CHAPTER 3: A BRIEF HISTORY OF ECONOMIC DEVELOPMENT

I. The Age of Modern Economic Growth

The world we've seen is divided – startlingly so – with 55 high-income economies (1.3 billion people), 103 middle-income countries (4.9 billion people), and 36 low-income countries (0.8 billion people). How did these vast differences across the world come about? How is it that there are countries like the United States at more than $50,000 dollars per person per year of income, and countries like Niger at under $500 dollars per person per year, less than 100th the income levels of the high-income countries when measured at market exchange rates? This huge gap certainly did not exist two centuries ago.

Just before the great takeoff of modern economic growth – before the start of the Industrial Revolution around 1750 – the world was fairly equal in income levels. To be more precise, the world was nearly equal in its poverty. Just about every part of the world was rural, with smallholder peasant farmers trying to eke out a survival for their families. A bad harvest could mean famine and death in any part of the world. Today's rich countries in Europe were certainly not exempt, as the hunger that fueled the French Revolution demonstrates.

The story of today's inequality therefore is also the story of the era of modern economic growth, the period since the start of the Industrial Revolution. It is only in this period that some parts of the world experienced sustained increases of gross domestic product per person over long stretches, and thereby transformed themselves from rural to urban, from peasant agriculture to high-yield agriculture, and from cottage industry (e.g. spinning and weaving) to modern industry and by now to a modern high-tech, knowledge-intensive industrial and service economy. It is only in this modern period of roughly 250 years that the vast gaps in income between the rich and the poor opened up.

How did this happen? And why did modern economic growth take off early only in some places in the world? If all countries started poor, why did some get rich while others were left behind? We need to understand the nature of modern economic growth and why it has varied so much across the world. And as sustainable development is also a set of goals including the end of poverty, we must consider what can be done to unlock rapid economic growth in today's low income and especially in the Least Developed Countries.

This takeoff of modern economic growth is a new event from the point of view of the long haul of human history. Our modern species, Homo sapiens, have been around for roughly 150,000 years. Our civilization, based on settled agriculture, is roughly 10,000 years old. During almost all of that period, economic change was so gradual that life seemed unchanged from one generation to the next, aside from wars, famines, and other temporary shocks. The idea of sustained economic progress simply did not exist. There was no evidence for it.

We can see that very starkly in the depiction in Figure 3.1 (as best it can be estimated) of the growth of the world economy over the very long haul of human history from 1 AD. The estimate of the total world output is essentially flat for almost 1,800 years (and would be flat for even longer if we went back further in time). The economic takeoff begins around 1750, and then world output shoots up sharply and dramatically. That steep upward sloping line, looking almost vertical in recent years, continues upward today because the world economy is growing very strongly today, though at different rates in different parts of the world.

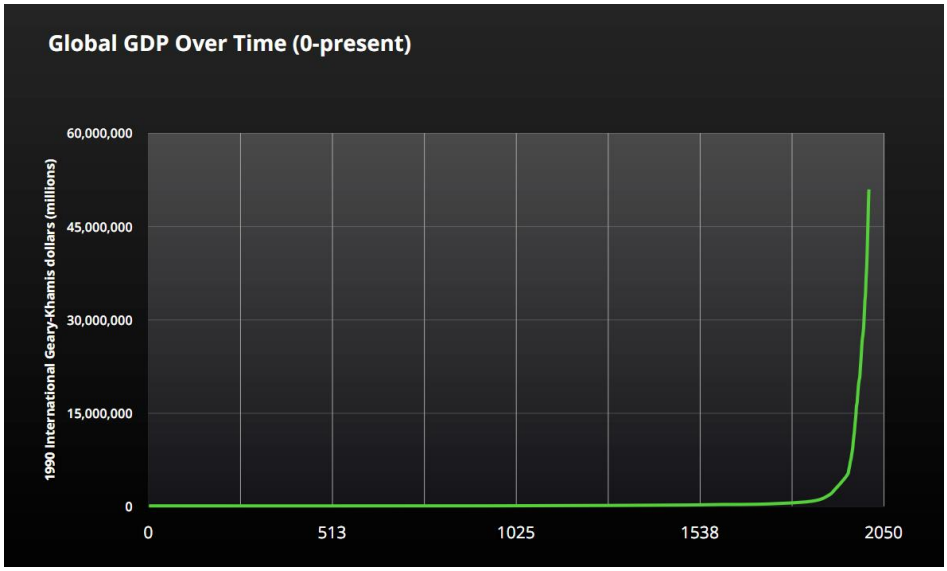


Figure 3.1. Global GDP Over Time (0AD-Present)

The total output of the world, which is the sum of the gross domestic product in each country, has two parts. One is the GDP per person in the world, and the other is the world population. The product of the two gives us total world output. Was the world economy's takeoff around 1750 due to rising output per person, or was it due to a rise in the number of people? In fact, both factors have played a huge role. The world population was fairly stable for thousands of years, below half a billion people at the time of the Roman Empire, though of course with significant fluctuations such as during bad periods like the Black Death. Starting in the middle of the 18th century the world population turned steeply upward, as Figure 3.2 shows. This population increase was largely enabled by changes in economic and technological know-how, most importantly in the ability to grow food and thereby sustain a larger global population.

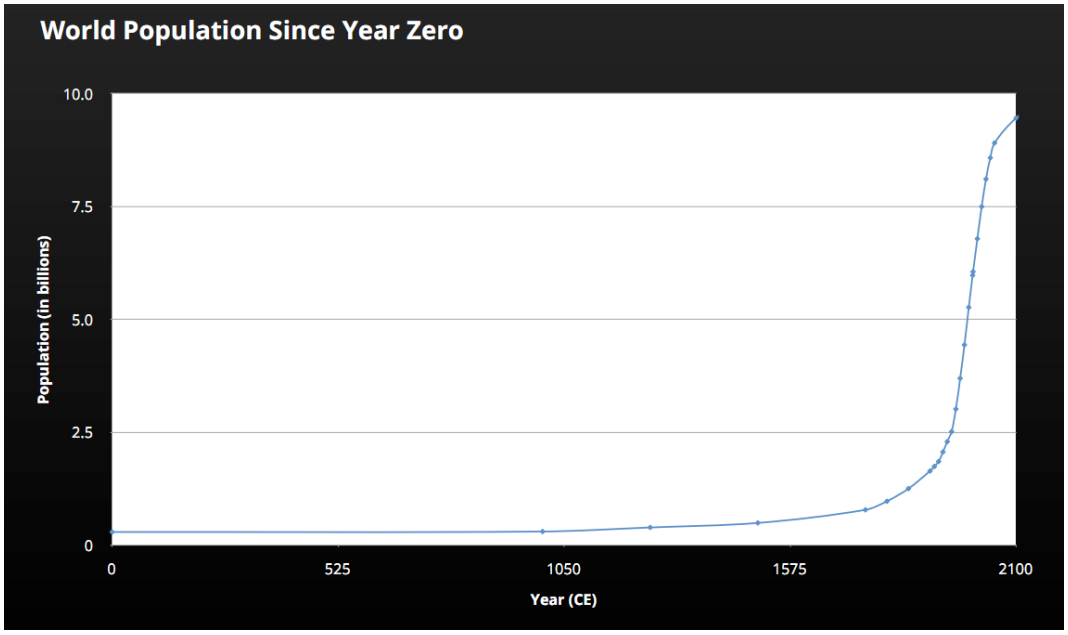


Figure 3.2. World Population Since Year Zero

Output per person also soared, starting at roughly the same time (the onset of the Industrial Revolution). The graph in Figure 3.3 of world output per capita is also nearly flat for centuries. If there was a long-term rise in output per person, the progress that occurred over decades, even over centuries, were nearly imperceptible before the middle of the 18th century. Only then did output per person begin its steep climb.

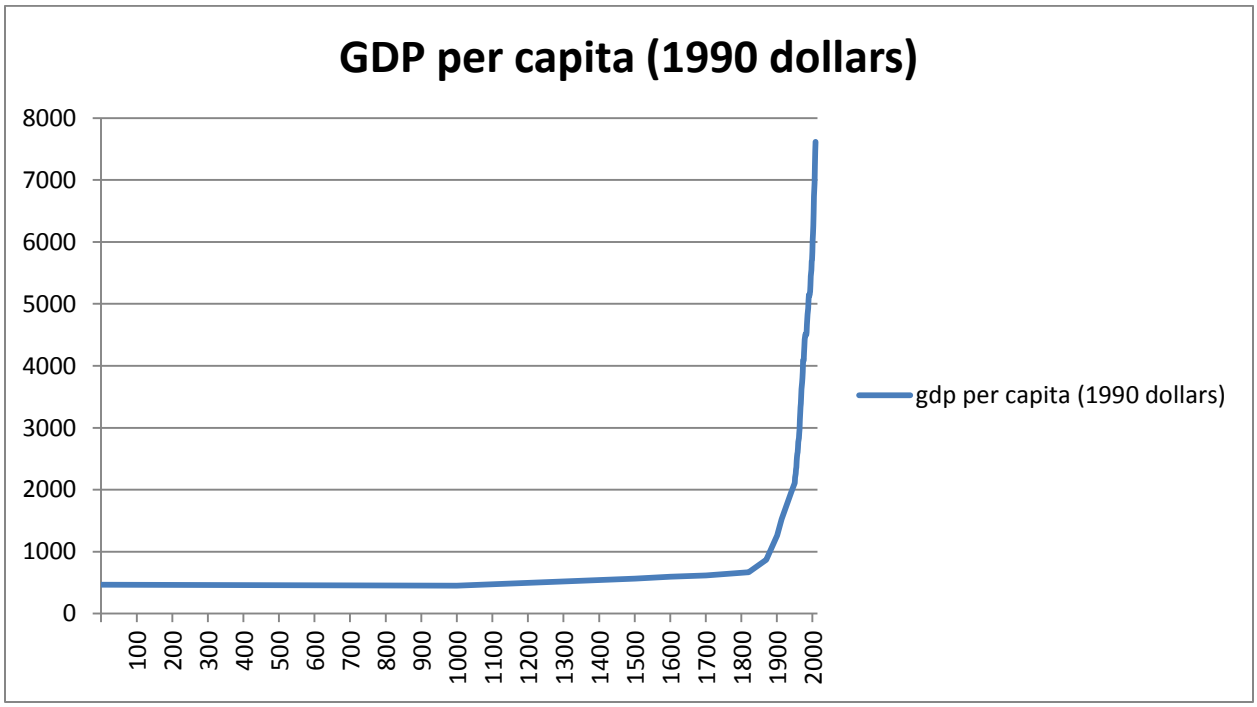


Figure 3.3. Global GDP Per Capita

These numbers are of course rough estimates, the best possible reconstructions using various kinds of evidence. The world before 1750 was a world of poverty; one that could nonetheless produce beautiful treasures for human history, like the Egyptian pyramids, the Acropolis, the Great Wall of China, the Hagia Sophia in Constantinople, and the Notre Dame Cathedral. Yet for all of those grand monuments, most people in most ages lived difficult rural lives, always on the edge of famine, disease and early death.

One of the greatest economists of modern history, the British economist John Maynard Keynes, wrote a quite remarkable description of this long period of near stasis from the time of the Roman Empire until the onset of the Industrial Revolution. Keynes wrote:

> From the earliest times of which we have the record, back say to 2000 years before Christ, down to the beginning of the 18th century there was no very great change in the standard of life of the average man living in the civilized centers of the earth… This slow rate of progress, or lack of progress, was due to two reasons – to the remarkable absence of important technical improvements and to the failure of capital to accumulate. The absence of important technical inventions between the prehistoric age and the comparatively modern times is truly remarkable. Almost everything which really matters and which the world possessed at the commencement of the modern age was already known to man at the dawn of history. Language, fire, the same domestic animals which we have today. Wheat, barley, the vine and the olive, the plow, the wheel, the oar, the sail, leather, linens and cloth, bricks and pots, gold and silver, copper, tin and lead – and iron was added to the list before 1000 B.C. – banking, statecraft, mathematics, astronomy, and religion.[1]

Keynes' point is that technology is crucial for the long haul of economic development. For a very long period of history, technology was relatively unchanging, so much so that farmers in Roman times and in early 17th century England would have experienced similar conditions: the same techniques, similar living standards, a world little changed over a span of 17 centuries!

Then, dramatically, everything changes. The curves of population, output per capita, and technological advancement, start soaring out of sight. That is our next subject to understand, how the Industrial Revolution began and how it changed human history and human destiny.

II. The Industrial Revolution Begins in England

Modern economic growth began in England. This unique phenomenon started in one particular place on the planet. We can watch it and therefore we can understand how this came about. It is a bit like a biologist being able to watch the start of life itself. Life as we know it appeared just once, and from there it has evolved. Modern economic growth also has a kind of DNA. It also came together from a

[1] John Maynard Keynes, "Economic Possibilities for our Grandchildren."

number of different materials, and something took off. This was an extraordinarily unusual occurrence that happened in England in the middle of the 18th century. If it were so easy to create economic life, it would have happened in many places. But as Keynes rightly pointed out, this did not happen. What happened in the middle of the 18th century in England was a unique coming together of various forces that allowed economic life to take off and eventually spread to the entire world economy.

What is it about the Industrial Revolution? We can take a hint from the word *industry* itself. For the first time a society moved beyond agriculture as the economic base to one in which industry was the economic base. This required a fundamental change of know-how and technology. Just as life depends on the complex interactions of many components of a living cell, so too, the life of a modern economy requires the interactions of many parts. New technologies – the steam engine, mechanized spinning and weaving, large-scale steel production – were certainly vital, but many complex economic interconnections were needed as well. Rural areas needed higher food productivity to produce a surplus for the industrial workforce (which obviously was no longer growing its own food). Transport was needed to carry food from farms to industrial towns and industrial goods, such as linens and apparel, from the factories to the countryside. New ports and global shipping carried manufactured goods abroad as exports, to be traded for the primary commodities needed for industrial production. A worldwide supply system began to take hold. And these increasingly complex transactions required markets, insurance, finance, property rights, and other "software" and "hardware" of a modern market-based economy.

Thus, the emergence of modern economic growth reflected the unique confluence of several factor, and England was the place where these factors first aligned. One sees several notable things happening in the 1600s and 1700s in England, including many social and technical innovations imported from the Netherlands, across the North Sea. First, agricultural productivity started to rise. There was more urbanization. More trade. A more sophisticated market economy began to take hold. Property rights deepened in complexity and flexibility (e.g. in the formation of new companies or the protection of patents for new discoveries). The rule of law deepened. And of course there was the wonder of the Scientific Revolution of the 1500s and 1600s. Galileo had paved the way for a new physics, and opened the path for the incredible discoveries of perhaps the greatest physicist of all time, Isaac Newton. Newton changed the way that humanity looked at the world, in terms of timeless and discoverable laws of nature. Sir Francis Bacon, writing ahead of Newton, predicted that science and technology could dramatically transform the world for human benefit. In this, he proved among the most prescient thinkers of history.

One of the great technological breakthroughs came in 1712, with the invention of a steam engine by Thomas Newcomen. Newcomen's new invention burned coal to create motive force that could be used to pump water out of the shafts of coal mines. And then came a wonderfully creative and fiercely targeted genius, who realized that Newcomen had, however, made a couple of design mistakes. James Watt, working in a Glaswegian university lab, improved upon Newcomen's steam engine; and the Watt steam engine came to life in 1776. From a technological point of view, this was the most important breakthrough of the industrial era, and the technological trigger of most that followed. It was now

possible to harness massive amounts of coal-powered energy efficiently and economically. James Watt was after profits and the patent; his aims included intellectual property, glory, and riches. He was working in an environment in which he could succeed, because the beginnings of commercial law existed in England, as opposed to many other places on the planet where such property rights had not yet been recognized.

These are some of the components that uniquely came together in England. And for all of the genius of Newcomen and Watt, if there had been no coal and iron ore in England, there never would have been a steam engine or Industrial Revolution! The coal and iron ore deposits were also transportable, thanks to the favorable transport conditions in England via rivers, canals, and roads. Topography, river ways, canals, ports, and mineral deposits therefore all helped, in combination with market incentives, rule of law, and a scientific outlook fostered by great universities. These are the special conditions – nature and nurture one can say – that converged in mid-18th century England to make possible the Industrial Revolution.

The first individual to describe this phenomenon was Adam Smith, the author of *The Wealth of Nations* and rightly known as the father of modern economics. He published *The Wealth of Nations* in 1776, the same year James Watt produced modern steam engine, the American colonies declared their independence, and Edward Gibbon published *The Decline and Fall of the Roman Empire*. Quite a year for a takeoff! Adam Smith was the first economist to explain the workings of a modern economy in terms of specialization and the division of labor. He gave us the idea of the Invisible Hand, by which individuals acting out of their own narrow self-interest, trading in the marketplace, bring about a rise in productivity and therefore the "wealth of nations." As one of Smith's many wonderful observations in *The Wealth of Nations* explains:

> It is not from the benevolence of the butcher, the brewer or the baker that we expect our dinner, but from their regard to their own interest. We address ourselves not to their humanity, but their self-love and never talk to them of our necessities but of their advantages.

In other words, it is the motivation of meeting our own wants and needs, via market transactions, which gives rise to the division of labor and the workings of the modern economy.

We also know the images of the early modern industrial era created by James Watt's steam engine: new factory towns with the massive coal burning and smoke pouring out of the new high chimneys. Factories that until recently had been powered by human or animal traction, or by wind and water, could now operate with vastly more powerful steam engines. The scale of industrial activity began to soar.

Figure 3.4. Industrial Factories

The steam engine of course made possible new forms of transport as well, including steam-powered railroads and steam-powered ocean freighters. The far greater energy also allowed a far greater scale of industrial transformation of materials than ever before. The production of steel soared, and this in turn made possible the massive expansion of cities, industries, and infrastructure of all kinds.

The transformation of life was dramatic, and often traumatic. One of the fiercest critics of the harshness of early industrialization was of course none other than Karl Marx. Marx and his co-author Friedrich Engels wrote *The Communist Manifesto* in 1848 as a kind of ironic tribute to the power of the new industrial economy and the breakthroughs in industrial technology. Marx and Engels described this new world in vivid language:

> Modern industry has established the world market, for which the discovery of America paved the way. This market has given an immense development to commerce, to navigation, to communication by land. This development has in its turn reacted on the extension of industry and in proportion as industry, commerce, navigation, railways extended in the same proportion, the bourgeoisie, the new capitalist class developed, increased its capital and pushed into the background every class handed down from the Middle Ages.

A new world indeed had arrived, one that would overrun the old and create a new global age, in part based on European colonial domination powered by the new industrialization. As Marx and Engels famously put it:

> The bourgeoisie, by the rapid improvement of all instruments of production, by the immensely facilitated means of communication, draws all, even the most barbarian, nations into civilisation. The cheap prices of commodities are the heavy artillery with which it batters down all Chinese walls, with which it forces the barbarians' intensely obstinate hatred of foreigners to capitulate. It compels all nations, on pain of extinction, to adopt the bourgeois mode of production; it compels them to introduce what it calls civilisation into their midst, i.e., to become bourgeois themselves. In one word, it creates a world after its own image.

III. The Great Waves of Technological Change

By the early 19th century, the new era of modern economic growth was now underway. Markets and technological advance drove this process, first in a highly uneven way, and eventually to nearly the entire world (as Marx foresaw). This is the period that Simon Kuznets, the great Nobel laureate, economic historian, and conceptualizer of economic development, called the era of modern growth.

We have defined economic growth as the sustained increase of gross domestic product per person. For a global average, we sum the national GDPs to find the Gross World Product (GWP), which we divide by the world population. For more than 200 years now, the era of modern economic growth, the GWP per capita has increased on a sustained basis, though in a very uneven way across different regions of the world. A few of the world's poorest countries still have not yet achieved that takeoff of modern economic growth that other countries experienced two centuries ago.

We need to understand that global growth process. In order to do so, we need to make a quite basic distinction between two kinds of economic growth. Each one is characterized by a sustained increase of output per person, but they each have a very distinct underlying dynamic. One kind of growth is the growth of the world's technological leaders. In the early 19th century that was certainly England; in the middle to end of the 19th century, it was Germany and the United States; in the 20th century the United States was by far the most technologically dynamic country in the world. The "technological leaders" had a very particular kind of economic growth driven by relentless technological advance, in which advances in one technology tend to spur advances in other technologies as well, through new innovations and new combinations of processes. For example, after James Watt invented his improved steam engine in 1776, it was taken up in textiles, mines, steam-powered rail, steam-powered ships, steel production, and countless other areas. Each of these sectors became its own site of technological advances, which then spurred further technological breakthroughs.

Economists have given a name to this kind of growth: *endogenous growth*. "Endogenous" means something that arises from within a system, rather than from the outside. Endogenous growth means economic advancement that emerges from the internal workings of the economy. In its simplest description, a technological breakthrough raises GDP, which in turn raises the incentives for innovation more generally, since a higher GDP offers the prospect of higher profits for new products and processes. These new innovations raise GDP still further, spurring yet more innovations. And the innovations combine in novel ways, giving rise to new kinds of equipment, machinery, industry, and manufacturing techniques.

There is a second kind of economic growth, the growth of a "laggard" country that for whatever reasons of history, politics and geography lagged behind as the technological leaders charged ahead. China, for example, did not industrialize in the 19th century. At some point countries like China and today's emerging economies begin to catch up, by drawing on the technologies and organizational systems of the leaders. This kind of growth is very different from endogenous growth. It is sometimes called

"catch-up" growth. The technologies that fuel it come from outside of the economy engaged in rapid catching up. The essence of the strategy is to import technologies from abroad rather than develop them at home. It is still true that even imported technologies need to be adapted to local conditions, but they do not need to be invented and tested anew.

Catch-up growth can be considerably faster than endogenous growth. Technological leaders have tended to grow at around 1-2 percent per capita, while the fastest catching up countries (like South Korea and China) have enjoyed per capita GDP growth of 5-10 percent per annum. No technological leader has ever sustained such rapid growth rates, and no laggard country has sustained them after the point of catching up with the leading countries. Super-rapid growth is about closing gaps, not about inventing wholly new economic systems or technologies.

These two different mechanisms of growth, the first one based on continuing innovation and the second one based on closing a gap by adopting (and adapting) the technologies of those countries already ahead, are the two major ways that economic growth proceeds in the world. *The failure to recognize the fundamental differences between endogenous growth and catch-up growth has led to all sorts of confusion in the discussion of economic development.* For example the kinds of institutions that countries need in order to innovate and spur endogenous growth are typically quite different from the institutions needed to promote rapid catch-up growth. The first is based on innovation; the second on rapid adoption and diffusion of existing (though mostly foreign) technologies.

For catch-up growth, a strong role of government (as in China, South Korea, and Singapore), for example, can often be a major spur to the rapid adoption of advanced technologies from abroad. Innovation per se is not as important as the rapid development of infrastructure, and the ability to link the domestic economy with high-tech foreign companies from abroad. This can be done, for example, by enticing foreign companies to invest in high-tech production in the catch-up economy, both to serve the fast-growing home market and also to produce goods at low cost for exports to the world market.

Let us focus first on endogenous growth, the growth of the technological leaders. Economists sometimes call this a process of "dynamic increasing returns to scale" or a chain-reaction economy. Innovations spur further innovations, keeping the growth process alive, just like in a nuclear chain reaction. The basic mechanism is the following. A new innovation causes the growth of GDP. This in turn increases the purchasing power of the market for further innovations. Other potential inventors therefore scale up their own research and development (R&D) in search of profitable innovations. Some of these R&D efforts prove to be successful, increasing the GDP still further, and thereby spurring even more R&D. The process continues in a chain reaction of innovation, economic growth, and then further innovation. And the innovation process is helped by the fact that various innovations can be *combined* to produce new innovations. The Industrial Revolution, for example, began with steam power, and then with advances in steel production, and those two sectors permitted an explosion of innovation in other kinds of heavy machinery, including the railroads, ocean steamers, and eventually the breakthrough of automobiles based on the internal combustion engine.

Ever since the onset of the Industrial Revolution there have been waves of technological change, often bunched together because of the incentives of a growing marketplace and the R&D potential of combining new technologies. We speak loosely of the steam age, the age of electricity, the age of the automobile, the age of aviation, etc. There have also been many theories of these technology waves. Perhaps the most influential in economic history has been that of the Russian economist Nikolai Kondratiev, who worked at the time of the Russian Revolution and whose greatest masterwork, *The Major Economic Cycles*, was published in 1925.

Kondratiev's main idea was that economic development was propelled by waves of major technological change dating back to the Industrial Revolution. He regarded these long waves of technological change as the main drivers of economic advancement, and also as the sources of economic crisis when the growth dynamics of one cycle reach their conclusion while the next technological wave has not yet gathered force. Followers of Kondratiev today generally identify roughly four to six such long waves of technological change. One such illustrative classification, with five such waves, is shown in Figure 3.5. I would like to emphasize here that different researchers in the Kondratiev tradition come up with somewhat different timing and labels for the technology waves.

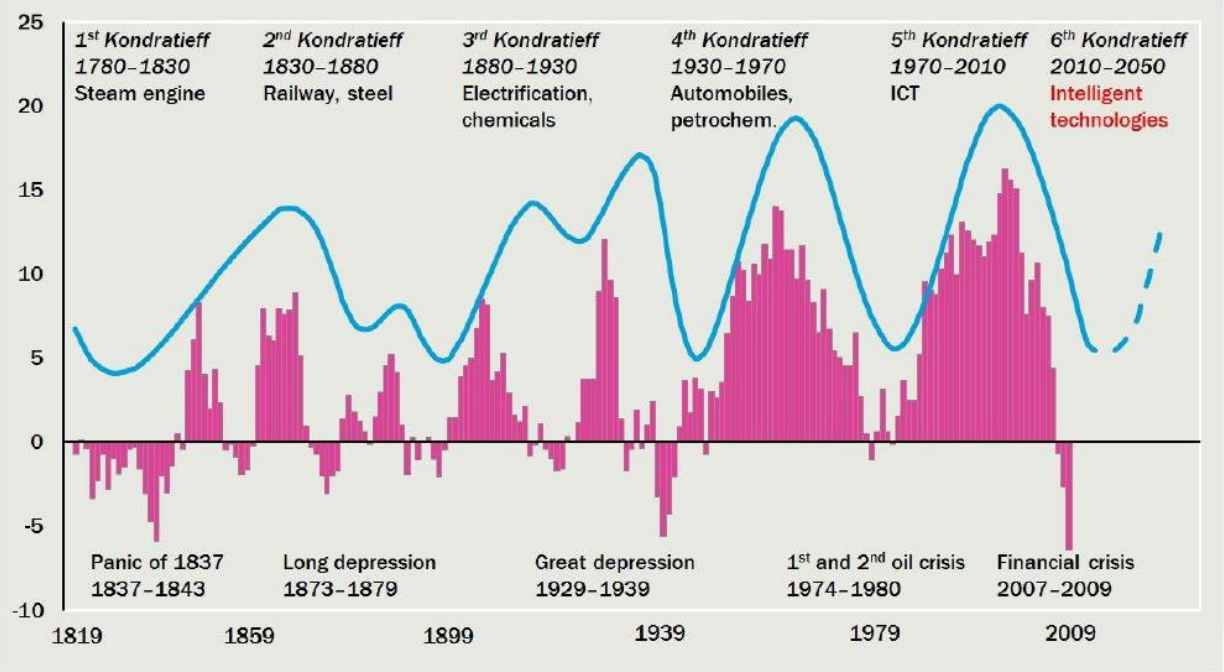


Figure 3.5. Kondratiev Waves

In the classification in Figure 3.5, the first of the "Kondratiev waves" puts the steam engine at the core, from 1780 to 1830, roughly from the time of James Watt's invention to its widespread application. This classification seems to be unimpeachable; the steam engine truly defines the first breakthrough of modern economic growth.

The second of the technological waves is the great burst of railway and steel, dating to about 1830. These are crucial applications built upon the steam engine, the growing metals industry, and the development of precision engineering. These technologies transformed national economies and the world economy by dramatically reducing transport costs, and thereby linking distant markets. Primary commodities (such as coal and ore deposits, or grain and timber production overseas) could now be profitably shipped and traded in international markets.

The third of the technology waves is the age of electricity, which itself had a few major sub-phases. Major discoveries of the physics of electricity date back to the end of the 18th century and the first half of the 19th century, to Benjamin Franklin, Michael Faraday, and the initial understanding of electromagnetism, and electro-magnetic induction. Then towards the end of the 19th century Thomas Edison, George Westinghouse and others applied the growing scientific knowledge of electricity to give us electric lighting and incandescent bulbs on city streets, and then on to electricity in homes and factories. Electricity generation through coal-fired steam turbines and hydropower created the new power-generation industry.

The fourth technological wave is put 1880 to 1930, the age of automobile, which dramatically expanded mass transport, and allowed the growth of major cities, and the chemical industry, which brought new materials, including explosives, chemical fertilizers, dyes, and eventually polymers, including plastics. One could add to this wave the age of modern aviation of the first half of the 20th century. While the underlying technologies for the automobile, including the internal combustion engine, began in the second half of the 19th century, the dramatic scale-up began in the early years of the 20th century with the Model-T in 1908, built at low cost with Henry Ford's process innovation of the modern assembly line. The mass production of automobiles and trucks deeply transformed the way we live, where we live, how we produce goods, and of course how we ship and trade goods in the economy.

The fifth wave in this classification dates to around 1970, but again, with roots that go back much earlier. This is the wave of information and communications technology (ICT) made possible by the digital revolution. Fundamentally, the digital revolution is built on the realization that complex information can be stored as 0's and 1's (bits and bytes), and that these bits of information can be processed and transmitted with unimaginable speed and precision through new inventions such as transistors (to process and store the information) and fiber optics (to transmit massive amounts of information).

The age of ICT has given rise to the new "knowledge economy," in which massive amounts of data can be stored, processed, and transmitted globally, for uses in just about every sector of the economy (education, health, finance, entertainment, production, logistics, agriculture, and much more). The invention and spread of mobile phones, and now smart phones and other handheld devices, has made the ICT revolution also a mobile revolution, where information can readily reach every nook and cranny of the planet. Combined with advances in space science, notably satellite systems, ICT is also enabling breakthroughs in geo-positioning, mapping, spatial planning, and countless other applications of geographic information.

The ICT revolution, the wave we are living through now, builds on waves of scientific and technological innovations. Intellectual giants such as Alan Turing, John von Neumann, and Claude Shannon pioneered the basic concepts of digital information and computation in the 1930s and 1940s. World War II gave a major spur to countless technologies, including semiconductors, radar, digital communications, computers, coding, and others. The invention of the transistor at the end of the 1940s was the next crucial step in the ICT revolution, and it in turn led to the concept of the integrated circuit in the late 1950s, which in turn spurred the modern computer revolution.

Beginning in the late 1950s, the newly invented integrated circuit gave rise to an imaginably dynamic process of technological advance, based on the ability to pack more and more transistors into an integrated circuit, and thereby giving rise to an upward spiral of the capacity to store, process, and transmit bits of information. In 1965, Gordon Moore, then the CEO of Intel, noted the phenomenon that the transistor count on an integrated circuit was doubling roughly every 18-24 months, and had been doing so since the late 1950s. He predicted that this doubling process would continue for years into the future. Indeed, it has continued till now, roughly 50 years since Gordon Moore first made this observation. There have been roughly 58 years of Moore's Law by now. That means around 30 doublings of transistors on an integrated circuit. Thirty doublings, or 2^{30}, equals 1,073,741,824. The capacity to manage bit and bytes of information has increased by roughly 1 billion times since the mid-1950s!

Add to that the ability to transmit that information through satellites, fiber optics, and microwave, and we have arrived at the mobile information revolution. In the 1980s, almost all telephony was carried on fixed landlines, and most of the world was still without a phone. As of 1990, there were around 50 million cellphone subscribers, all in the high-income world. As of 2014, there are roughly 7 billion mobile subscribers, and around 1 billion smartphone users, reaching into the most remote villages of the world. By 2020, almost all of the world will be within range of wireless broadband. The Internet, with its own technological marvels (such as asynchronous packet switching) and its globally shared protocols and standards, means that the world of online information is now commonly accessible (or at least potentially accessible) by nearly all parts of global society.

Will there soon be a Kondratiev sixth wave of technological change? The one we really need now is a wave of Sustainable Technologies – ways to produce and mobilize energy, to transport ourselves and transport goods, which relieve the massive human pressures and human-caused destruction of the Earth's ecosystems. Indeed, one could say that spurring this sixth wave, the wave of sustainable technology, is a core part of achieving sustainable development. We need now to promote the next great wave, of sustainable technologies. Fortunately, many of the advances and insights of the fifth wave will be helpful for the sixth. Energy efficiency, sustainable materials, nanotechnology, and breakthroughs in sustainable chemistry and food production, will all benefit enormously from the recent advances of computation science and information technology.

IV. The Diffusion of Economic Growth

We have seen how modern economic growth burst forward in England in the middle of the 18th century, and how subsequent waves of technological change have kept the process of endogenous economic growth continuing now for well over two centuries. This process describes well how the technological leaders have continued to forge new advances in economic life and transformation, and how GDP per capita has continued to rise for two centuries.

During this period, the US has been the main technological leader for well over a century, and has been near the technological forefront dating back to 1820 or so. Since that time, per capita growth of the US economy has averaged around 1.7 percent per year. This does not seem very dramatic, especially since many developing countries are achieving growth rates of up to 10 percent per year. Yet 1.7 percent per year achieved for two centuries is a great achievement indeed. The US in 1820 had a GDP per capita on the order of $2,000 measured in 2014 US dollars. With 1.7 percent growth over around 194 years, from 1820 to 2014, the US economy has expanded by a factor of roughly 26 times. Thus, the economy of $2,000 per capita in 1820 is now an economy of around $52,000 per capita. (Note that 1.017, which is 1 plus the growth rate, taken to the 194^{th} power, equals 26.3.)

But economic growth has another crucial dimension. For most of the world economic growth has been about catching up with the technological leaders. This second type of growth might also be called a process of *diffusion,* because diffusion means that something spreads from one place to another. Think of the ripples in the pond when you throw a stone, moving away from the center place where the stone hits the water. If the point of contact of the stone and the pond is where the endogenous technological growth is taking place, the ripples signify the diffusion of those technologies – and the modern economic growth that goes along with them – to more and more of the world.

How does that ripple effect work? Why is it that some places in the world are able to follow a technology leader pretty close at hand, whereas other parts of the world seemingly have not yet been able to take advantage of advances in technologies that are already more than a century old? Perhaps one billion people or more do not have access to electricity in the 21st century, a technology that was developed and adopted by the technological leaders at the end of the 19th century.

What has stopped the ripples from reaching those places? The patterns of diffusion lie at the heart of the study of economic development. Yes, part of the study of development is the study of the technological leaders. Yet an equally if not more important part is the study of diffusion of technologies and rising GDP per capita from the leaders to the rest.

Economists have been thinking about this puzzle for a long time. In *The Wealth of Nations*, Adam Smith talked about the fact that diffusion would take considerable time, and that economic growth would typically start at the coast of a country and move to the interior only after a considerable lag in time. Why at the coast? Because conditions for trade, specialization, and market dynamics are much easier at the coast. And why would the lag time to reach the interior be long? That, noted Smith, is because transport costs are very high to bring goods and services into the interior of a country or continent,

except for those places well served by rivers or easily reached by manmade canals. In Book 1 of *The Wealth of Nations*, Smith explains:

> Since such therefore are the advantages of water carriage [water-based transport], it is natural that the first improvements of art and industry should be made where this conveniency opens the whole world for a market to the produce of every sort of labor and that they should always be much later in extending themselves into the inland parts of the country.

Today, more than 200 years after Smith wrote, landlocked countries like Bolivia, Chad, Niger, Kyrgyzstan, and Nepal still face the disadvantages of high transport costs. Of course, many technological advances since Adam Smith's time, including rail, trucking, and now Internet-based services, have allowed even the distant parts of the world to integrate more closely with the global economy.

There are several general factors that are conducive to the movement of those ripples from the center of the technological forefront out to the rest of the world. A poor country that is close to a rich country is likely to receive the ripples sooner than a poor country that is very distant from the high-income economies. Proximity matters, just as the ripples move outward from the spot where the stone hit the water. In the 19th century, Western European countries that were geographically close to Great Britain had an advantage for their own economic development. The proximity meant that they could more easily access Britain's advanced technologies, and that they could sell their own production into Britain's booming market. In the 20th century, proximity to the US made a difference. In the early 21st century, proximity of poor Asian countries to Japan, South Korea, and now China, has made a difference in speeding catch-up growth.

Favorable agricultural conditions are also a huge benefit for receiving the ripples from abroad. Countries with high agricultural potential (e.g. farm lands that are easy to irrigate or that can grow multiple crops in a year) are more likely to make rapid advances in farm yields that in turn free up labor for work in industry and services.

Places with their own energy resources, be it coal, oil and gas, hydroelectric power, or now solar and wind potential, have a huge advantage in catch-up growth. While it is generally possible to export goods and import primary energy in return (as South Korea and Japan do), it is generally very hard to get that process started in a place without any domestic low-cost sources of primary energy. In the 19th century, regions with coal had an advantage. In the 20th century, regions with oil and natural gas had the advantage. In the 21st century, perhaps the desert regions, with massive potential of low-cost solar energy, will now have the advantage!

A physical environment conducive to human health is also important for receiving the technological ripples from abroad. A disease-ridden environment, one that is burdened by malaria, worm infections, and other terrible infectious diseases, can be serious impediments to the diffusion of economic growth. I will note later that the "excess disease burden" of parts of the tropics, notably tropical Africa, has definitely been one factor in holding back the "catch-up growth" of these poor, laggard, tropical regions.

And finally, though by no means least, is politics. If the politics are dysfunctional; if a colonial power dominates the society; if a dictator rules, or if chaos and violence grip a country, then catch-up growth is not possible. During the 19th century and until the 1960s and 1970s, many countries could not catch up simply because they were under foreign rule. European empires held most of Africa and much of Asia in economic stagnation. The imperial powers were not interested in the economic development of their colonies. They were more interested in the exploitation of the primary commodities – from the mines, oil wells, forests, farmlands, and fisheries – of those countries. In the late 20th century, the political problems have often been internal rather than international. Despots and dictators have often "run" the economy for their personal or tribal benefit, not for the benefit of economic growth of the entire country.

Historical Patterns of Catch-Up Growth

We can apply these general insights to understand the actual ripples that have spread over the world economy since the start of the Industrial Revolution. My colleague Gordon McCord and I have found it interesting and worthwhile to ask the following question:

When did each economy in the world first escape from extreme poverty?

This is like asking when the ripples of global economic growth first arrived each national economy. To measure extreme poverty for this purpose, we use the threshold of GDP per capita of $2,000, measured in PPP prices.

The first country in history to reach the $2,000 threshold was Great Britain, the home of the Industrial Revolution. That is where the proverbial stone (of endogenous economic growth) first hit the water, around 1820. Then the ripples started to spread from Great Britain, and by now, two centuries later, have reached most of the world. Within Europe, the closer the country is to England, the faster the ripples reached that country. For example, Western European countries reached $2,000 earlier than Eastern European countries. Belgium, France, and the Netherlands reached the $2,000 threshold ahead of Spain and Scandinavia. Since Europe is relatively compact, diffusion reached almost the whole continent in the 19th century.

For the rest of world, the story is obviously much different. The ripples have to travel much longer distances, face far more complex conditions, and encounter barriers such as malaria, desert conditions, landlocked regions, and so forth, which have blocked rapid catching up growth. Moreover, politics got in the way – big time. Europe's conquest of far-flung colonies in the 19th century set back the economic prospects of those places, often for a century or more. It was only upon political independence of those colonies that national governments were able to start investing in the education and infrastructure needed for catch-up growth.

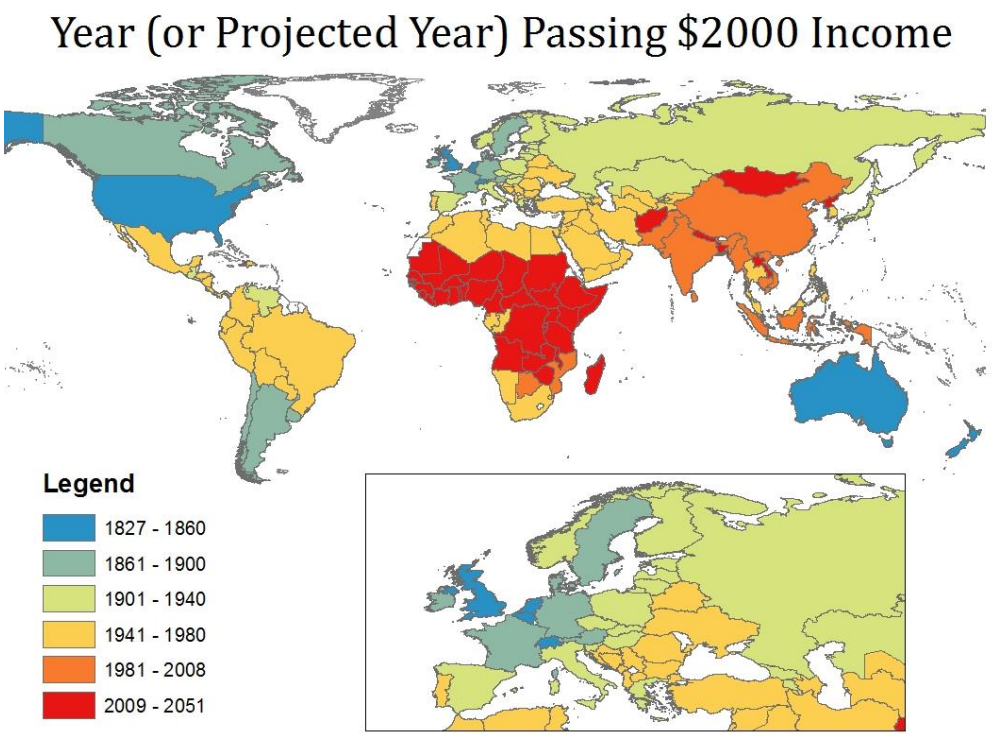


Figure 3.6. Year (or Projected Year) Passing $2,000 GDP per capita

Figure 3.6 shows an approximate timing of the takeoff. The first major economic advance (measured by achieving $2,000 per capita GDP) outside of Europe occurs in places settled by Britain itself, such as the United States and Australia. These British offshoots had several favorable conditions for catch-up growth: vast arable land and energy resources, good coastlines for trade, strong connections with British industry, and technological knowledge. These countries had achieved modern economic growth by 1860.

The next group of countries, which achieved the $2,000 threshold by 1900, includes Argentina, Uruguay, Chile, and Japan. All of these are temperate-zone countries with favorable conditions for agriculture. Japan became the first Asian economy to achieve catch-up growth. Looking at the map, we can see that Great Britain and Japan have lots of geographical similarities. Both are islands off of the main Eurasian landmass. Both have been relatively protected from invasions from the mainland. Both have been able to trade heavily with the mainland. Both are temperate-zone economies, with relatively high-yield agriculture. Both have relatively healthful environments, free of the burdens of massive tropical diseases. Both had achieved substantially urban, literate and politically stable societies by the 19th century.

Much of the rest of the world did not have the economic good fortune of Europe, the US, Canada, Japan, Australia, and the Southern Cone of Latin America (Argentina, Chile, and Uruguay). Most of the rest of the world had to wait till after 1950 to have the ripples of modern economic growth reach their economies! As I have emphasized, large swaths of the world were held by back imperial conquests. The

European empires did not pursue broad-based modern economic growth in most of their colonies. (There were a few exceptions, such as Hong Kong and Singapore, where the colonies served as trading posts rather than as sources of raw materials.) By the end of the 19th century, India, much of Asia, and virtually all of Africa (Figure 3.7) was under European colonial rule. Most of the colonized regions did not experience modern economic growth until decolonization in the 1940s-1960s.

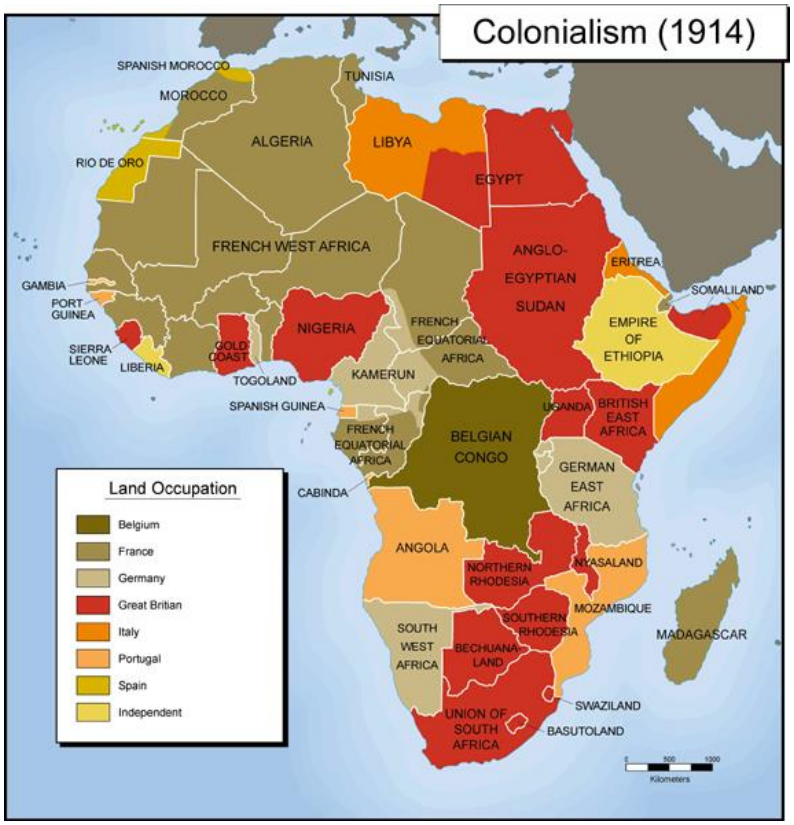


Figure 3.7. Africa Under Colonial Rule (1914)

V. Economic Development Since World War II: The Making of Globalization

As of the beginning of the 20th century, the world economy could be described as follows. On the whole, it was a miraculous economic age, unprecedented in the long sweep of human history. Waves of technological change had led to unprecedented breakthroughs in the ability of humankind to produce goods and services, meet material needs, extend lifespans, solve long-standing problems of public health, and make breakthroughs in quality of life in countless ways through electrification, modern transport, and mass industrial production. Yet by 1900 the world was also one of unprecedented gaps between the rich and poor. Modern economic growth had come to Europe and to a few other temperate-zone countries (the US and Canada, the Southern Cone of South America, Japan, Australia, and New Zealand), but not yet to the rest of the world.

At the end of World War I, the great British economist John Maynard Keynes looked back to the period just before World War I and described the unique global circumstances this way (in his famous work, *The Economic Consequences of The Peace)*:

> What an extraordinary episode in the economic progress of man that age was which came to an end in August, 1914 with World War I. The inhabitant on London could order by telephone, sipping his morning tea in bed, the various products of the whole earth in such quantity as he may see fit and reasonably expect their early delivery upon his doorstep. He could at the same moment and by the same means adventure his wealth in the natural resources and new enterprises of any quarter of the world and share without exertion or even trouble in their prospective fruits and advantages. Or he could decide to couple the security of his fortunes with the good faith that the townspeople of any substantial municipality in any continent that fancier information might recommend. But most important of all, he regarded this state of affairs as normal, certain, and permanent, except in the direction of further improvement. And any deviation from it is aberrant, scandalous and avoidable.

Of course Keynes was speaking as a brilliant and highly privileged Englishman. He was the one sitting in bed, sipping his tea and ordering commodities from all parts of the world. Those under the fist of colonial rule could obviously not do the same.

Still, Keynes was also expressing the uniqueness of an era where modern economic growth had taken hold in many parts of the world and had already created a global market economy (as Marx, we recall, had predicted in 1848). That global economy succumbed tragically and unexpectedly to war and chaos, for no good reason, with the outbreak of World War I in 1914. That war, in turn, unleashed worldwide chaos, millions of deaths from violence, millions more from infectious diseases such as the 1918 flu pandemic, and also the upheavals of revolution, most importantly the 1917 Bolshevik Revolution that gave birth to Soviet-era communism. World War I unleashed tremendous political and financial crises that led to huge monetary and financial instability in the 1920s and that in played a key (though complex) role in the onset of the worldwide Great Depression in 1929. And of course the Great Depression gave rise to another way of political horrors, including the rise to power of Adolph Hitler in Germany in early 1933 and the rise of fascism in Japan in the 1930s as well. One can say, in the shortest of shorthand, that World War I unleashed mass deaths after 1914; economic chaos in the 1920s; the Great Depression in the 1930s; and the onset of World War II in 1939, which was to engulf the world until 1945.

By the end of World War II, many cutting-edge technologies (radar, semiconductors, computers, space science, aviation, nuclear energy, and many more) had continued to advance rapidly, though many of the pre-war technological leaders including Germany and Japan were in ruins. But the world's main technological leader, the United States, was certainly not in ruins in 1945. Other than the 1941 Japanese attack on Pearl Harbor, the US had passed the war largely unscathed. By the end of World War II the US was far and away the world's leading economy and would remain so till the end of the century.

By 1945 the world economy was roughly divided into three parts. The first (called "the First World") included the US, Western Europe, and Japan, the market-oriented industrial world that operated within a security system led by the United States. The second (called "the Second World") included the communist countries led by the Soviet Union, and after 1949 including China. The third included most of the newly independent countries just escaping from the colonial rule. Some of these post-colonial countries signed up to the US security umbrella. A few joined the Soviet bloc. Many, however, declared themselves to be unaligned. These constituted the new "Third World." By the 1960s, a fourth informal term crept into the global parlance, "the Fourth World," signifying the poorest of poor countries. With the end of the Cold War in 1991, this jargon of first-, second-, third- and fourth world countries has largely been abandoned.

The world economy evolved under these geopolitical divides for several decades. The First World recovered from the damage of World War II remarkably quickly during the 1950s. Endogenous technology-driven economic growth took hold and living standards rose rapidly in the high-income countries. The post-World War II period for these countries was briefly a period of rebuilding, and then a period of dynamic, endogenous growth. In the Second (communist) World, industrialization seemed to be rather dynamic for a time, but by the 1960s the Second World was already facing a crisis of economic stagnation. By the 1970s economic development under communist systems was basically screeching to a halt, which prompted some of the Second World countries to begin reform. China was the first great reformer of the communist group, when Deng Xiaoping came to power in 1978 and opened China to a market system and to international trade and investment. Those reforms unleashed China's own catching-up growth with remarkable success, to the point where China became the fastest growing major economy in history.

Other parts of the communist world took longer to break free because the Soviet Union refused to make similar reforms for a long time, until Mikhail Gorbachev came to power in 1985 and began his own market reforms. After that came the democratic and economic revolutions of Eastern Europe in 1989. With the end of the Soviet Union itself at the end of 1991, the Second World finally became part of the world economy.

The so-called Third and Fourth Worlds included dozens of countries, each with their own economic history, politics, and strategies. A few of the countries were soon interested in integrating with the First World economies. These countries realized that the arrival of economic ripples could lift them into a very special kind of catch-up industrialization. This new form of "late industrialization" took the form of local factories producing for multinational companies as part of global production systems. For example, a company in South Korea or in Taiwan would begin to produce electronics goods or clothing for retailers in the United States and Europe, according to the technology designs and intellectual property of the US and European companies. The early adopters of this strategy for catching up were called the "Asian Tigers," and included South Korea, Taiwan, Hong Kong, and Singapore. By the 1960s these four economies were growing extremely rapidly, by integrating their new industrial base with the high-tech industries of the First World. As their success became evident, other developing countries also took

notice, and began to open their economic doors to trade and foreign investment in order to attract new multinational companies and to catch the ripples of global technology-based growth.

This is how our own era of globalization came into being, step by step, after World War II. The new catch-up growth took off in countries that opened their borders to trade and foreign investment. New global production systems, centered around large multinational companies, used the poorer countries as places for low-wage, labor-intensive parts of their production systems. The global value chain of production (e.g. used to produce a car, a shirt, or a home computer for global sales) was increasingly divided up among many countries, to take advantage of different wage levels, local skills, and transport conditions. Poor countries were able to become part of global production systems when they offered good infrastructure, transport, and low-cost and reasonably skilled labor.

This new globalization of production was facilitated by many breakthroughs in technology and transport, including standardized containerization of trade in 20-foot containers that allowed easy transport from ships to trucks. Other key technologies included computer assisted design and manufacturing (CADCAM), the Internet, and mobile telephony. These ICT technologies revolutionized the ability of companies to engage in sophisticated, dispersed global production systems, and thereby create globally integrated companies, often with hundreds of thousands of employees operating in more than 100 countries. The world's large multinational companies thereby became the main agents for the continuing transmission of economic ripples around the world and the diffusion of modern economic growth.

Japan was one leader in this process, and it developed a wonderful metaphor: the flying geese model. When geese fly in formation, one goose flies in front, and then in back are others following the lead. This is how economic development in Asia proceeded as well, with the industrialization first of Japan (with endogenous technological change), and then flying in formation just behind came South Korea and Taiwan, Hong Kong and Singapore. Behind them came Indonesia, Malaysia, and Thailand; and then behind them, China and Vietnam; and now Cambodia, Laos, and Myanmar.

Figure 3.8. Flying Geese Formation

Figure 3.9 shows where the world's multinational textile and clothing production was located as of 1999. Every red dot is a production site. Note that virtually every dot in Asia is on the coast, just as Adam Smith predicted and explained in 1776, well before the advent of such global production chains. Again, we see how geography interacts with technology to account for the ripples of global growth.

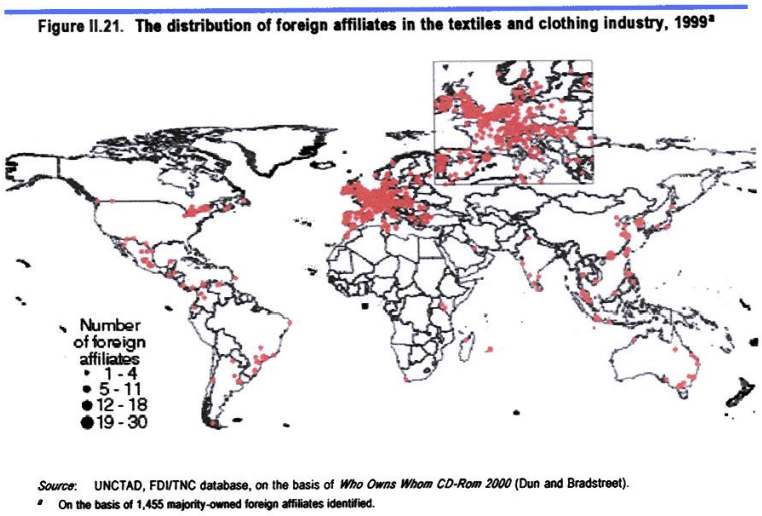


Figure 3.9. Distribution of Textile Production Sites

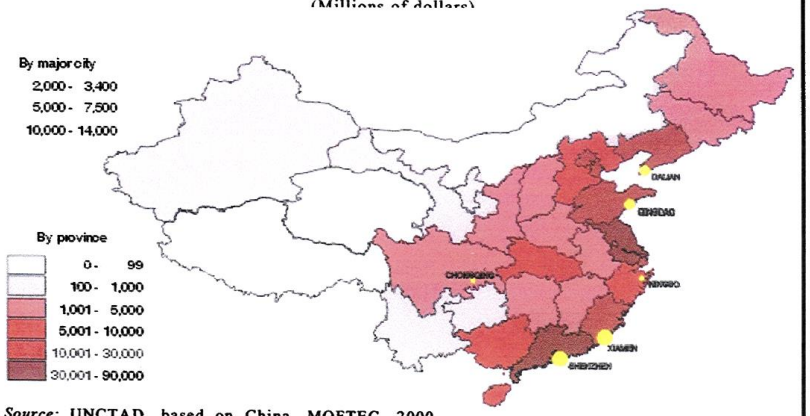
Figure 3.10 shows a map of China's foreign direct investment (FDI) during the growth spurt of 1978-2000. After Deng Xiaoping opened China to the world in 1978, foreign investment made China an export base for world manufacturing production. China became the industrial workshop of the world, typically using industrial technologies and processes brought from the outside, often through foreign direct investment of multinational companies. Once again, we see the wave going from coastal provinces, where FDI is the highest, into the interior, just as Adam Smith had told us it would.

Box II.2. Inward FDI at the sub-national level: some examples (continued)

to have a better chance of attracting FDI than widely separated cities (Wei et al., 1998; Gong, 1995). In Thailand, among 68 provinces, Rayong accounted for 31 per cent of total approved FDI during 1987-2000, followed by Krung Thep (Bangkok province) (12 per cent) and Chon Buri (11 per cent) (box figure II.2.2).

Box figure II.2.1. Distribution of FDI stock in China, by province and major city, 1999

(Millions of dollars)



Source: UNCTAD, based on China, MOFTEC, 2000.

Figure 3.10. Distribution of FDI in China

By the early years of the 21st century, the economic development that had started as a local phenomenon in England and had then spread across into Western Europe and to the other temperate-zone nations, had finally spread to Japan by the late 19th century; and after World War II to the post-colonial world. By now, the ripples of modern economic growth have reached almost the entire planet.

There are still a few places where modern economic growth has not yet reached. These are generally places of great geographical difficulties. They include places far in the interior of continents, high in the mountains, and relatively isolated as distant islands in oceans. These places have many burdens and few benefits. In the coming chapters, we will discuss how poverty reduction and economic growth can reach those places that have still not benefited much from the era of modern economic growth.