Comments on Daniel Sichel's Review Article on *The Rise and Fall of American Growth*

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ABSTRACT

Daniel Sichel's review focusses mainly on the future of innovation and technology. In contrast, my book is mainly about the past, and the reasons why the growth rate of total factor productivity in the years since 1970 has averaged only about one-third the rate registered between 1920 and 1970. My explanation is that a series of "Great Inventions" in the late 19th century, led by electricity and the internal combustion engine, utterly changed methods of production in the business economy and conditions of work on the job and at home. The digital revolution since 1960 has transformed business methods further and led to a temporary recovery of productivity growth between 1995 and 2004, but slow growth since 2004 suggests that the major impacts of the digital revolution are largely over, while technological transformations in the future will be evolutionary rather than revolutionary.

Daniel Sichel's thoughtful review article in this issue of the *International Productivity Monitor* divides my book *The Rise and Fall of American Growth: The U.S. Standard of Living since the Civil War* (Princeton University Press, 2016) into two parts, devoted respectively to the "past" and the "future". His review consists of three paragraphs about the past and 11 about the future. Readers of Sichel's review who have not seen the actual book might be surprised to learn that Sichel has stood the book's organization on its head. In contrast to his review, the book devotes 16 chapters to the past, one to recent and future innovation, and one to the "headwinds." Sichel's main topic, whether to be pessimistic or optimistic about future technological change, is a minor side-show in the book.

The Growth Slowdown Has Already Happened - When and Why

Instead, the book's case for the decline in American growth rests on what has already happened prior to 2015, not what is about to happen. Slower growth is nothing new, but extends back to 1970. In the data that I constructed for the book that refer to the total economy, the annual growth rate of total factor productivity (TFP) reached 1.89 per cent for the 50 years between 1920 and 1970, and has been just one-third as much, 0.63 per cent, in the 45 years between 1970 and 2015. For the standard BLS data covering the private business sector, as interpreted by John Fernald, the annual TFP growth rate slowed from 2.05 per cent between

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1947:Q1 and 1972:Q4 to just 0.79 per cent between 1972:Q4 and 2016:Q3, and the latter rate drops further to 0.53 per cent when the dot-com decade of 1995: Q4 to 2004: Q4 is excluded.[2]

The primary contribution of the book is to argue that economic growth does not proceed steadily through time, and that there are good reasons why growth is faster in some eras than others. Growth ignited slowly with the first industrial revolution of the late 18th century and then gathered full speed with the second industrial revolution of the late 19th century. The book singles out what it calls the "special century" of 1870-1970 as exhibiting utter and complete change in methods of farming, manufacture, office work, and household production.

Its honour role of "great inventions" begins with electricity and all its spinoffs including electric light, elevators, machines for every industry, and home appliances. Joining electricity in importance is the internal combustion engine, which made possible motor and air transport. Other inventions of that era include entertainment and communications including the telephone, phonograph, radio, motion pictures, and television, and progress in chemicals and plastics. Central heating that was initially introduced in the late 19th century was joined by air conditioning in movie theaters and offices in the 1920s and 1930s and in homes starting in the 1950s. The standard of living was greatly enhanced by the diffusion of two old inventions - clean running water and piped waste disposal. In the first half of the 20th century, infectious diseases were largely eliminated, as was infant mortality, and life expectancy grew twice as fast as in the second half of the 20th century. While all this was going on, the American economy was benefitting from the permanent one-time boost in productivity as the urban-rural division shifted from 25-75 to 70-30.

The book asks why the third industrial revolution (post-1970) associated with computers and communications did not have the same impact on TFP as had the inventions of the earlier second revolution. Its answer is that the digital revolution, while profound, did not alter economic life along as many dimensions as had the earlier inventions. Computers did little to transform the "big three" of household consumption - food, clothing, and shelter. Transportation by auto, truck, and airplane was little changed by the computer. The big changes were in business practices as the typewriter and the Marchant calculating machine were replaced in the 1980s by personal computers driving spreadsheet and word processing software, and when in the 1990s the personal computer became connected to the rest of the world with access to search engines and e-commerce.

Interpreting the Recent Past

For reasons that are not entirely understood, the transition from typewriters to PCs to the internet, which could have been predicted to provide a steady impetus to the growth of business sector productivity between 1970 and 2015, had its main impact on growth in labour productivity and TFP during the shorter interval 1995-2004. That decade stands out in the data not only for a robust albeit temporary revival in TFP growth, but also for an acceleration in the rate of price decline and quality improvement in computer hardware, a boom in the GDP share of ICT investment, a temporary rise of economy-wide net investment, and a temporary surge in the growth of manufacturing capacity.

2 The TFP data are constructed by John Fernald from the Federal Reserve Bank of San Francisco based on the underlying BLS and BEA data. See http://www.frbsf.org/economic-research/indicators-data/total-factor-productivity-tfp.

When the book proposes controversially that the major impact of the third industrial revolution was largely over by 2005, it is again commenting on the past rather than speculating about the future. In the twelve years since the end of 2004, growth in TFP has been even slower than during 1973-95. Perhaps more important, the outstanding statistical features of the 1995-2004 decade have gone away - the GDP share of ICT investment peaked at 4 per cent of nominal GDP around 2000 and by 2014 had fallen to 3 per cent, economy-wide net investment has declined to the lowest level of the postwar years, and manufacturing capacity is barely growing. Worse yet, according to research at the Federal Reserve Board by David Byrne, the share of computer and communications hardware that is imported from abroad has increased to nearly 90 per cent, depriving the economy of this source of rapid TFP growth within the manufacturing sector.

More broadly, production methods in the business sector appear to have stabilized since 2005 after the rapid changes made possible by internet-enabled personal computers in the 1980s and 1990s, including the transition from card and paper catalogues to electronic catalogues with their unlimited capacity and their ability to keep track of inventory. While e-commerce continues to grow, it has reached only about 8 per cent of retail sales, leaving the other 92 per cent of the retail sector stuck in its traditional production methods with hardly a robot in sight, including humans at checkout counters, stocking shelves, and slicing meat and cheese at the deli counter. Goods travel from warehouses to retail stores in trucks driven by humans, and there is still little use of robots in warehouses. Even at Amazon warehouses, the robots merely move shelves to the humans, who still select the goods and pack them.

Throughout the service sector, checking in at the office of the doctor, dentist, or veterinarian is handled by a human sitting behind a 2005-era flat-screen desktop computer. Doctors and nurses now enjoy the efficiency of electronic medical records, but nurses still draw blood, hook patients up to IVs, and doctors still make diagnoses with equipment including CT scans and MRIs that was introduced long ago. Just as the ATM machine did not eliminate bank tellers, so the use of artificial intelligence (AI) has proven to be complementary to radiologists rather than replacing them all.

All this appears to neglect the smart phone revolution, which is truly a remarkable new invention that has become ubiquitous among young and old, rich and poor alike. There is a debate among economists as to how much extra consumer welfare has been created that has been excluded from GDP. The amount is surely very large, but social networks, photo-taking, and game-playing are part of consumer leisure activities that do not enhance business sector productivity or allow business firms to pay higher wages. While smart phones have made limited inroads in the business world, for instance as dashboard GPS assistants for taxi drivers and tablet ordering devices in fast-food restaurants, they have so far had little impact in replacing laptops and desktops, and may indeed subtract from productivity by being a distraction at work.

There are those who argue that the benefits of the smart phone demonstrate that productivity growth is fundamentally mismeasured. Yes, the consumer surplus has been omitted from GDP, but history provides a steady stream of examples of consumer welfare that has been created by inventions whose value was never included in GDP. The book argues that the value of omitted consumer surplus was greatest in the first half of the 20th century, when we consider the consumer surplus added by electric light, motor

transport creating freedom to travel and ridding the streets of horse manure, the value of kitchen appliances, bathrooms, running water, central heating, and above all the cure of infectious diseases and infant mortality along with the extension of life expectancy.

The Future of Productivity Growth

The book's forecast of future labour productivity growth for 2015-2040 is 1.2 per cent for the total economy, about the same as the 1.26 annual rate registered in Fernald's quarterly business sector data for 2004:Q4 to 2016:Q3. Thus I am not forecasting some new age in which innovation disappears. There has been lots of innovation in the past 12 years and I expect it to continue in the areas of medical advances, 3-D printing, robotics, artificial intelligence, and self-driving vehicles.

A bedrock assumption is that the temporary productivity growth revival of 1995-2004, that brought us the transition from the typewriter to the web-enabled personal computer with its plethora of free information, will not recur because none of the other characteristics of the 1995-2004 era are present now, because IT investment is now low as is economy-wide net investment, because computer equipment is increasingly imported rather than produced domestically, and because the growth of manufacturing capacity has slowed radically since its late 1990s bubble.

Sichel's view of the future rests in part on the convincing work with his co-authors showing that official statistics understate the rate of advance of semiconductor technology. But none of this research forecasts an acceleration of advance beyond that already experienced since 2005. However fast semiconductor technology has advanced since 2005, it has not mattered for business sector productivity. As Hal Varian, Chief Economist of Google, stated in a quote for the book, technological change in desktop and laptop computers has come to a halt "because no one needs a superfast chip on their desktop."

Sichel offers numerous examples of ongoing innovation that make him optimistic that future labour productivity growth will be faster than my assumed 1.2 per cent rate. But he does not consider the countervailing possibility that it could be slower, as it has been in the real world which has generated business sector labour productivity growth of only 0.6 per cent in the six years since 2010.

The Headwinds

Sichel devotes only a single paragraph to the headwinds. He accepts the demographic headwind, the fact that the retirement of the baby boomers will reduce hours worked per member of the population for most of the next 25 years, reducing growth in output per capita by 0.4 per cent per year. He dismisses the education, inequality, and fiscal headwinds, suggesting that they can all be overcome by "good policy choices."

I take the headwinds more seriously. The steady advance of educational attainment was a basic source of productivity growth in the 20th century, but now high school attainment has reached a plateau while college attainment inches up, increasingly inhibited by tuition cost inflation. Most of those who enter community colleges drop out, while 40 percent of those who graduate from four-year colleges are unable to find a job that requires a college education. The sources of rising inequality are not going away, nor are the barriers to social mobility faced by children growing up in poverty as contrasted with children lucky enough to have two college-educated parents.

The book concludes the headwinds section with a section on "sociological decay," a set of changes which government policy can do little to offset. Marriage has declined as a share of the

population, particularly for those with a high school education or less. The percentage of children growing up in single-parent families has greatly increased, as has the share of the high-school educated male population which has experienced time in prison. These inescapable facts suggest that the quality of the labour force may decline in the next two decades rather than improve. Nothing in Sichel's review denies the likelihood that future growth of median income per person will be substantially slower than productivity growth, close to if not equal to the 0.8 percentage point subtraction suggested in the book.

Final Assessment

The main point of the book is not about the future but about the past. Economic growth is not a steady process but for good reasons peaked in terms of labour productivity and TFP growth in the middle five decades of the 20th century, 1920-70. Sichel's hopes for the future cannot erase the decline in TFP growth by roughly two-thirds when the 1920-70 half century is compared to the 45 years since 1970. Since 1970 we have had 35 years of disappointing productivity growth only partially offset by 10 years of revival between 1995 and 2004. For me, the odds are 35-10 that the future will look much like the past 45 years excluding the miraculous but temporary 1995-2004 revival.