Dinàmica Macroeconòmica 2019-2020

"All truth passes through three stages. First, it is ridiculed. Second, it is violently opposed. Third, it is accepted as being self-evident." **Arthur Schopenhauer (1788–1860)**

1. Technological solutions are not complete solutions

"… global hunger is often seen as a technical problem, rather than a distribution problem. Thus, the Green Revolution, initiated in the mid-1900s, was offered as a way to increase global production of food, declaring that this would help stem international hunger. It was also part of a development project that hoped to undercut revolutionary movements in the Third World. Rather than promoting the redistribution of land through agrarian reform, to give people access to the means of production, a technical package was promoted throughout the global South (…) High-yield varieties of cereal crops, which required massive inputs of fertilizers and pesticides, and extensive systems of irrigation, were promoted (…) This model imposed the industrial-agricultural practices of the global North throughout the world. The Green Revolution geared agricultural production to specialization in exports. It furthered the concentration of land within nations, as the new practices were expensive to operate and maintain (…) The Green Revolution did increase global food production at a rate that surpassed population growth. However, hunger, malnutrition, and famine persisted. This illustrates the important point that technological fixes rarely solve problems that have their origin in larger social structures. Obviously, producing enough food for all people is a *necessary* condition to avoid hunger, but it is far from a *sufficient* one. Thus, although society is faced with a technical challenge of producing enough food, high food production will not in and of itself eliminate hunger."

York, Richard; Brett Clark (2010): "Nothing new under the sun? The old false promise of new technology", Review (Fernand Braudel Center) 3(2/3), 203-224.

"The main difficulty underlying the use of technology to solve social problems is that these problems are fundamentally different from technical problems."

Volti, Rudi (2017): *Society and technological change*, Worth Publishers, New York.

2. When technologies solve a problem, they create new ones

"The industrial 'solution' to the soil and food crises has contributed to the climate crisis, while agricultural land continues to be degraded. The historic pattern with regard to addressing the depletion of soil nutrients is clear: each 'solution' creates new problems, new ecological rifts, without necessarily solving the old one."

"Many of the aforementioned solutions are rooted in a sincere concern to address climate change. Each of these 'new ideas' to attend to longstanding ecological contradictions are based on the same approach that capitalism has always used to confront crises frame each crisis as a technical problem that can be solved through modern technology, while ignoring the social barriers to adoption and the underlying socio-ecological contradictions of the capitalist world-system (…) This approach is very dangerous, given that if a problem is assumed solvable through technological development, it is also assumed that it is unnecessary to take actions to preserve forests, curtail the burning of fossil fuels, transform agricultural production, and change the political-economic conditions that have created these problems. Each of the proposed solutions identified above entails numerous unintended ecological consequences and would, therefore, likely set off another wave of environmental problems that would need to be addressed in the future."

"Capitalism is inherently anti-ecological as it systematically subordinates nature in its pursuit of endless accumulation. Its appetite is insatiable, as it attempts to overcome, surmount, and/or conquer what ever social and natural obstacles it confronts in its development. Even if the proposed solutions were implemented, the social rela tions driving ecological degradation are still in place, continuing to generate problems."

York, Richard; Brett Clark (2010): "Nothing new under the sun? The old false promise of new technology", Review (Fernand Braudel Center) 3(2/3), 203-224.

"…technological advance has been the greatest single source of economic growth. (…) While technological development has been the primary source of economic advance, it has not been cost-free. One of the most pleasant myths about technology is that it can work its wonders without altering existing social arrangements. Americans in particular have often seen technological progress as the surest basis for progress in general, and have tended to believe that technological solutions to problems are less painful than solutions that require political or social changes (…) Technological change is often a subversive process that results in the modification or destruction of established social roles, relationships, and values. Even a technology that is used exclusively for benign purposes will cause disruptions by altering existing social structures and relationships."

Volti, Rudi (2017): *Society and technological change*, Worth Publishers, New York.

3. The paradox of development (Morris, 2010)

"Rising social development generates the very forces that undermine further social development." An unintended consequence of success is new the emergence of new problems, whose solutions lead to additional (probably, more serious) problems. Social development stagnates or declines when the challenge of temporary success is not met: every society races against itself under an unstoppable Red Queen effect.

Morris, Ian (2010): *Why the West rules —for now. The patterns of history and what they reveal about the future*, Profile Books, London.

4. Technological change creates winners and losers

"The disruptive effects of technological change can readily be seen in the economic realm, where new technologies can lead to the destruction of obsolete firms (…) Sometimes the disruption is less apparent when technological innovation results in the creation of entirely new industries that are not in direct competition with existing ones. Many new industries and individual firms owe their existence to the emergence of a new technology. Witness, for example, the rapid growth of personal computer manufacturing, peripheral equipment production, software publishing, and app development that followed the invention of the integrated circuit."

"Technological changes, both major and minor, often lead to a restructuring of power relations, the redistribution of wealth and income, and alterations to human relationships. One recent and much-debated instance of a disruptive new technology is the rise of ride-sharing services like Uber and Lyft."

Volti, Rudi (2017): *Society and technological change*, Worth Publishers, New York.

5. The Jevons paradox: improving the efficieny in the use of a resource (by adopting a new technology) does not imply reducing the use of the resource

"It is wholly a confusion of ideas to suppose that the economical use of fuel is equivalent to a diminished consumption. The very contrary is the truth." (Jevons, 1866, p. 123)

"The number of tons of coal used in any branch of industry is the product of the number of separate works, and the average number of tons consumed in each. Now, if the quantity of coal used in a blast-furnace, for instance, be diminished in comparison with the yield, the profits of the trade will increase, new capital will be attracted, the price of pig-iron will fall, but the demand for it increase; and eventually the greater number of furnaces will more than make up for the diminished consumption of each. And if such is not always the result within a single branch, it must be remembered that the progress of any branch of manufacture excites a new activity in most other branches, and leads indirectly, if not directly, to increased inroads upon our seams of coal." (Jevons, 1866, pp. 124-125)

Jevons, William Stanley (1866): *The coal question*, 2nd ed., Macmillan, London.

"While on the surface it seems obvious that improvements in efficiency must help curb resource use, since by definition improved efficiency reduces the amount of resources used per unit of production or consumption, there is a considerable amount of evidence that rising efficiency is often correlated with rising resource use at various scales and in various contexts through its connection to growth of production and consumption."

York, Richard; Julius Alexander McGee (2015): "Understanding the Jevons paradox", Environmental Sociology, DOI: 10.1080/23251042.2015.1106060.

6. Information ≠ knowledge ('Big Data ≠ Big Wisdom'), technological world ≠ social world

"Those who have the technical knowledge and competence (…) to invent the marvelous technologies that are integral parts of our lives do not necessarily have the accompanying social, managerial knowledge, and skills (…)—in short, the maturity—that are necessary to manage their marvelous creations. They are so mesmerized by the positive aspects of their inventions that they are virtually unable to consider the inevitable negative aspects, let alone to do anything serious about them until the worst actually happens (…) The technology community has only itself to blame for not practicing proactive crisis management. While not perfect by any means, proactive crisis management is the best we have in anticipating and planning for the worst, and especially, doing everything humanely possible to ensure that it never happens. But to do this requires technology companies with a greater conscience. Designing and sustaining ethical technology companies are a task of the utmost importance. Nothing less ensures that technology will continue to be one of the greatest threats facing humankind."

"More than two decades into the internet revolution, we now know that 'technology is an amplifer' for humanity's worst traits as well as our best. What it doesn't do is make us better people." (Nicholas Carr, "Connection Can Bred Contempt", cited in The Week, May 5, 2017, p. 16, cited in Mitroff, p. vii)

Mitroff, Ian I. (2019): *Technology run amok. Crisis management in the digital age*, Palgrave Macmillan, Cham, Switzerland.

7. Facts that, together, lead an organization and its leaders to disaster

"1. Too much early success is actually detrimental to long-term survival and prosperity. It makes one complacent and thereby blind to the fact that there are serious problems lurking within one's basic business model that need to be addressed sooner rather than later.

2. The fact that one has weathered early crises also blinds one to the fact that one needs to start building a serious program in crisis management in order to be prepared for major crises later on that can't be easily dismissed.

3. The smug assumption that compared to technology, management is easy, if not trivial, prevents one from taking management seriously (…)

4. The best crisis-prepared companies take immediate responsibility for their crises. They don't issue meaningless apologies that only make the initial crises worse.

5. And, finally, The Technological Mindset blinds its proponents to the fact that all technologies are abused and misused in ways not envisioned by their creators. Worst, it seriously hampers one from considering that all technologies come with serious downsides, and therefore, from taking appropriate preventative actions to mitigate their worst effects."

Mitroff, Ian I. (2019): *Technology run amok. Crisis management in the digital age*, Palgrave Macmillan, Cham, Switzerland.

8. Theoretical approaches on the choice and effects of technologies

"… how scholars have historically explained technology choices in the workplace. Two schools of thought have dominated explanations to date. The first school, known as technological determinism, predicts inevitable and universal roles, patterns of use, and

Mapping Theoretical Perspectives on Technology Choices along Two Dimensions

	Determinism *Outcomes are inevitable; external forces are the agents of change*	**Voluntarism** *Outcomes are not inevitable; humans are the agents of change*
Materialism *Physical causes drive human action*	Technological determinism • Contingency theory • Fitts lists	Sociomateriality Critical realism
Idealism *Ideas and beliefs drive human action*	Deskilling/Upskilling theories	Social constructivism • Structuration theory • Practice theory

consequences for a technology; the second school, <u>social constructivism</u>, argues for local roles, patterns of use, and consequences that are particular to individuals or organizations."

"The first distinction is between <u>determinism</u> (external forces are the agents of change; outcomes are inevitable) and <u>voluntarism</u> (humans are the agents of change; outcomes are not inevitable). The second distinction is between <u>materialism</u> (physical causes drive human action) and <u>idealism</u> (ideas and beliefs drive human action). We show that, in the two-by-two scheme that results from these two distinctions, technological determinism is a form of materialistic determinism, and social constructivism is a form of idealistic voluntarism. Recent alternatives to these two schools of thought, including sociomateriality and critical realism, are forms of materialistic voluntarism. We argue that idealistic determinism, the understudied fourth conceptual space in this two-by-two scheme, offers the potential for a new, alternative perspective whose advantages address the shortcomings of existing explanations of technology choice."

Bailey, Diane E.; Paul M. Leonardi (2015): *Technology choices: Why occupations differ in their embrace of new technology*, MIT Press, Cambridge, MA.

9. The more complex a technology, the less comprehensible and the less secure?

"... today's technological complexity has reached a tipping point. The arrival of the computer has introduced a certain amount of *radical novelty* to our situation (...) Computer hardware and software is much more complex than anything that came before it, with millions of lines of computer code in a single program and microchips that are engineered down to a microscopic scale. As computing has become embedded in everything from our automobiles and our telephones to our financial markets, <u>technological complexity has eclipsed our ability to comprehend it</u>."

"... we simply have no idea of the huge number of ways that these incredibly complex technologies can go wrong."

"... there are certain trends and forces that overcomplicate our technologies and make them incomprehensible, no matter what we do. These forces mean that we will have more and more days like July 8, 2015, when the <u>systems we think of as reliable come crashing down in inexplicable glitches</u>."

Arbesman, Samuel (2016): *Overcomplicated. Technology at the limits of comprehension*, Current, New York.

> **"People are just curious. What follows in the wake of their discoveries is something for the next generation to worry about."**
> **Werner von Braun**

10. Defining elements of technology: how controllable is technology?

"<u>We live in an era of technological enthusiasm</u>. It's not too vast a generalization to say that Americans, along with much of the world, are deeply, passionately in love with the technologies they use in their personal lives. We're also beguiled by the promises of scientists and engineers who say that, thanks to them, we'll soon be able to do just about anything we want to do. 'At our current rate of technological growth,' said Elon Musk, CEO of Tesla Motors and SpaceX, 'humanity is on a path to be godlike in its capabilities.' (...) Such comments also testify to a more recent wrinkle in utopian visions: that <u>new technologies will be able to remedy the problems created by previous technologies</u>. We see the same faith at work in the conviction of those who believe we'll come up with some way of reversing the catastrophe of global warming by 'geoengineering' the climate of the entire planet."

"Four basic, overlapping characteristics or sets of characteristics can be cited as <u>fundamental elements of the nature of technology</u>. They are (1) Technology is by nature <u>expansive</u>. (2) Technology is by nature rational, direct, and <u>aggressive</u>. (3) Technology by its nature <u>combines</u> or converges with other technologies. (4) Technology by its nature strives for <u>control</u> (...) The four characteristics (...) point to the central question of <u>whether technology at some point becomes autonomous</u>— that is, does technology at an advanced stage of development become impossible for human beings to control?"

"If there is a single lesson (...) that I could drum into the mind of every technician on the planet, it would be the <u>certainty of uncertainty</u>. For despite their willingness to acknowledge uncertainty on the micro level and to use it to improve performance, technophiles consistently evince a depressingly broad degree of myopia in regard to uncertainty on the macro level. In other words, scientists and engineers will focus intently on the inconsistencies that appear within their specific projects and work diligently to get rid of them. At the same time they'll be perfectly willing to overlook the unpredictable results of their projects' interactions with other, supposedly unrelated technologies in the world at large. In doing so they ignore two (…) principles:

1. There are no unrelated technologies.

2. The more powerful a given technology, the more widely its effects will radiate outward, the more difficult it will be to predict those effects, and the more damaging those effects can potentially be (…) The effects of powerful technologies radiate outward, producing in the process consequences that are both unintended and unexpected, often at velocities that exceed our ability to stop or contain them."

"Technology doesn't fix technology, technology *demands* technology. Given that we seem unable to make even minor sacrifices of consumption and convenience, we probably have no choice but to stay, in some fashion, the technological course (…) The societies we've constructed are so utterly dependent on our machines that any attempt to abruptly disconnect would be spectacularly, fatally disruptive. Unless and until we find a way to reposition ourselves in relation to nature, we're pretty much stuck."

"It's a truism that power corrupts, and at its most fundamental level technology is about power. It follows that arrogance and overconfidence may be natural by-products of technological power."

"[Norbert Wiener] said that the only true security comes from 'humility and restrained ambitions' (…) Technology is a two-edged sword, he said, 'and sooner or later it will cut you deep'."

"I see no harm in mentioning two general suggestions that would, if widely and comprehensively pursued, move us in a positive direction. The first of these is restraint. Cut back, on everything (…) My second suggestion is (…) pay some attention to redressing the imbalance, in the culture in general and in education in particular, between means and ends."

Hill, Doug (2016): *Not so fast: Thinking twice about technology*, The University of Georgia Press, Athens, Georgia.

11. Some laws on technology

- Arthur C. Clarke's third law of prediction: "Any sufficiently advanced technology is indistinguishable from magic."
- Variation on Clarke's third by Mark Stanley (Freefall): "Any technology, regardless of how advanced, will seem like magic to those who do not understand it."
- Melvin Kranzberg's six laws of technology
  - First law. "Technology is neither good nor bad; nor is it neutral."
  - Second law. "Invention is the mother of necessity."
  - Third law. "Technology comes in packages, big and small."
  - Fourth law. "Although technology might be a prime element in many public issues, nontechnical factors take precedence in technology-policy decisions."
  - Fifth law. "All history is relevant, but the history of technology is the most relevant."
- Amara's law (Roy Charles Amara, 1925-2007): "We tend to overestimate the effect of a technology in the short run and underestimate the effect in the long run."
- Hutber's law (Patrick Hutber): "Improvement means deterioration." (Anything presented as an improvement hides a deterioration.)

- Murphy's laws (Koch, Richard (2013): *The 80-20 principle and 92 other power laws of nature*)
    - o "Left to themselves, things go from bad to worse."
    - o "If anything can go wrong, it will."
    - o "If several things can go wrong, the one that will cause the most damage will go wrong first."
    - o "If anything just cannot go wrong, it will anyway."
    - o "The probability of anything happening is proportional to the damage it will cause."

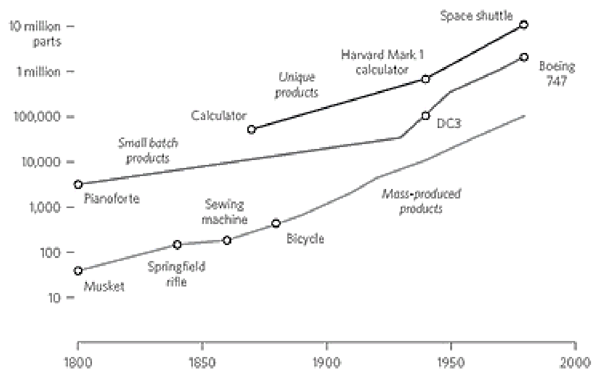
12. Is technological evolution inevitable?

"… we do have three types of evidence strongly suggesting that <u>the paths of technologies are inevitable</u>:

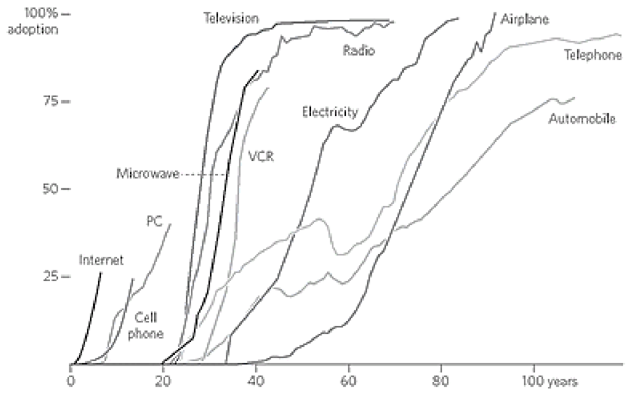
1. In all times we find that <u>most inventions and discoveries have been made independently</u> by more than one person.

2. In ancient times we find <u>independent timelines of technology on different continents converging</u> upon a set order.

3. In modern times we find sequences of improvement that are difficult to stop, derail, or alter."



Complexity of manufactured machines



Accelerating Pace of Technology Adoption. The percentage of U.S. consumers owning or using a particular technology plotted over the number of years since its invention

Kelly, Kevin (2010): *What technology wants*, Viking, New York.

13. The technological project

Capaldi and Lloyd (2011, pp. xiii-xv) hold that the <u>rise of the tecnological project</u> in the West (the <u>control and transformation of nature for human benefit</u>) has been the most important development in the last 400 years. They attribute to the technological project: (i) the changes in the mind set, beliefs and institutions in the West; (ii) the expansion of the West to dominate the Rest; (iii) the Industrial Revolution; and (iv) the internationalization of Western institutions ('globalization'). <u>The free market economy is seen as the most effective institution to develop the technological project</u>.

14. The two competing narratives of Political Economy

(i) <u>The liberty narrative</u>. It originated with John Locke but became associated with Adam Smith. This narrative: (a) promotes personal autonomy and both economic and political liberty; (b) has a positive view of markets, technology and private property; and (c) encourages the pursuit of happiness (progress is improvement).

(ii) <u>The equality narrative</u>. It originated with Jean-Jacques Rousseau but became associated with Karl Marx. This narrative: (a) promotes the social good, restrictions of individual autonomy and both economic and political equality; (b) emphasizes the problems caused by markets, technology and private property; and (c) encourages the securing of happiness (progress is perfection).

Capaldi, Nicholas; Gordon Lloyd (2011): *The two narratives of Political Economy*, Scrivener, Salem, MA and Wiley, Hoboken, NJ.

15. The three recent epochs of capitalism

(1) The Belle Epoch (1880-1914): the first era of global financial capitalism; (2) the Golden Age (1945-1975) of capitalism; (3) the Neoliberal Era (1980-2019): the second era of global financial capitalism. The Belle Epoch, the product of the cumulative development of capitalism, collapsed: two world wars with a Great Depression in between. By comparing the Belle Epoch with the Neoliberal Era, Thomas Piketty (2014) anticipates the persistence of a low-growth regime and a traumatic end to the Neoliberal Era (global wars and economic crises), unless there is a global political peaceful reorganization that stops the forces that, through the progressive accumulation of capital in fewer hands, is exacerbating class conflict. As in the Golden Age, an interventionist welfare state (at a global scale) is the needed counterbalancing force, to temper the forces of global financialization, even at the price of sacrificing economic growth.

Piketty, Thomas (2014): *Capital in the twenty-first century*, Belknap Press, Cambridge, MA.

16. A tale of good news: the possibility of abundance

Diamandis and Kotler (2012) claim that, thanks to progress in exponentially growing technologies (such as robotics, computational systems, artifical intelligence, broadband networks, digital manufacturing, 3-D printing, nanomaterials, human-machine interfaces, synthetic biology, biomedical engineering…) "for the first time in history, our capabilities have begun to catch up to our ambitions. Humanity is now entering a period of radical transformation in which technology has the potential to significantly raise the basic standards of living for every man, woman, and child on the planet. Within a generation, we will be able to provide goods and services, once reserved for the wealthy few, to any and all who need them. Or desire them. Abundance for all is actually within our grasp." "Imagine a world of nine billion people with clean water, nutritious food, affordable housing, personalized education, top-tier medical care, and nonpolluting, ubiquitous energy. Building this better world is humanity's grandest challenge."

17. Emerging forces of abundance

(i) Exponential technologies: networks and sensors; artificial intelligence; robotics; digital manufacturing; infinite computing; medicine; nanomaterials; nanotechnology…

(ii) The do-it-yourself innovator: "small groups of dedicated DIY innovators can now tackle problems that were once solely the purview of big governments and large corporations."

(iii) The technophilanthropists: "The high-tech revolution created an entirely new breed of wealthy technophilanthropists who are using their fortunes to solve global, abundance-related challenges." The rich can, and will, save the world.

(iv) The rising billion, the poorest of the poor. The combination of a global transportation network with the internet, microfinance and wireless communication technology are transforming the bottom billion into an emerging market force: the 'world's biggest market'.

Diamandis, Peter H.; Steven Kotler (2012): *Abundance: The future is better than you think*, Free Press, New York.

18. The Malthusian view (Thomas Robert Malthus)

Assuming that population tends to grow if unchecked and that there is a limit to the increase in agricultural productivity, it is not possible for an economy to enjoy population growth and real income growth: population growth is always constrained by food supply.

19. The Neo-Malthusian view

All economies are ultimately constrained by the carrying capacity of the Earth.

20. The Boserupian view (Ester Boserup)

Population growth is not constrained by food supply, because population growth causes improvements in agricultural productivity and technology: an increasing population leads to the intensification (more labour invested) in the use of existing resources (land).

21. The conventional view: three regimes of economic development

Galor and Weil (1999, p. 150; 2000, p. 806) characterize the process of economic development in terms of three regimes. In historical order, they are called Malthusian, Post-Malthusian, and Modern Growth Regimes.

• In the Malthusian Regime technological progress and population growth was almost negligible ("glacial by modern standards"), whereas income per capita (living standards) was nearly constant. In addition, there exists a positive relationship between income per capita and population growth: an increase in per capita income leads to an increase in population growth.

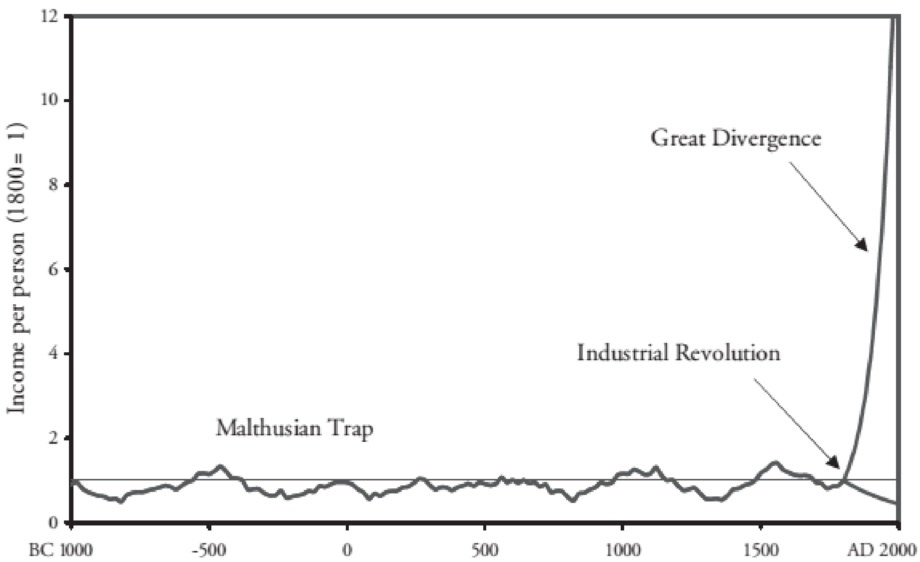
• In the Post-Malthusian Regime income per capita grows but the positive relationship between per capita income and population growth still holds: a rising income per capita continues to lead to a rising population growth rate.

• The Modern Growth Regime is the opposite of the Malthusian Regime: technological level and income per capita steadily grow, at a higher rate than in the Post-Malthusian Regime, and the relationship between the level of income per capita and the population growth rate turns out to be negative, since now a rising income per capita leads to a declining population growth rate.

Galor, Oded; David N. Weil (1999): "From Malthusian stagnation to modern growth", American Economic Review 89(2), 150-154.

Galor, Oded; David N. Weil (2000): "Population, technology, and growth: From Malthusian stagnation to the demographic transition and beyond", American Economic Review 90(4), 806-828.

22. The conventional view of the history of humanity (Clark, 2007, p. 1)

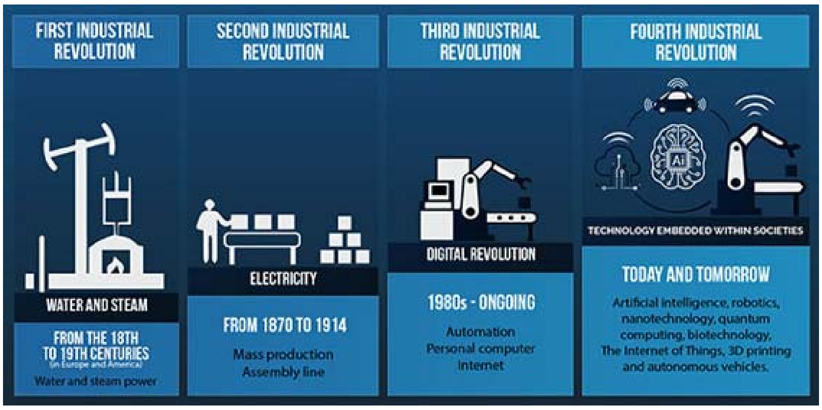


"The basic outline of world economic history is surprisingly simple. Indeed it can be summarized in one diagram [shown on the right, taken from Clark (2007, p. 2)]. Before 1800 income per person—the food, clothing, heat, light, and housing available per head—varied across societies and epochs. But there was no upward trend. A simple but powerful mechanism (...), the Malthusian Trap, ensured that short-term gains in income through technological advances were inevitably lost through population growth. Thus the average person in the world of 1800 was no better off than the average person of 100,000 BC. Indeed in 1800 the bulk of the world's population was poorer than their remote ancestors."

Clark, Gregory (2007): *A farewell to alms: A brief economic history of the world*, Princeton University Press, Princeton, New Jersey.

23. 100 things machines learnt to do in 2016. Sebastian Huembfer, https://goo.gl/fgKVAu
https://medium.com/echobox/100-things-machines-learnt-to-do-this-year-80b727a64231

24. 'Artificial intelligence is the new electricity' (Andrew Ng)



Just as during the Second Industrial Revolution the easy accessibility to electricity made mass production and assembly lines possible, artificial intelligence is seen as the crucial element for the Fourth Industrial Revolution (tool to power other technologies and be a new part of our lives).

Rouhiainen, Lasse (2018): *Artificial intelligence: 101 things you must know today about our future.*

25. Fourth Industrial Revolution (or Industry 4.0, term coined at the Hannover Fair 2011)

"By enabling "smart factories," the fourth industrial revolution creates a world in which virtual and physical systems of manufacturing globally cooperate with each other in a flexible way. This enables the absolute customization of products and the creation of new operating models. The fourth industrial revolution, however, is not only about smart and connected machines and systems. Its scope is much wider. Occurring simultaneously are waves of further breakthroughs in areas ranging from gene sequencing to nanotechnology, from renewables to quantum computing. It is the fusion of these technologies and their interaction across the physical, digital and biological domains that make the fourth industrial revolution fundamentally different from previous revolutions. In this revolution, emerging technologies and broad-based innovation are diffusing much faster and more widely than in previous ones, which continue to unfold in some parts of the world."

	%
10% of people wearing clothes connected to the internet	91.2
90% of people having unlimited and free (advertising-supported) storage	91.0
1 trillion sensors connected to the internet	89.2
The first robotic pharmacist in the US	86.5
10% of reading glasses connected to the internet	85.5
80% of people with a digital presence on the internet	84.4
The first 3D-printed car in production	84.1
The first government to replace its census with big-data sources	82.9
The first implantable mobile phone available commercially	81.7
5% of consumer products printed in 3D	81.1
90% of the population using smartphones	80.7
90% of the population with regular access to the internet	78.8
Driverless cars equaling 10% of all cars on US roads	78.2
The first transplant of a 3D-printed liver	76.4
30% of corporate audits performed by AI	75.4
Tax collected for the first time by a government via a blockchain	73.1
Over 50% of internet traffic to homes for appliances and devices	69.9
Globally more trips/journeys via car sharing than in private cars	67.2
The first city with more than 50,000 people and no traffic lights	63.7
10% of global gross domestic product stored on blockchain technology	57.9
The first AI machine on a corporate board of directors	45.2

Drivers of the Fourth Industrial Revolution. "All new developments and technologies have one key feature in common: they leverage the pervasive power of digitization and information technology."

Why a Fourth Industrial Revolution is under way. (i) "Velocity: Contrary to the previous industrial revolutions, this one is evolving at an exponential rather than linear pace." (ii) "Breadth and depth: It builds on the digital revolution and combines multiple technologies that are leading to unprecedented paradigm shifts in the economy, business, society, and individually." (iii) "Systems impact: It involves the transformation of entire systems, across (and within) countries, companies, industries and society as a whole."

Percentage of respondents who expect that the specific tipping point will have occurred by 2025, Deep Shift—Technology Tipping Points and Societal Impact, Global Agenda Council on the Future of Software and Society, World Economic Forum, September 2015.

Schwab, Klaus (2017): *The fourth industrial revolution*, Crown Business, New York.

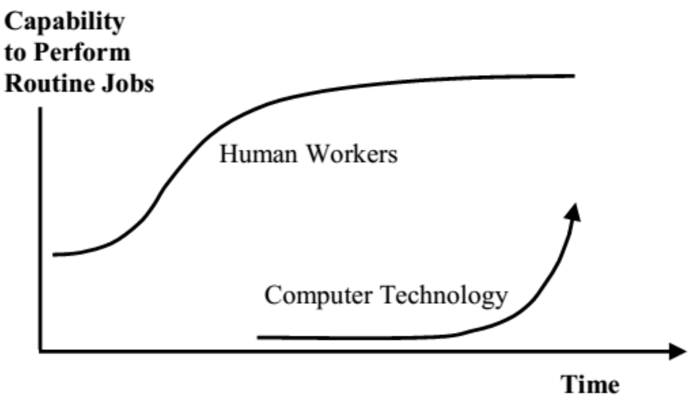
26. On automation (replacement of human jobs by machines)

What if machines will eventually be able to do most jobs people currently do (jobs performed by typical people are automated) and that the people displaced by machines will not be able to find a new job? Martin Ford argues tha when "full automation penetrates the job market to a substantial degree, an economy driven by mass-market production must ultimately go into decline. The reason for this is simply that, when we consider the market as a whole, the people who rely on jobs for their income are the same individuals who buy the products produced." Since machines are not consumers, the more business automate jobs, the smaller becomes the consumer base; with a reduction in the potential set of consumers, business are forced to cut more jobs, so global demand is further narrowed down. Automation then sets in motion a downward spiral process in which the direct gains of automation in production are eventually neutralized by the indirect, global negative impact in consumers' demand.

27. The Luddite fallacy fallacy?

Named after the Luddite movement (start of the 19th century) advocating machine destruction, the Luddite fallacy refers to the claim that machine automation is incapable of creating unemployment at a global scale. The argument is that the unemployment caused by technological innovation (due to the workers' outdated skills) is temporary. On the one hand, automation reduces production costs and, therefore, prices, and that stimulates consumption demand. On the other, technological innovation allows new production activities to emerge and create new job opportunities. This line of reasoning encapsulates the conventional economic wisdom that technological improvements ultimately create jobs.

28. Human capability vs computer technology

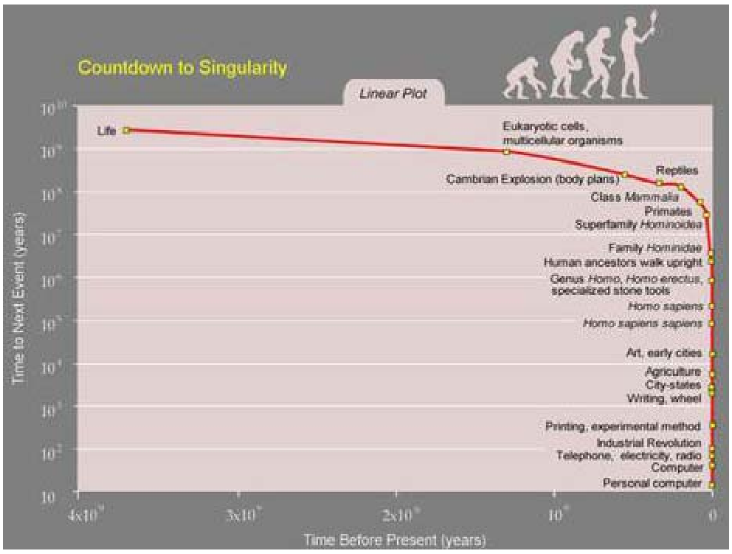


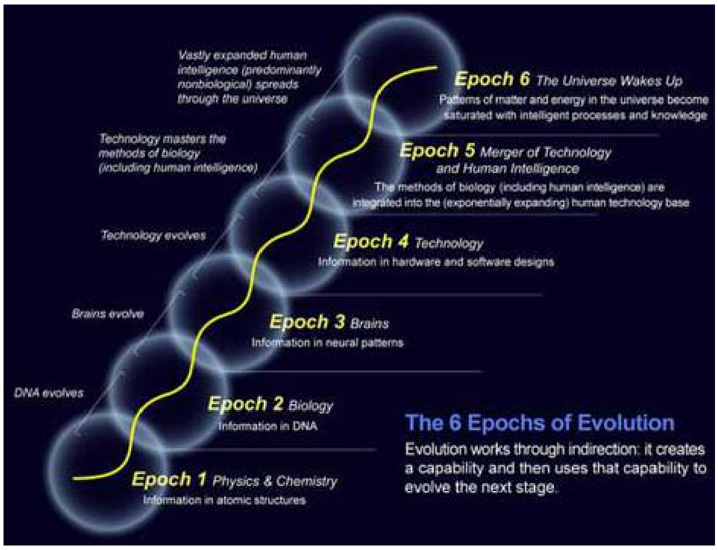
Ford replies to the Luddite fallacy view that they suffer from a fallacy of composition effect. Specifically, that view rests on two premises: (i) machines help workers to raise their productivity; and (ii) the average worker can use machines to improve their productivity. "What happens when these assumptions fail? What happens when machines become workers—when capital becomes labor? It is important to note that such a change in the relationship between workers and machines will have a worldwide impact." "… technological progress will never stop, and in fact, may well accelerate. While today jobs that require low and moderately skilled workers are being computerized, tomorrow it will be jobs performed by highly skilled and educated workers." "The reality is that the Luddite fallacy amounts to nothing more than a historical observation. Since things have worked out so far, economists assume that they will always work out." (Ford, pp. 97-99)

29. The technological singularity (Ray Kurzweil)

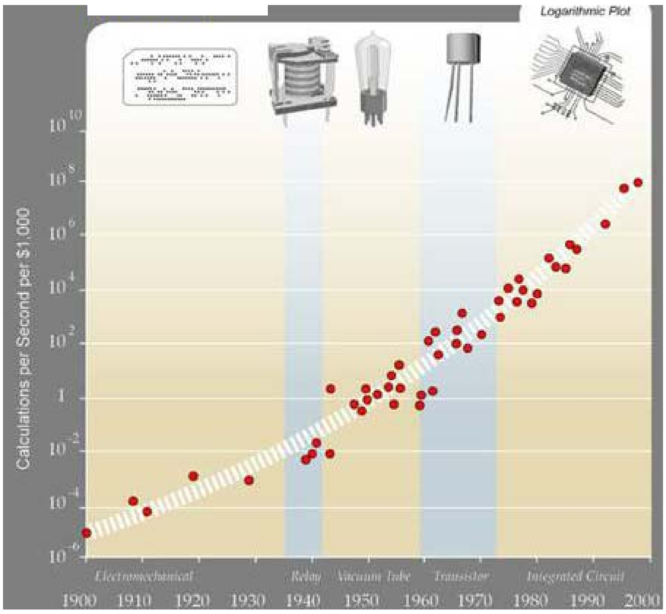
The technological singularity is the hypothesis that exponential technological progress will bring a dramatic change (seismic consequences) in human life and human societies (transcend our biological limitations).

Kurzweil justified this hypothesis on the grounds of the '<u>law of accelerating returns</u>.' A technology subject to this law progresses in proportion to its level: the better the technology, the more rapidly it becomes better. <u>Moore's law</u> is offered as an example: it is the conjecture, by Gordon Moore in the 1960s, that computing power (number of transistors in a fixed area, memory capacity) doubles every 1-2 years. Murray Shanahan hypothesizes that the technological singularity could be precipitated by developments in artificial intelligence and/or neurotechnology.





Moore's law



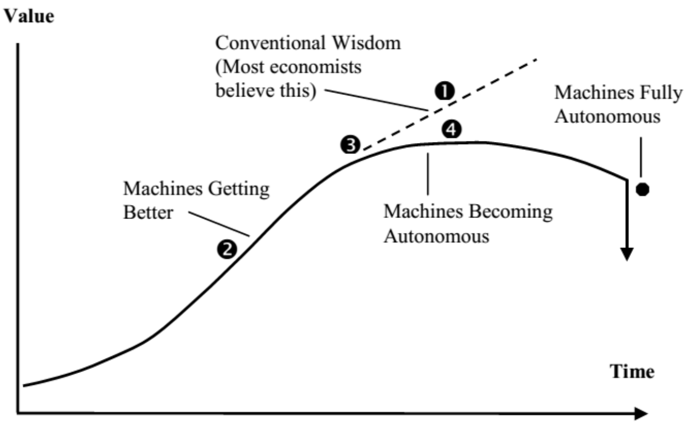
30. The singularity is near

"To this day, I remain convinced of this basic philosophy: no matter what quandaries we face—business problems, health issues, relationship difficulties, as well as the great scientific, social, and cultural challenges of our time—<u>there is an idea that can enable us to prevail</u>. Furthermore, we can find that idea. And when we find it, we need to implement it." (Kurzweil, 2005)

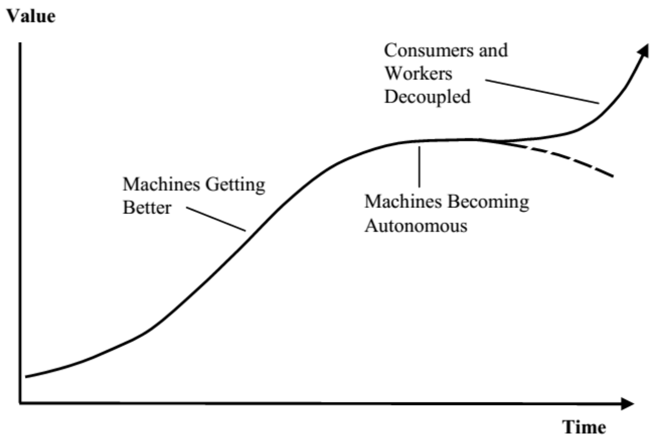
"As the figure demonstrates, there were actually four different paradigms—electromechanical, relays, vacuum tubes, and discrete transistors—that showed exponential growth in the price-performance of computing long before integrated circuits were even invented. And Moore's paradigm won't be the last. When Moore's Law reaches the end of its S-curve, now expected before 2020, the <u>exponential growth will continue with three-dimensional molecular computing</u>, which will constitute the sixth paradigm." (Kurzweil, 2005)

31. Economic paradox of the singularity: technology could kill itself off

"In a free market economy, (…) there is no incentive to produce products if there are no consumers with sufficient discretionary income to purchase those products. This is true even if intelligent machines someday become super-efficient producers. <u>If average—or even exceptional—human beings are unable to find employment within their capabilities, then how will they acquire the income necessary to create the demand that in turn drives production</u>? If we consider the singularity in this context, then is it really something that will necessarily push us forward exponentially? Or could it in actuality lead to rapid economic decline?" (Ford, p. 102)



Ford's 'scary graph': value added (wage, average income) of the average worker operating the average machine (Ford, p. 136: "As more machines begin to run themselves, the value that the average worker adds begins to decline.")



32. Where are we now? Ford's (pp. 224-25) cases

❶ "...conventional wisdom is correct, and the current crisis is just an aberration."

❷ "...we are still far away from the point where automation is going to become important."

❸ "...we are going to see increasing economic impacts, and we will have difficulty in achieving sustained, long-term growth. If I had to bet, I would choose this case."

❹ "If things have gotten away from us, then we could, in fact, be much further along than we imagine. This could perhaps be explained by suggesting that consumer borrowing masked the reality of the situation (...) and that the current crisis is the beginning of the reckoning (...) If this is the case, we need to adopt new policies rapidly."

Ford, Martin R. (2009): *The lights in the tunnel: Automation, accelerating technology and the economy of the future*, Acculant Publishing.

Kurzweil, Ray (2005): *The Singularity is near: When humans transcend biology*, Viking, New York.

Shanahan, Murray (2015): *The technological singularity*, MIT Press, Cambridge, MA and London.

33. Peter Frase's futures

	ABUNDANCE	SCARCITY
EQUALITY	Communism	Socialism
HIERARCHY	Rentism	Exterminism

The future world can end up dominated by either scarcity or abundance (reflecting ecological limits) and also by either hierarchy or equality (reflecting the political limits of a class society). Equality + abundance = communism ('from each according to their ability, to each according to their need'). Hierarchy + abundance = rentism ('the techniques to produce abundance are monopolized by a small elite'). Equality + scarcity = socialism ('live within your means while providing everyone the best lives possible'). Hierachy + scarcity = exterminism ('communism for the few' and 'genocidal war of the rich against the poor').

Frase, Peter (2016): *Four futures: Life after capitalism*, Verso, New York.

34. Joel Garreau's future scenarios

- Curve scenario. Exponential improvement of information technologies extends over genetics, nanotechnology and robotics.
- Singularity scenario. Exponential improvement is unstoppable, a super-intelligence emerges, which continues its own development at an exponential rate.
- Heaven scenario (Ray Kurzweil). All good things happen, even without aiming for them: end of poverty and disease, the coming of peace, the triumph of love, wisdom and beauty…

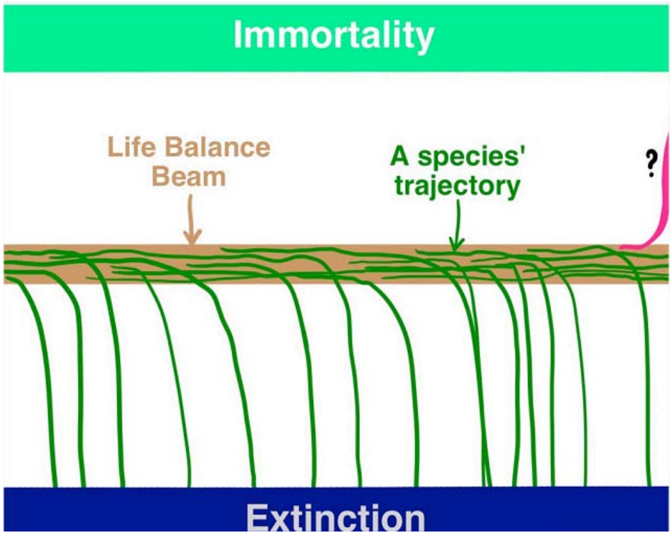
• <u>Hell scenario</u> (Bill Joy). Technological advances (in fields such as genetics, nanotechnology and robotics) will threaten the survival of humanity.

• <u>Prevail scenario</u> (Jaron Lanier). Humanity rises to the occasion: ordinary people choose to follow the right path, and make the right decisions, effectively.

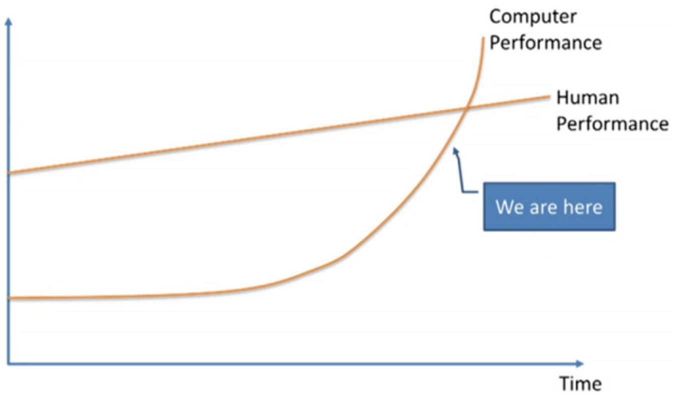
Garreau, Joel (2005): *Radical evolution: The promise and peril of enhancing our minds, our bodies – and what it means to be human*, Doubleday, New York.

Joy, Bill (2000): "Why the future doesn't need us", Wired 8.04.

35. Artificial superintelligence (ASI): curse or blessing?



"… <u>there is no way to know what ASI will do or what the consequences will be for us</u>. Anyone who pretends otherwise doesn't understand what superintelligence means (…) Looking at history, we can see that life works like this: species pop up, exist for a while, and after some time, inevitably, they fall off the existence balance beam and land on extinction—Bostrom calls extinction an attractor state—a place species are all teetering on falling into and from which no species ever returns (…) <u>ASI would have the ability to send humans to extinction, many also believe that used beneficially, ASI's abilities could be used to bring individual humans, and the species as a whole, to a second attractor state—species immortality</u>. Bostrom believes species immortality is just as much of an attractor state as species extinction, i.e. if we manage to get there, we'll be impervious to extinction forever."



"Superintelligence will yield tremendous power—the critical question for us is: Who or what will be in control of that power, and what will their motivation be? The answer to this will determine whether ASI is an unbelievably great development, an unfathomably terrible development, or something in between."

Urban, Tim (2015): *The AI revolution. The road to superintelligence.*

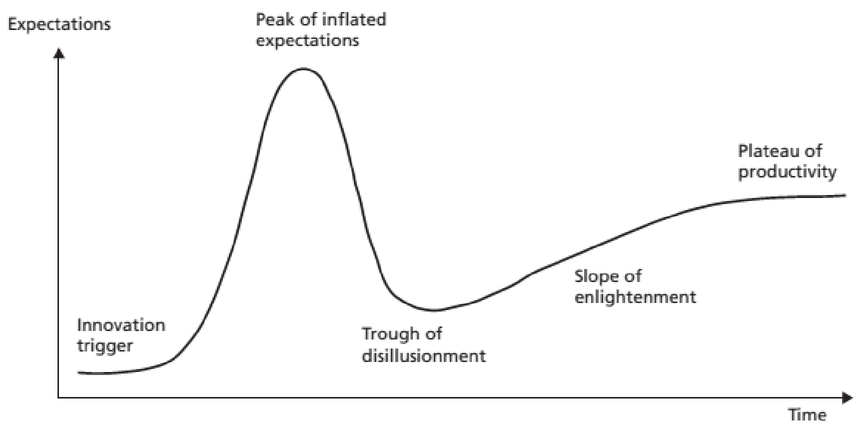


FIGURE 7.1. The "hype cycle" in technological innovations. *Source*: Reproduced from Fenn and Raskino 2008.

Beckert, Jens (2016): *Imagined futures. Fictional expectations and capitalist dynamics.*

36. Doubling time for the world economy (Robin Hanson, 2008)

Pleistocene hunter–gatherer society: 224,000 years.
Farming society: 909 years.
Industrial society, 6.3 years.

Hanson, Robin (2008): "Economics of the singularity", IEEE Spectrum 45(6), 45-50.

"… the human species took tens of thousands of years to spread across most of the globe, the Agricultural Revolution thousands of years, the Industrial Revolution only hundreds of years, and an Information Revolution could be said to have spread globally over the course of decades."

"Over long historical timescales, there has been an increase in the rate at which knowledge and technology diffuse around the globe. As a result, the temporal gaps between technology leaders and nearest followers have narrowed."

Bostrom, Nick (2014): *Superintelligence. Paths, dangers, strategies*.

37. Moore's law of everything (Samuel Arbesman, 2013)

"… there are regularities in these changes in technological knowledge. It's not random and it's not erratic. There is a pattern, and it affects many of the facts that surround us, even ones that don't necessarily seem to deal with technology. The first example of this? Moore's Law."

"These technological doublings in the realm of science are actually the rule rather than the exception. For example, there is a Moore's Law of proteomics, the field that deals with large-scale data and analysis related to proteins and their interactions within the cell. Here too there is a yearly doubling in technological capability when it comes to understanding the interactions of proteins (…) So while exponential growth is not a self-fulfilling proposition, there is feedback, which leads to a sort of technological imperative: As there is more technological or scientific knowledge on which to grow, new technologies increase the speed at which they grow.

"These doublings have been occurring in many areas of technology well before Moore formulated his law. As noted earlier, this regularity just in the realm of computing power has held true as far back as the late nineteenth and early twentieth centuries, before Gordon Moore was even born. So while Moore gave a name to something that had been happening, the phenomenon he named didn't actually create it. Why else might everything be adhering to these exponential curves and growing so rapidly? A likely answer is related to the idea of cumulative knowledge. Anything new—an idea, discovery, or technological breakthrough—must be built upon what is known already. This is generally how the world works. Scientific ideas build upon one another to allow for new scientific knowledge and technologies and are the basis for new breakthroughs. When it comes to technological and scientific growth, we can bootstrap what we have learned before toward the creation of new facts. We must gain a certain amount of knowledge in order to learn something new (…) We should imagine that the magnitude of technological growth is proportional to the amount of knowledge that has come before it. The more preexisting methods, ideas, or anything else that is essential for making a certain technology just a little bit better, the more potential for that technology to grow."

Arbesman, Samuel (2013): *The half-life of facts: Why everything we know has an expiration date*, Current, New York.

38. On interpreting empirical evidence

Fig. 1 next represents a variable growing at 1‰ (0.1%) per year for 3,000 years; Fig. 2, 1‰ growth for 25,000 years. In both cases, 1 is the inial value. The same phenomenon (1‰ annual growth) looks like different depending on the scale chosen: in Fig. 2 it appears as if something extraordinary had happened (an apparently 'glacial' growth suddently turns explosive), whereas Fig. 1 suggests that everything is 'business as usual'.

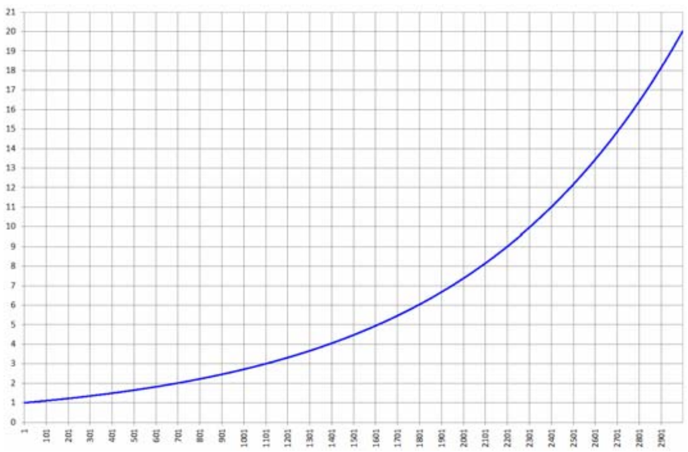


Fig 1. 1‰ growth for 3,000 years

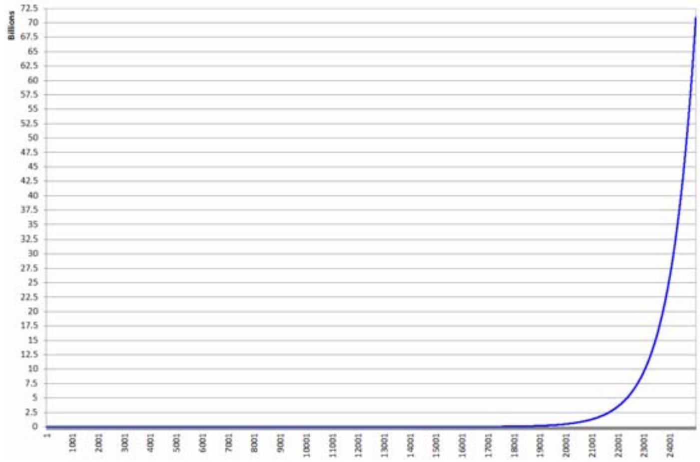


Fig 2. 1‰ growth for 25,000 years

39. Ecocide and neo-liberalism

"**Ecocide**: Acts undertaken with the intention of disrupting or destroying, in whole or in part, a human ecosystem. Ecocide includes the use of weapons of mass destruction, whether nuclear, bacteriological, or chemical; attempts to provoke natural disasters such as volcanoes, earthquakes, or floods; the military use of defoliants; the use of bombs to impair soil quality or to enhance the prospect of disease; the bulldozing of forests or croplands for military purposes; the attempt to modify weather or climate as a hostile act; and, finally, the forcible and permanent removal of humans or animals from their habitual place of habitation on a large scale to expedite the pursuit of military or other objectives."

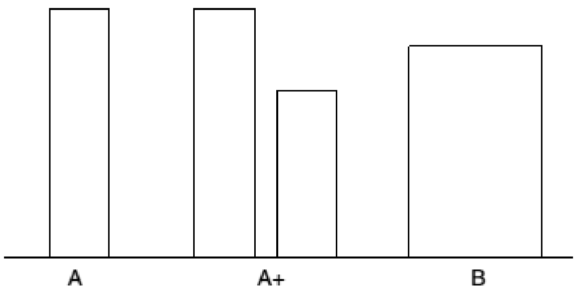
"**Neo-liberalism**: A tenacious movement based on populist ideology, arguing for the reduction of bureaucracy and state control. Neo-liberalism advocates the need for a weak state, 'free market'-based solutions, and the separation of economic and political spheres. When confronted with environmental issues, neo-liberal discourse tends to stress that their seriousness is exaggerated, and it criticizes environmentalists for downplaying the remarkable resilience and recovery power of nature."

"**Overshoot, ecological**: The condition of a population when it exceeds its available carrying capacity or maximum persistently supportable load. The population may survive temporarily but will eventually crash as it depletes vital natural capital (resource) stocks. A population in overshoot may permanently impair the long-term productive potential of its habitat, reducing the habitat's future carrying capacity."

Broswimmer, Franz (2002): *A short history of mass extinction of species*.

40. Derek Parfit's (1984) repugnant conclusion on population ethics

"For any possible population of at least ten billion people, all with a very high quality of life, there must be some much larger imaginable population whose existence, if other things are equal, would be better even though its members have lives that are barely worth living." Parfit (1984, p. 388)



The conclusion is sustained by the following argument. The height of the bars on the chart represent the quality of life and their width the amount of people. Case A represents a society with a high standard of living. Case A+ comes from A by adding the same amount of people as in case A but with a slightly smaller standard of living. It appears that it is more desirable to have case A+ than A. Finally, case B arises from A+ by letting all the population in A+ to have the same standard of living, slightly above the average standard from A+. It also appears that B is more desirable than A+. Granted this, the repugnant conclusion follows by replicating the previous line of reasoning starting with B rather than A.

Parfit, Derek (1984): *Reasons and persons*, Clarendon Press, Oxford, UK.

41. Machine | platform | crowd : trends reshaping the business world

"In March of 2015, strategist Tom Goodwin pointed out a pattern. "Uber, the world's largest taxi company, owns no vehicles," he wrote. "Facebook, the world's most popular media owner, creates no content. Alibaba, the most valuable retailer, has no inventory. And Airbnb, the world's largest accommodation provider, owns no real estate." (…) The three examples we've just described—AlphaGo's triumph over the best human Go players, the success of new companies like Facebook and Airbnb that have none of the traditional assets of their industries, and GE's use of an online crowd to help it design and market a product that was well within its expertise—illustrate three great trends that are reshaping the business world."

"The first trend consists of the rapidly increasing and expanding capabilities of machines, as exemplified by AlphaGo's unexpected emergence as the world's best Go player. The second is captured by Goodwin's observations about the recent appearance of large and influential young companies that bear little resemblance to the established incumbents in their industries, yet are deeply disrupting them. These upstarts are platforms, and they are fearsome competitors. The third trend, epitomized by GE's unconventional development process for its Opal ice maker, is the emergence of the crowd, our term for the startlingly large amount of human knowledge, expertise, and enthusiasm distributed all over the world and now available, and able to be focused, online."

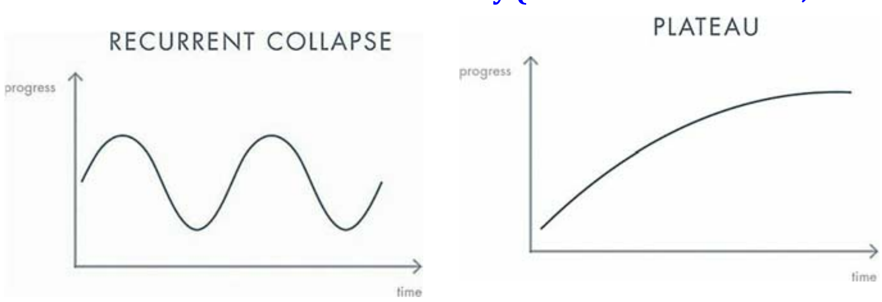
McAfee, Andrew; Erik Brynjolfsson (2017): *Machine, platform, crowd: Harnessing our digital future*, W. W. Norton & Company, New York.

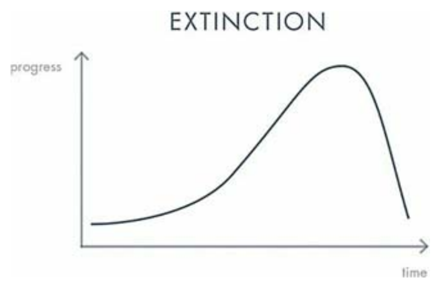
42. The most important lesson in history?

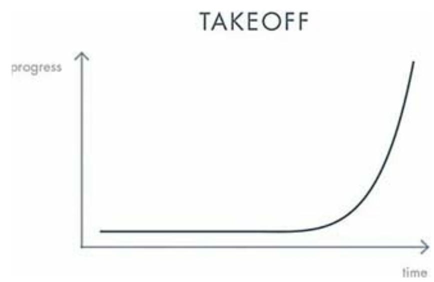
"…perhaps the most important lesson we can learn from history is that short-term solutions and quick profits come at a great price in the long run."

Fawcett, Bill (2013): *Doomed to repeat: The lessons of history we've failed to learn*, William Morrow.

43. Nick Bostrom's futures of humanity (in Thiel and Masters, 2014)





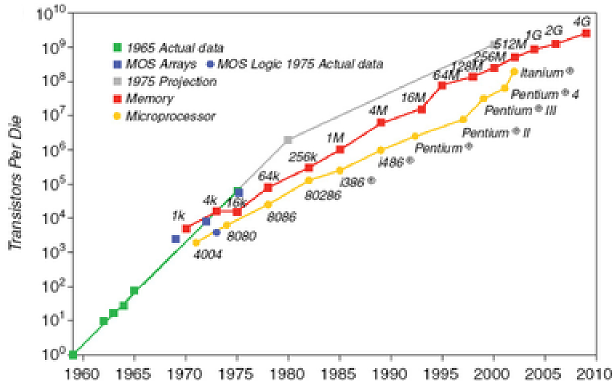


Thiel, Peter; Blake Masters (2014): *Zero to one: Notes on startups, or how to build the future*, Crown Business, New York.

44. Tim Hardford's lessons of the history of technology

- "One: don't be dazzled by the fancy stuff."
- "Two: humble inventions can change the world if they're cheap enough."
- "Three: always ask, 'To use this invention well, what else needs to change?' "

Hardford, Tim (2018): "What else needs to change?," Opinion piece, WTO 2018 Trade Report.



"Moore's law still working after nearly fifty years", Hey, Tony; Gyuri Pápay (2015): *The computing universe*