

**2024-02-01 Th: Spring 2024:
Econ 115 ::**

III. Modern Economic Growth: Technological & Industrial Change

2024-02-01 Th: Spring 2024: Econ 115 :: III. Modern Economic Growth: Technological & Industrial Change

Last Lecture (Globalization):

1. 1870 as the inflection point...
- 2.

2024-02-01 Th: Spring 2024: Econ 115 :: III. Modern Economic Growth: Technological & Industrial Change

Last Lecture (Globalization):

1. 1870 as the inflection point...
2. Malthusian, still, as of 1870—and 1919 (Keynes)?...
3. Dover-Circle economies leading the way (creating learning, teaching, dominating)...
4. Globalization as a necessary—albeit a secondary—cause: necessary, but only a small part of sufficient...
 - Trade globalization (global division of labor; global influences)...
 - Investment & knowledge globalization (mobilizing human societal power potentially anywhere)...
 - Migration globalization (100 million people; underdevelopment of the tropics; origin of the grossly unequal economic order)...
 - The gold standard (as orchestrator)...
5. ~~The American century: resource expansion, free labor, American system, Lev Bronstein~~

2024-02-01 Th: Spring 2024: Econ 115 :: III. Modern Economic Growth: Technological & Industrial Change

This Lecture:

1. 1870 as the inflection point...
2. Malthusian, still, as of 1870—and 1919 (Keynes)?...
3. Dover-Circle economies leading the way (creating learning, teaching, dominating)...
4. Globalization as a necessary—albeit a secondary—cause: necessary, but only a small part of sufficient...
 - Trade globalization (global division of labor; global influences)...
 - Investment & knowledge globalization (mobilizing human societal power potentially anywhere)...
 - Migration globalization (100 million people; underdevelopment of the tropics; origin of the grossly unequal economic order)...
 - The gold standard (as orchestrator)...
5. ~~The American century: resource expansion, free labor, American system, Lev Bronstein~~

READINGS: This Class: Kuznets & Vries

- **Kuznets, Simon.** 1971. *Modern Economic Growth: Findings & Reflections*. NobelPrize.org. Nobel Media AB. Lecture to the memory of Alfred Nobel, December 11, 1971. <<https://www.nobelprize.org/prizes/economic-sciences/1971/kuznets/lecture/>>.
- **Vries, Peter.** 2010. "The California School and Beyond: How to Study the Great Divergence?" *History Compass* 8 (7): 730–751. <<https://compass-onlinelibrary-wileycom.libproxy.berkeley.edu/doi/10.1111/j.1478-0542.2010.00698.x>>

Kuznets

1. How does Kuznets define modern economic growth, and what are its key components?
2. What are the importances of technology, institutional adjustments, and ideology in Kuznet's vision of what modern economic growth is?
3. Kuznets outlines six characteristics of modern economic growth. Discuss each characteristic and its implications for economic development.
4. How do these six characteristics distinguish modern economic growth from earlier economic epochs?
5. What is the role of technological innovations in driving modern economic growth.
6. How do these innovations impact productivity, economic structure, and societal changes?
7. What kinds of structural transformation take place in economies experiencing modern growth? Discuss the shift from agriculture to industry and services, and its implications for labor and societal structures.
8. Modern economic growth has been limited in its global spread. Discuss the reasons behind this limited spread and the impact on countries that have not yet fully experienced modern economic growth.
9. What is the interplay between economic growth and social changes such as urbanization, secularization, and changes in family structure?
10. How do these social changes complement or conflict with economic growth?
11. What are the specific challenges faced by less developed countries in achieving modern economic growth?
12. What factors have limited their ability to exploit the potential of modern economic growth?
13. What policy recommendations can be derived from Kuznets' analysis for promoting sustainable and inclusive economic growth, especially in less developed countries?
14. What do you foresee as the future trajectory of modern economic growth?
15. How might emerging technologies reshape this trajectory?
16. How might global challenges like global warming reshape this trajectory?

Vries

1. How did the introduction of steam power during the Industrial Revolution in Britain and parts of Western Europe contribute to the Great Divergence, especially in escaping Malthusian constraints?.
2. Why did the momentum of the First Industrial Revolution not lead to stagnation at a higher level but instead to sustained and substantial growth?
3. How did some less developed countries manage to catch up with or even overtake more advanced countries, while others failed, leading to a widening gap between developed and developing nations?
4. How have Eurocentric approaches influenced our understanding of the Great Divergence, and what are the limitations of these perspectives?
5. How does the California School's reinterpretation of the economic history of China and other non-Western societies challenge traditional Eurocentric narratives of the Great Divergence?.
6. In what ways do proponents of the California School argue for China's central position in the early modern global economy, and how does this reinterpretation alter the debate on the Great Divergence?
7. What are the strengths and weaknesses of the 'surprising resemblances' thesis, which suggests minimal differences in wealth and development levels among various Eurasian economies before the Great Divergence?
8. What are the challenges in analyzing and comparing the economic histories of Europe and Asia, particularly in terms of chronological and regional specificity?
9. How did the dynamics of trade and production contribute differently to the economies of Britain and China during the period leading up to the Great Divergence, especially considering the roles of service income and mercantile capitalism?
10. How did differences in the modes of production between pre-industrial China and Britain play a crucial role in the unfolding of the Great Divergence?

What Happens Around & After 1870...

The Dover Circle

Longest-Run Global Economic Growth

Date	Technological Ideas-Stock Growth Rate h	Technological Ideas Stock Level H (1870 = 1)	Average Annual Real Income per Capita y	Total Human Population P (millions)
800	0.014%	0.297	\$900	240
1500	0.052%	0.429	\$900	500
1770	0.149%	0.643	\$1,100	750
1870	0.442%	1.000	\$1,300	1300
2010	2.159%	20.557	\$11,600	6900

Date	Ideas-Stock Growth h	ideas Level H	Annual Real Income per Capita y	Population P (millions)	Total Real Income Y (billions)
800	0.022%	0.2	\$900	8	\$7.20
1500	0.096%	0.5	\$1,000	25	\$25.00
1770	0.200%	0.8	\$1,400	75	\$105.00
1870	0.914%	2.0	\$2,800	175	\$490.00
2010	2.514%	68.0	\$50,000	800	\$40,000.00
	\$80,040				

The Counterfactual Agrarian, Commercial-Gunpowder, Steampunk, etc.—They Are Not the World We Live in Today...

Modern Economic Growth:

- We did have:
 - Industrial research lab: routinization & rationalization of invention & innovation
 - Modern corporation: routinization & rationalization of the deployment of ideas
 - Globalization
 - Transport
 - Communications
 - Migration
 - American ascendancy: “the furnace where the future is being forged”
- Ideas growth of 2.1%/yr
 - Doubling time of 35 years
 - More change in one year than in 50
- Enormous growth in global inequality

Date	Technological Ideas-Stock Growth Rate h	Technological Ideas Stock Level H (1870 = 1)	Average Annual Real Income per Capita y	Total Human Population P (millions)	Total Real World Income Y (billions)
-48000	0.002%	0.011	\$1,200	0.2	\$0.24
-8000	0.003%	0.036	\$1,200	2	\$2.4
-6000	0.009%	0.043	\$900	5	\$4.5
-3000	0.018%	0.074	\$900	15	\$14
-1000	0.030%	0.136	\$900	50	\$45
150	0.060%	0.272	\$900	200	\$180
800	0.014%	0.297	\$900	240	\$216
1500	0.052%	0.429	\$900	500	\$450
1770	0.149%	0.643	\$1,100	750	\$825
1870	0.442%	1.000	\$1,300	1300	\$1,690
2010	2.159%	20.557	\$11,600	6900	\$80,040

Science, Technology, Entrepreneurship, & Innovation

People have been inventive and ingenious for a long time...

- So why is it only after 1500 that we get technological progress that is more than glacial?
 - 1602: **Tomasso Campanella**: *The City of the Sun*: “[This age] has in it more history within 100 years than all the world had in 4,000 years before! of the wonderful inventions of printing and guns, and the use of the magnet... and how it all comes of Mercury, Mars, the Moon, and the Scorpion!” <<http://books.google.com/?id=rLljDwAAQBAJ>>:
 - **0.15%/year**
- And why is it only after 1770 that we get:
 - 1848: **Karl Marx & Friedrich Engels**: *Manifesto of the Communist Party*: “The bourgeoisie, during its rule of scarce one hundred years, has created more massive and more colossal productive forces than have all preceding generations together. Subjection of Nature’s forces to man, machinery, application of chemistry to industry and agriculture, steam-navigation, railways, electric telegraphs, clearing of whole continents for cultivation, canalisation of rivers, whole populations conjured out of the ground — what earlier century had even a presentiment that such productive forces slumbered in the lap of social labour?...”?
 - **0.44%/year**
- But all that was only the appetizer compared to post-1870 Modern Economic Growth!:
 - **2.1%/year**

GROWTH OF “TECHNOLOGY”

Year	World	Global North
-3000	0.013%	0.015%
-1000	0.030%	0.035%
0	0.061%	0.046%
800	0.022%	0.016%
1500	0.052%	0.111%
1770	0.149%	0.200%
1870	0.442%	0.914%
2010	2.140%	2.514%

Prerequisites for Modern Economic Growth

- **700%/century**
- 1870: The industrial research lab
- 1870: The modern corporation
- 1870: The global market economy
- 1870: Start of the demographic transition
- **56%/century** .
- 1830: The engineering profession
- 1830: The machine tool industry
- 1800-1850: Bob Allen's four policies:
 - Banks
 - Schools
 - Railroads, and other infrastructure
 - Appropriate tariffs
- 1750: Laws to be changed for general utility
- 1750: Laws not to be changed for the powerbrokers' benefit
- 1730: Steampower
- -30000: Coal
- 1700: Cotton
- 1689: Curbing of the British monarchy
- 1650: Sugar
- 1600: Capitalist mode of production
- **15%/century**
- 1600: Nothing by claim—by experiment only
- 1550: Freedom of occupation
- 1500: Global trade
- 1500: Columbian exchange
- **5%/century**
- 1215: Rule of law
- 1100: Tinkering metalworking culture (lots)
- Merchants and makers have a political voice (lots)
- 900: Printing
- 700: Individualism
- 530: Codified law [Rome]
- -150: Science [Hellenistic Greece]
- -300: Commercial society
- -400: Philosophy
- -600: Coinage
- -3000: Trade & Credit...
- -3000: Division of labor
- -3000: Writing
- -12000: Settlement

Two Heads Are Better than One, & c....

People have been inventive and ingenious for a long time...

- More numbers, non-rival goods, better communications, yes.
- We stand on the shoulders of giants, yes—but we also step on toes and have already picked all the low-hanging fruit
- Market economy—but we have seen very many market economies
- Something to be said for *limited government*: a rule of law that makes entrepreneurs “hard” rather than “soft” targets who have to spend much of their time training to defend themselves.
- But what is special about the technological revolutions that underpin Modern Economic Growth?
- A high degree of *coordination*: **(Michael) Polanyi**: “Self-coordination of independent initiatives leads to a joint result... unpremeditated by any... [as if] guided as by ‘an invisible hand’ towards the joint discovery of a hidden system...”

GROWTH OF “TECHNOLOGY”

Year	World	Global North
-3000	0.013%	0.015%
-1000	0.030%	0.035%
0	0.061%	0.046%
800	0.022%	0.016%
1500	0.052%	0.111%
1770	0.149%	0.200%
1870	0.442%	0.914%
2010	2.140%	2.514%

Particular Features of Science

“Spontaneous coordination of independent initiatives by mutual adjustment”. Like a polity, like a market, but not... What are they?

- The ruthless authority of experiment
- The consensus of the community
- The strong rule of priority
- A fiduciary as opposed to a mercenary institution

(Michael) Polanyi: “Self-coordination of independent initiatives leads to a joint result... unpremeditated by any... [as if] guided as by ‘an invisible hand’ towards the joint discovery of a hidden system.... [E]ach consecutive step... [must be] decided upon by the person most competent.... Organis[ing] the group... under a single authority would eliminate their independent initiatives... reduce their joint effectiveness...paralyse their cooperation. Essentially the same is true for the advancement of science by independent initiatives adjusting themselves consecutively to the results achieved by all the others...”

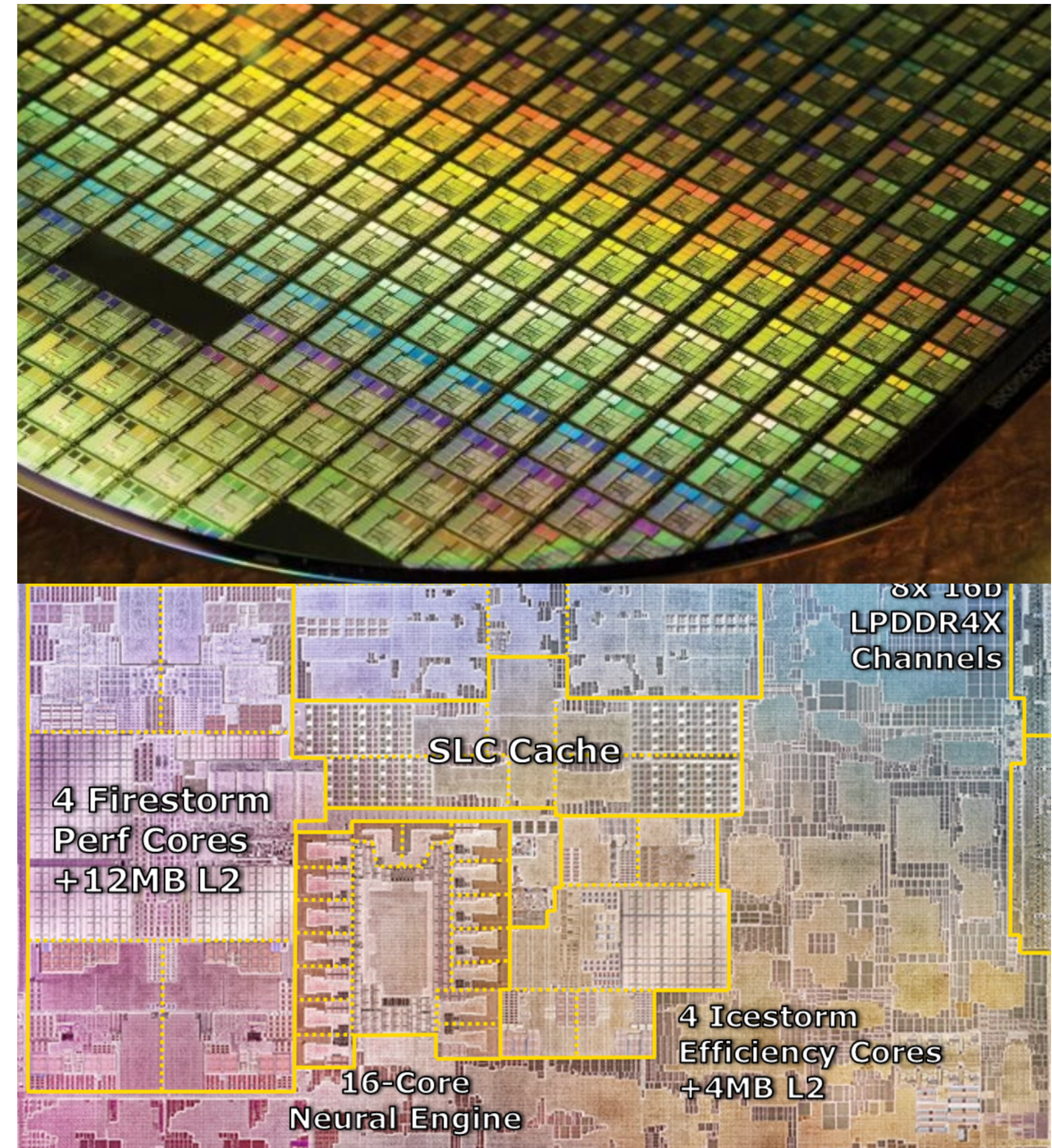
(Michael) Polanyi: “The market [is] but a special case of coordination by mutual adjustment. In the case of science, adjustment... by taking note of... published results.... In the case of the market... adjustment... mediated by... prices broadcasting current exchange relations.... Prices ruling the market... transmit... information... provide... incentive.... Scientists... motivated by current professional standards.... Authoritative pronouncements... [yet] the highest encouragement to dissent... in some particular.... It took eleven years for the quantum theory... [of] Planck... to gain final acceptance.... Scientific tradition enforces its teachings in general, for the very purpose of cultivating their subversion in the particular...”



From Science to Technology

Dasgupta: *Science & Technology as Institutions* (ch. 5):

- “Publicly funded R&D... the Wicksell-Samuelson solution... to... incentives in knowledge production.... Science.... Priority is the prize... ‘moral possession of discoveries to winners, even though no one obtains legal possession of them.’ ...”
- “Not only... Science, but also in a parallel institution, where discoveries and inventions are privatized.... Technology.... Monopoly rights to knowledge, or patents... disclos[ing]... findings without obliging... shar[ing] the profits from those findings.... A legal means of making a piece of knowledge an excludable commodity.... Like the rule of priority in Science, the patent system encourages contests in Technology.... Technology is market-driven and thus enforced by the law; whereas in Science, behaviour is community-driven and thus enforced by norms....”
- “It should then be no surprise that the character of what is produced... differs... basic research (whose output is an input in the production of further knowledge) and... applied research (whose output is an input in the production of goods and services), interprets the two in terms of differences in their products....”
- “Europe... during the Age of Enlightenment... created institutions that enabled the production, dissemination, and use of knowledge—in effect, the entire knowledge industry—to be transferred from small elites to the public at large, a transfer that so sharpened the analytic-empirical mode of reasoning that it became routine...”



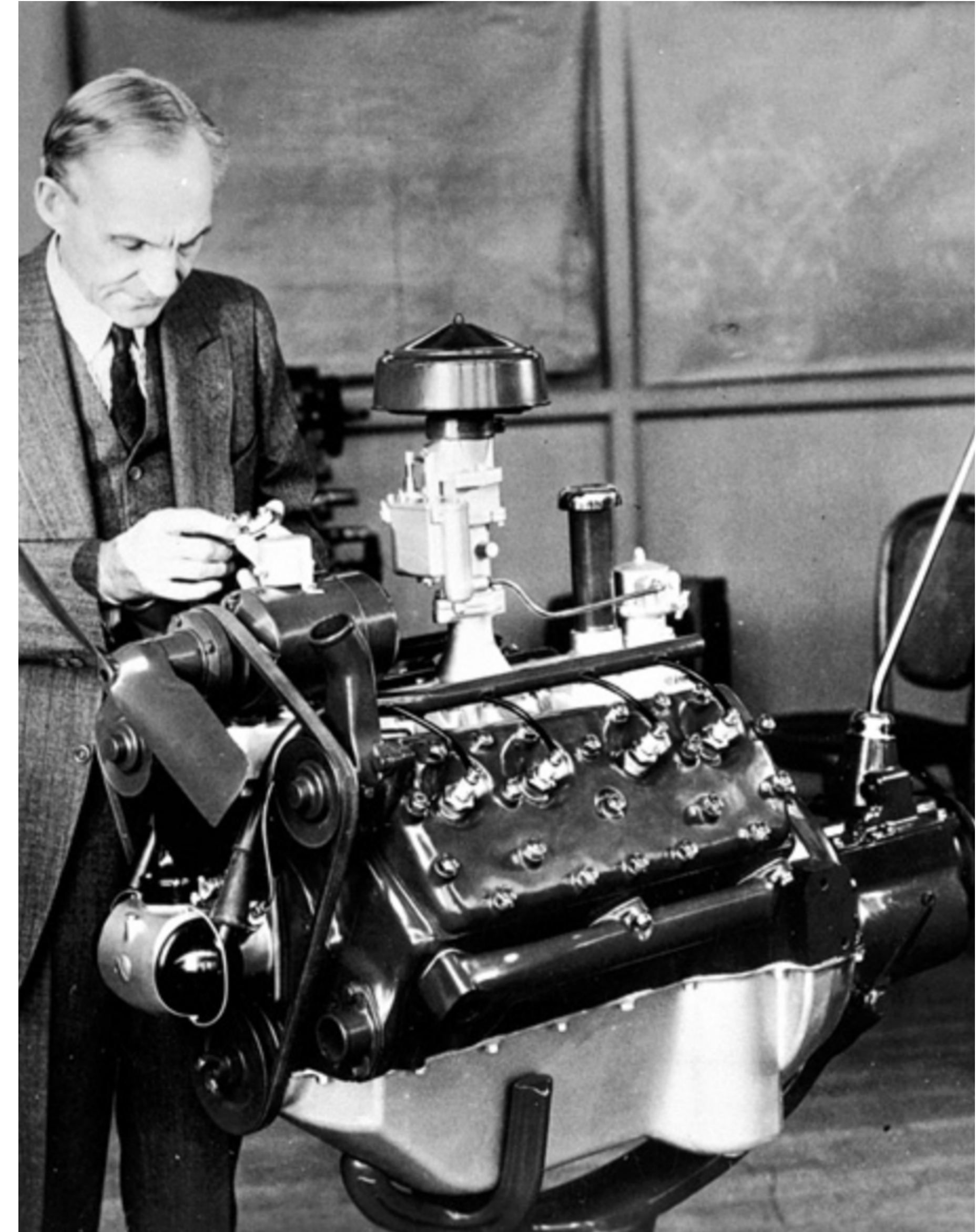
From Technological Possibilities to Entrepreneurship

William Baumol: *Entrepreneurship: Productive, Unproductive, & Destructive* <<https://github.com/braddelong/public-files/blob/master/readings/article-baumol-entrepreneurship.pdf>>:

- “Entrepreneurship is the imaginative pursuit of position, with limited concern about the means.... We can expect changes in the structure of rewards to modify the nature of the entrepreneur's activities, sometimes drastically. The rules of the game can then be a critical influence...”
- “The productive contribution of the society's entrepreneurial activities varies... [primarily from] their allocation between productive... and... unproductive activities... heavily influenced by the relative payoffs society offers.... Policy can influence the allocation of entrepreneurship more effectively than it can influence its supply...”
- “Violent economic activity... inspired frequent and profound innovation...the stirrup... a requisite for effective cavalry tactics. Castle building... the crossbow, the longbow, and... gunpowder.... These innovations can be interpreted as contributions of military entrepreneurs undertaken at least partly in pursuit of private economic gains... [and] obviously differs vastly from the introduction of a cost-saving industrial process or a valuable new consumer product...”
- “The Roman reward system, although it offered wealth to those who engaged in commerce and industry, offset this gain through the attendant loss in prestige. Economic effort ‘was neither the way to wealth nor its purpose. Cato's gods showed him a number of ways to get more; but they were all political and parasitical, the ways of conquest and booty and usury; labour was not one of them, not even the labour of the entrepreneur’ (Finley 1965, p. 39).”
- “Balazs (1964, p. 53) concludes that [in China under the Song] ‘what was chiefly lacking... was not mechanical skill or scientific aptitude... [or] wealth, but scope for individual enterprise.... No security... [no property] rights... no alternative investment other than landed property, no guarantee against being penalized by arbitrary exactions from officials or against intervention by the state. But perhaps the supreme inhibiting factor was the overwhelming prestige of the state bureaucracy...”

Etienne Balazs: *Chinese Civilization & Bureaucracy: Variations on a Theme* (New Haven: Yale Univ. Press, 1964).

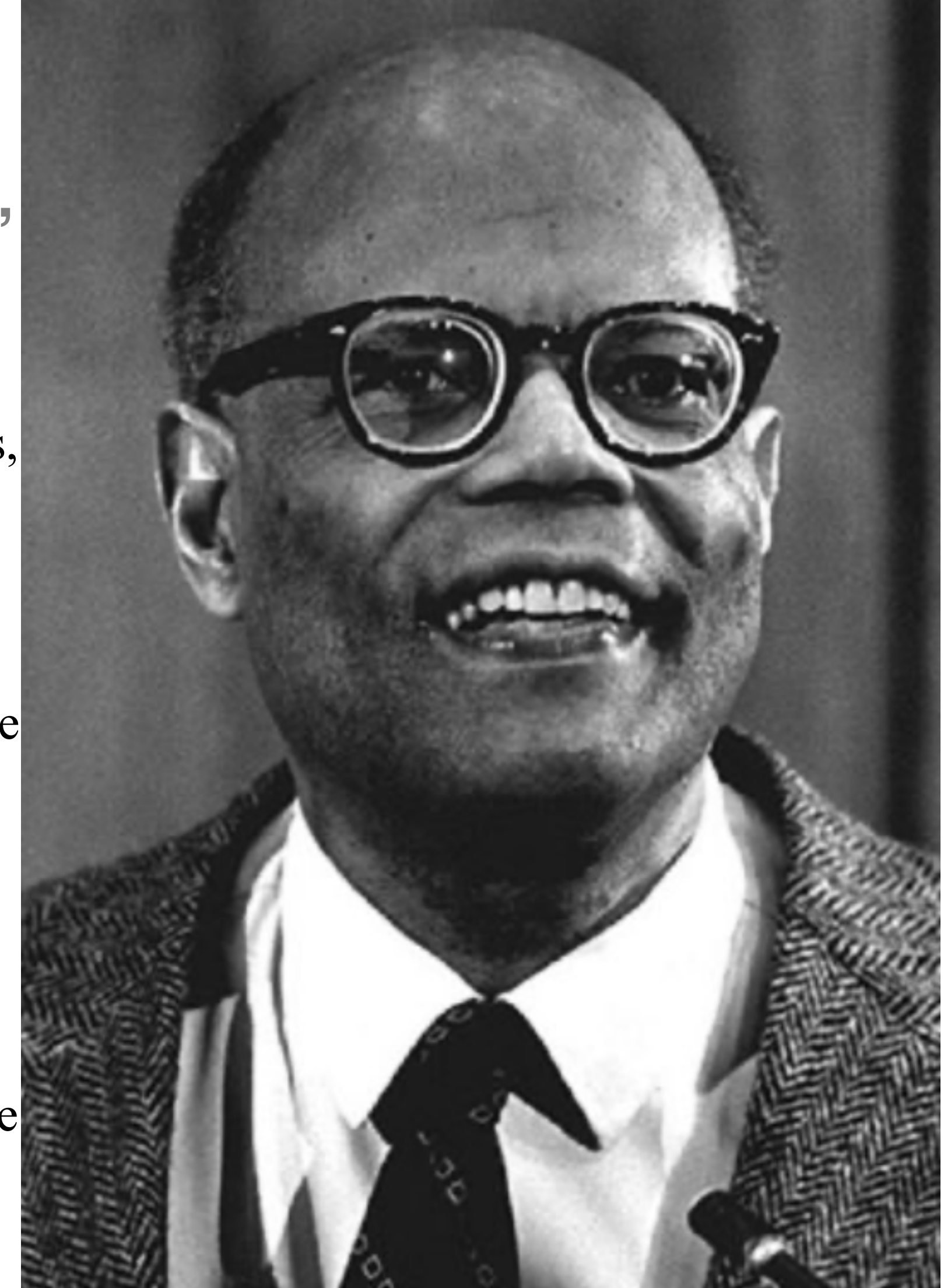
Moses I. Finley: *Technical Innovation & Economic Progress in the Ancient World* (Econ. Hist. Rev. 1965).



The 1870 Growth Acceleration

Modern science to rationalize and routinizing discovery, the industrial research lab to rationalize and routinize invention and development, and the modern corporation to routinize development, diffusion, and deployment...

- Plus general purpose technologies—machine tools, non-human power sources
- Arthur Lewis: “New commodities: telephones, gramophones, typewriters, cameras, automobiles, and so on, a seemingly endless process whose latest twentieth-century additions include aeroplanes, radios, refrigerators, washing machines, television sets, and pleasure boats. Thus a rich man in 1870 did not possess anything that a rich man of 1770 had not possessed; he might have more or larger houses, more clothes, more pictures, more horses and carriages, or more furniture than say a school teacher possessed, but as likely as not his riches were displayed in the number of servants whom he employed rather than in his personal use of commodities...”
- Not so much the particular technologies, as the grasping of the fact that there was a broad and deep range of new technologies to be discovered.
- As much as it was new technologies, it was large-scale corporate organizations that could and did plan the division of labor to make use of and then market technologies.
- And as much, it was that the global market meant that there was now a great deal of money to be made from the routinization of the exploration, development, and deployment of technological possibilities



Nicola Tesla

Conventional to talk about Thomas Alva Edison;
but I want to talk about Nicola Tesla:

- Nicola Tesla could not have had a career without the industrial research lab, the modern corporation, and George Westinghouse
- Born on July 10, 1856 in the town of Smiljan, in the Krajina region of the province of Croatia, in the Habsburg empire then reigned over by the young Emperor Franz Josef in Vienna.
- Fourth of five children.
- His father was literate—a priest .
- His mother was not.
- His parents wanted him to become a priest.
- He wanted to become an electrical engineer.



Nicola Tesla II

Went off to Graz, Austria, to go to college. Dropped out after two years.

- Broke off relations with his family and friends
- Worked as an engineer for two years
- Suffered a “nervous breakdown”.
- His father persuaded him to return to college at Prague’s Karl-Ferdinand University.
- Perhaps he did.
- But if so only for one summer.
- And then his father died.
- 1881 finds Nikola Tesla working in Budapest for a startup, the National Telephone Company of Hungary, as chief electrician and chief engineer. But he does not stay.
- 1882 sees him in Paris working as an improver and adapter of American technology.
- On June 6, 1884 Tesla arrived in New York with nothing in his pockets save a letter of recommendation from engineer Charles Batchelor to Thomas Edison: “I know of two great men,” Batchelor had written. “You are one of them. This young man is the other.” And so Edison hired Tesla.



Nicola Tesla III

Tesla had an “eccentric personality,” as people put it. He wrote:

- “I had a violent aversion against the earrings of women... bracelets pleased me more or less according to design. The sight of a pearl would almost give me a fit but I was fascinated with the glitter of crystals... I would get a fever by looking at a peach... I counted the steps in my walks and calculated the cubical contents of soup plates, coffee cups and pieces of food—otherwise my meal was unenjoyable. All repeated acts or operations I performed had to be divisible by three and if I missed I felt impelled to do it all over again, even if it took hours...”
- To medicalize: autism/OCD. But is “medicalization” really something we want to do?
- This, coupled with bizarre and utopian claims about the future course of science and technology, made it difficult for him to find and maintain financial backers and colleagues.
- He was, as much as Mary Wollstonecraft Shelley’s fictional Dr. Viktor von Frankenstein, the very model of the lone mad scientist.
- Yet George Westinghouse found a place for him:
 - Our entire electrical power grid and everything that draws off of it
 - Our electric appliances and engines today
 - Alternating-current generators, polyphase systems, and long-distance transmission through high-voltage power lines,
- The world from space at night, illuminated by the electric power grid, is Tesla’s world.



Nicola Tesla IV

How could Tesla make a difference?

- He made a difference because he could work for corporations' industrial research labs...
- And his ideas could be developed and applied by corporations...
- In America Tesla went to work for Edison Machine Works. He would later claim that Edison promised him \$50,000—the entire net worth at the time of the Edison Machine Works, the same multiple of average wages back then that \$7 million would be today, and the same share of GDP back then that \$40 million would be today—to improve and redesign Edison's direct current generators, but that in 1885 Edison refused to pay.
- Tesla quit
- Tesla found himself digging ditches for a living for a couple of years
- Tesla on Edison's death: Edison “had no hobby, cared for no sort of amusement of any kind and lived in utter disregard of the most elementary rules of hygiene His method was inefficient in the extreme, for an immense ground had to be covered to get anything at all unless blind chance intervened and, at first, I was almost a sorry witness of his doings, knowing that just a little theory and calculation would have saved him 90 percent of the labor. But he had a veritable contempt for book learning and mathematical knowledge, trusting himself entirely to his inventor's instinct and practical American sense...”

Nicola Tesla V

Then the financial backers pull the plug:

- Dominant financier J.P. Morgan backed Tesla, directly and indirectly, for a long while.
- But then in 1907 Morgan decided that the heroic age of electricity was over
- Time to rationalize operations
- Time to replace the visionary inventors like Tesla and the executives like George Westinghouse who would cater to them.
- Time for managers who would routinize the business, and focus on the bottom line.

Combined & Uneven Development Up to 1914

The “Modernity” of the Global North by 1914:

- Heavy industries—coal, oil, machinery, metallurgy, electricity, internal combustion, organic chemicals, &c.:
 - In 1913 Britain burned 194 million tons of coal
 - Total coal-equivalent energy consumption of Britain today less than 3x 1913
 - Average U.S. passenger RR mileage in 1913: 350/person
 - Average U.S. airline miles today: 3000/person

Growth from 1870 to 1914:

- An “economic El Dorado” according to John Maynard Keynes
- The chaining-up of the Malthusian Devil

And yet: agriculture and landlords still dominant:

- Agriculture largely unmechanized
- Nitrogen artificial fertilizers just coming on line
- People still worked like dogs in the South Pacific to mine the products of avian defecation off of islands offshore of Chile—and then ship the guano back to Europe as fertilizer
- More than half of Americans still working on the farm
- Only Britain and Belgium with less than half of the labor force in agriculture
- Social and political dominance of landlord-aristocrats

Catch Our Breath

Let's reflect on what we have just heard & seen...

1. Comments
2. Questions
3. Readings

