1810.
Okay.
Uh, what would be your GDP per capita in 2010
based on a growth rate of zero one and 2%
zero?
Obviously, you have the same income 1%.
You get 7000, 2%, you get 52,000.
That's enormous.
That's like 52 times your original value just by growing
one extra percentage a year.
That's the power of growth because it compounds.
Okay.
So just conceptually okay.
This is us GDP per capita, real GDP per capita
on the right hand side 1820 it was like I
don't know, $600.
And by the time they reached 2016 again, PGP um,
$60,000 roughly.
That's the absolute scale, right?
It's absolute because you go from 500 all the way
to 60,000.
We hinted this at last time.
And this makes you makes it look like whoa, it's
growing faster and faster and faster.
Correct.
But no, it's not growing faster and faster and faster.
It's actually growing at a constant rate.
Roughly concentrate.
Because if you look at the left level left hand
side this is logs.
This is levels and logs just mean that.
Remember I said that.
You if you if you graph this based on the
proportional scale.
Okay that's log then this distance.
Being the same as this distance is proportional.
So this is what, 15 times 500.
And this is you know this is going to be
15 times 7000.
Okay, so going from 500 to 7500 is not in
and going from 7500 to, um, you know, a more
than 100,000 is is the multiple the proportion.
It's proportional.
Right.
It's 15 times.
It's not based on absolute scale.
You understand?
So, um, in other words, let's say you have a
scale that goes from zero.
Sorry, 1 to 50.
Okay.
50 to 250 to 150 to 1250.
And that's equal distance.
Why?
Because it's proportional.
It's every time it's five times more than the past.
You're not doing an absolute scale right.

Then that would look like the right hand side but
proportional scale.
You transform this into log.
So taking logs gives you proportional scale.
That's the curve that you get.
It's basically a line right.
It's telling you that this is actually growing in a
constant rate.
Now why do we make such distinctions.
Obviously sometimes absolute is more relevant.
Sometimes proportional scales more relevant because this gives you the
illusion that is growing faster and faster and faster.
Whereas actually the growth rate is actually constant.
Okay.
And we'll see this with let's see if I have
a picture here.
Um.
Okay, well, we'll get to that anyway.
So when we look at, uh.
Countries catching up with other countries you might have.
So let's say that let's say India is growing like
this.
Right.
Because absolute scale, it's it's going to lag the US
by quite a lot.
And it gives you the illusion that India and US
are the gap is widening whereas actually it's catching up.
Okay.
Well we'll see that.
And there's there's an example in the textbook.
So sometimes we want to use log scales which is
the proportional scale.
Sometimes we want to look at the absolute scale.
But usually when we look at something that has exponential
growth which is roughly constant growth, we usually look at
the log scale to illustrate that this is actually, in
fact, growing at a constant rate rather than at this
scale, which looks like it's growing as if it's growing
faster.
And that's that's the only thing you wanted to I
wanted to clarify.
Okay.
Um, okay.
So now let's look at a set of growth facts.
Now again, you're not going to be obviously tested on
memorising who grew at what rate and who's richer then
which other country.
Right.
This is like one minute on Google.
Right.
So obviously that's not what you're going to be tested
on.
You're going to be tested on conceptual things and things
that are very much similar to the practice problems you
have.
Right.
But in lecture and this is, you know, different from
what you go do in your section or your classes,
is that we want to lay out the big pictures,
the conceptual things, teaching you how to think about these
things.
But some of that does revolve around some facts, which
is still important to weave in.
In order for us to get a feel of why
these things are relevant.
Okay.

So just you're going to see a lot of facts,
but you're not going to be expected to memorise, uh,
which country grew the fastest between 1980 and 1920?
Okay.
Sorry.
1980 and 2000 okay.
So look at growth rates.
This is why it's the power of growth okay.
Luxembourg 17,000 per capita GDP 1960.
Um by the time 2010 75,000.
The implied constant growth rate over this period over the
last 50 years is 2.91.
Now a country that started with much smaller per capita
GDP, um, a fourth of what was in Luxembourg, Singapore
basically almost caught up.
Why?
Because it grew at five more than 5% per year
on average in the last 50 years.
Right?
So so just by outgrowing another country by a couple
of percentage points, you can really catch up very fast
over time.
Um, let's look at something.
Some other interesting facts.
Now you know the other countries right.
So so one thing we we, we've seen with this
production function and this, you know, curve outcome.
So our output as a function of capital.
This tells you that developing countries have one way to
catch up, right?
There should be.
This theory embeds catching up.
Why?
Because the richer countries are already at a very high
capital stock level.
So even if you put additional capital stock, you're going
to grow much slower.
That's what we saw with that graph.
Okay.
We're going to we're going to try to hone this
in today.
That means developing countries should inherently have a catch up
growth because they started out at a lower capital stock.
Correct.
Um, so this is a puzzle of why these developing
countries, in principle, should just be catching up by just
increasing their capital stock have been growing not only at
low rates but potentially also at negative growth rates.
So actually Congo is poorer in 2010 than it was
in 1960s.
Um, let's look at a few others.
Uh, these are the East Asian Tigers.
Singapore, South Korea, Taiwan, Hong Kong is not here.
Uh, but they basically all grew at more than 5%
for a long time.
Okay.
50 years growing at more than 5%.
Per capita income is the reason why they started out
being relatively poor.
Could be so rich.
And if you look at Botswana, um, not that far
behind the East Asian Tigers, but clearly, uh, over sustained
compounding growth over a couple of decades has fallen behind.
Okay.
So in summary, these are the ones that have outperformed
Botswana, Singapore and South Korea between 1960 and 2010.

Again, it's PGP adjusted its real GDP because we have
constant dollars.
And so what did we say?
Thailand.
Sorry Singapore, South Korea Taiwan uh, Hong Kong, the East
Asian tigers.
Okay.
Thailand is usually referred to as the tiger cub.
But not sure you're supposed to say that these days
anymore.
But anyways, Thailand.
Malaysia was also growing fast now 4 to 5%.
Why is China?
China actually outperformed all these countries, but we're taking the
growth rate from 1960 to 2010.
Now.
China started growing really in the 1980s, but fastest growth
1990 onward.
Otherwise China would definitely be on the very, very top.
Botswana very interesting.
Right?
Botswana in the middle of, you know, Africa.
Um, and we know African economies have performed very poorly,
uh, in general, uh, you know, look at Zimbabwe, obviously,
um, all these countries are very, very different.
Again, this is really, you know, quite interesting.
Right.
What's what's similar geographies, um, similar starting point.
Why do countries grow faster than others.
Right.
This is something that we can explore.
Um, other countries obviously grew slower.
Look at, you know, United Kingdom, us, uh, advanced economies,
2 to 3%.
That's pretty good, given that they were already rich.
And how do they grow?
Well, obviously not based on accumulating capital, as we'll see
through technology and innovation.
Okay.
And these are also developing countries.
They should be growing very fast because of ketchup.
These countries are now growing very fast.
But again, just compare similar countries and similar regions.
You know, if we put Indonesia or, you know, Bangladesh
or um, uh, uh, Myanmar or uh, Cambodia again, similar
regions, but growing a lot slower.
Okay.
So this is the majority of countries, as you see,
uh, has grown at around 1 to 2, 1 to
2, 2 to 3%.
Very, very few are able to sustain 5% average growth
for a period of 50 years.
Okay, so, um, this is kind of interesting.
There's a rule rule of 72.
Okay.
Basically divide the growth rate by 72 and roughly roughly
speaking.
Okay.
And that's, um, that's how much, uh, it takes for
you to double, uh, the, uh, your living standards.
Okay.
So 2%, if you grow at average 2% per year,
you double your living standard in 35 years.
Okay.
If you grow at 6% per year, you're going to
double your living standards in 12 years.

If you grow at 12% per year, you double your
living standards in six years.
That's the power of growth, okay?
You can become twice as rich as you are if
you grow at 12%.
Same thing with your investment.
Okay.
If you can manage a 12% return every year, you're
going to double your money in six years.
That's the power of that's the rule of 72.
But that's roughly the case.
You don't have to memorise that.
Just, uh, something, um, funny fun if you if you
do remember.
Um, okay, so this meant that Asian tigers were able
to double their per capita income in 15 years.
Every 15 years, if you can maintain that growth rate.
Um, what about the Madison project?
Angus?
Madison.
Uh, very interesting economist.
Um, he has growth rates.
That goes way back in history.
Right?
1820 and beyond.
I think there's some growth estimates since a thousand.
Now, if you take a whirlwind history of or look
at the world map and look at growth.
Uh, guess what the growth rate was between, let's say,
A.D. one year, 1 to 1000.
So I'll give you three choices.
One is 2% per year.
A two is 5%, B is 5% per year, and
C is.
Almost zero.
How many think it's 2% per year between year zero
and a thousand?
How many think it's be 5% per year?
How many thinks?
Zero.
Most of you did not answer.
I see that okay.
But yes, basically did not grow at all in real
terms.
Now when was the fastest growth?
After, you know, in the last few millennia.
I heard somebody whisper.
Yes.
Industrial revolution.
Yes.
In this country.
Okay.
That's when human per capita are living standards were doubling
during the Industrial Revolution.
What was it?
Um, living standards grew by 75% within one lifetime.
Okay.
During the Industrial revolution.
Now, obviously, lots of countries are growing faster than the
Industrial Revolution at this point.
But that was the first time because of the arrival
of technology, right?
Not because of capital.
Obviously, technology led to capital accumulation and labour force training
and all that.
But that was when really the world started to grow.

Okay, so let's look at 1820 now.
The US was poorer than UK at that point.
1820 UK was a lot richer.
And um, but it grew at a slower pace and
only by, you know, not even less than 1% at
points.
And guess what?
It became poorer than the US.
Um, uh, by 1970.
Okay.
Uh, obviously the US grew.
What does this tell you that that tells you that
US really grew after the 1920s or caught up after
the 1920s?
Uh, because the growth rate was much faster in that
period than in the century before.
In the century before us was a developing country.
This is when the height of the Industrial Revolution, this
country was the major power and exported not only goods,
but capital to Argentina and to developing countries, Latin America,
obviously, um, trade with India and so forth.
And um, uh, it was the richest country.
Now, interestingly, Argentina wasn't that far behind, right, because of
emigration, because of the UK's, uh, or Great Britain's, uh,
investments in Argentina, but because of the power of growth,
again, only a few percentage less than 1% slower, less
than one percentage of slower than us.
Is still today a developing country.
Okay.
So we're talking about growth in the long run.
And that's the important look at South Korea much poorer
in 1820.
Developing countries basically converge with US and UK in 2010.
Why.
Just power of growth.
So don't underestimate these couple percentage points or even less
than one percentage point that happens over the long term.
Uh, some other countries uh look at China.
Uh, China in 1990 was about $3,000 per capita.
And, um, you know, 13,000 by 2018.
Uh, not that long after.
So less than 30 years afterwards, and on average, 5.43
let's look at India, India and China or the same
at the same level of income in 1970.
And guess what.
China's a Chinese person is more than twice as rich
as an Indian person after as in India.
And after these years, because of one additional percentage point
of growth on average.
Okay, so this is, um, a growth rate.
So this is an annual growth of GDP per capita
in 2021.
Now this is a little bit tricky because it was
after the pandemic.
So 2021 was the was was the year that lots
of countries grew very fast.
But anyway, um, the fastest growth is the darkest area.
Uh, uh, you know, North America grew at 3 to
5%.
Actually, the basic the US grows at around 2% per
year.
Um, but during the pandemic, uh, after the pandemic, it
was, uh, very fast.
And that's the distribution.
Look at a negative growth rate in a lot of
these Central African nations or some of the East, uh,

sorry, some of the, uh, Asian countries as well.
Um, so again, we're not seeing that developing countries are necessarily growing faster.
Right.
But that's what the theory should tell us, as we'll see.
Okay.
So let me let me summarise two types of growth okay.
The first is catch up growth and catch up growth is important concept because we've seen it from uh, the production function that because of the diminishing returns to capital and labour, if you're already really very rich, then each additional unit of additional investment doesn't get you that much additional right.
Which means that if you started out, let me just make sure that we get this.
Um.
Up soap soaps.
Uh, let's see that.
Basically, let me just show you the graph here.
Right here.
If your capital stock is here, which is, you know, you're richer if you have a higher capital stock.
Then you can invest in that additional income is not going to be a lot.
But if you start out here, start out from a compared to, you know, down here you can you're on a very steep curve.
Every additional unit of capital stock you can grow.
Same thing with labour.
Every more additional person or more education per person gets you to be on that steep curve.
This is what we mean by catch up growth.
By starting out at a lower income or lower level of education, you can grow faster.
Okay, so that's what we mean by catch up growth.
Um.
And the second is sustained growth.
How do we have sustained growth in the long run?
It has to come from technology.
It comes from efficiency.
It comes from a right.
Because there's a is not subject to diminishing returns.
We saw it's proportional 1% increase in a least a 1% increase in income.
So when we talk about rich countries, how do you get to be growing at 2% per year indefinitely, like the US has been for a long period of time.
This country so.
So.
Okay.
Because of continued innovation and technology, not because of capital accumulation, but technology.
Sustained growth for hundreds of years will need to come from a technology.
So when we talk about catch up growth, we see this in this picture.
Okay.
So this is GDP of that country relative to US GDP per capita income relative to the US in 1950.
Obviously, countries like China, um, Brazil, uh, Mexico were clearly very poor relative to the US, around 10%.
And uh, South Korea was at around 30%.
Sorry, sorry.
No, no, no, South Korea was here was less than

10% of of US GDP, less than 10% of US
income 1950s.
And the fact that this.
Line is going up.
Getting to.
6,070% of U.S. income for South Korea means that it's
catching up, right?
And even countries like China, which is not that obvious
from this graph, but it's still, you know, going from
less than 10% to 20% of per capita income adjusted
means it's catching up.
You see the same thing with Brazil.
Okay.
Um, you you see the same thing.
Well, you don't see same same thing with Mexico because
Mexico did catch up.
And then in relative terms it declined.
Right.
So it's falling behind Spain, obviously one of the few
countries that were able to escape the middle income trap.
25% of per capita income, all the way to more
than 50.
More than half.
Okay.
So you can see that there is definitely catching up
going on here.
That's catch up growth.
And if we look at the US and treat it
as a frontier because it keeps on growing at 2%
per year because of technology and innovation, we're catching up
to the frontier.
Okay, so we discussed a lot about this, but I
just wanted to compare a few country pairs and illustrate
why these things are important.
Right.
Just look at Botswana.
We said right with Rwanda Botswana was less than half
of the income.
Um, compared to Rwanda 1960.
But now it's what?
It's more than eight times richer.
Okay.
A real middle income country.
Botswana because of average 6.6% growth.
Now look at Singapore and Brazil.
Another interesting pair started out around the same.
So what's what's important is that initial values don't matter
that much.
If you look at constant growth rates over the long
run it doesn't really matter so much where you started.
It's all about growth.
Because again, new growth compounds based on past growth.
Singapore and Brazil were similar levels of income, and Singapore's
$80,000 per capita income 2017 compared to Brazil, only 14
one is a rich country.
One's a middle income country.
Why?
Because of average growth is 6% per year.
Same thing with Mexico.
Spain.
Uh, you see, the US, UK is roughly okay, like
with France.
Um, actually France grew faster so that so there's even
catching up among the advanced economies.
Right.
Catching up.

And if you look at Congo, um, Congo was the
same income as Singapore.
Look at this.
It's really quite amazing.
Quite remarkable.
Remarkable what growth does.
Right.
Still at 800.
Poverty still in a poverty trap.
And Singapore is a rich country.
Okay, so this is growth over time.
Last time we talked about income across countries is the
power of growth.
Okay.
So the interesting thing is I mentioned, I think referred
to in the first lecture is that even though income
inequality is something that's heatedly debated among the politicians, all
that leading to a lot of, um, uh, political, uh,
you know, agendas, global inequality actually fell because of two
large economies growing at a very fast rate, China and
India, which together represent 40% of the population, actually 90%
of the population in the in the world today still
live in developing countries, as I think I mentioned.
And that convergence, that catching up is actually leading to
a smaller inequality across countries.
Okay, so that's why the power of growth is actually
very important.
Now let's just do an experiment just to highlight why
these growth rates matter so much.
Right.
So there's a debate.
Obviously there's heightened US-China tensions.
Uh, some groups would say, uh, China is going to
overtake the US's largest economy in the world.
And very short time period.
Obviously that's significant.
Some people say, no, China is never going to overtake
the US as the largest economy in the world.
Right.
So which one is going to be right?
It's going to depend on how the relative growth rates
between the two in the next few years.
So the red line solid line is China based on
a 5%, uh, growth rate per year?
Okay.
Quite high.
Uh, it was announced that it was 5.2% last year.
Again, if you agree with the official statistics and China,
let's just assume that US keeps a constant growth rate
of 2% per year, which is a fair assumption.
Right?
So at this point, 5% 2031 in less than ten
years, China will overtake the US as the largest economy
in the world.
Now if China grows at 4%, so only two additional
percent per year compared to the US, then uh, it
will overtake the US in 2035.
You can do this experiment with 3%.
Or obviously if China grows at the same rate as
the US, it's never going to overtake the US or
it grows lower.
Now, per capita income is a little bit trickier.
Okay.
Uh, this is per capita income, uh, p for 2022
in China versus the US.
And if China grows at 5% per year, it's going

to be another 40 years before China has the same
income as the US.
So obviously per capita GDP because of the the base
being so different because the US keeps on going, it's
going to take much longer.
Right.
So growth rates is very sensitive.
You know you play around with growth rates.
You see that it makes a huge difference okay.
So why and how does a nation grow is what
we're going to try to tackle.
Last time aggregate production function.
We've drilled this in you know these um the factors.
Now.
So how do we grow?
Either you grow a, you increase your capital stock or
you increase your efficient units of labour.
So education or labour force right?
Remember that A is not just from innovation and expansion
of knowledge as we understand it, but also the efficiency
of production.
So emerging markets or developing countries again, they just need
to improve efficiency, right?
Getting credit to the most productive entrepreneurs, giving farmers the
right equipment, um, you know, increasing the health of the
population, all that gets you growth because it increases either
H or A.
Okay.
Right.
So these are the three things.
So let's look at K first okay.
Capital accumulation.
So how does a country grow based on capital accumulation?
Now, what is capital accumulation?
Where does capital accumulation come from?
First of all, let's look at this equation.
Suppose that government spending exports imports is equal to zero.
Okay.
That means that y is equal to consumption plus investment.
Right.
Let's for sake of simplicity.
Now investment as we know.
Is new capital accumulation of new capital.
Right?
Purchase of a new capital.
So what determines investment or what determines physical capital accumulation
is what we're interested in.
And so.
On the income side.
Your income is equal to consumption plus savings, right?
Whatever you don't consume, you save.
Correct.
That's the definition of savings.
So these two things put together means that investment is
equal to saving.
Okay.
So that gives you your answer.
How does physical capital accumulation and therefore in other words,
how does growth occur?
It comes from saving.
Because saving is equal to investment in investment is equal
to purchase of new capital.
What does this tell you?
It tells you that countries in principle who save more
should be growing faster.
Correct.

Let's look at a relationship between saving and investment.
And guess what we see in extremely positive relationship.
Right.
But it's not completely linear.
The cluster here, it's not always that you save more
and you invest more.
Sometimes countries that save more did not invest as much
as a country that saved less.
But it's roughly this relationship savings and investment is positively
correlated.
Okay.
So we have a first theory of growth here.
You grow faster when you accumulate more capital and you
accumulate more capital when you save more.
So saving is very, very important.
Right.
If we're in a closed economy now, what determines aggregate
saving?
Well, this requires a different kind of model to think
about how much you want to consume, how much you
want to save, when you want to consume one you
don't want to save.
We're not going to talk about this and this, this,
um, this course.
But just, you know, if you think about it for
a second, you obviously think about you make your consumption
decisions based on your income, but not only today, but
also your income in the future.
Right?
If you know that you're having a steady.
Wage growth forever.
You're going to consume more.
Right.
If you think that there's a lot of uncertainty.
Am I going to lose my job?
Is there going to be another pandemic?
You save more.
So there's some optimisation going on behind this, which is
not, you know, for you to really, uh, you need
to master here.
But just think about, you know, what determines saving.
So consumption is good.
Everybody likes consumption.
But saving is better because it leads to long run
growth.
Now, if we map this theory onto the real world,
I can tell you that East Asian countries saved save
and saved a lot during their fast growth periods, and
African countries save a lot less.
Latin American countries save a lot less.
Now, this is not conclusive.
This is not the only theory of growth, but this
is the pattern that we do see.
Is that lots of countries that say very little compared
to a few countries saved a lot.
Uh, gets you growth differences.
But saving a lot doesn't mean that you're necessarily going
to grow a lot, because there are other factors like
technology and labour.
And remember that we're hitting the diminishing returns to capital.
So the more you save, the additional impact on output
or income is going to be smaller and smaller and
smaller.
But this is the first theory of growth, okay.
When we save we grow because of capital accumulation.
So can we get sustained growth through physical capital accumulation?

No, because it hits diminishing returns to scale.
Diminishing returns to investment or increasing the numbers.
Know same thing or raising their human capital?
No.
Because you know how many education years of education can
you have?
You have a limit there, right?
And the more you go to school, the less you
work.
So there's obviously some boundary here.
This is the only thing TFP increasing technology that has
no bounds to growth.
As we've seen from these two graphs that we have
already discussed.
Right.
So sustain growth comes from um, TFP, uh, and not
physical capital accumulation.
And we're going to learn the solo model growth.
Next lecture to understand these dynamics more in length.
Okay.
So these are we already discussed.
So coming back to technology, this is the only reason
or only way for countries to grow indefinitely.
But again technology is also going to be an exponential
growth.
Right.
Um, but why?
Because again, it makes more sense to think that the
more stock of technology you have, the bigger the increment.
Of the innovations, right?
Think about all the microchips that we have.
It revolution they AI.
It obviously builds on the past stock.
So stock versus flow remember.
So the bigger the stock the bigger the flow.
That's proportional.
That's why it's constant growth or it's exponential growth.
So we think about a as being exponential growth.
Then that's the only way to think about um that's
the only way to have sustained growth.
Catch up growth is based on capital and labour.
Sustained growth is based on technology.
So let's look at, um.
Uh, if we decompose the growth right into hours.
Sorry.
Physical capital per hour.
So that's k this is, uh, labour, labour force.
You know, population growth has been pretty constant.
Right.
So here to have an increase in the efficiency labour
force is really the years of schooling.
So if we look at 1950 so this is GDP
per hour work.
So productivity labour productivity um we see two patterns.
One is capital per hour is growing.
Right.
So there's capital accumulation.
Correct.
This is physical capital per hour worked.
And second efficiency units of labour is increasing through average
years of schooling.
It used to be in the 1950s.
You basically are done after after middle school and now
13 years.
So tertiary education secondary education right on average.
So that has also contributed to the increase in GDP.

So now we look at a decomposition of the growth
in these three factors okay.
So the last column okay pay attention here.
Last column is the growth rate of GDP per hour.
Okay, 3.54% between 2000 2007, 2.47% of that 3.54% growth.
How much of it did it come from?
Physical capital accumulation.
0.89% of the 3.54% came from capital accumulation.
How much came from human capital?
0.28.
How much came from technology?
Right.
What is a it's everything else that's not covered by
capital and human capital.
So this minus this minus this gets you everything else
that we cannot explain.
We call this the black box of efficiency.
What we can see is that over this period, the
biggest contributor.
To growth for the US is what?
Technology, right?
Much more important than capital accumulation or human capital accumulation.
Again, this all sums up to the seventh column, because
six is everything minus the growth rate, minus what's due
to capital and humanly human capital.
Okay.
And so this is basically we can see we're graphing
this the percentage that's due to technology.
And it's much faster even though.
So look at this.
Interestingly enough in the 1980s technology did not contribute a
lot to the US.
Why?
Potentially because this was the period of investment we invested
hugely on.
The IT revolution only came into fruition after the 1990s.
And then we see a lagged effect of the productivity
gains.
Right.
This might be true with today's AI as well.
We're investing a huge amount in AI, and then a
decade later, maybe it will be faster or more than
we see in the productivity numbers.
But what is really interesting about this graph, it tells
you that sustained growth for a country like the US
really comes from productivity growth.
Okay, so, um, let's see just three, three more graphs.
So the last time we didn't really get into this,
but production function.
Right.
What makes you more productive?
What makes labour productivity go up?
Well, the way you want to see this, I'm going
to switch back to the the the.
The production function here is that, you know, if you
keep labour constant, right, what gets you more output is
more capital stock.
Right?
So the idea is that how do you increase labour
productivity.
Well one is by increasing a one is increasing capital
stock.
Right.
Again holding labour constant.
How do you get more income by raising a or
k.

So that means that this is the idea is that
if you give people the right equipment or more equipment,
they become more productive.
Labour goes up, labour productivity goes up.
Right.
That's the thing that I wanted to just emphasise.
We didn't get to this last lecture coming, looking at
this production function, the way to increase capital productivity.
How do you increase capital productivity by increasing a or
by increasing schooling.
How do you increase labour productivity by increasing k or
analogy.
So what we see here.
Is that there is a very positive relationship between the
capital intensity.
So how much capital per person and labour productivity.
Right.
So more equipment gets you also more labour productivity.
And this is labour productivity.
We see a convergence also between these countries with China
India and Brazil and labour productivity being the highest in
the advanced economies.
Okay, so I know we're almost out of time.
One more minute.
This is a growth whirlwind.
Growth contribution to the world since year one.
So at that point, countries like.
China and India.
Is that India?
Yes, it is India.
Um, comprised of more than the world's GDP.
Uh, half of the world's GDP.
So almost 30%.
Uh, actually China by really interesting 18 mid 18 or
early 18 19th century, uh, comprised more than a third
of the global GDP.
Okay.
And then of course, it fell dramatically because of slow
growth and USA picks up.
Okay.
Western Europe this is probably mostly this country.
And now it's declining.
Western economies are declining as a global as a share
of GDP, global GDP, with the likes of emerging markets
like China and India catching up.
And over time, the developing world is going to contribute
to more than or actually, right now it's already more
than half a world GDP coming from developing countries.
So this is a very interesting thousand year millennial year
history of growth and the relative compositions of these different
regions.
So we can see there are cycles of civilisations.
So the Western Europe Europe kind of dominance is really
only the last 203, 300 years.
But obviously as we know, there's only one way to
sustain growth, right.
Why did these countries start to fall over time?
Because it was not based on technology, right?
It was not based on innovation.
It was based on already being rich and not investing
in innovation.
And that's what they fell.
And only with innovation.
If one thing you're going to remember with growth, a
growth theory, sustained long term growth comes from technology.
Even if catch up growth comes from investment and investment

in capital and schooling.
Okay.
See you on Thursday.
I.
Even the.
Most.
You know then.
Coming out of the fire.