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Perspectives on *The Rise and Fall of American Growth*[†]

By Robert J. Gordon*

The four contributions to this symposium develop viewpoints that are highly complementary to the main findings of my book, adding depth to my analysis without raising significant critical objections. In this paper, I begin by providing the general reader with the essence of the book's main themes concerning the history of the American standard of living since 1870 and its likely future progress over the next 25 years. Then I turn to comments on each of the four contributions.

I. The Special Century and Its Aftermath

The 100 years after 1870 witnessed an economic revolution, freeing households from an unremitting daily grind of painful manual labor, household drudgery, darkness, isolation, and early death. Only 100 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 45, but to age 72. The economic revolution of 1870 to 1970 was unique in human history,

The book is based on the idea that economic growth is not a steady process that creates economic advance at an even, regular pace. Instead, progress occurs much more rapidly in some eras 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. The central thesis of the book 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 I call "the Great Inventions," principal among which were electricity and the internal combustion engine.

The book's second big idea is 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 involving entertainment, communication, and the collection and processing of information. Technology for processing information evolved from the mainframe to networked personal computers, search engines, and e-commerce. Communication advanced from dependence on landline phones to ever smaller and smarter mobile phones. But 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 both qualitatively and quantitatively after 1970.

The third big idea follows directly from the second. Any consideration of US economic progress in the future must look beyond the pace of innovation to contemplate the headwinds that are blowing like a gale force to slow down the vessel of progress. Chief among the headwinds is the rise of inequality that since the late 1970s has steadily directed an ever larger share of the fruits of American growth to those at the top of the income distribution. Other headwinds include the slowing rate of advance of educational attainment, the demographic drain on economic growth caused by the aging of the population and the retirement of the baby-boom generation, and the fiscal challenge of a rising debt/GDP ratio as Social Security and Medicare approach insolvency.

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II. Measures of Progress and the Dimensions of Mismeasurement

The diminished impact of innovation, due to the narrower scope of the post-1970 inventions, is evident when we compare growth rates of labor productivity and total factor productivity (TFP) across selected eras of the past 125 years. In Figure 1, the height of each vertical bar shows the growth rate of labor productivity (output per hour), with growth at a rate of 2.82 percent per year in the middle five decades of the twentieth century, 1920–1970, more than a full percentage point faster than in the first period shown in the graph (1890–1920) or in the last period that extends from 1970 to 2014. Each vertical bar is divided into three parts in order to decompose the growth of labor productivity into its three components. The top section, displayed in white, is the contribution to productivity growth of rising educational attainment. The middle section, shaded in gray, displays the effect of the steadily rising amount of capital input per worker hour, usually called "capital deepening."

What remains after deducting the contributions of education and capital deepening is the growth of TFP. This measure is the best proxy available for the underlying effect of innovation and technological change on economic growth. The results may surprise some readers. Because the contributions of education and capital deepening were roughly the same in each of the three time intervals, all the faster growth of labor productivity in the middle interval is the result of more rapid innovation and technological change. The margin of superiority of TFP growth in the 1920–1970 interval is stunning, being almost *triple* the growth rate registered in the other two periods.

Are these very different TFP growth rates credible? A major theme of the book is that real GDP, the numerator of output per hour, greatly understates the improvement in the standard of living, particularly for the United States in the special 1870–1970 century. First, changes in real GDP omit many dimensions of improvement in the quality of life that matter to people. Second, the price indexes used to convert current-dollar spending into constant inflation-adjusted "real" dollars overstate price increases. The book suggests that the improvements in the standard of living that are missed by real GDP data were more important before 1970 than after. Among

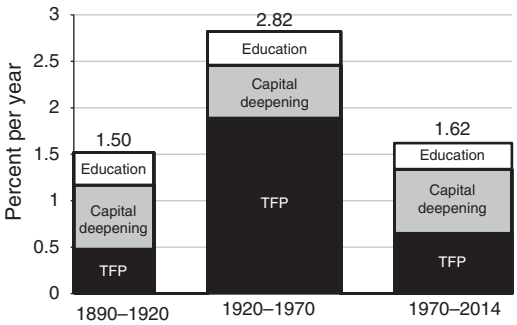

Figure 1. Growth Rate of Output per Hour and its Components, Selected Intervals, 1890–2014

Source: Gordon (2016), Figure 1-2.

the more important are the value of clean running water, waste disposal, and the indoor bathroom, not to mention the value of the reduction of infant mortality from 22 percent in 1890 to less than 1 percent after 1950. As shown in Nick Crafts' Table 1, an explicit allowance for declining infant mortality greatly increases the peaking of TFP growth in the 1929–1950 interval, as does an allowance for shorter work hours.

After 1970, real GDP continued to miss the value of advances, but the extent of mismeasurement declined along with the narrower scope of innovation. And the measurement of price change improved, with the introduction of hedonic price indexes for information technology equipment. In contrast to the era before 1936 when there was no consumer price index (CPI) for automobiles, during the postwar years quality changes in new automobiles were carefully measured by the CPI, including the value of government-mandated anti-pollution devices.

III. The Future

The book provides forecasts of growth in productivity and the standard of living over the next 25 years, from 2015 to 2040. The point of departure for the productivity forecast is to begin by dividing the interval since 1970 into three subperiods—1970–1994, 1994–2004, and 2004–2015. The book argues that the 1994–2004 subinterval, when output per hour grew at 2.26 percent per year, was atypical and unlikely to be repeated. In this decade emerged the sharp stepwise upward shift in productivity associated with the digital revolution that replaced paper,

file-card catalogs, file cabinets, and Linotype operators with proprietary and Internet software, electronic catalogs, and flat screens. If that decade is not relevant to form a basis for the likely future growth of productivity, then our point of departure shifts to the average growth rate achieved from 1970 to 1994 and from 2004 to 2015, a rate of 1.38 percent per year. When we subtract 0.18 percentage points to reflect the slowing advance of educational attainment, we arrive at the projected 2015–2040 labor productivity growth rate of 1.20 percent as shown on the first line of Table 1. This compares to a rate of 2.26 percent per year achieved from 1920 to 2014.

To translate projected growth in output per hour to output per person, a forecast of −0.4 percent annually is made for the future evolution of hours per person, due largely to the retirement of the baby-boom generation. This results in a forecast for output per person for 2015–2040 of 0.80 percent per year as contrasted to the historical rate of 2.11 percent per year. A further subtraction of 0.40 percentage points per year is made to reflect the anticipated continuation of rising inequality at roughly the same rate experienced from 1975 to 2014. An additional subtraction of 0.1 percentage points is made for the anticipated cuts in social benefits or increases in Social Security and Medicare taxes needed to counteract the continuous upward creep in the Federal debt/GDP ratio that will result from the aging population. The resulting forecast for growth in disposable median income per person of 0.3 percent per year contrasts with the rate of 1.69 percent per year actually achieved from 1920 to 2014.

Table 1—Past and Future Growth Rates

	1920–2014	2015–2040
Output per hour	2.26	1.20
Average output per person	2.11	0.80
Median income per person	1.82	0.40
Disposable median income per person	1.69	0.30

Source: Gordon (2016, Figure 18-5).

IV. The Contribution by Gregory Clark

Greg Clark (2016) supports my view that the future pace of TFP growth will be substantially slower than that achieved in the special century from 1870 to 1970. While he views his paper as reinforcing my approach, in actuality his reasons for future TFP pessimism go beyond my analysis into areas that are not explicitly treated in my view of the future. He makes the important point that the service industries account for 80 percent of aggregate value added, and that many jobs in the service industries are "the timeless ones of the preindustrial economy—cooking, serving food, cleaning, …" and many others. The digital revolution has left many of these tasks unchanged, and he imagines that service workers could be transported from the fourteenth century and could do many of today's service jobs with a minimum of training. Clark is careful, however, to caution that not all service jobs are characterized by slow productivity growth.

EQ 1

In looking forward, Clark places primary emphasis on the role of research and development (R&D), arguing that in the past TFP growth has been most rapid in R&D-intensive industries. He presents a stunning calculation that more than 80 percent of corporate R&D expenditures takes place in industries accounting for less than 5 percent of value added, implying that hope for a future technological acceleration rests on a surprisingly small segment of the economy. He argues convincingly that information technology, which has absorbed a large share of R&D spending in the past, will exhibit slower TFP growth in the future, both because its share of nominal value-added has been shrinking, and because the pace of progress in the miniaturization of computer chips has been slowing down. Another R&D-intensive area, medical care, is encountering steeply rising costs of extending human life by an additional year. Overall, while I view Clark's view of education as too pessimistic ("no progress since the printing press"), the other aspects of his downbeat view of the future provide additional reasons for caution that go well beyond those provided in my book.

EQ 2

V. The Contribution by Nicholas Crafts

The paper by Nick Crafts (2016) provides several new findings that complement the book. His Table 1 supports the book's theme that measurement errors in GDP were more significant before 1970 than afterward. He converts the value of

declining mortality into annual growth rates and shows that in both the 1900–1929 and 1929–1950 intervals, the welfare-augmented measure of real GDP per person *triples* the growth rates of conventional measures due to declining mortality and increased life expectancy. His table also shows that welfare-augmented GDP per person is further increased during 1929–1950 by placing a value on reduced weekly hours of work.

Crafts, in Tables 2 and 3, presents several alternative series for TFP growth in the 1930s and 1940s. He supports the emphasis in the book on the great leap forward of TFP from 1929 to 1950, which is based on modern national income accounts data for GDP (labeled in Table 3 "Modern NIPA"). He reports on work with coauthors that shifts part of the measured growth in 1941–1947 from the category of TFP to the category of educational attainment. I welcome this new work that probes the role of sectoral reallocation in boosting the measured contribution of rising educational attainment.

Crafts questions the book's explanation of rapid TFP growth in the 1929–1950 interval, which points to aspects of New Deal legislation and World War II production achievements. Crafts counters that there was a decline during World War II in new technology publications, in private R&D, and in highway infrastructure investment, while there was explosive growth in the 1930s and 1940s in government regulations. I stand by the book's arguments that in the 1930s unionization, higher wages, and shorter hours boosted productivity, while during World War II the high-pressure economy yielded breakthroughs in production methods through learning by doing. While private investment virtually ceased, there was a sharp jump in manufacturing capacity financed by the government, the number of machine tools in American industry doubled between 1940 and 1945, and all those new machine tools were of a more modern design than the old tools that they supplemented.

VI. The Contribution by Benjamin Friedman

The Friedman (2016) paper provides an elegant and nuanced summary of the book's major themes. He places its emphasis on innovation in the context of writings by early economic historians who stressed American exceptionalism and the power of technological change. He quotes Francis Wayland who cautions that it is "impossible to tell" how far the "increased productiveness of human industry" should extend and "what reason have we to assume that the gifts of God are exhausted?" In this spirit some critics, although not Friedman, have accused me of ignoring the validity of past forecasts of technological optimism like those of Wayland; instead I am accused not just of forecasting that technological change is waning but of claiming that it is over. In contrast, as argued above, my forecast for future productivity growth of 1.20 percent per year does not represent a sudden arrival of stagnation but rather is close to the 1.38 percent average growth rate of productivity achieved on average during 1970–1994 and 2004–2015, sub-periods when technological change proceeded apace.

In his section of "Looking Forward" Friedman contrasts my view of the future with that of Erik Brynjolfsson and Andrew McAfee, whom I have labeled as "techno-optimists." Friedman rightly points out that their optimism about a buoyant future based on accelerating technological change in the areas of robots, artificial intelligence, and driverless cars must be tempered by pessimism about the future of work. In contrast my view that innovation will continue to proceed at the same rate as in the recent past, together with the observed decline of the US unemployment rate to 5.0 percent, provides room for optimism that there will be plenty of jobs in the future, albeit with growth in wages that may be disappointingly slow.

AQ 1

VII. The Contribution by Acemoglu, Moscona, and Robinson

Acemoglu, Moscona, and Robinson (2016)—henceforth, AMR—acknowledge that the book highlights the role of the government in stimulating economic growth through land grants, food and drug regulations, the establishment and subsidization of land-grant universities and agricultural experimental research stations, and above all the patent system. In fact, the book points to the low price of patents in comparison with Britain as an important stimulus to American innovation. But AMR complain that the book "does not link these important institutional underpinnings to the pace and nature of American innovation." The authors appear to believe that the rapid pace of innovation in a particular time period like the 1870s and 1880s

was caused by a particular institutional environment. Here I must disagree, because the institutional background through such channels as the patent system was relatively stable during the period examined in the book. The timing of inventions like electricity and the telephone reflected a spontaneous response of inventors to technological opportunities rather than changes in the institutional environment. The particular institution examined by the authors, the US post office, was if anything the beneficiary of technological change rather than its cause, and the book traces the innovations of parcel post and rural free delivery made possible by the spread of the railroad network and the invention of the motor car.

REFERENCES

Acemoglu, Daron, Jacob Moscona, and James A. Robinson. 2016. "State Capacity and American Technology: Evidence from the Nineteenth Century." *American Economic Review*. http://dx.doi.org/10.1257/aer.p20161071.

Clark, Gregory. 2016. "Winter is Coming: Robert Gordon and the Future of Economic Growth." *American Economic Review*. http://dx.doi.org/10.1257/aer.p20161072.

Crafts, Nicholas. 2016. "The Rise and Fall of American Growth: Exploring the Numbers." *American Economic Review*. http://dx.doi.org/10.1257/aer.p20162070.

Friedman, Benjamin. 2016. "A Century of Growth and Improvement." *American Economic Review*. http://dx.doi.org/10.1257/aer.p20161069.

Gordon, Robert J. 2016. *The Rise and Fall of American Growth: The U.S. Standard of Living Since the Civil War*. Princeton: Princeton University Press.

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1.	Please add Brynjolfsson and McAfee to the reference list and include a citation here.	

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