A Framework for Understanding Economic Growth

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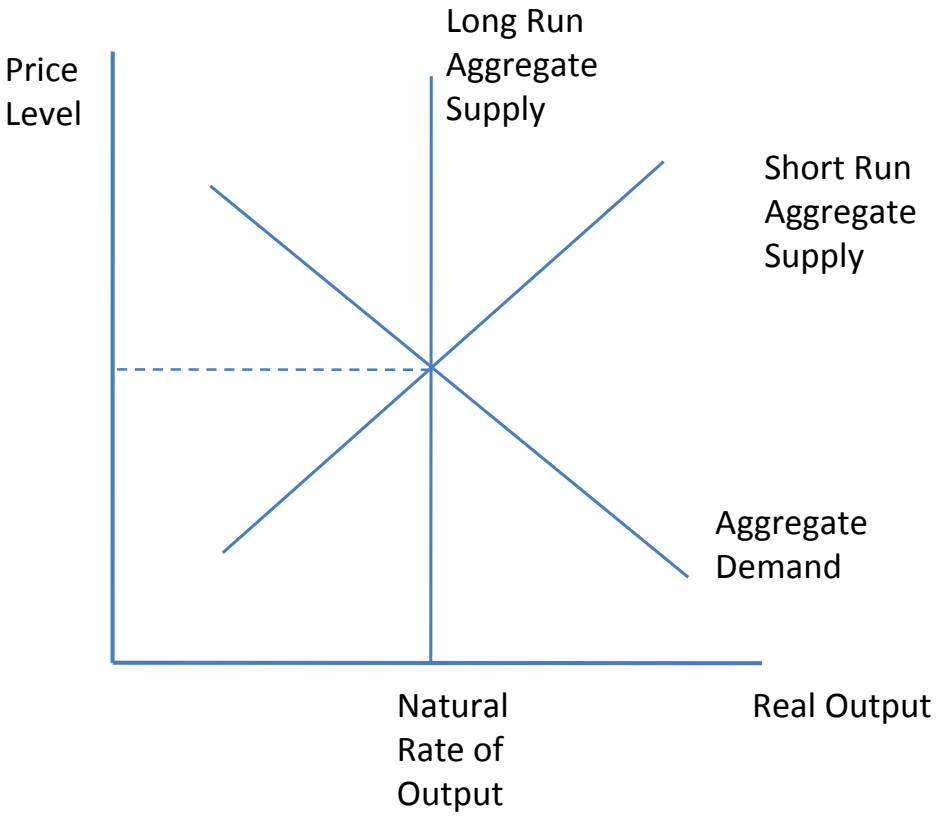
My goal in this paper is to provide a framework for understanding economic growth or differences in the level of income among nations. By a framework, I mean an intellectual structure on which different theories or empirical results can be put together. I will also give my own reading of the important empirical results in the field – however, even if you don't agree with my readings, I hope that the general framework can serve as a useful organizing device for some of the discussions over the next couple of days.

In light of recent events in the world economy, I am going to start with a picture that is not usually part of discussions of economic growth, but rather belongs to the realm of short run macro.

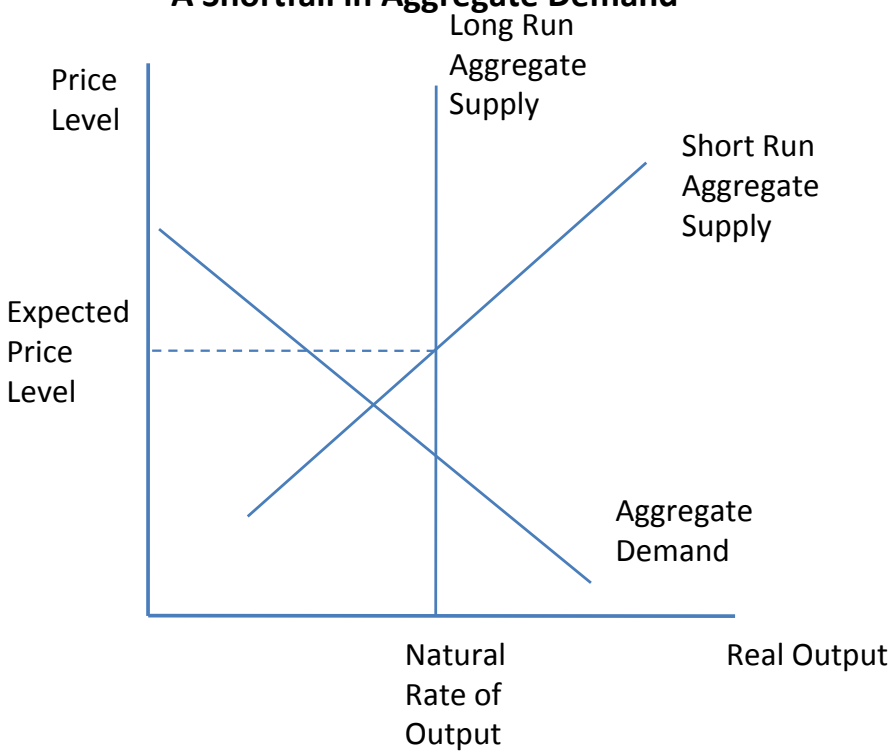
[Slide] **Short Run Macroeconomics**



Most of you probably saw this picture in intermediate macroeconomics, but just to remind you: on the horizontal axis is real output in an economy; on the vertical axis is the price level. There are three curves: The short run aggregate supply (SRAS) curve represents the total quantity of output that firms and workers are willing to supply as a function of the price level. Higher prices raise short run aggregate supply because of some nominal rigidity like sticky wages or sticky prices. The long run aggregate supply (LRAS) curve represents the level of output produced when prices are perfectly flexible. The level of output for the LRAS is also known as the natural rate of output, and it corresponds to a level of unemployment called the "non-accelerating inflation rate of unemployment," or NAIRU. The short run aggregate supply curve intersects the long run aggregate supply curve at the point where actual prices are equal to the expected prices embodied in the SRAS curve. The aggregate demand curve represents total demand for goods and services in the form of consumption by households, investment by firms, government purchases, and net export. It slopes downward as a function of the price level for reasons embodied in the IS-LM model. Equilibrium output and prices are given by the intersection of the Aggregate Demand and the Short Run Aggregate Supply curves. Output can differ from the natural rate only as long as prices differ from their expected level.

Now, if you are not a Keynesian, or don't believe in sticky prices or any of that other mumbo-jumbo, that is no problem. I put this diagram up only to highlight the fact that in some periods, output in an economy is determined not by productive capacity, but rather by demand factors [slide].

A Shortfall in Aggregate Demand



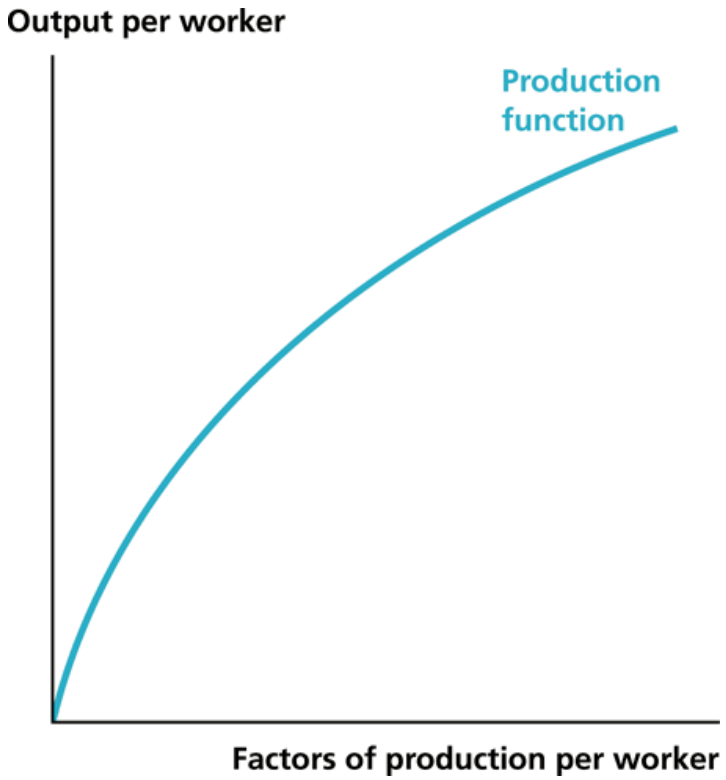
During the great moderation of the past two decades, a lot of macroeconomists came to believe that large gaps between actual output and the natural rate of output were a thing of the past, and so attention shifted to developments on the supply side. Now many economies find themselves with seriously deficiency aggregate demand, and no one is quite sure when or how this situation will be remedied

I also want to take this opportunity to mention where the financial sector, fits into things. The answer is in two places. First, the financial sector is part of the story of aggregate supply. As I will discuss later, the efficiency with which capital is allocated determines the productive capacity of the economy, and thus the position of the long run and short run aggregate supply curves. If you damage the banking system, you move the aggregate supply curves to the left. The second place that finance enters this story is regarding the aggregate demand curve. In a modern economy, credit mediated through the financial system is involved in an enormous fraction consumption and investment, both components of aggregate demand. If you damage the banking system, you move the AD curve to the left as well. From the fact that last year's financial crisis had a negative

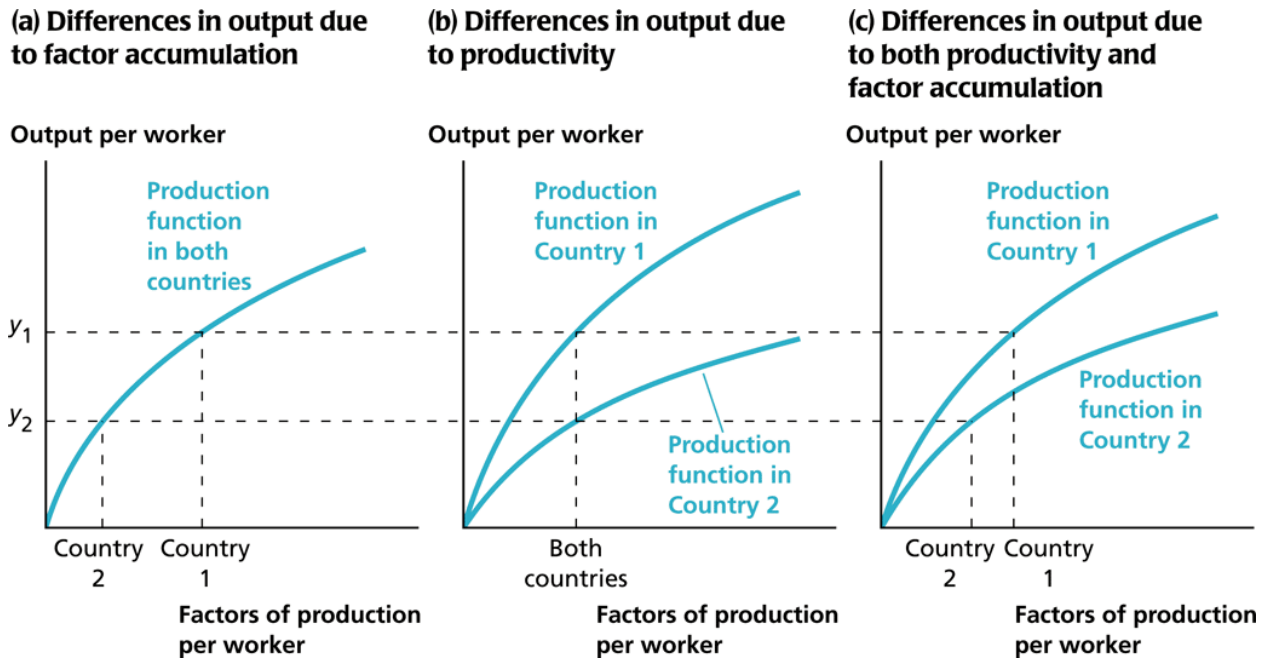
impact on prices, despite massive monetary and fiscal stimulus, we can infer that the damage that the banking system suffered had a bigger impact on aggregate demand than on aggregate supply.

Despite these current goings-on, the field of economic growth is traditionally focused on the long run AS curve, and that is where my focus will be as well.

In thinking about what determines the level of income in a country, or what causes the level of income to change over time, my approach will be to try to break down the question into some more manageable pieces. The first distinction I want to make is between the accumulation of factors of production and the productivity with which those factors are used. I am going to summarize that distinction in the simplest possible manner by thinking about a production function. [slide] On the vertical axis is output per capita, and on the horizontal axis I have written "factor of production per capita" where these factors will be all the different inputs that a country can accumulate, such as physical capital and human capital. The production function tells us how factors of production are converted into output.

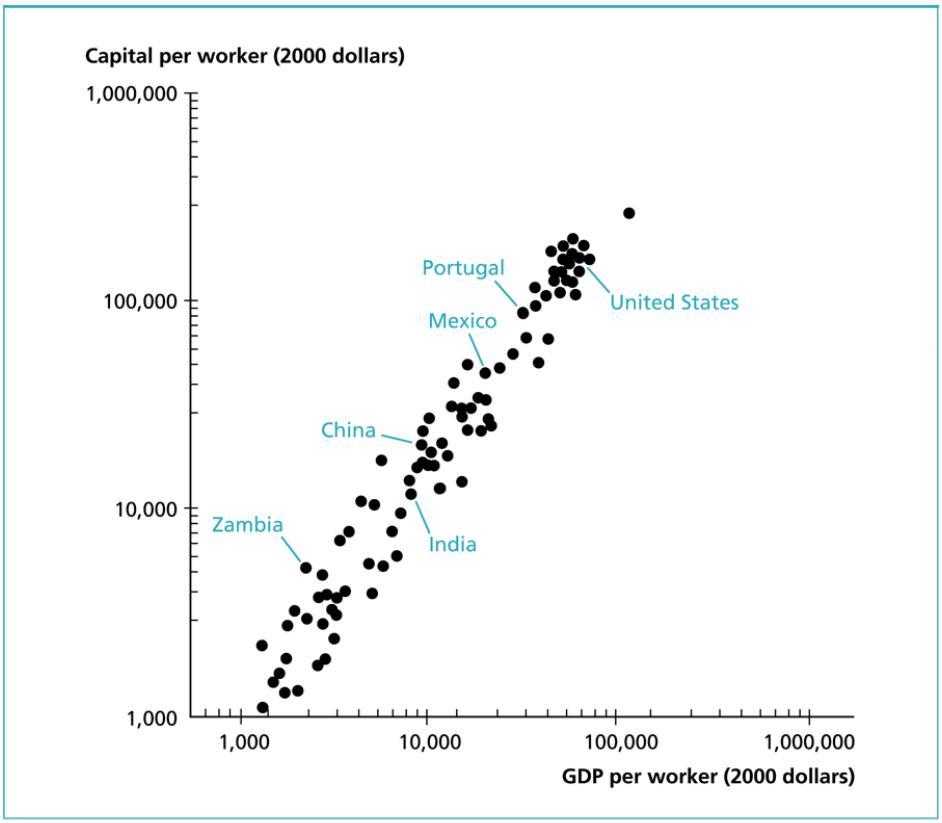


Using this picture, we can say that there are two things that can make a country richer: it can have more factors of production, or it can have a better production function. [slide] The figure makes the same point, thinking about comparing two countries that have different levels of income per capita.



So right away, with this analysis, we have a diagnostic tool that we can apply to think about why a particular country is poor. We might want to ask, to what extent is the country poor because it has few factors of production, and to what extent is it poor because it does a bad job of converting those factors of production into output. That approach, which is called development accounting, is exactly where I will be going in a few minutes. Before getting there, however, I want to talk some directly about factors of production.

Physical capital is tools, machines, buildings, and other things like that – the kind of capital that Marx talked about, and the stuff that we focus on in the Solow model of growth. [slide]



Sources: Calculations based on Heston et al. (2006) and World Bank (2007a).

As the figure shows, the level of physical capital per worker differs enormously among countries.[1] Physical capital is built up through investment, financed either by savings or capital flows from abroad. A lot of old fashioned thinking in development economics focused on how to raise the domestic savings rate in order to finance capital formation. I say that this line of thought is old-fashioned because today the world is awash in investable funds (and will be all the more so over the next few years, as the US gets out of the business of running massive current account deficits). So for a country with good institutions, productive workers, and so on, lack of domestic savings should theoretically not pose an obstacle to rapid development. However, the strategy of borrowing from abroad to fund investment clearly carries heavy risks – and those risks don't seem to be getting any smaller over time. We also have the example of the countries that have grown most quickly, such as the East Asian Tigers and most recently China doing so accompanied by massive saving. So maybe the old fashioned idea that saving a lot is a key to growth is not so crazy.

[1] Data are from Weil (2008).

The other point that I want to mention briefly about physical capital is that capital goods have higher prices relative to consumption in poor countries than in rich countries. This means that a given rate of national saving, measured in a country's own currency, results in less physical capital in a poor country than it does in a rich country.

Human capital is the characteristics of workers that allow them to produce more output. The most obvious form of human capital is education. It is worth mentioning that governments are very heavily involved in the creation of human capital in the form of education, although I don't think that there is a fully accepted explanation for why that is. (Some possibilities are externalities, paternalism, and indoctrination.)

A few quick comments about how human capital levels compare across countries[2] [slide]

Average Years of Education

	1960	2000
Developing Countries	2.05	5.13
Advanced Countries	7.06	9.76

1) If you look at data on years of schooling, there has been remarkable convergence of human capital between poor and rich countries over the last several decades.

2) Again, if you look at schooling levels, the difference in human capital between poor and rich countries is much smaller than the difference in physical capital. Rich countries have on the order of twice as much average

[2] Data from Weil (2008).

schooling as poor countries, but roughly ten times as much physical capital per worker.

3) Of course, we know that years of schooling is a far-from-ideal measure of human capital from education because the quality of schooling differs enormously among countries. But my suspicion is that even if you did the measurement right, you would find that levels of human capital from education differ by less than physical capital levels

Beyond formal education, there are a host of other dimensions of productive human capital. James Heckman has stressed non-cognitive skills and motivations which are imparted outside of the classroom. Another form of human capital to which economists are paying increasing attention is health. Part of the story of growth in the rich world over the last two centuries is improvements in physical health that allow people to work harder and think more clearly. Evidence of this improving health is that adult height has risen by about ten centimeters over this period. If you measure health by, say, life expectancy, then the evidence shows that health differences between rich and poor countries have been declining quite rapidly over the last half century.

One important characteristic of all these factors of production that I have discussed is that their accumulation takes time. In the Solow model, we know how to formally model the dynamics of capital accumulation, to solve for half-lives of income gaps, and all that. In the case of human capital in the form of health, the biggest constraint is that so many important inputs to adult health take place at or near the beginning of life. For that reason, even if there is some great improvement in the health environment of a country – the eradication of malaria, say – the full productive effect will not be seen until the existing labor force is replaced by children born after the health improvement took place, in other words, not for several decades. In the case of human capital from education, the important constraint is that producing educated people requires educated people as an input. Thus, for example, even with the best institutions, organization, and so on, it would extremely difficult to take a place like Africa up

to a high level of education faster than a few generations, simply because there as so few educated people to serve as teachers for the teachers.

Finally, I want to mention briefly the connection between the accumulation of factors of production and population growth. As we know from the Solow model, faster population growth, by diluting the stock of capital per worker lowers the level of output per worker. A similar effect is present for human capital: when population growth is rapid, the fraction of society's resources that must be devoted to investments in children is higher. Slowing population growth, which is usually part of the process of economic development, yields benefits through both these channels. Further, when fertility falls there is a period of several decades in which the share of the population made up of working age adults is unusually high. In Mexico, for example, the demographic gift from low fertility has contributed one percent per year to growth of GDP per capita over the period 1985-2015.[3] Of course in the long run, slow population growth gives you population aging and all the economic headaches associated with that.

So now, as promised, I want to return to the question of how much of the variation in income among countries is due to the accumulation of factors of production. The conceptual model is simple. We start with an equation relating output, productivity, and factor accumulation in a single country:

$$Output\ per\ Worker_t = Factors\ of\ Production\ per\ Worker_t \times Productivity_t$$

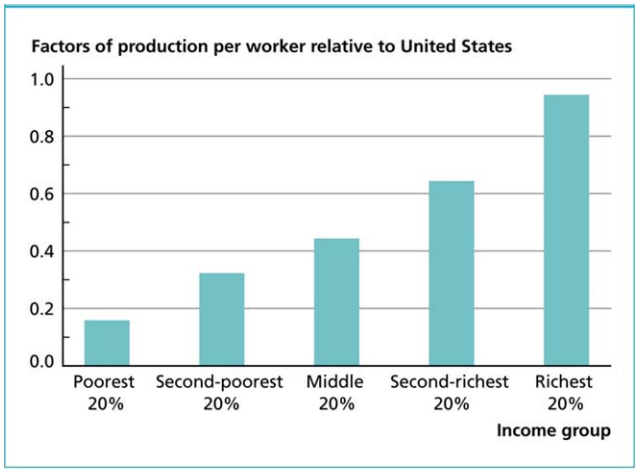
Taking the ratio between countries *i* and *j*:

$$\left[Output\ per\ Worker\right]_i / \left[Output\ per\ Worker\right]_j = \left[Factors\ of\ Production\ per\ Worker\right]_i / \left[Factors\ of\ Production\ per\ Worker\right]_j \times \left[Productivity\right]$$

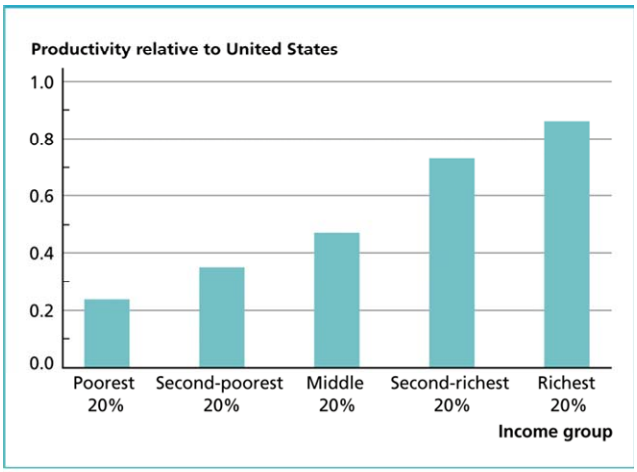
We can measure output and accumulation of factors of production and back out productivity as a residual.

Here is what we see when we apply this framework to data from a large cross section of countries.[4] [slide]

[3] This calculation comes from Weil (2008), Chapter 5.
[4] Data are from Weil (2008), Chapter 7.



For sources, see Table 7.2.



For sources, see Table 7.2.

The figure on the left shows the ratio of factors of production of per worker in quintiles of the world income distribution to the level in the United States; the figure on the right shows the ratio of productivity in these same country groups relative to the United States. The striking thing is how similar the two pictures look. Doing the mathematics more formally yields the same conclusion. 44% of the variation in income per capita among countries is due to variation in productivity, and 56 % of the variation is due to factor accumulation. The other point to make is just how large differences in productivity are among countries. The poorest quintile of countries in the world produces at one quarter the level of productivity of the United States.

We can also apply this analysis to individual countries. [slide]

Development Accounting for Mexico

Output per Worker	0.29
Physical Capital per Worker	0.27
Human Capital per Worker	0.79
Factors of Production per Worker	0.56
Productivity	0.52

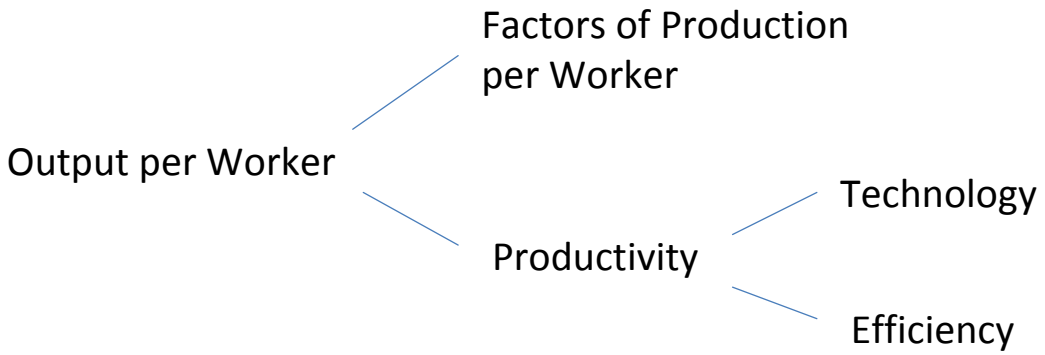
Data for year 2000. All quantities relative to United States.

The slide shows the case of Mexico. Notice first, that as I suggested above, in this data the gap in human capital is much smaller than the gap in physical capital. When we combine human and physical capital per worker into a single aggregate, it is equal to 56% of the US level. Output per worker in Mexico is 29% of the US level, which implies that productivity in Mexico is 52% of the US level. What this means is that low productivity is more important than low factor accumulation in explaining Mexico's income relative to the US. Since as mentioned above the typical country has more of its income gap explained by factors of production than by productivity, this makes Mexico slightly atypical. If one had to do a "diagnosis" based solely on this evidence, it would be that Mexico has more of a problem with productivity than it does with factor accumulation. This finding matches the analysis that Professor Heckman presented at this conference.

OK, so that is very interesting, but of course we are left asking "what is productivity?" That is, what determines how much output a country produces with a given set of factors of production?

Just as I divided the determinants of output into two pieces (factors of production and productivity), I am going to divide productivity into two pieces, which I will call technology and efficiency.

[slide] **The Conceptual Framework**



Technology is the available knowledge about how factors of production can be combined to produce output. So think steam engines, lasers, all those cool inventions that raise output. A crucial quality of technology, as Paul Romer has

stressed, is that it is non-rival: use of an idea by one person does not make it any less productive for another. That is obviously good news for poor countries. Even if cutting edge technology in the rich world is protected by secrecy or patents, the technology of only a few decades ago, which is only a little bit worse than the cutting edge, is pretty much freely available.

The other part of productivity, efficiency, is somewhat harder to describe. It is a residual: it is all the other aspects of an economy, beyond technology, that determine how much output gets produced from a given amount of factors of production. Efficiency will reflect things like how production is organized, whether factors of production that are available actually get used for producing output as opposed to sitting idle; whether factors of production are allocated to the sector or firm where they will be most productive, and so on.

Just as we did earlier, we can write productivity as the product of technology and efficiency, and we can do a decomposition of the gap in productivity between two countries into the part due to technology and the part due to efficiency. I would like to be able to show you nice quantitative decompositions of this, as I did in the case of productivity and factors of production. Unfortunately, I don't have the date to do this. What I can do is tell you what I think.

If the *i* and *j* in the equation are the same country at two different points in time – for example, the United States in the year 2000 vs. the United States in the year 1900 -- then I am pretty confident that the dominant force in rising productivity is changing technology. The reason is that we have abundant evidence of technology getting better over time. In the case of efficiency, I am not even sure whether the trend in the US over the last 100 years has been positive or negative.

When it comes to differences among countries (that is, if I consider *i* and *j* to be two countries at a single point in time), I think that the dominant source of variation is efficiency. The reason is that productivity differences that we observe are just really large. In the figure that I showed earlier, average productivity in the bottom quintile of countries was only one-quarter of the US level. It is hard

to attribute a significant fraction of that gap to technology, given how easily technology crosses national borders. To give an example, if even half of the gap in productivity between India and the United States were due to technology, it would imply that India was using technology that was, on average, 75 years behind the level of the United States.[5]

So what are the determinants of efficiency, and why is production in some countries so much less efficient than in others? I can give a very partial list here,

- Institutional framework (functioning of the legal system, property rights, corruption, etc.)
- Barriers to mobility of people or productive factors among regions – so factors are not used where they are most productive.
- Trade restrictions (legal or physical) that prevent countries from exploiting comparative advantage
- Monopolies – lead to misallocation of factors among firms and also to wasteful expenditures of resources to protect rents.
- Government ownership of firms – often leads to excessive employment
- The functioning of the financial system, and how good a job it does of directing capital to its most productive uses.

In all of these cases, both economic theory and microeconomic evidence point to a link with efficiency. But right now research is not far enough along to know what factors are most important in determining efficiency differences among countries.

Now, if it sounds like I am saying that poor countries are full of inefficiencies and rich countries are not, let me clear: my view is that rich countries have plenty of inefficiencies. Think about US residential investment over the last few years, or the Japanese retail industry, or labor market regulation in Europe, for example. It is simply that poor countries have even more inefficiencies than do rich countries.

I also want to point out that many of the factors listed here that affect efficiency also affect output through the channel of factor accumulation. For

[5] Weil (2008), Chapter 10.

example, if a government does a poor job of protecting property rights, that contributes to inefficiency directly, because it leads to inefficient forms of production. But poor property rights also discourage the accumulation of physical capital, and governments that function poorly usually don't do a good job of investing in human capital.

I want to conclude by drawing the link from the framework as I have laid it out, which is in terms of the *level* of income, and economic growth, which was in the title of my talk.

The link between the two is the concept of the steady state level of income. The steady state is the level of income toward which a country is moving, and it is a function of the level of productivity (and thus technology and efficiency and all the things that determine productivity) and the rates of factor accumulation, such as the savings rate. Growth is a positive function of the gap between steady state income and the current level of income. The speed with which income catches up to its steady state level depends on the lags in factor accumulation that I discussed above.

Now consider what happens when a country does something "good for growth," for example reforming an inefficient institution. There is an instantaneous change in the steady state level of income, followed by a period of transitional growth as the country moves toward its new steady state. In the new steady state, growth will not be any higher than it was prior to the reform. So being "good for growth" really means being good for the *level* of income in the long run and good for *growth* in the short run. However, the short run over which transitional growth may be important lasts for many decades.

References

Weil, David N., *Economic Growth*, Second Edition, Boston: Addison-Wesley, 2008. (Spanish Translation: *Crecimiento Economico*, Pearson, 2007).