© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

CONTENTS

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

Chapter 1

INTRODUCTION

The Ascent and Descent of Growth

> The century after the Civil War was to be an Age of Revolution—of countless, little-noticed revolutions, which occurred not in the halls of legislatures or on battlefields or on the barricades but in homes and farms and factories and schools and stores, across the landscape and in the air—so little noticed because they came so swiftly, because they touched Americans everywhere and every day. Not merely the continent but human experience itself, the very meaning of community, of time and space, of present and future, was being revised again and again, a new democratic world was being invented and was being discovered by Americans wherever they lived.
>
> —Daniel J. Boorstin, 1973

THE SPECIAL CENTURY

The century of revolution in the United States after the Civil War was economic, not political, freeing households from an unremitting daily grind of painful manual labor, household drudgery, darkness, isolation, and early death. Only one hundred years later, daily life had changed beyond recognition. Manual outdoor jobs were replaced by work in air-conditioned environments, housework was increasingly performed by electric appliances, darkness was replaced by light, and isolation was replaced not just by travel, but also by color television images bringing the world into the living room. Most important, a newborn infant could expect to live not to age forty-five, but to age seventy-two. The economic revolution of 1870 to 1970 was unique in human history, unrepeatable because so many of its achievements could happen only once.

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

This book is based on an important idea having innumerable implications: Economic growth is not a steady process that creates economic advance at a regular pace, century after century. Instead, progress occurs much more rapidly in some times than in others. There was virtually no economic growth for millennia until 1770, only slow growth in the transition century before 1870, remarkably rapid growth in the century ending in 1970, and slower growth since then. Our central thesis is that *some inventions are more important than others,* and that the revolutionary century after the Civil War was made possible by a unique clustering, in the late nineteenth century, of what we will call the "Great Inventions."

This leads directly to the second big idea: that economic growth since 1970 has been simultaneously dazzling and disappointing. This paradox is resolved when we recognize that advances since 1970 have tended to be channeled into a narrow sphere of human activity having to do with entertainment, communications, and the collection and processing of information. For the rest of what humans care about—food, clothing, shelter, transportation, health, and working conditions both inside and outside the home—progress slowed down after 1970, both qualitatively and quantitatively. Our best measure of the pace of innovation and technical progress is total factor productivity (hereafter TFP), a measure of how quickly output is growing relative to the growth of labor and capital inputs. TFP grew after 1970 at barely a third the rate achieved between 1920 and 1970. The third big idea follows directly from the second. Our chronicle of the rise in the American standard of living over the past 150 years rests heavily on the history of innovations, great and small alike. However, any consideration of U.S. economic progress in the future must look beyond innovation to contemplate the headwinds that are blowing like a gale to slow down the vessel of progress. Chief among these headwinds is the rise of inequality that since 1970 has steadily directed an ever larger share of the fruits of the American growth machine to the top of the income distribution.

Our starting point, that a single hundred-year period, the "special century," was more important to economic progress than have been all other centuries, represents a rebellion against the theory of economic growth as it has evolved over the last sixty years. Growth theory features an economy operating in a "steady state" in which a continuing inflow of new ideas and technologies creates opportunities for investment. But articles on growth theory rarely mention that the model does not apply to most of human existence. According to the great historian of economic growth, Angus Maddison, the annual rate of

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

growth in the Western world from AD 1 to AD 1820 was a mere 0.06 percent per year, or 6 percent per century.[1] As succinctly stated by economic commentator Steven Landsburg,

> Modern humans first emerged about 100,000 years ago. For the next 99,800 years or so, nothing happened. Well, not quite nothing. There were wars, political intrigue, the invention of agriculture—but none of that stuff had much effect on the quality of people's lives. Almost everyone lived on the modern equivalent of $400 to $600 a year, just above the subsistence level.… Then—just a couple of hundred years ago—people started getting richer. And richer and richer still.[2]

This book adopts the "special century" approach to economic growth, holding that economic growth witnessed a singular interval of rapid growth that will not be repeated—the designation of the century between 1870 and 1970 as the special epoch applies only to the United States, the nation which has carved out the technological frontier for all developed nations since the Civil War. This book's focus on the United States, however, does not deny that other nations also made stupendous progress, that western Europe and Japan largely caught up to the United States in the second half of the twentieth century, and that China and other emerging nations are now well on their way in the catch-up process to the techniques and amenities enjoyed by the developed world.

Our first order of business is to identify those aspects of the post-1870 economic revolution that made it unique and impossible to repeat. We are so used to the essential comforts of everyday life, of being clean and warm, that we can easily forget how recently those comforts were achieved. In 1870, farm and urban working-class family members bathed in a large tub in the kitchen, often the only heated room in the home, after carrying cold water in pails from the outside and warming it over the open-hearth fireplace. All that carrying and heating of water was such a nuisance that baths were not a daily or even weekly event; some people bathed as seldom as once per month. Similarly, heat in every room was a distant dream—yet became a daily possibility in a few decades, between 1890 and 1940.

Progress did not suddenly begin in 1870. Rather, that year marks the start of our saga, for the Civil War provides a sharp historical marker separating the antebellum and postbellum ages. A tale of economic progress needs numbers to document that progress, and the raw data of economics became much more

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

adequate with the first Census of Manufacturing, carried out in 1869, a year that coincidentally brought the nation together when the transcontinental railroad was joined at Promontory Summit in Utah.

Our starting point in 1870 should not be taken to diminish the progress that had been made in the previous half century. A newborn child in 1820 entered a world that was almost medieval: a dim world lit by candlelight, in which folk remedies treated health problems and in which travel was no faster than that possible by hoof or sail. Three great inventions of that half century—the railroad, steamship, and telegraph—set the stage for more rapid progress after 1870. The Civil War itself showcased these inventions when northern trains sped Yankee troops to the front and steamships blockaded supplies to the south from Britain, hastening southern defeat. And no longer was news delayed by days or weeks. Half a century earlier, the Battle of New Orleans had been fought on January 8, 1815, three weeks after the Treaty of Ghent was signed to end the War of 1812. Before development of the telegraph and undersea cable, news traveled very slowly. But during the Civil War, the daily newspapers carried dispatches announcing the outcomes of battles mere hours after they occurred.

The flood of inventions that followed the Civil War utterly transformed life, transferring human attention and energy from the mundane to soaring skyscrapers and airplanes. What makes the period 1870–1970 so special is that these inventions cannot be repeated. When electricity made it possible to create light with the flick of a switch instead of the strike of a match, the process of creating light was changed forever. When the electric elevator allowed buildings to extend vertically instead of horizontally, the very nature of land use was changed, and urban density was created. When small electric machines attached to the floor or held in the hand replaced huge and heavy steam boilers that transmitted power by leather or rubber belts, the scope for replacing human labor with machines broadened beyond recognition. And so it was with motor vehicles replacing horses as the primary form of intra-urban transportation; no longer did society have to allocate a quarter of its agricultural land to support the feeding of the horses or maintain a sizable labor force for removing their waste. Transportation among all the Great Inventions is noteworthy for achieving 100 percent of its potential increase in speed in little more than a century, from the first primitive railroads replacing the stagecoach in the 1830s to the Boeing 707 flying near the speed of sound in 1958.

Households in the late nineteenth century spent half their family budgets on food, and the transition of the food supply from medieval to modern also

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

occurred during the special century. The Mason jar, invented in 1859 by John Landis Mason, made it possible to preserve food at home. The first canned meats were fed to Northern troops during the Civil War, and during the late nineteenth century a vast array of branded processed foods, from Kellogg's corn flakes and Borden's condensed milk to Jell-O, entered American homes. The last step to the modern era, the invention of a method for freezing food, was achieved by Clarence Birdseye in 1916, though his invention had to wait for decades to become practical at home until in the 1950s the electric refrigerator had finally progressed enough to be able to maintain a zero temperature in its freezer compartment. In 1870, shoes and men's clothing were purchased from stores, but women's clothing was made at home by mothers and daughters. The sewing machine had only recently reached the mass market and "held out the impossible promise that one of the great drudge pastimes of domestic life could actually be made exciting and fun."[3] By the 1920s, most female clothing was purchased from retail outlets that did not exist in 1870—namely, the great urban department stores and, for rural customers, the mail-order catalogs.

Some measures of progress are subjective, but lengthened life expectancy and the conquest of infant mortality are solid quantitative indicators of the advances made over the special century in the realms of medicine and public health. Public waterworks not only revolutionized the daily routine of the housewife but also protected every family against waterborne diseases. The development of anesthetics in the late nineteenth century made the gruesome pain of amputations a thing of the past, and the invention of antiseptic surgery cleaned up the squalor of the nineteenth-century hospital. X-rays, antibiotics, and modern treatments for cancer were all invented and implemented in the special century.

What made the century so unique is not only the magnitude of its transitions, but also the speed with which they were completed. Though not a single household was wired for electricity in 1880, nearly 100 percent of U.S. urban homes were wired by 1940, and in the same time interval the percentage of urban homes with clean running piped water and sewer pipes for waste disposal had reached 94 percent. More than 80 percent of urban homes in 1940 had interior flush toilets, 73 percent had gas for heating and cooking, 58 percent had central heating, and 56 percent had mechanical refrigerators.[4] In short, the 1870 house was isolated from the rest of the world, but 1940 houses were "networked," most having the five connections of electricity, gas, telephone, water, and sewer.

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

The networked house, together with modern appliances, changed the nature of housework. The long days previously devoted to doing laundry on a scrub board, hanging clothes outside to dry, making and mending clothing, and baking and preserving food had now transitioned into fewer hours of housework. Hours released from housework were now available for women to participate in market work. The improvement in working conditions for men was even more profound. In 1870, more than half of men were engaged in farming, either as proprietors or as farm laborers. Their hours were long and hard; they were exposed to heat in the summer and cold in the winter, and the fruits of their labor were at the mercy of droughts, floods, and infestations of insects. Working-class jobs in the city required sixty hours of work per week—ten hours per day, including Saturdays. More than half of teenage boys were engaged in child labor, and male heads of households worked until they were disabled or dead. But by 1970, the whole concept of time had changed, including the introduction of blocks of time that were barely known a century earlier, including the two-day weekend and retirement.

Thanks to all these irreversible changes, the overarching transition in the half century after the Civil War was from an agrarian society of loosely linked small towns to an increasingly urban and industrial society with stronger private and governmental institutions and an increasingly diverse population. Milestones on the one-way road from a rural society to an urban one are marked off by the urban percentage of the population, defined as those living in organized governmental units with a population of 2,500 or more. The percent of the nation classified as urban grew from 24.9 percent in 1870 to 73.7 percent in 1970.[5]

There is no greater example of the importance of the inventions of the special century than the aftermath of Hurricane Sandy, a freakishly powerful storm that devastated much of New York City and the seacoast of New Jersey in late October 2012. Floods have been common throughout human history, but interaction between the weather and the Great Inventions had not previously occurred on such a scale. Sandy pushed many of its victims back to the nineteenth century. Residents of New York City below Thirty-Fourth Street learned what it was like to lose the elevators that routinely had carried them to and from their apartments. Not only was vertical movement impeded, but the loss of the subways to flooding, along with the electrical blackout, eliminated the primary means of horizontal movement as well. Anyone who had no power also lost such modern inventions as electric lighting, air-conditioning and fans to ventilate dwelling spaces, and refrigerators and freezers to keep food from spoiling. Many residents had no heat, no hot food, and even no running water. Those living in New Jersey

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

were often unable to find gasoline needed for commuting, because gas station pumps could not function without electricity. Moreover, communication was shut off after batteries were drained on laptops and mobile phones.

SINCE 1970: A NARROWER PALETTE OF PROGRESS COMBINES WITH DIMINISHING RETURNS

Designating 1870–1970 the "special century" implies that the years since 1970 have been less special. First, the technological advance started to show its age. With a few notable exceptions, the pace of innovation since 1970 has not been as broad or as deep as that spurred by the inventions of the special century. Second, after 1970, rising inequality meant that the fruits of innovation were no longer shared equally: though those at the top of the income distribution continued to prosper, a shrinking share of the growing economic pie made its way to the Americans in the middle and bottom of the income distribution.

The special century was special not only because everyday life changed completely, but also because it changed in so many dimensions, including those associated with electricity, the internal combustion engine, health, working conditions, and the networking of the home. Progress after 1970 continued but focused more narrowly on entertainment, communication, and information technology, in which areas progress did not arrive with a great and sudden burst as had the by-products of the Great Inventions. Instead, changes have been evolutionary and continuous. For instance, the advent of television in the late 1940s and early 1950s caused attendance in motion picture theaters to plummet as television sets became ubiquitous—but movies did not disappear. Instead, they increasingly became a central element of television programming, especially after cable television opened up hundreds of channels that needed programs for viewers to watch. Similarly, television did not make radio obsolete but rather shifted the radio's role from a central piece of living room furniture into a small and portable device, most often listened to in the car. Nothing appeared to make television obsolete; instead, the technical aspects of TV became ever better, with huge, flat, high-definition color screens becoming standard.

Communication was dominated by the landline telephone for more than a century from its 1876 invention to the 1983 breakup of the Bell telephone monopoly. Since then mobile telephones have prompted an increasing share of households to abandon use of landline telephones. Information technology and the communication it enables have seen much faster progress after 1970 than

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

before. The transition from the mainframe computer of the 1960s and 1970s to the isolated personal computer of the 1980s to the web-enabled PC of the 1990s to smartphones and tablets of recent years represents the fastest transition of all—but, again, this is relevant only to a limited sphere of human experience. Total business and household spending on all electronic entertainment, communications, and information technology (including purchases of TV and audio equipment and cell phone service plans) amounted in 2014 to only about 7 percent of gross domestic product (GDP).

Outside the sphere of entertainment, communications, and information technology, progress was much slower after 1970. Frozen food having long since arrived, the major changes in food availability have entailed much greater variety, especially of ethnic food specialties and out-of-season and organic produce. There has been no appreciable change in clothing other than in styles and countries of origin, whereas imports of clothing have caused an almost complete shutdown of the domestic U.S. apparel industry. By 1970, the kitchen was fully equipped with large and small electric appliances, and the microwave oven was the only post-1970 home appliance to have a significant impact. Motor vehicles in 2015 accomplish the same basic role of transporting people and cargo as they did in 1970, albeit with greater convenience and safety. Air travel today is even less comfortable than it was in 1970, with seating configurations becoming ever tighter and long security lines making the departure process more time-consuming and stressful.

American achievements after 1970 have been matched by most developed nations, but in one important regard Americans fell significantly behind, struggling with the enormous cost and inefficiency of the nation's health-care system. Compared to Canada, Japan, or any nation in western Europe, the United States combines by far the most expensive system with the shortest life expectancy. Progress in medicine has also slowed after 1970 compared to the enormous advances made between 1940 and 1970, which witnessed the invention of antibiotics, the development of procedures for treating and preventing coronary artery disease, and the discovery of radiation and chemotherapy, still used as standard treatments for cancer.

THE STANDARD OF LIVING AND ITS MEASUREMENT

The most accessible definition of the standard of living is the ratio of real GDP (that is, the total production of goods and services adjusted for price inflation)

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

per member of the population, or "real GDP per person." The use of this measure of the standard of living is easily explained by the reliability of population data for most countries and the widespread standardization of methodology for measuring real GDP. Comparisons of nations often rank countries by their level of real GDP per person, and it has become conventional to discuss the "convergence" of poor nations to the living standard of rich countries using the criterion of the growth rate of their real GDP per person.

This book shows that there are two important reasons why real GDP per person greatly understates the improvement in the standard of living for any country, and particularly for the United States, in the special century. First, GDP omits many dimensions of the quality of life that matter to people. This occurs by design rather than being a flaw in the concept of GDP, because GDP is a measure of goods and services exchanged in markets and is not intended to include the value of nonmarket activities that matter to people. Second, the growth of GDP, even on its own terms as a measure of market activity, is systematically understated, for price indexes used to convert current-dollar spending into constant inflation-adjusted "real" dollars overstate price increases. We begin in this section by broadening the concept of the standard of living beyond real GDP, next turns to the sources of price index bias, and concludes with examples of major aspects of human activity that are either omitted from GDP or greatly understated in their importance.

The standard of living is defined with reference to Gary Becker's theory of time allocation.[6] Utility is created for the household by combining market-purchased goods and services with time. Added household equipment, such as TV sets, and technological change, such as the improvement in the quality of TV-set pictures, increase the marginal product of home time devoted to household production and leisure. For instance, the degree of enjoyment provided by an hour of leisure spent watching a TV set in 1955 is greater than that provided by an hour listening to the radio in the same living room in 1935. The addition of an automatic washing machine and dryer makes the time devoted to household production more valuable than it was when the laundry was done with a scrub board and an outdoor clothesline.

The Becker framework is broadened by adding a third element, the decrease in the household's welfare created by the disutility of the market work that must be performed to obtain money to buy market goods and services. For instance, if a particular quantity of goods and services that in 1900 could be purchased using the income earned from sixty hours of work can be bought in 1940 using

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

the income earned from forty hours of work, then the subtraction for the disutility of work is smaller in 1940 than it was in 1900. The interpretation of shorter work hours has a long history in the sources of growth literature, going back to Edward Denison, who argued that people would produce more per hour when the work week was shortened from sixty to forty hours, simply because fatigue made those extra work hours relatively unproductive.[7]

Improvements taking the form of a decreased disutility of work need not involve a reduction of hours, but rather may involve a decrease in the physical difficulty of work and in the discomfort involved in the nature of a work—for example, working in the intense heat of a steel mill. Consider the greatly diminished disutility of a farmer who now plants his field in an air-conditioned and GPS-equipped tractor, contrasting it with the 1870 farmer guiding a plow behind a horse or mule. This approach interprets the improvement in the standard of living by viewing members of each household both as consumers and as workers.

The greatly increased quality of work includes the shift from the physical strain and danger of manual blue-collar work to air-conditioned work in offices, hotels, and retail stores. It includes such improvements of quality as increased flexibility and control over one's own work hours, a contrast to the highly regimented nature of assembly work in the heyday of manufacturing. Likewise, the "quality of youth" has been improved by the end of child labor and the advance of educational attainment, captured by the sharp contrast between the children of 1900 guiding mules in dark and dangerous coal mines and the pampered teenagers of 2015 texting, tweeting, and playing games on multiple electronic gadgets.

Thus, by including home production, the value of leisure time, and the decreased unpleasantness of work, our concept of the standard of living goes beyond changes in the quantity and quality of goods and services purchased on the market. Yet even those items included in GDP are subject to error because of flaws in the price indexes used to convert current-dollar spending into constant inflation-adjusted dollars. This conversion requires a set of price indexes to translate, say, 1965 spending by consumers on gasoline from the current 1965 price paid of $0.30 per gallon to the price that would have been paid for the same gasoline in the 2009 base year of $3.00 per gallon. In this example, because the price of gasoline increased by a factor of ten between 1965 and 2009, the 1965 spending on gasoline of $20 billion in current 1965 prices would be converted into $200 billion in base-year 2009 prices. The summing up of all the goods and services purchased in 1965 as valued in 2009 prices yields the total of real GDP in 1965 and in every other year.

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

But not all products are like gasoline, a commodity that maintains a constant quality over the decades. When a new product is introduced—say, the room air conditioner—there is no allowance for the improvement in consumer welfare of being able to sleep on a hot summer night in a cool bedroom. The available price indexes tell us what happens to the price of the air conditioner once it is being sold, but nothing about its fundamental value. Even worse, new products typically experience a sharp decline in price in their early years as manufacturers ramp up production to achieve economies of scale, yet the official indexes have consistently been introduced many years after the new product was available for sale. For instance, the room air conditioner was first sold in 1951 but was not included in the official price index until 1967; the videocassette recorder (VCR) was first sold in 1978 but was not included in the price index until 1987.

One of the most important product introductions was the Model T Ford, which went on sale in 1908 at an initial price of $950. Over the next fifteen years, Henry Ford's introduction of the assembly-line method of manufacturing to the production of automobiles brought an astonishing reduction in price to $269 in 1923 (see table 5–2). The number of current dollars spent on Model T Fords represented more than three times the real GDP in 1923 as in 1908, a fact entirely missed in the GDP statistics, because there was no price index for cars at all until 1935.

Thus price indexes miss the welfare benefits of new products and the welfare-boosting effect of the price reductions early in the lives of new products. In addition, there is "quality bias" in the measurement of the quality of existing goods. In any given month, most models of TV sets are the same as those sold in the previous month, and the price index captures any month-to-month price change in existing models. However, this ignores the constant introduction of new models offering larger screens or higher-definition picture with little change in price. Consumers flock to the new models and stop buying the old models, but the price index makes no allowance for the improvement in the ratio of quality to price.[8] Improvements in the fuel efficiency of automobiles and the energy efficiency of home appliances, such as room air conditioners and clothes dryers are particularly significant sources of quality bias in the official price indexes.

Price indexes also miss the benefit to consumers of new types of retail outlets. For example, Walmart usually charges lower prices for food than does a traditional supermarket.[9] There are two price indexes—one for eggs at the

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

supermarket, and another for eggs at Walmart. Because consumers' ability to purchase identical eggs for, say, 20 percent less is never recorded as a reduction in price, increases in GDP are missed, for the price indexes overstate how much consumers are actually paying for eggs. This "outlet substitution bias" has caused large amounts of real GDP to be missed again and again, first when department stores replaced small specialty merchants, again when mail-order catalogs competed with small country general stores, again when food began to be sold in supermarkets, again when Walmart offered food for lower prices than conventional supermarkets, and most recently when Internet sales offered wider variety and lower prices than traditional outlets.

Many sources of the higher standard of living are not included in GDP at all, starting with the enormous advance in the quality of housing represented by the replacement of outhouses by indoor plumbing and the replacement of wood fires and potbelly stoves by central heating. The invention of the antibiotic penicillin might save thousands of lives, each of great value, but the GDP statistics would record only the expenses of the labor and equipment used in its discovery and production. Other similar examples include Pasteur's germ theory of disease and the attendant emphasis on soap and cleanliness, the development of urban sanitation infrastructure that made indoor plumbing possible, and the realization in the late nineteenth century that some food being sold was tainted, adulterated, or diluted.

A final dimension of improvement is the indirect effect of increased life expectancy in providing leisure and locational choice after retirement from work. In earlier eras, workers often died before the age of retirement or had no financial resources enabling them to enjoy retirement, leaving them confined as dependents in the dwellings of their children. Now most people outlive the date of retirement, often with enough financial resources to move to a sunny retirement community offering golf, pools, card games, and Facebook contact with children and grandchildren.

Some improvements in the quality of housing involved inventions, particularly electrification. But others did not—the transition from tenements to suburban single-family homes largely resulted from the positive income elasticity of housing square feet, as well as from the development of credit institutions that allowed working-class families to buy their own homes. Higher incomes also spilled over to affect other types of purchases that did not necessarily require innovations, including public expenditures on clean water and education.

This distinction between innovation-driven and income-driven progress should be qualified: The demand for residential space required transportation

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

innovations to make suburbs possible, while clean water depended on filtration and chlorination technology. The coexistence of industries experiencing rapid productivity growth (e.g., manufacturing) and those with little or no productivity growth (e.g., house-building or education) is summarized by the paradigm of "Baumol's disease," in which the relative price of the innovation-intensive industries, e.g., the production of computers, declines over time while the relative price of the noninnovative industries, e.g., the playing of a string quartet, increases over time. Baumol's disease can be cured in some instances, exemplified by how the inventions of phonograph records, tapes, CDs, and MP3s have allowed a single performance of a string quartet to be heard by millions. But some parts of economic activity still exhibit Baumol's disease without technological relief for rising relative costs, including seats for live performances, college tuition, and medical care expenses.

This theme of mismeasurement interacts with the designation of the one hundred years between 1870 and 1970 as the "special century." Measurement errors are greatest in the early years, both in the scope of the standard of living and in the extent of price index bias. Clearly the welfare benefits to consumers in the categories of life entirely omitted from GDP were greatest long ago: the transition from the scrub board to the automatic washing machine was a more important contributor to consumer welfare than the shift from manual to electronic washing machine controls or from a twelve-pound tub to an eighteen-pound tub. The most important unmeasured benefit of all, the extension of life expectancy, occurred much more rapidly from 1890 to 1950 than afterward. Price index bias was also greater in the early years of the special century. Nothing in the history of price index bias compares with the omission of automobile prices from the official price indexes over the entire period from 1900 to 1935. Price indexes themselves have been subject to continuous improvements: the price indexes of 2015 are better than those of 1995, which are themselves better than those of 1975 or 1955.

THE IRREGULAR ADVANCE OF THE LIVING STANDARD AND PRODUCTIVITY

Most of our attempt to broaden the concept of the standard of living is qualitative, for the concepts of improved consumer welfare in response to innovation and technological change cannot be measured precisely. Nevertheless, it is important that we comprehend the important message contained in the historical record for the standard concepts. Shown in figure 1–1 are the basic data

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

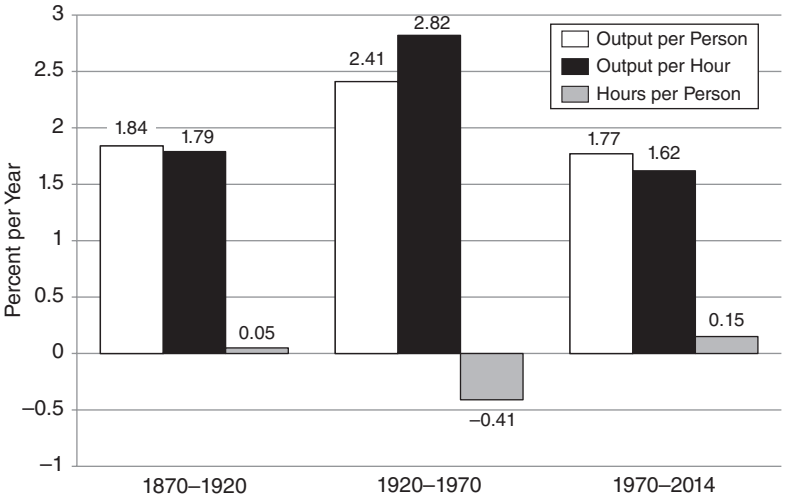

Figure 1–1. Annualized Growth Rate of Output per Person, Output per Hour, and Hours per Person, 1870–2014

Source: See Data Appendix.

for the standard of living, productivity, and hours worked per person covering the post-1870 period, divided at 1920 and 1970. Shown for each of the three periods are three bars, each depicting the average annual growth rate over the respective interval. The left (white) bar in each group of three shows the growth rate of per-person real GDP, the middle (black) bar growth in real GDP per hour (i.e., labor productivity), and the third (gray) bar growth in hours worked per person.

There are two striking aspects to this historical record. The first is the symmetry of the graph: the first and last periods are almost identical in the height of each bar, but the middle period (1920–70) is quite different. Output per person growth is substantially higher in the middle period, and productivity growth is much higher—2.8 percent per year compared to 1.8 percent in the first period and 1.7 percent in the last period. The much greater excess of productivity growth over output per person in the middle period, compared to that in the first and last periods, reflects the sharp decline in hours worked per person between 1920 and 1970. This raises a question: why did hours worked per person decline so rapidly in the middle interval? And a second question arises as well: did rapid productivity growth cause hours to decline, or did the decline in hours worked per person rather in some way contribute to relatively rapid productivity growth?

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

The decline in hours worked per person from 1920 to 1970 reflects numerous factors that all point in the same direction. First was the long-run decline in hours of work per week for production workers, which by 1920 had already declined from sixty to fifty-two hours per week. Second was the influence of New Deal legislation, both in reducing hours directly and also in empowering labor unions that fought for and achieved the eight-hour workday and forty-hour work week by the end of the 1930s. An unrelated factor was the baby boom of 1947 to 1964, which increased the child population (0–16) relative to the working-age population (16–64) and thus reduced the ratio of hours worked to the total population. The reverse feedback from productivity growth to shrinking hours reflects the standard view in labor economics that as real income rises, individuals choose not to spend all their extra income on market goods and services, but rather consume a portion of it in the form of extra leisure—that is to say, by working fewer hours.

The change in hours worked per person in the first period (1870–1920) was negligible and presumably reflects modest declines in the work week for urban working-class employees, offset by the effects of shifting employment from farms to cities, where working hours were longer and more regimented. The slight increase in hours worked per person after 1970 mixes two quite different trends. In the first portion of the interval, roughly between 1970 and 1995, hours worked per person rose as a reflection of the movement of women from housework into market employment. Then, after 1996, hours worked per person fell as a result of a steady decline in the labor force participation rate of prime-age males and of young people. After 2008, these labor force dropouts were joined by the retirement of the older members of the baby boom generation.

Why did labor productivity grow so much more quickly between 1920 and 1970 than before or after? We can divide the sources of the growth in labor productivity into three components, as shown in figure 1–2. The time intervals are the same as before, except that the absence of some data series requires that we choose 1890 rather than 1870 as our start date. Each bar is divided into three parts. The top section, displayed in white, is the contribution to productivity growth of rising educational attainment; these are the widely accepted estimates of Claudia Goldin and Lawrence Katz.[10] The middle section, shaded in gray, displays the effect of the steadily rising amount of capital input per worker hour; a continuing source of rising labor productivity is the larger quantity of capital, of increasingly better quality, with which each worker is equipped.[11] The

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

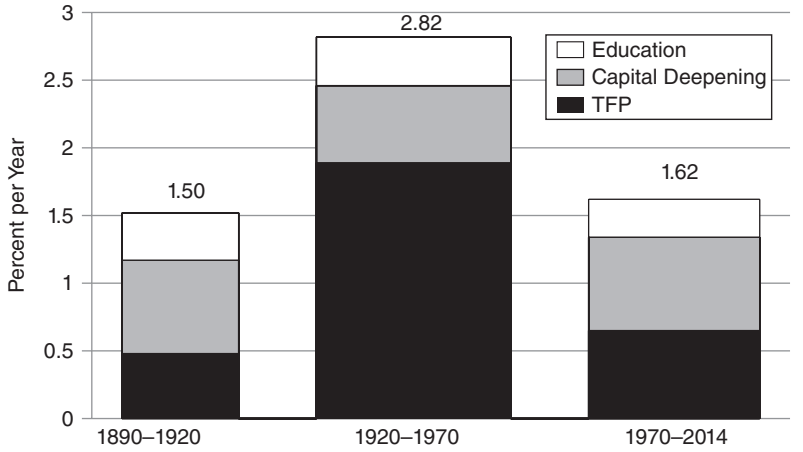

Figure 1–2. Average Annual Growth Rates of Output per Hour and Its Components, Selected Intervals, 1890–2014

Source: See Data Appendix.

effect of a rising ratio of capital input to labor hours is usually called "capital deepening."

What remains after deducting the contributions of education and capital deepening is the growth of total factor productivity (TFP), often called "Solow's residual" after the most prominent inventor of growth theory and growth accounting, Robert M. Solow. This measure is the best proxy available for the underlying effect of innovation and technological change on economic growth. And the results are surprising. Because the contributions of education and capital deepening were roughly the same in each of the three intervals, all the faster growth of labor productivity in the middle period is the result of more rapid innovation and technological change. I have previously called attention to this aspect of American economic history as "one big wave."[12]

The margin of superiority of TFP growth in the 1920–70 interval is stunning, being almost *triple* the growth rate registered in the two other periods.[13] To take another perspective, note that the fifty years 1920–70 represent 40 percent of the 124-year period from 1890 to 2014. If each year or decade were equally important, then the five decades starting in 1920 would have accounted for 40 percent of the cumulative TFP growth since 1890. But instead the post-1920 half century accounted for fully 66 percent of the cumulative TFP growth.

Our previous designation of the whole century 1870–1970 as "special" appears to conflict with the behavior of TFP growth as summarized in

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

figure 1–2. Apparently only the second half of the special century exhibited TFP growth that was substantially above average. We can state this puzzle in two symmetric ways: Why was TFP growth so slow before 1920? Why was it so fast during the fifty years after 1920?

The leading hypothesis is that of Paul David, who provided a now well-known analogy between the evolution of electric machinery and of the electronic computer.[14] In 1987, Robert Solow quipped, "We can see the computer age everywhere but in the productivity statistics."[15] David responded, in effect: "Just wait"—suggesting that the previous example of the electric dynamo and other electric machinery implied that a long gestation period could intervene between a major invention and its payoff in productivity growth. David counted almost four decades between Thomas Edison's opening in 1882 of the Pearl Street power plant in Lower Manhattan and the subsequent upsurge of productivity growth in the early 1920s associated with the electrification of manufacturing. He attributed the delayed implementation of electricity in manufacturing not just to the time needed to invent and perfect the machinery, but also to a sharp decline in the price of electricity itself.

David's analogy turned out to be prophetic, for only a few years after his 1990 article, the growth rate of aggregate U.S. productivity soared in 1996–2004 to roughly double its rate in 1972–96. However, the analogy broke down after 2004, when growth in labor productivity returned, after its eight-year surge, to the slow rates of 1972–96, despite the proliferation of flat-screen desktop computers, laptops, and smartphones in the decade after 2004. By way of contrast, in the 1920s, electricity's stimulation of industrial efficiency lasted much longer than eight years. Productivity growth soared in the late 1930s and into the 1940s, creating the remarkable average 1920–70 growth rate displayed in figure 1–2.

It is appealing to explain David's dynamo/computer analogy's failure to hold true longer than eight years by concluding that the electricity revolution was more important than the computer revolution. Moreover, the productivity upsurge after 1920 did not rely only on electricity, but also on the internal combustion engine. It is not surprising that motor vehicles had little impact on labor productivity or TFP growth before 1920, for they had come into existence only a short time before. There were only 8,000 registered motor vehicles in 1900, yet there were 26.8 million just three decades later, when the ratio of motor vehicles to the number of U.S. households had reached 89.2 percent. Productivity in the aggregate economy depends in part on how quickly workers,

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

including truck drivers and delivery personnel, can move from place to place. Just as the thousands of elevators installed in the building boom of the 1920s facilitated vertical travel and urban density, so the growing number of automobiles and trucks speeded horizontal movement on the farm and in the city.

WHY DID GROWTH PEAK IN THE MIDDLE OF THE TWENTIETH CENTURY?

Though the central task of this book is to extend our understanding of economic growth beyond the scope of GDP, one aspect of the record of U.S. real GDP growth nevertheless cries for explanation. Why, as shown in figure 1–2, was TFP growth so much more rapid during 1920–70 than before or since? An explanation is provided in chapter 16, which considers alternative explanations for the puzzle of the "Great Leap Forward." As shown in figure 16–5, the superior growth record of 1920–70 comes to an even more prominent peak at the middle of the twentieth century when TFP growth over 1890–2014 is split up into twelve separate decades. Why did TFP grow so rapidly midcentury?

The surprising answer of chapter 16 is that both the Great Depression and World War II directly contributed to the Great Leap. Had there been no Great Depression, there would probably have been no New Deal, with its NIRA and Wagner Act that promoted unionization and that both directly and indirectly contributed to a sharp rise in real wages and a shrinkage in average weekly hours. In turn, both higher real wages and shorter hours helped boost productivity growth—higher real wages by promoting substitution from labor to capital during 1937–41 and shorter hours by reducing fatigue and improving efficiency.

Less speculative is the productivity-enhancing learning by doing that occurred during the high-pressure economy of World War II. Production miracles during 1941–45 taught firms and workers how to operate more efficiently, and the lessons of the wartime production miracle were not lost after the war: productivity continued to increase from 1945 to 1950. In addition to the increased efficiency of existing plant and equipment, the federal government financed an entire new part of the manufacturing sector, with newly built plants and newly purchased productive equipment. Chapter 16 shows the staggering amount of this new capital equipment installed during the war—its acquisition cost in real terms was equal to fully half the stock of privately owned equipment that had existed in 1941 and was more modern, and hence more productive, than the old equipment.

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

The productive efficiency of the new capital installed during 1937–41, as well as during the war itself, brings us full circle to Paul David's explanation of the long lag between the first electric generating plant in 1882 and the electrification of industry that centered on the period 1919–29. His focus on the 1920s as the breakthrough decade misses the fact that the full force of the expansion of modern equipment, not just in manufacturing, but also in the rest of the economy, was centered in the years 1929–50. Economists are so distracted by the unprecedented slump in output during the depressed years of the 1930s that they forget how much innovation occurred in that decade. Alex Field is responsible for the revival of interest in 1930s innovation, and the present book provides evidence of rapid progress during that decade in many dimensions, including radio, the quality of motion pictures, and a sharp jump in the quality of motor vehicles.[16]

SETTING THE LIMITS: THE SCOPE AND RESULTS OF THIS BOOK

Scope. The subject of this book is the standard of living in the United States, the country that has expanded the frontier of technology, innovation, and labor productivity since 1870. Where the United States has led, the major nations of western Europe have followed, with Japan a laggard until after World War II. Both world wars greatly delayed implementation of the Great Inventions of the late nineteenth century in Europe and Japan, so much so that in 1950 the level of labor productivity in western Europe was only half that in the United States. When Europe caught up in the years the French call "les trentes glorieuses" (1945–75), Europeans were chasing the frontier carved out by the United States decades earlier. In fact, it has been claimed that the percentage of the French population having access to electricity and an automobile in 1948 was roughly equal to that of the United States in 1912.

Not only is this book limited to the American experience between 1870 and 2014, but it is also limited to the viewpoint of the household in its twin roles as consumer and worker. Many of the traditional topics of American economic history fall outside its purview, including financial booms and crashes, the rise of the trusts and ensuing antitrust legislation, the Progressive Era, and the struggles of labor unions. Our interest in Prohibition is not in its adoption or abolition, but rather its role in causing U.S. consumption of food and drink to be substantially understated in the data for the 1920s.

A book of such vast scope must be selective, so there is little room here for much detail, if any, about regional differences. The details of farm life reflect

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

the typical farms of the Midwest and the Great Plains in the late nineteenth century, taking only a sideways glance at the plight of southern sharecroppers. Only once do rural southern farmers receive attention, and even then only in tables showing how far behind they were in 1940 in obtaining the modern conveniences of electricity, running water, and indoor bathrooms, compared to urban dwellers, among whom conversion to the modern world was almost complete.

Approach. This book intends to create a quantitative and qualitative record of the changes in the American standard of living that so greatly increased consumer welfare, especially during the special century, 1870–1970. It focuses on the aspects of improvements of human life that are missing from GDP altogether. For instance, real GDP calculates food consumption by adding the constant-dollar cost of beef, pork, potatoes, and onions while placing no value on the shift from the boring 1870s meal of "hogs 'n hominy" to the much more varied diet of the 1920s. Chapter 3, which covers the evolution of food and clothing, combines the quantitative record of what Americans actually ate with the stories of inventors and their inventions of processed food, from Underwood's deviled ham to Kellogg's corn flakes. The treatment of clothing focuses on the effect of the sewing machine in easing the burden of women, gradually shifting from the making of clothing at home to market-purchased clothing. We care not only about what families ate and wore, but also about where they bought it, so chapter 3 includes the dazzling arrival of the great urban department stores, often the first buildings fully outfitted with electric lights, and the utter transformation of rural purchases made possible by the mail-order catalogs of Montgomery Ward and Richard Sears.

Subsequent chapters trace the improvements that are omitted from GDP across the many dimensions of the home and its equipment, public and personal transformation, information, communication, entertainment, and public health and medicine and, in the most novel part of the book, treat in detail of improvements in working conditions for adult males on the job, adult women in the home, and youth during the gradual transition from child labor to schooling.

Inventions and Inventors. The major inventions of the late nineteenth century were the creations of individual inventors rather than large corporations. We go behind the scenes to Thomas Edison's laboratory in Menlo Park, New Jersey, where on the epochal night of October 10, 1879, a particular variety of cotton filament finally made possible an electric light bulb that would last not just for an hour but for days and weeks. We also visit Karl Benz's lab, where, just

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

ten weeks after Edison's discovery, he took the last step in developing a reliable internal combustion engine.

Although this book is about the United States, many of the inventions were made by foreigners in their own lands or by foreigners who had recently transplanted to America. Among the many foreigners who deserve credit for key elements of the Great Inventions are transplanted Scotsman Alexander Graham Bell for the telephone, Frenchmen Louis Pasteur for the germ theory of disease and Louis Lumière for the motion picture, Englishmen Joseph Lister for antiseptic surgery and David Hughes for early wireless experiments, and Germans Karl Benz for the internal combustion engine and Heinrich Hertz for key inventions that made possible the 1896 wireless patents of the recent Italian immigrant Guglielmo Marconi. The role of foreign inventors in the late nineteenth century was distinctly more important than it was one hundred years later, when the personal computer and Internet revolution was led almost uniformly by Americans, including Paul Allen, Bill Gates, Steve Jobs, Jeff Bezos, Larry Page, and Mark Zuckerberg. Among the pioneering giants of the Internet age, Sergei Brin (co-founder of Google) is one of the few to have been born abroad.

Organization. The book proper begins with chapter 2, on living conditions in 1870. Part I includes eight chapters (chapters 2–9) on the revolutionary advances in the standard of living through 1940, a dividing year chosen both because it is halfway between 1870 and 2010 and because 1940 marks the year of the first Census of Housing, with its detailed quantitative measures of housing and its equipment. Part II (chapters 10–15) extends the narrative from 1940 to the present day, and its chapters are organized to give less attention to food, clothing, and other aspects of life that changed slowly and to place more emphasis on the rapid changes that occurred in the spheres of entertainment, communication, and information technology. Part III begins in chapter 16 with an attempt to explain "the Great Leap Forward," assessing reasons why labor productivity and TFP grew so much more rapidly from 1920 to 1970 than before or after. Then chapter 17 compares changes in the pace of innovation since 1970 with that likely to occur in the next quarter century. Part III concludes with chapter 18, on the headwinds that are slowing U.S. economic growth below the pace that otherwise would be made possible by technological advance. The book closes with a short postscript chapter proposing a menu of directions for policy that might be helpful tacks against the headwinds.

The Rise and Fall of Growth in the Standard of Living. The subsequent chapters trace out a distinct sense of ascent and subsequent descent in the growth rate of the standard of living, labor productivity, and TFP. The historical record

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

displayed in figures 1–1 and 1–2 provides the quantitative part of this record. A major theme is that real GDP understates the true growth in the standard of living and that many new inventions that made possible the achievements of the special century through 1970 were beyond anyone's imagination. Along every dimension in the chapters of part I, we find aspects of life being improved in ways not included in GDP—for example, take the transition from the country store to the Sears catalog, which greatly improved well-being by substantially increasing consumer choice and reducing prices. The chapters of part II (except for chapter 12, on entertainment and communication, and chapter 13, on information technology) have a different character. They all cover progress from 1940 until today but typically find that progress was rapid from 1940 to 1970 but slowed thereafter. Maintaining growth at the pace of the years before 1970 proved to be beyond the realm of possibility. Nevertheless, progress has continued after 1970, albeit at a slower pace, and often in realms receiving little attention in part I, evident, for instance, in the rapid decline in automobile fatality rates and an airline fatality rate that has been virtually zero for close to a decade[17] Likewise, fatalities by homicide have declined in almost every city since 1990.

The new element in part III is the headwinds—inequality, education, demography, and debt repayment—that are buffeting the U.S. economy and pushing down the growth rate of the real disposable income of the bottom 99 percent of the income distribution to little above zero. The outlook for future growth in the U.S. standard of living is not promising, and this book ends by doubting that the standard of living of today's youths will double that of their parents, unlike the standard of living of each previous generation of Americans back to the late nineteenth century.

The Past and the Future. This book's sober ending requires a distinction between the past and the future. The past is a matter of record, the future a matter for speculation. We know that the growth rate of labor productivity since 1970 has been disappointing, as shown in figures 1–1 and 1–2, and the growth rate of TFP since 1970 is barely a third of the rate achieved between 1920 and 1970. It is also evident that the modest growth rate of average per-person real GDP has not been shared equally. Moreover, the population is aging, educational attainment is flagging, and the slowing of growth creates a feedback loop requiring higher tax rates and/or lower transfer payments.

Knowing what we do about the recent past, what can we extrapolate to the future? We cannot predict every new invention; indeed, even for those on the horizon, such as driverless cars and legions of small robots, we can debate

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

their likely effect and importance. But there is much that we can predict. For instance, the baby boom generation is currently aged between fifty and sixty-eight, so we can predict with reasonable accuracy the effect of its members' retirement within a percentage point or two, depending on how many of them will work until later ages than past generations. If American high school students regularly rank poorly in international tests of reading, math, and science, then a sudden spike in scores to levels previously unseen may be considered improbable. If the stock market continues to advance, we know that inequality will increase, for capital gains on equities accrue disproportionately to the top income brackets.

This book's predictions that future growth will be slower than in the past are strongly resisted by a group of commentators whom I collectively call the "techno-optimists." They tend to ignore both the slow productivity growth of the past decade, as well as the force of the headwinds. Instead, they predict a future of spectacularly faster productivity growth based on an exponential increase in the capabilities of artificial intelligence. Another group of economists dismisses pessimism out of hand. The economic historian Deirdre McCloskey writes, for instance, that "pessimism has consistently been a poor guide to the modern economic world. We are gigantically richer in body and spirit than we were two centuries ago." [18] Whereas McCloskey has room in her toolkit for only one rate of growth spanning the past two centuries, this book provides three separate growth rates over the past 150 years, divided at 1920 and 1970. Yes, we are "gigantically" ahead of where our counterparts were in 1870, but our progress has slowed, and we face headwinds that are stronger barriers to continued growth than were faced by our ancestors a century or two ago.

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

INDEX

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

For general queries, contact webmaster@press.princeton.edu

© Copyright, Princeton University Press. No part of this book may be distributed, posted, or reproduced in any form by digital or mechanical means without prior written permission of the publisher.

For general queries, contact webmaster@press.princeton.edu