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The past and the future of innovation: Some lessons from economic history[☆]

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A B S T R A C T

In recent years, economists have revived the specter of slow growth and secular stagnation. From the point of view of economic history, what should we make of such doomster prophecies? As economic historians all know, for 97% or so of recorded history, the stationary state well-describes the long-run dynamics of the world economy. Growth was slow, intermittent, and reversible. The Industrial Revolution rang in a period of sustained economic growth. Is that growth sustainable? One way to come to grips with that question is to analyze the brakes on economic growth before the Industrial Revolution and examine how they were released. Once these mechanisms are identified, we can look at the economic history of the past few decades and make an assessment of how likely growth is to continue. The answer I give is simple: there is no technological reason for growth in economic welfare to slow down, although institutions may become in some area a serious concern on the sustainability of growth.

1. Introduction

A concern that economic growth may be coming to an end is not unusual during a severe recession: Hansen wrote his famous article proposing the concept of secular stagnation at the end of Depression (Hansen, 1939), and Summers (2016), inspired by the 2008 recession, has recently revived the concept. The most detailed pessimist prognostications are Cowan (2011) and Gordon (2016). Gordon and Cowan come from the supply side and believe that technological progress has sufficiently exhausted itself to be unable to counteract other "headwinds," whereas Summers focuses on aggregate demand.[1] In what follows I will focus entirely on the supply side, because insufficient aggregate demand and excess savings, insofar as they are a problem at all, can and probably will be offset by growing government deficits, at least in the U.S.

As I will argue below, reports of the demise of technology-driven economic growth in the developed world are premature. It is of course true that *measured* GDP growth and variables derived from it such as TFP growth have performed poorly in the twenty-first century after 2006. Gordon (2018, p. 16) insists on using productivity growth as his "metric of transformation." There is serious doubt whether such measures are a correct reflection of the actual achievements of technological progress. In a seminal article, William Nordhaus has argued that we have failed to measure correctly the true rate of price decline in lighting.[2] More generally, the

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1 A particularly insightful analysis is Vijg (2011). See Mokyr (2013) for details on his predictions.

2 Nordhaus (1997). The quality improvement of lighting has experienced a resurgence in the recent decade with the emergence of LED lighting, which is far more energy efficient, involves no fire hazards, has much greater durability (30 to 50 times that of incandescent bulbs) and provides more light than earlier-generation light bulbs, including halogen lights. Lighting accounts for 15% of global electricity consumption and 5% of worldwide greenhouse gas emissions. If all lighting switched world-wide to LED lights, we would cut lighting-demand for power back by 85% ("Rise and Shine", 2015). A similar calculation for the decline of the cost of computing power was recently suggested, only half tongue-in-cheek, by

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tenuous link between productivity growth and welfare-enhancing technological progress seems to have become weaker in the past decades. There are many reasons for this, including the *un*-measurement (as opposed to *mis*measurement) of improvements in digital technology, the rapid improvement in the quality of many existing products, and the hard-to-measure improvements in the service sector, such as the public sector, diagnostic and preventive medicine, and on-line retail commerce. To put it differently, students of contemporary technological progress should wean themselves of TFP-fetishism; aggregate measures such as GDP (the basis for TFP calculations) were designed for a wheat-and-steel economy, not for an information and mass-customization economy in which the service economy accounts for 70–80% of value added. While GDP may still be useful for assessing short-term cyclical fluctuations, its value for an age of rapid product innovation is questionable (Coyle, 2014). What matters here is not just that TFP mismeasures the true rate of technological change (which has always been understood), but that the gap is growing over time. The very phenomenon it purports to measure increases the mismeasurement. For that reason, the TFP data that Gordon (2018) employs tell us little about the rate of innovation in the past (much less the future), whereas the narratives in his book (2016) do so in spades.

Many of the issues that Gordon (2018) outlines are real, but none of them demonstrates that the rate of technological progress will slow down. Part of the techno-pessimist predictions seem internally inconsistent. One cannot worry about possible technological unemployment or "layoffs that occur when machines replace labor" (Gordon, 2018, p. 5) and at the same time be concerned about labor productivity not rising. Another problem is that the United States may have become in some ways atypical of the industrialized world: with its welfare state under pressure and growing income inequality, it has shown less willingness or ability to deal effectively with the losers who also accompany technological disruptions. The rise in mortality rates documented by Case and Deaton and cited by Gordon is rather atypical and concentrated among some specific demographic groups. As shown by Alon (2017), some of the growing inequality in the U.S. can be attributed to a deterioration of the education system (specifically high schools) that occurred in the 1970s when vocational education was downgraded and pre-college specialization was phased out, and one that is fairly easily remedied. Most important, however, is the expected impact of digital technology and artificial intelligence on the quality and content of teaching (see below). In contrast to Gordon's dire predictions, then, human capital can expect major improvement in the foreseeable future.

What can the economic historian add to this debate? Very slow economic growth, even "secular stagnation," were of course the rule almost everywhere before the Industrial Revolution. In what follows, I sum up my views on the origins of what McCloskey (2016) has felicitously termed the "Great Enrichment."[3] It focuses on the basic fact, known to every economic historian, that before the Industrial Revolution economic growth was slow, intermittent, and reversible. Years of growth were normally offset by years of decline. Even after the Great Enrichment, episodes of economic decline did happen, but the "good years" began to outweigh the bad ones. Economies became more resilient to outside shocks, whether natural or man-made. Asking "why" economic growth was so weak before the Industrial Revolution may seem otiose, since it was the normal, natural state of affairs. Yet the answers points to the many ways in which "modern" economies differ from traditional ones, and thus underline that the Industrial Revolution was in many ways what the physicists call a "phase transition," a major transformation not only of the level and rate of growth of the system, but rang in an entirely new economic dynamic. It is almost like writing the history of life on earth during the Cenozoic era: mammal species proliferated and evolved, but the entire dynamic of evolution and the environment in which it took place changed in geologically very recent times with the appearance of homo sapiens.

2. Three reasons why economic growth was so slow before the industrial revolution

The literature on why and how modern economic growth emerged in the West is vast. In my own writing, as well as that of many others, a large number of theories and arguments have been proposed. I will single out below three fundamental classes of models that have been adduced to explain why there was so little growth before the Industrial Revolution, but no claim is made that they exhaust the issue. The three classes are: Malthusian demographic dynamics; political economy and rent-seeking; and the absence of a foundation of knowledge (epistemic base) of techniques in use.

By far the most popular and widely cited reason why premodern economies did not grow faster is population dynamis. The idea was famously enunciated by Malthus and has since carried its name, although it was perhaps most eloquently expressed by Wells (1923, p. 68): humanity "spent the great gifts of science as rapidly as it got them in a mere insensate multiplication of the common life." The argument is known to every economist. Under some fairly reasonable assumptions, any rise in income per capita or productivity, whether derived from the "great gifts of science" or any other source, will lead to a decline in deaths and a rise in births, and as population growth sets in, diminishing returns to a fixed factor such as land or more generally the environment will set in, and income will decline (Clark, 2007; Galor, 2011; Ashraf and Galor, 2011).[4]

De Long (2017) who has calculated that the cost of a new iphone using the technology of 1957 would be 150 trillion dollars and consume 30 times the electricity power of the world today.

[3] The term "Great Enrichment" seems better suited than the term "Great Divergence" popularized by Pomeranz (2000). The latter focuses on the relative gap between West and East, without recognizing that even in the areas that fell behind (and still have not fully caught up), poverty has declined sharply and living standards are far higher than they were in 1750, the alleged date at which "divergence" began.

[4] Recent thinking about Malthusian models in history has considerably modified our strong commitment to the "iron law of wages" as a powerful constraint on growth in the past. Highly developed regions were more urbanized and experienced higher mortality rates. Through this and other mechanisms, economic growth raised the death rates and thus allowed the Malthusian system to have multiple equilibria: one highly urbanized and mobile, and the other traditional Malthusian describing a population of subsistence farmers (Voigtläender and Voth, 2013a, 2013b). In the Netherlands and England, estimated GDP was not wholly stationary as fundamentalist Malthusians have asserted, and roughly doubled between the