Secular stagnation? Not in your life

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In the aftermath of the Great Recession, many economists are persuaded that slow growth is here to stay. This chapter argues that technological progress – particularly in areas such as computing, materials, and genetic engineering – will prove the pessimists wrong. The indirect effects of science on productivity through the tools it provides scientific research may dwarf the direct effects in the long run. Although technological advances may polarise labour markets, they also bring widespread benefits that are not accurately reflected in aggregate statistics.

There is nothing like a recession to throw economists into a despondent mood. Much as happened in the late 1930s, many of my colleagues seem to believe that 'sad days are here again'. Economic growth as it was experienced by the world through much of the 20th century, they tell us, was a fleeting thing. Our children will be no richer than we are. Some of the best economists of our age, including Larry Summers, Paul Krugman, and my own colleague Robert J. Gordon, are joining the chorus of the doomsayers. It is said that we are faced by headwinds that inevitably will slow down growth and perhaps condemn us to secular stagnation. There is no denying that the population of the world is getting older, and that the fraction of people working (and supporting the aged) is falling everywhere except in Africa. The 'big pushes' driven by millions of married women taking jobs and the huge increase in college graduates that drove post 1945 growth were one-off boons, but they are no more. Growing inequality exacerbates demography. Slow growth is here to stay, say the secular stagnationists.

What is wrong with this story? The one word answer is 'technology'. The responsibility of economic historians is to remind the world what things were like before 1800.

Growth was imperceptibly slow, and the vast bulk of the population was so poor that any disruption in food supply caused by a harvest failure could kill millions. Almost half the babies born died before reaching the age of five, and those who made it to adulthood were often stunted, ill, and illiterate. What changed this world was growth driven by technological progress. Starting in the late 18th century, innovations and advances in what was then called 'the useful arts' slowly began improving life, first in Britain, then in the rest of Europe, and eventually in much of the rest of the world. The story has been told many times over, but as Nobelist Robert Lucas once wrote, once you start thinking about it, it's hard to think of anything else.

Why did it all happen? In brief: science advanced. The exact interaction between science and technology is a subtle and complex one, time-variant, and culture-specific. There can be little doubt that technology *can* advance without a good scientific understanding of why techniques work the way they do, but such progress was halting and slow, and inevitably ran into diminishing returns and fizzled out. After 1750 the epistemic base of technology slowly began to expand. Not only did new products and techniques emerge; it became better understood why and how the old ones worked, and thus they could be refined, debugged, improved, combined with others in novel ways and adapted to new uses. In short: scientific progress led to productivity growth and a sharp increase in economic welfare from the mid-19th century on (Mokyr 2002). It was a protracted process, because many of the natural processes were complex and often contained technical problems that defied solution for a long time. But between 1780 and 1914, huge advances were made in the understanding of how to make steel, what makes us sick, what fertilizers to use, how to make artificial substances and materials, and how to convert heat into motion (that is, use engines) – to name but a few.

The important thing to remember is that the relationship was a two-way street. One of the reasons science advanced so rapidly is that technology itself provided the tools and instruments that allowed 'natural philosophers' (as they were known during the Scientific Revolution) to study the physical world. The most famous of those was the telescope, used by Galileo to study the stars – and astronomy would never be the same. A less hackneyed but technologically more significant example is the barometer; invented by a student of Galileo's named Evangelista Torricelli in 1643, it showed the existence of atmospheric pressure. At about the same time, European instrument builders perfected the vacuum pump, showing that, *contra* Aristotle, a vacuum was indeed possible. Those two scientific insights, as much as anything, spurred the development of the first steam engines early in the 18th century (known appropriately as *atmospheric* engines). In 1800 another Italian named Volta invented the 'pile' – the first battery ever made. In its first decades, this contraption served primarily as a tool for chemical research, allowing chemists to map out the newly discovered world of elements and compounds, which unleashed the chemical industries of the 19th century. Or take the improved microscopes developed in the first half of the 19th century. Advances in optics made it possible to eliminate what was known as spherical aberration and thus to get greatly improved image resolution. Would the germ theory of disease and the subsequent revolution in medical technology have occurred without improved microscopes? In that fashion, technology pulled itself up by its bootstraps: an invention in one area allowed scientific progress to occur and thus created technological progress in what could be quite another field.

Compared to the tools we have today for scientific research, those of Galileo and Pasteur look like stone-age tools. Yes, we build far better microscopes and telescopes and barometers today, but digitalisation has penetrated every aspect of science. It has led to the re-invention of invention. It is not just 'IT' or 'communications'. Huge searchable databanks, quantum chemistry simulation, and highly complex statistical analysis are only some of the tools that the digital age places at science's disposal. Digital technology is everywhere, from molecular genetics to nanoscience to research in medieval poetry. Quantum computers, still quite experimental, promise to increase this power by orders of magnitude. In much recent writings, the importance of ICT on output and productivity has been stressed, and it is clearly of great importance. What needs to be kept in mind, however, is that the *indirect* effects of science on productivity through the tools it provides scientific research may, in the long run, dwarf the direct effects. A striking example is the growing use of high-powered computers and radically new software in material science.

Materials are the core of our production. The terms Bronze Ages and Iron Age signify their importance; the great era of technological progress between 1870 and 1914 was wholly dependent on cheap and ever-better steel. In many ways, core-materials can be viewed as general-purpose technologies made famous by Bresnahan's and Trajtenberg's (1995) seminal paper on the topic. But what is happening to materials now is nothing short of a sea change, with new resins, ceramics, and entirely new solids designed *in silico*, being developed at the nano-technological level. These promise the development of materials nature never dreamed of and that deliver custom-ordered properties in terms of hardness, resilience, elasticity, and so on. Graphene, the new super-thin wonder material, is another substance that promises to revolutionise production in many lines. The new research tools in material science have revolutionised research. Historically, progress in material science had been always the result of tedious and inefficient 'trial and error' or highly uncertain serendipity. The classic example is William Perkin's discovery of aniline purple in 1856 and Henry Bessemer's invention of the eponymous steel-making process the same year. Compare those with the situation today: researchers can now can simulate *in silico* the quantum equations that define the properties of materials, using high-throughput super-computers, and experiment with materials having pre-specified properties.

But not all research tools depend wholly on computational capacity. Of perhaps even more revolutionary importance is the powerful technology developed by Stanley Cohen and Herbert Boyer in the early 1970s, in which they succeeded in creating transgenic organisms through the use of micro-organisms. Genetic selection is an old technology; nature never intended to create poodles. But genetic engineering is to artificial selection what a laser-driven fine-tuned surgical instrument is to a meat axe. The potential economic significance of genetic engineering is simply staggering, as it completely changes the relationship between humans and all other species on the planet. Ever since the emergence of agriculture and husbandry, people have 'played God' and changed their biological and topographical environment, creating new phenotypes in plants and animals. Genetic engineering means we are just far better at it.

Not all of it will be net progress; much of it is needed to offset the unanticipated costs of previous technological advances, most obviously climate change. But the advance can be seen in less expected areas. In the first half of the 20th century, a vicious fungus imported unintentionally from the Far East wiped out practically the entire population of American chestnuts (around four billion trees). Recent work has transplanted a gene that carries immunity from the by-products produced by the fungus (from wheat genes) into the somatic cells of chestnut trees, and these transgenic trees promise to be immune and may lead to the resurrection of a once-proud American icon and reverse one of the worst ecological disasters that ever befell North America (Rosen 2013).

As science moves into new areas and solves issues that were not even imagined to be solvable, there are inventors, engineers, and entrepreneurs waiting in the wings to use the new knowledge and design new gizmos and processes based on it that mostly will continue to improve our lives. The interplay between science and technology creates a self-reinforcing or ‘auto-catalytic’ process that seems unbounded.

Speculation on what the new technologies will look like is rife. Robots and the artificial intelligence are front and centre in this debate, at once wished-for (who likes making beds?) and feared as job-killers. ICT remains an area in which we have not seen the half of it, with the much-heralded ‘internet of things’ touted as the next breakthrough. But perhaps the most unexpected advances may come from less glamorous corners. Combine the new materials mentioned above with three-dimensional ‘printing’ and you have mass-customisation, a truly revolutionary concept in the history of manufacturing the like of which was not seen since the Industrial Revolution. ‘Nanobombs’ that physically penetrate bacterial and other cell membranes are the next weapon in mankind’s never-ending war on microbes and possibly cancer. An area of progress few anticipated a decade ago is the use of ICT in the utilisation rate of fixed assets such as real estate and cars, as well as human capital. Enterprises such as Airbnb, Uber, Lyft and others are creating rental markets for assets that were previously lying idle much of the time. Many of these breakthroughs are not 'on the horizon' – they are here. The economy may be facing some headwinds, but the technological tailwind is more like a tornado.

So, if everything is so good, why is everything so bad? Why the gloominess of my colleagues? Part of the story is that economists are trained to look at aggregate statistics like GDP per capita and its derivatives such as factor productivity. These measures were designed for a steel-and-wheat economy, not one in which information and data are the most dynamic sector. Many of the new goods and services are expensive to design, but once they work, they can be copied at very low or zero costs. That means they tend to contribute little to measured output even if their impact on consumer welfare is very large. Dealing with altogether new goods and services was not what these numbers were designed for, despite the heroic efforts by BLS statisticians. The aggregative statistics miss much of what is interesting.

Another characteristic of many of these goods is the 'dumbing-down' of the user; the ingenuity in a piece of modern technology such as a smartphone is fully frontloaded. A few thousand highly skilled and creative hardware engineers and a few tens of thousand software and application writers design it with incredible technical sophistication, so that hundreds of millions can use it without any. For that reason, there are few jobs in the high-technology sector, but those that are there pay well. Modern technology often leads to winner-take-all outcomes, and the inequality implications in terms of income – though *not* in terms of access to the good itself – are worrisome. What we gain as consumers, citizens, viewers and patients we may lose as workers. The demand for labour 'hollows out' and the demand for medium-skilled labour declines unless and until new jobs are created to absorb those replaced by automatons and robots.

It is impossible to know if such jobs will be created at a sufficient pace. Our own time has created occupations that may have sounded incomprehensible or grotesque to our grandparents, from cybersecurity experts to video-game designers to canine psychiatrists. If the past is any guide, the future holds occupations that will look just as strange to us. This very human shortfall of imagination is largely responsible for much of today's pessimism. In many other respects, too, the labour-market outlook is not wholly bleak. The nature of the labour market is changing, to be sure, but if telecommuting and driverless cars can cut the commuting time for an increasingly urbanised workforce tormented by traffic jams, at least one major (and uncounted) tax on workers will be eliminated. Such an improvement would not be reflected in the aggregate output and productivity statistics.

In short: technology is not our enemy, it is our best hope. It will never be painless, and there will always be those who draw the short straw in the vast lottery of creative destruction. But if you think rapid technological change is undesirable, try secular stagnation.

References

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