Welcome to The Power of Macroeconomics. The purpose of this lesson is to examine how and why nations grow and prosper
When you read the daily business news it is dominated by reports of stock price fluctuations, the monthly unemployment and inflation rates, trade statistics and speculation about whether the Federal Reserve will raise interest rates.

But as important as these events are for job hunters or investors, they are only small ripples on the longer wave of economic growth.
Year in and year out, advanced economies, like the United States, accumulate larger quantities of capital equipment, push out the frontiers of technological knowledge and become steadily more productive.
Over the long run of decades and generations, living standards, as measured by output per capita, or consumption per household, are primarily determined by the level of productivity and growth of a country.
In this lecture, we are going to examine the complicated process of economic growth. In doing so, we will not only come to better understand the critical role that productivity plays in this process. We will also gain some valuable insights into both how and why government policies play a critical role in the growth process. So let's start our journal now with a simple definition.
Economic growth represents the expansion of a country's potential GDP or national output.

And a closely related concept is the growth rate of output per person. This determines the rate at which the country's standard of living is rising.
So what is the recipe for such economic growth?
To begin with, successful countries need not follow the same path. Britain, for example, became the world economic leader in the 1800s by pioneering the industrial revolution, inventing steam engines and railroads, and emphasizing free trade.
Japan by contrast came to the economic growth race later. It made its mark by first imitating foreign technologies, and protecting domestic industries from imports. And then by developing tremendous expertise in manufacturing and electronics. However, even though their specific paths may differ, all rapidly growing countries share certain common traits.

The same fundamental process of economic growth and development that helped shape Britain and Japan is at work today in developing countries like China and India.
Indeed, economists who have studied growth have found that the engine of economic progress must ride on the same four supply side wheels, no matter how rich or poor the country.

These four wheels, or supply factors of growth, are, human resources, including labor supply. Education, discipline and motivation.
Natural resources including land, minerals, fuels and environmental quality.
Capital formation including machines, factories and roads.

And technology from science and engineering to management and entrepreneurship. Let's look at each of these four supply side factors individually now.

Labor inputs include, of course the quantity of workers. However, many economists believe that the quality of labor inputs, the skills, knowledge, and discipline of the labor force, is the single most important element in economic growth.

A country might buy the most modern telecommunications devices, computers, electricity generating equipment, and fighter aircraft. However, these capital goods can be effectively used and maintained only by skilled and trained workers. Improvements in literacy, health, and discipline, and most recently, the ability to use computers, add greatly to the productivity of labor.

The second supply factor or production is natural resources. The important resources here are, arable land, oil and gas, forests, water, and mineral resources.

Some high income countries like Canada and Norway, have grown primarily on the basis of their ample resource base. With large outputs in agriculture, fisheries, and forestry. Similarly, the United States with its temperate farmlands is the world's largest producer and exporter of grains. But the possession of natural resources is hardly necessary for economic success in the modern world.

New York City prospers primarily on its high density service industries. While many countries that have virtually no natural resources, such as Japan, have thrived by concentrating on sectors that depend more on labor and capital than on indigenous resources.

The third supply factor of growth is capital formation. Tangible capital includes structures like roads, and power plants, and equipment, like trucks and computers. In this regard, some of the most dramatic stories in economic history, often involve the rapid accumulation of capital.

For example, in the 19th century, the transcontinental railroads of North America brought commerce to the American heartland, which had been living in isolation. While in the 20th century, successive waves of investment in automobiles, roads, and power plants, increase productivity, and provided the infrastructure which created entire new industries.

Note, however, that accumulating capital requires a sacrifice of current consumption over many years. Countries that grow rapidly, tend to invest heavily in new capital goods.

In the most rapidly growing countries, 10 to 20% of output may go into capital formation.

In this regard when we think of capital we must not concentrate only on private sector investment. In fact, many investments are undertaken only be governments, and provide the necessary social overhead capital and infrastructure for businesses to prosper. Roads, irrigation and water projects, and public health measures are important. All these involve large investments, that tend to be indivisible, or lumpy, and sometimes have increasing returns to scale.

These projects generally involve external economies or spill-overs, that private firms cannot capture. So the government must step in, to ensure that they are effectively undertaken.

In addition to the three supply factors discussed above, technological advance has been a vital fourth ingredient in the rapid growth of living standards. Historically, growth has definitely not been a process of simple replication, adding rows of steel mills, or power plants next to each other. Rather, a never-ending stream of inventions and technological advances led to a vast improvement in the production possibilites of Europe, North America, and Japan.

Technological change denotes changes in production processes or the introduction of new products or services. Process inventions that have greatly increased productivity were the steam engine, the generation of electricity, the internal combustion engine, the wide bodied jet, the photocopier machine, and the fax machine. Fundamental product inventions include the telephone, the radio, the airplane, the phonograph, the television, and the VCR. Today the most dramatic technological developments are occurring in electronics and computers. Where tiny notebook computers can now out perform the fastest computer of the 1960s. These inventions provide the most spectacular examples of technological change. But technological change is a continuous process of small and large improvements.

This is witnessed by the fact that the United States issues over 100,000 new patents annually. And there are millions of other small refinements that are part of the routine progress of an economy. While the four supply factors of growth relate to the physical ability of the economy to expand, there are two other factors that are equally important. First, there is the demand factor.

To realize its growing production potential, a nation must fully employ its expanding supply of resources. This requires a growing level of aggregate demand.

Second, there is the efficiency factor. To reach its production potential, a nation must not only achieve full employment, but also two kinds of economic efficiency.

Specifically, a country must achieve productive efficiency. That is, it must use its existing and new resources in the least costly way to produce what it does. And it must also achieve allocative efficiency, meaning that the specific mix of goods and services it produces must maximize society's well-being. An idea developed more fully in microeconomics.

Now, we can illustrate how the six factors of economic growth interact using the following production possibilities curve. Here we see that a country starts at point A. Then growth is made possible by the four supply factors which shift the production possibilities curve outward. As from A-B to C-D. But economic growth is realized only when the demand and efficiency factors move the economy from point A to point B. This table summarizes the results of one of the most famous studies ever conducted in economics. The study was done by Edward Denisen. He estimated what percentage of annual U.S. growth between 1929 and 1982 was accounted for by each factor listed

in the table. Here, we see quite clearly that productivity growth has been the most important force underlying the growth of U.S. real output and income. In particular, while item one shows that 1 3rd of the increase in real output occurred because of increases in the quantity of labor, item 2 indicates that the remaining 2 3rds was due to increases in labor productivity. Now here is where this table really gets interesting, because it helps answer this question.

Which factors of growth have been most instrumental in increasing labor productivity? Clearly, the quantity of capital, more education and training, economies of scale and production, and improved resource allocation, have all been important. However, the most important factor, accounting for a full 28% of increased productivity, has been technological advance. Just as our growth theory suggested. And by the way, you should note that the eighth category is a negative number. It estimates the negative impact that legal and regulatory constraints have had on productivity and growth.

Now that we have identified the various factors that determine economic growth, let's to turn to a discussion of their relative importance. And here there is much controversy. While some economists and policy makers stress the need to increase capital investment, others advocate measures to stimulate research and development and technological change. Still a third group emphasizes the role of a better educated work force.

To better understand this controversy, it is useful to trace the history of growth theory. Early economists like Adam Smith and Thomas Malthus stressed the critical role of land in economic growth.

The Wealth of Nations, published in 1776, Adam Smith provided a handbook of economic development. He began with a hypothetical, idyllic age. That original state of things, which precedes both the appropriation of land and the accumulation of capital stock. This was a time when land was freely available to all and before capital accumulation had begun to matter.

What would be the dynamics of economic growth in such a golden age? Because land is freely available, people simply spread out onto more acres as the population increases, just as the settlers did in the American west. because there is no capital, national output exactly doubles as population doubles. What about real wages? Wages earn the entire national income, because there is no subtraction for land rent or interest on capital. Output expands in step with population, so the real wage per worker is constant over time.

But this golden age cannot continue forever. Eventually, as population growth continues, all the land will be occupied. Once the frontier disappears, balanced growth of land, labor and output is no longer possible. New laborers begin to crowd onto already worked soils. Land becomes scarce and rents rise to ration it among different uses.

Population still grows and so does the national product. But output must grow more slowly than does population. Why? Because of an immutable law known in economics as the law of diminishing returns.

It's a law discussed much more fully in microeconomics, however in this context it is an easy law to explain. Specifically, with new laborers added to a fixed supply of land each worker now has less land to work with. This increasing labor to land ratio means that, at some point, the extra or marginal product of each additional worker must begin to decrease. And so, too, must the workers real wages because of this decline in productivity.

How bad could get things get? The Dower Reverend Thomas Malthus thought that population pressures would drive the economy to a point where workers were at a minimum level of subsistence. In particular, Malthus reasoned that whenever wages were above the subsistence level, population would expand. While below subsistence wages would lead to high mortality and population decline.

Therefore, Malthus reasoned, only at the level of subsistence wages could there be a stable equilibrium of population. And in this world, Malthus believed that the working classes would be destined to a life that, in the words of the philosopher Thomas Hobbes, would be nasty, brutish, and short. In fact it was this gloomy Malthusian picture that lead to the critical depiction of economics as the dismal science.

These figures contrast the process of economic growth in Adams Smith's golden age, versus the Malthusian gloom. In the left hand figure as population doubles the production possibility frontier or PPF shifts out by a factor of two in each direction. Showing that there are no constraints on growth from land or resources.

In contrast, the right-hand figure shows the pessimistic Malthusian case where a doubling of population leads to a less than doubling of food and clothing. Lowering per capita output as more people crowd on a limited land and diminishing returns drive down output per person.

The ultimate result can be seen in these figures. In the left-hand figure we see the red line rising exponentially past both straight line projections for wheat and barley and oat production into a Malthusian doomsday. The right-hand figure shows how bushels per capita decline over time due to diminishing returns.

Fortunately, Malthus' dismal forecast was dramatically wide of the mark because Malthus did not recognize that technological innovation and capital investment could overcome the law of diminishing returns.

As a result, land did not become the limiting factor in production. Instead the industrial revolution brought forth power driven machinery that increased production. Factories that gathered teams of workers into giant firms. Railroads and steamships that linked together the far points of the world. And iron and steel that made possible stronger machines and faster locomotives. Moreover, as market economies entered the 20th century, important new industries grew up around the telephone, the automobile, and electric power. While capital accumulation and new technologies became the dominant force effecting economic development.

To understand how these twin forces of capital accumulation, and technological change can affect an economy, it is helpful to understand the so-called neoclassical model of economic growth.

This approach was pioneered by Professor Robert Solow of MIT. Who was awarded the 1987 Nobel Prize for this and other contributions to economic growth theory.

The major new ingredients in Solow's neoclassical growth model are, capital and technological change. The approach of this growth model is to use a tool known as the Aggregate Production Function, or APF, which relates technology and inputs like capital and labor, to total potential GDP. We need not get deeply into the mechanics of this APF model here, but it is very useful to first understand the underlying principle of the Neoclassical Growth Model, and then understand three of its major insights.

The basic underlying principal of the Neo-Classical growth model is what economists call Capital Deepening. This is the process of increasing the amount of capital per worker.

Examples of Capital Deepening include more farm machinery and irrigation systems in farming. More railroads and highways in transportation. And more computers and communication systems in banking.

In each of these industries societies have invested heavily in capital goods. And as a result, the output per worker has grown enormously in farming, transportation, and banking.

The first major insight of the model is that in the absence of technological change, capital deepening does not lead to a proportional increase in output. Can you think why this might be true?

The reason why capital deepening does not lead to a proportional increase in output, is the law of diminishing returns. With this law not apply the land, mind you, as in the Malthusian case, but rather, in this case, apply the capital.

The basic idea is that as you add more and more capital to a fixed supply of labor, eventually the marginal product of capital must fall as the law of diminishing returns kicks in.

The second major insight of the neoclassical growth model is that while capital deepening can dramatically increase the productive output of an economy, it will eventually lead to economic stagnation in the absence of technological change. To understand this important point we have to answer this question. What happens to worker wages and the return on capital as a result of capital deepening? What do you think the answer is? For workers the news is good. The wage rate paid to workers will tend to rise as capital deepening takes place. Why? Because each worker has more capital to work with and his or her marginal product therefore rises. As a result the competitive wage rate rises along with the marginal product of labor.

However, for the owners of capital, the news is less satisfying. As capital deepens, diminishing returns to capital set in. So, the rate of return on capital and the real interest rate fall.

What this means, of course, is that in the long run, the economy will enter a so-called steady state in which capital deepening ceases as the capital labor ratio stops rising. This is because

even as capital deepening is driving real wages up, the returns to capital are falling, so that at some point, further investments in capital deepening become unprofitable.

At this point, the economy enters a steady state in which, without technological change, both capital incomes and wages end up stagnating. Now this is certainly a far better outcome than the nasty and brutish world of subsistence wages predicted by Malthus. Nonetheless, the long run equilibrium of the neoclassical growth model, makes it clear that if economic growth consists only of accumulating capital through replicating factories with existing methods of production, then people's standard of living will eventually stop rising. And that's why we must come to understand the importance of technological change in averting this fate, as modern economies in this century have so obviously done.

This leads to the third major insight of the neoclassical growth model. It is ultimately only through technological change that we can avoid the trap of economic stagnation. Technological change represents both advances in production processes, and the introduction of new and improved goods and services. It also includes new managerial techniques, as well as new forms of business organizaton.

For example, gas in diesel engines, conveyor belts, and assembly lines were significant developments of the more distant past.

While more recently we have bigger, faster and more fuel efficient aircraft, Integrated microcircuits, computers, xerography, containerized shipping, and the internet, not to mention biotechnology, lasers, and superconductivity. This figure uses the concept of the aggregate production function that we have discussed earlier to illustrate the differing roles that capital deepening and technological change play in economic growth. On the horizontal axis, capital deepening is measured by capital for worker, while output per worker is represented on the vertical axis and represents the upward march of economic growth. Now here is where things get a little complicated. The gray line represents the aggregate production function for the technology available in 1950.

It traces the pace of economic growth, that would occur because of capital deepening, holding the technology constant. Similarly, the red line represents the aggregate production function for the technology available in 1995. Now, if you can answer these next two questions, you've understood the neoclassical growth model. How is technological change represented in the figure? And, how might we measure the total effect of capital deepening, and technological change on growth? In this case, technological change is represented in the figure by an upward shift of the APF curve. From the gray line, to the red line that is, from APF 1950 to APF 1995.

This upward shift shows the advances in productivity that are generated by the vast array of new processes and products, like electronics, computers, advances in metallurgy, improved service technologies, and so forth. As for how we measure the total effect of capital deepening, and technological change on growth. One way to do it is simply by using the arrow in the figure. It indicates the increase in output per worker from q divided by

l1950, to q divided by l1995. More broadly, the good news in the figure, is that instead of settling into a steady state of economic stagnation, the economy enjoys rising output per worker, rising wages, and increasing living standards, even as the returns to capital rise as well.

Is more growth always good? And, if so, what demand and supply side government policies might be used to improve productivity and growth?

Increased economic growth increases our wages and our standard of living. But, there are some major disadvantages of rapid growth that have been noted by many economists.

Indeed critics of growth say it results in dirtier air, a dying ocean, global warming, ozone depletion and other environmental problems. Such critics also point out that while growth may permit us to make a better living it does not guarantee us the good life in this sense. Growth often means worker burnout and alienation. And accompanying health problems. Not just for assembly line workers. But in the high stress managerial ranks as well. These are all fair comments.

But one important distinction to make in talking about the merits of growth is between economic growth and population growth. In this regard, congested neighborhoods, crowded cities, and gridlocked freeways are often the consequence of too many people, not too many goods and services.

This observation brings us back to the really essential measure of growth, GDP per capita, and the underlying question of whether there are really any serious grounds for desiring less GDP per person. And a reduced standard of living. From this perspective, let's turn now to our final question. How might the government use public policy to stimulate growth? From the demand-side of the equation. Low growth is often the consequence of inadequate aggregate demand and the result in recessionary gap.

And both fiscal and monetary policies can be used to address this problem. For example, monetary policy, which provides low real interest rates, helps promote high levels of investment spending. While a fiscal policy, which eliminates budget deficits, can reinforce this easy money policy. Having said this, when economists think about ways to stimulate productivity and growth, they are more often thinking about the supply side of the equation.

A major reason is that, as we have learned, policies which can successfully shift the economy's supply curve out, do so with the twin advantages of both lower unemployment and lower inflation.

Let's use what we have learned then about growth theory and the various factors of growth to guide us through some supply side policy options. First, we know that productivity increases as the ratio of capital to labor increases. And to boost the capital labor ratio we must accelerate the rate of investment in new plant and equipment. In fact the current U.S. tax code offers a variety of incentives to stimulate investment, including accelerated depreciation, tax credits for new investments, and lower business tax rates.

The second way to increase productivity is to improve the quality of our human capital, that is, our labor force and its managers. In this category, policy options range from tuition tax credits and

expanded student loans to job retraining programs and a focus on lifetime-learning.

A third way to increase productivity is to, accelerate the rate of technological change, because such change allows us to produce more goods and services from a given amount of resources.

Here the policy options are very similar to those for increasing investment in new plant and equipment. Namely, tax incentives.

In this regard, an increase in the rate of investment in new plant and equipment works hand in hand with increased R&D. Because it speeds the diffusion of new technology and accelerates the rate of productivity gains.

Fourth way to increase the rate of productivity growth is to raise the level of investment in public infrastructure. Just as new plant and equipment help workers produce more, so to does modern infrastructure help businesses produce more.

This means that in the quest to balance its budget, the United States must be careful not to ignore appropriate investments in basic infrastructure. Bridges and airports to smart roads and the information superhighway. Indeed, as President Clinton once remarked during his administration, deficit reduction at expensive public investment has been and will continue to be self-defeating.

More broadly, many of the factors that determine productivity growth, will be enhanced by in increase in the domestic savings rate. This is because increased saving ultimately helps provide the funds necessary to invest in new plant and equipment, human capital, research and development, and public infrastructure. At present, the US has one of the lowest savings rates of any of the industrialized nations. And policy options to address this problem include such things as expanded tax preferences for individual retirement accounts and other pension funds. Well that concludes our discussion of growth and productivity. In the next lecture we tackle the thorny problem of budget deficits. In the meantime, please remember that economics is not something to be memorized, but rather something to conceptualize. Did you study it? Think about it, too. Your job and your business might just depend upon it.