Power and Progress:
Our Thousand-Year Struggle Over Technology and Prosperity

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The Mother of All Surveillance

- In 1791, Jeremy Bentham proposed the panopticon, as an efficiency-enhancing monitoring system. In a well-lit, circular building, a centrally-placed guard station would watch over people effectively.
- Today, the panopticon is remembered as a prison system, but originally it was proposed by Jeremy's brother, Samuel, as a way of organizing factories, when he was working for the Czar in St. Petersburg.
- Jeremy Bentham himself was emphatic that this was a system that could be applied across different settings, writing

> *"You will be surprised when you come to see the efficacy which this simple and seemingly obvious contrivance promises to be to the business of schools, manufactories, Prisons, and even Hospitals. . . "*

In the Name of Progress

- To Bentham, this was all "in the name of progress". New technologies would expand capabilities and bring better behavior, and this would ultimately be beneficial for the entire society.
- In this, Bentham was not alone.
- Adam Smith was equally emphatic that technological advances would, almost automatically, generate better outcomes, not just for capital-owners, but also for workers.

  "In consequence of better machinery, of greater dexterity, and of a more proper division and distribution of work, all of which are the natural effects of improvement, a much smaller quantity of labour becomes requisite for executing any particular piece of work, and though in consequence of the flourishing circumstances of the society, the real price of labor should rise very considerably. . . "

- Interestingly, not so much David Ricardo, who became very worried about machines replacing labor by the third edition of his Principles, writing:

  "If machinery could do all the work that labour now does, there would be no demand for labour. "

Modern Thinking

- Smith was prescient about what modern economics would conclude two centuries later.
- Or perhaps we have been very much influenced by his ideas.
- Whichever is the case, his predictions are very much in line with 21st-century economics.
- If we assume that the aggregate production function takes a Cobb-Douglas or similar form, any improvement in output directly generates a proportional improvement in wages.
- But one reaches the same conclusion with other neoclassical assumptions about the nature of technology and market structure.

The Productivity Bandwagon

- Technological "advances" thus always help labor — what we call a **productivity bandwagon**.
- If you believe in the productivity bandwagon, almost all technological advances should be welcomed with open arms.
- Even if there is some short-term "disruption", everybody will ultimately be the beneficiary of these advances.
- Reed Hoffman summarizes the modern version of this belief:

  "Could we have a bad twenty years? Absolutely. But if you're working towards progress, your future will be better than your present."

The View from the Workers

- This is not what workers in the midst of the Industrial Revolution perceived, however. They thought that, in the name of progress, they were suffering and even being exploited.
- They complained not only about their incomes, but working conditions, factory discipline, and other problems, as industrialization was underway. In the words of a weaver,

  "no man would like to work in a power-loom, they do not like it, there is such a clattering and noise it would almost make some men mad; next, he would have to be subject to a discipline that a hand-loom weaver can never submit to."

- They linked their plight to not just factory discipline, but also mechanization. As another contemporary put it,

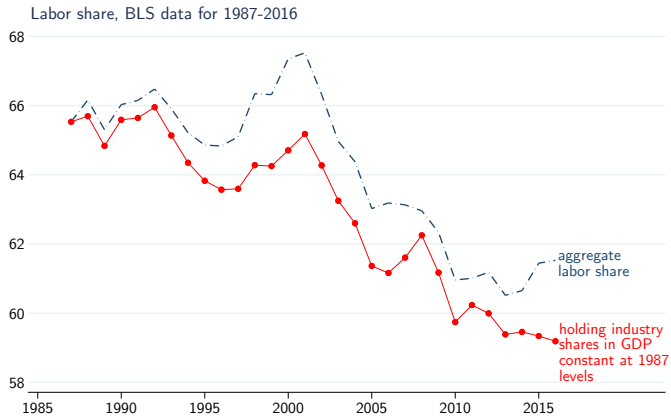
  "I am determined for my part, that if they will invent machines to supersede manual labor, they must find iron boys to mind them."

- Although there is a debate on this, the evidence suggests that, on the whole, average real incomes for workers did not increase from the middle of the 18th century to the 1840s, while work hours rose substantially.
- Prominent examples of workers losing out while there is major technological progress are not confined to the early stages of the British Industrial Revolution.

Whose Progress?

- Other telling examples include:
  - A whole series of technological improvements in medieval and early modern agriculture, including better plows, smarter crop rotation, more use of horses, and much improved mills, created almost no benefits for peasants.
  - Advances in European ship design from the late Middle Ages made trans-oceanic trade possible and created massive fortunes for some Europeans. But the same kinds of ships also transported millions of enslaved people from Africa to the New World.
  - The introduction of steam engines into British coal mining allowed deeper mines to operate, employing thousands more children, some as young as five years old, in incredibly dangerous and unhealthy conditions. Children did not benefit from the productivity gains in that industry.
  - The cotton gin greatly increased agricultural productivity by expanding cotton cultivation across the American South, and this shift intensified the savageries of slavery.
  - The transcontinental rail network across the US spearheaded a dynamic stage of American industrialization, and brought nothing but suffering for the indigenous peoples whose lands were expropriated and who suffered forcible removal and further population declines.
- These issues are not confined to history either. We are living through them.

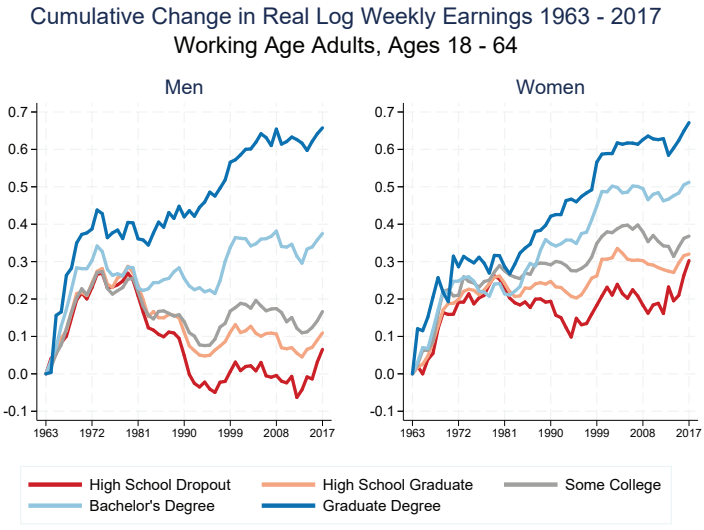
Current Shifts Against Labor



- Similar trends in other industrialized countries.

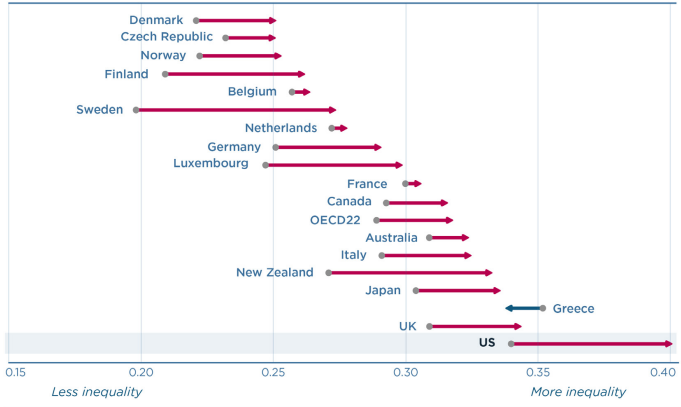
What About Real Wages?

- In the US, this does not look too good either.



Rise in Inequality Is Not Just a US Phenomenon

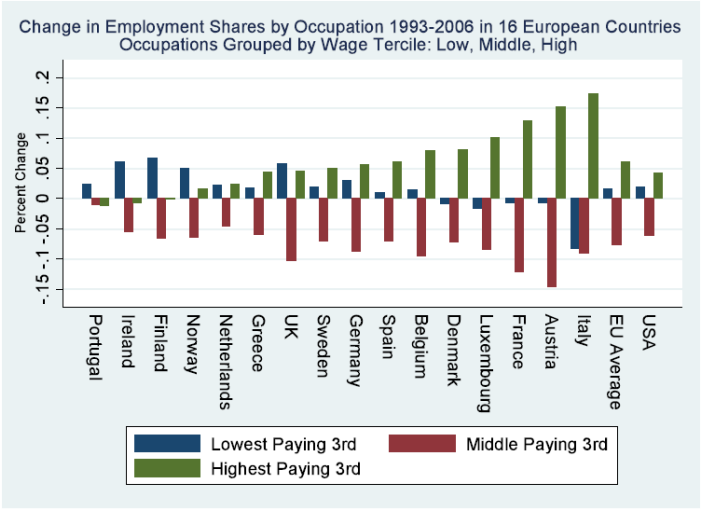
Figure 1: Change in Gini coefficient, 1985 to 2013



Note: 1985 data refer to 1985 or closest available year. 2013 data refer to 2013 or nearest available year. The Gini coefficient measures how equally income is distributed across a population, from 0 (perfectly equal) to 1 (all income to one person).

Source: Organization for Economic Cooperation and Development (OECD), "In It Together: Why Less Inequality Benefits All."

Disappearance of Middle-Class Jobs: Not Just a US Phenomenon



- Acemoglu and Autor, 2011.

Choice over Technology

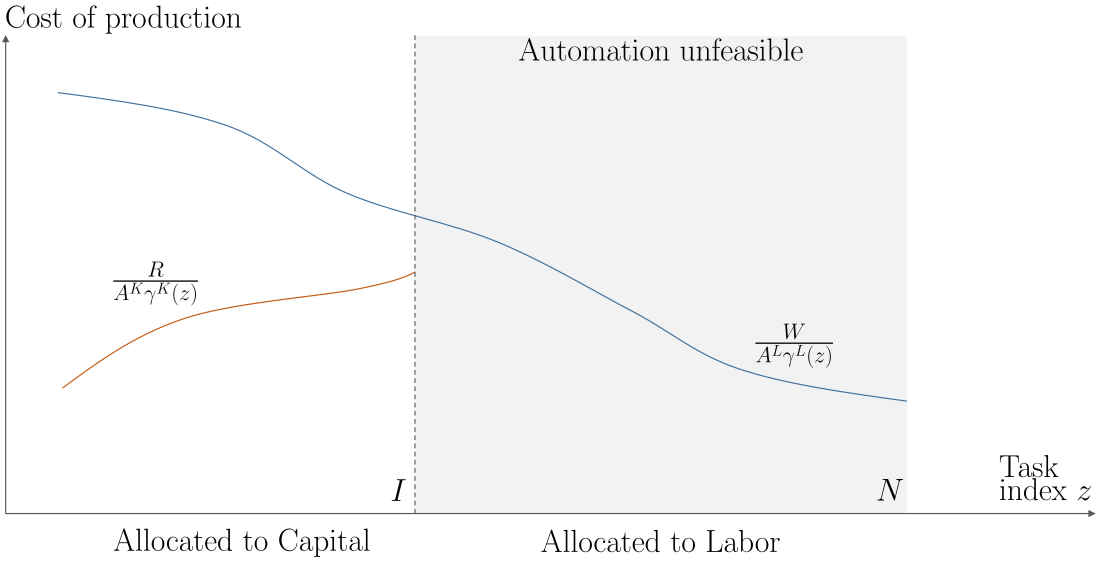
- Our current views of technology are colored not just by a strong belief in the productivity bandwagon, but also because we tend to ignore that technology is highly **malleable**.
- What that means is that there is a **choice** about how and in what direction to develop technology, and different directions create different winners and losers.
- Once you abandon faith in the productivity bandwagon, choice over the direction of technology becomes even more critical.
- And, it is a highly contested choice.
- The absence of an automatic productivity bandwagon and this choice (and struggle over the direction of technology and the type of prosperity) are the fundamental building blocks of our conceptual framework.

The Productivity Bandwagon and Its Limits

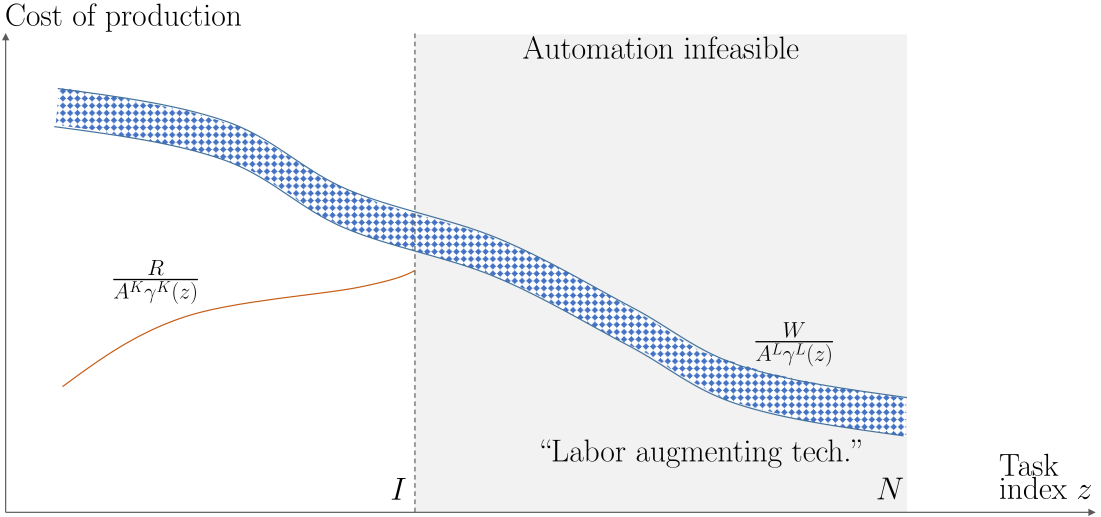
- So why doesn't the productivity bandwagon apply?
- Many reasons, but most importantly:
  1. Automation: productivity increases may come from technological changes that reduce the role of labor (Acemoglu and Restrepo, AER 2018). This happens when capital and machinery are substituted for labor in tasks that were previously assigned to workers. In this case, average productivity increases, but the marginal productivity of labor may decline or increase much less.
     - Automation is not the only type of technological advance, and there is often a choice between automation vs. more worker-friendly ways of deploying machinery, for example, by creating new labor-intensive tasks important for the production process.
  2. Rent-sharing: even increases in marginal productivity do not necessarily translate to higher wages. That depends on whether there is a coercive labor market (as in Acemoglu and Wolitzky, Econometrica 2011) or the type of rent-sharing arrangements and how these are affected by technology.

How to Think About All of This? Allocation of Tasks to Factors

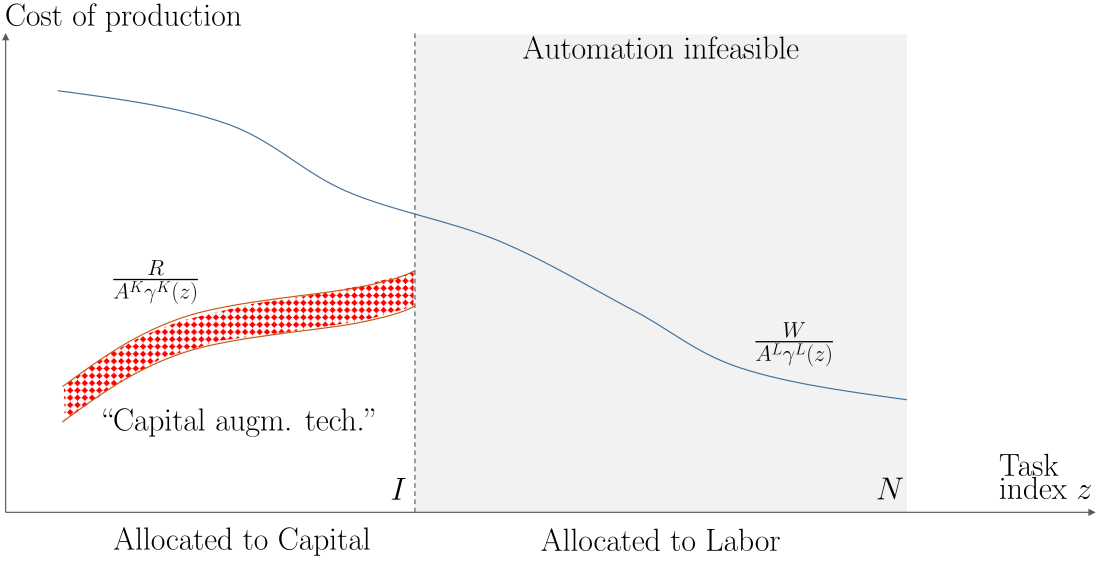
- A diagrammatic summary of Acemoglu and Restrepo (AER, 2018).



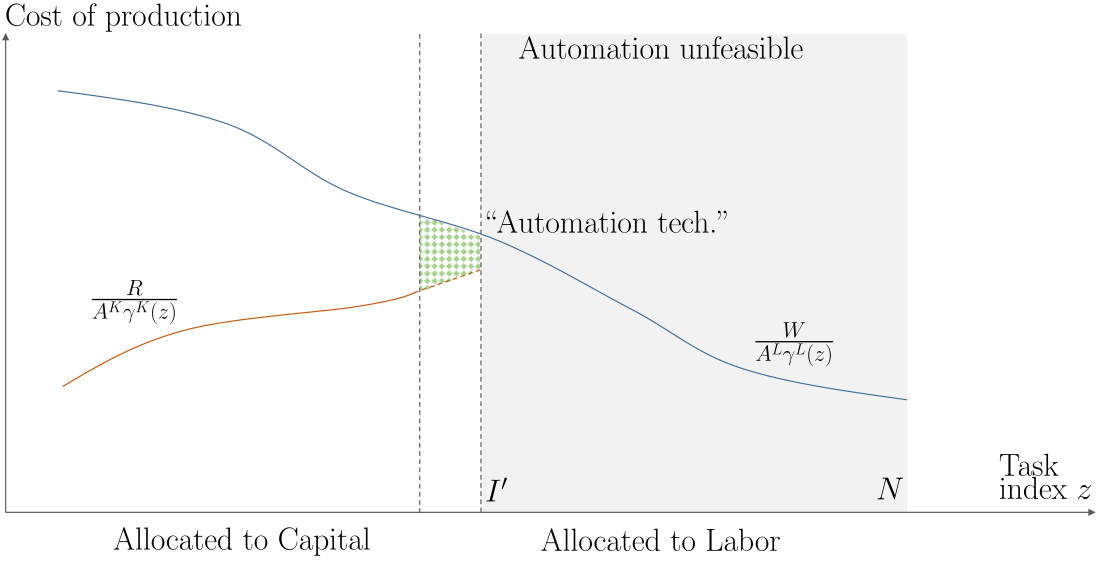
Labor-Augmenting Technological Change



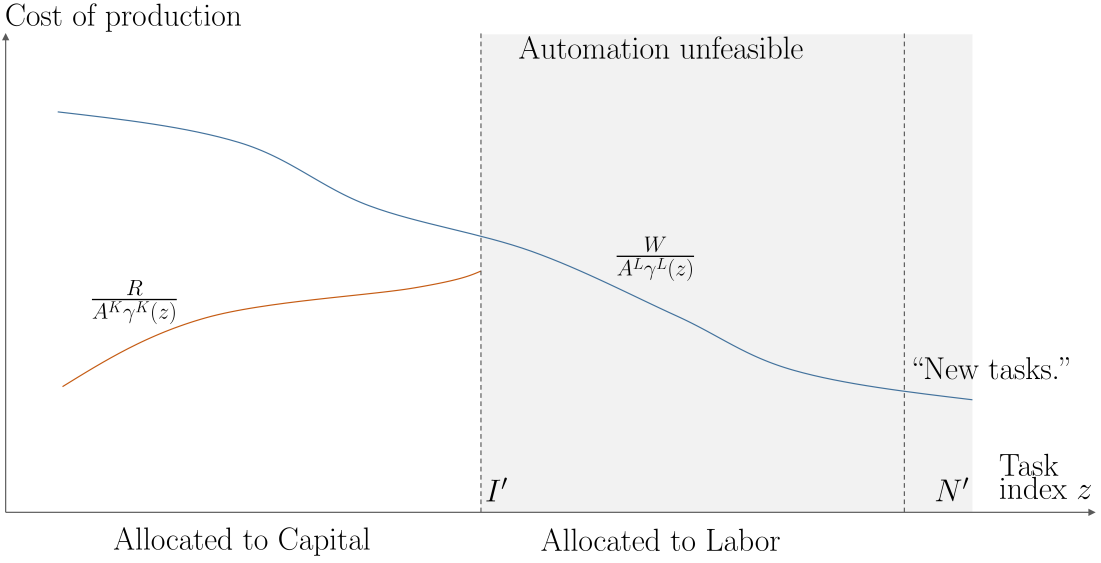
Capital-Augmenting Technological Change



Automation


Cost of production
Automation unfeasible
"Automation tech."
$\frac{R}{A^K\gamma^K(z)}$
$\frac{W}{A^L\gamma^L(z)}$
I'
N
Task index z
Allocated to Capital
Allocated to Labor

Very Different Implications from New Tasks



A Little More Theory

- Production consisting of tasks, combined with constant elasticity for simplicity.

$$Y = \left(\int_{N-1}^{N} \mathcal{Y}(z)^{\frac{\sigma-1}{\sigma}} dz \right)^{\frac{\sigma}{\sigma-1}}$$

Elast of substitution

Output

Task services

- Tasks can be produced using capital or labor:

$$\mathcal{Y}(z) = \begin{cases} A^L \gamma^L(z) \ell(z) + A^K \gamma^K(z) k(z) & \text{if } z \in [N-1, I] \\ A^L \gamma^L(z) \ell(z) & \text{if } z \in (I, N]. \end{cases}$$

Feasible to automate

New tasks

Production Function Representation and the Labor Share

$$Y(L,K) = \left(\left(\int_{N-1}^{I} \gamma^K(z)^{\sigma-1} dz \right)^{\frac{1}{\sigma}} (A^K K)^{\frac{\sigma-1}{\sigma}} + \left(\int_{I}^{N} \gamma^L(z)^{\sigma-1} dz \right)^{\frac{1}{\sigma}} (A^L L)^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}$$

- The labor share is given by

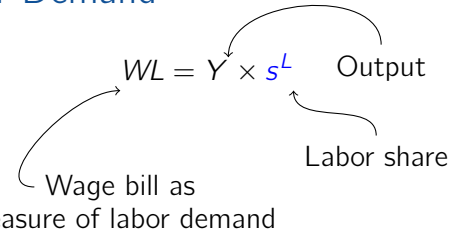
$$s^L = \frac{\Gamma(N,I)(W/A^L)^{1-\sigma}}{(1-\Gamma(N,I))(R/A^K)^{1-\sigma} + \Gamma(N,I)(W/A^L)^{1-\sigma}}$$

Task content $\Gamma = \frac{\int_I^N \gamma^L(z)^{\sigma-1} dz}{\int_{N-1}^I \gamma^K(z)^{\sigma-1} dz + \int_I^N \gamma^L(z)^{\sigma-1} dz}$

Task-price subs.

- When $\sigma = 1$ or $\gamma^L(z) = \gamma^K(z) = 1$, then $\Gamma = N - I$.
- Factor-augmenting technologies and automation work through different channels: task content vs task-price substitution
- Automation always reduces the labor share regardless of the value of σ.

Automation and Labor Demand



- For now, ignoring markups and other non-competitive elements.

$$\frac{\partial \ln WL}{\partial I} = \frac{1}{\sigma - 1}\left[\left(\frac{R}{A^K \gamma^K(I)}\right)^{1-\sigma} - \left(\frac{W}{A^L \gamma^L(I)}\right)^{1-\sigma}\right] \quad \text{(Productivity effect}>0\text{)}$$

$$+ \frac{1}{\sigma}\frac{1 - s^L}{1 - \Gamma(N, I)}\frac{\partial \ln \Gamma(N, I)}{\partial I} \quad \text{(Displacement effect}<0\text{)}$$

- In the absence of the displacement effect, the wage bill changes proportionately to output, and the labor share is constant.
- Because the displacement effect is negative, wage bill increases less than output and wages can fall.

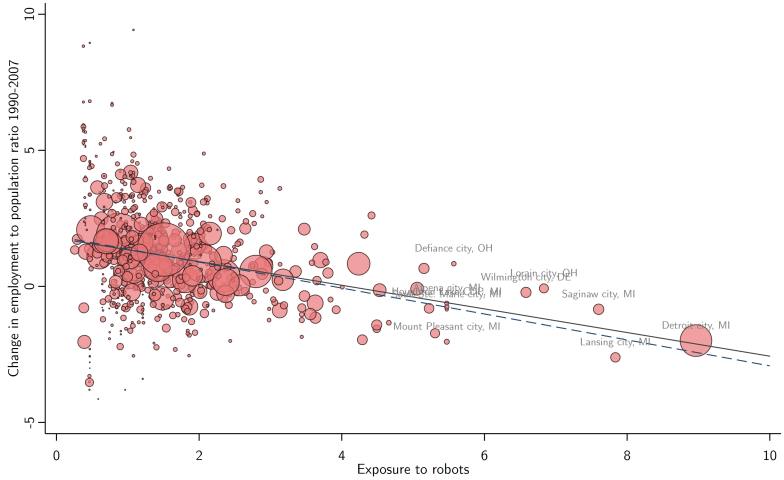
Robots and Jobs: Local Labor Market Effects

- Let's look at the equilibrium effects of automation in a little more detail, focusing on local labor markets affected by robots.
- Zero in on labor markets where the distribution of industry employment makes adoption of robots more likely — according to "exposure to robots" measure in Acemoglu and Restrepo (JPE, 2020).
- Loosely speaking, exposure to robots is given by a Bartik measure of baseline industrial structure interacted with the penetration of robots into that industry in countries that are more advanced than the US in robot adoption:

$$\begin{aligned} \text{exposure to robots}_c &= \sum_i \text{robot penetration industry}_i \times \text{baseline industry share}_{ic} \\ &= \sum_{i \in \mathcal{I}} \overline{APR}_i \times \ell_{zi}^{1970}, \end{aligned}$$

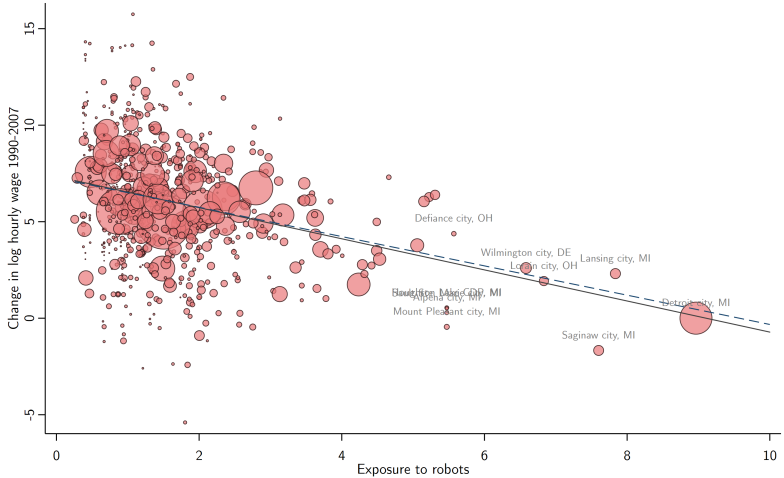
- Then see how this affects employment and wages.

Exposure to Robots and Local Employment



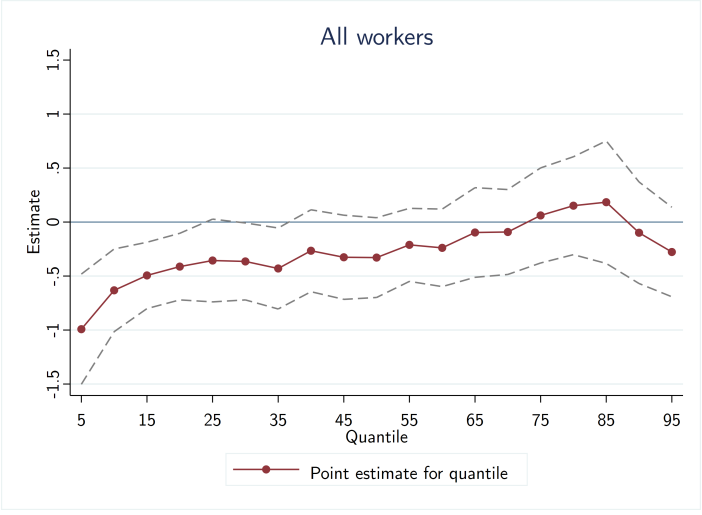
- Dashed line excludes the most exposed areas; thus the relationship is unchanged without the key parts of the industrial heartland.

Exposure to Robots and Local Wages



- Dashed line excludes the most exposed areas.

Inequality: Effects on the Distribution of Wages



- Negative effects concentrate in the bottom seven deciles.

Automation and Inequality

- In fact, the effects of automation on inequality are much greater than suggested by this evidence.
- Acemoglu and Restrepo (Econometrica,2022): 50-70 % of changes in the US wage structure between 1980 and 2016 are due to automation — experienced by groups specialized in routine tasks in industries undergoing automation.
- In the data the effects of automation are very different from those of other technological changes and overall capital deepening.

Task Displacement and Inequality

- A summary: task displacement = Measure of how specialized the demographic group is in tasks that can be automated in industries undergoing rapid automation.
- Changes in wage structure driven by wage declines of demographic groups experiencing task displacement.

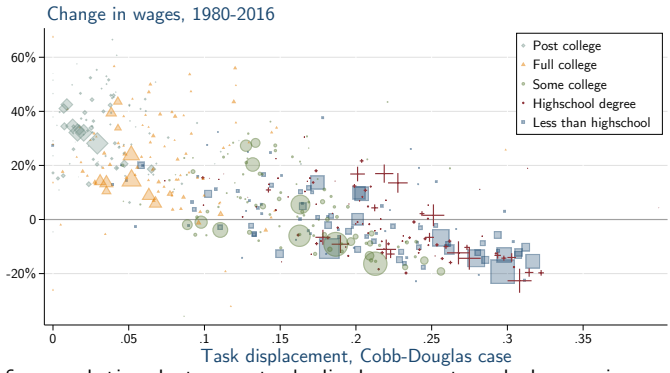


Figure: Reduced-form relation between task displacement and change in wages, 1980–2016.

Understanding the Direction of Technology: Why This Impact of Automation? Why Now? Displacement and Reinstatement, 1947-1987

- Change in task content=displacement + reinstatement.
- Empirical counterparts of automation and new tasks.

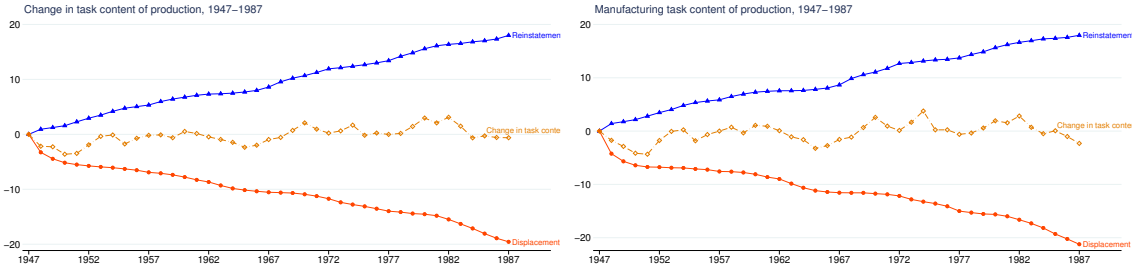


Figure: Estimates of the displacement and reinstatement effects, 1947-1987.

Displacement and Reinstatement Today—1987-2017

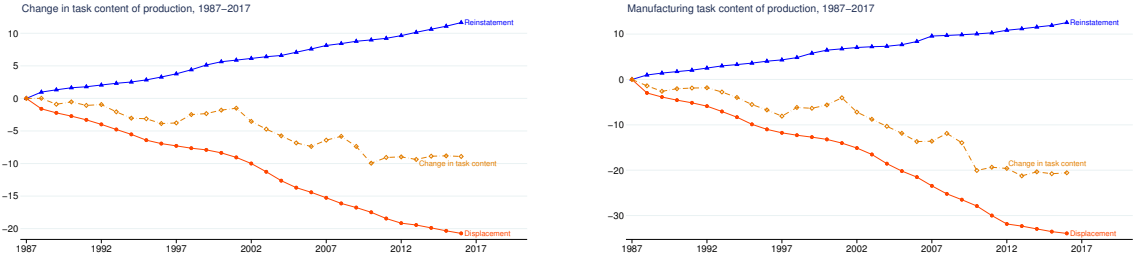


Figure: Estimates of the displacement and reinstatement effects, 1987-2017.

- Very different than during 1947-1987.
- Much faster displacement and much slower reinstatement.
- Changes in tasks content correlated with measures of automation and new tasks — consistent with theory. All of this multiplied with AI.

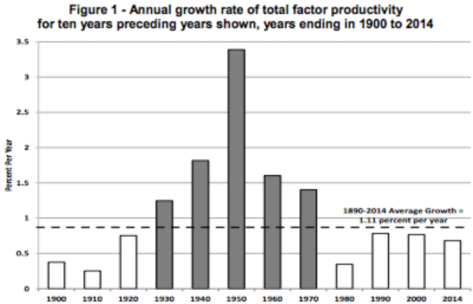
Can Productivity Growth Save us?

- In principle, even if technology goes in a highly automating direction, labor might benefit if productivity gains from new technologies are substantial.
- To recap, in our framework (drawing on and extending Acemoglu and Restrepo, AER 2018), automation will always reduce the labor share.
- But if productivity growth is substantial and there is sufficient rent-sharing, so that labor shares in the productivity increases to some degree, workers will also benefit.
- Can we count on that?
- Doubtful. First, labor's bargaining position has become weaker and weaker, because of institutional changes; changes related to ideas (how best to organize the economy?); and new technologies that allow much greater surveillance and monitoring in workplaces.
- But worse, productivity growth does not seem to be very rapid either.

Are We At Least Getting the Productivity Benefits from Automation?

- No.

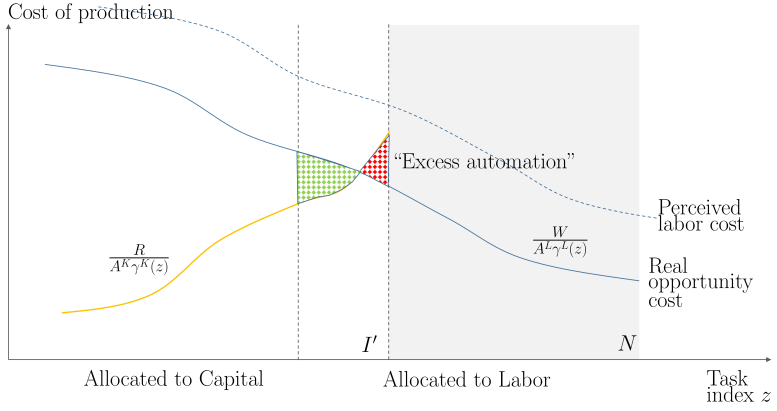
Reality Is Different



- Why not? Perhaps because of **excessive automation**.

Why Not? Perhaps the Double Whammy of So-so Automation

- **Excessive automation**: so-so automation technologies — hence plenty of labor displacement, but not much productivity gains (impact on TFP may even be negative).



Reinterpreting Industrialization

- The early stages of industrialization were impoverishing for many groups.
- Child labor became endemic in coal mines and textile mills, under awful conditions.
- Work hours expanded, and working conditions deteriorated.
- Pollution and infectious diseases became rampant in industrializing cities.
- These casualties of progress cannot be understood without recognizing:
  1. the fact that workers could not organize and did not have political voice;
  2. early technologies had a strong automation bias, as exemplified by the spinning and weaving machinery.
- Luddites were not entirely wrong.

Reinterpreting industrialization (continued)

- But by the second half of the 19th century, things look different.
- Railways, for example, created plenty of high-wage jobs.
- They also stimulated employment growth in other sectors via backward and forward linkages.
- Crucially, this was partly because of different choices: railways adopted a higher-wage strategy, rather than the more monitoring-based approach of early textile factories. This was both because of difficulty of monitoring railway employees, and partly because of "efficiency wage" reasons.
- Even more critically, American technologies started spreading in Britain and Europe, and in many ways, these were more worker-friendly.
- Why? Partly because of the reasons identified by Habakkuk (1962): skilled labor was scarce in America, and this encouraged US employers to find ways of increasing the use and productivity of unskilled labor, combined with new machinery.
- In the words of a superintendent at the factory, for example, Samuel Colt's armory adapted interchangeable parts, which reduced labor requirements by "about 50 per cent", but required "first-class labour and the highest price is paid for it."

Reinterpreting industrialization (continued)

- But also crucially, because institutions started changing in a way that strengthened labor.
- Democratization was part of it. Equally important was collective bargaining, which became much easier after the formal recognition of trade unions in 1871 and the abolition of all master servant-style laws in 1877.
- These changes were not automatic by any stretch, but as the early radical and labor organizer John Telwall recognized, concentration of workers in factories and cities was a critical element of it:

  "Monopoly, and the hideous accumulation of capital in a few hands carry in their own enormity, the seeds of cure. Whatever presses men together though it may generate some vices, is favourable to the diffusion of knowledge, and ultimately promotive of human liberty. Hence every large workshop and manufactory is a sort of political society, which no act of Parliament can silence, and no magistrate disperse."

Towards Shared Prosperity

- The improvements in the direction of technology and organization of labor in the second half of the 19th century were limited, however.
- Foundations of shared prosperity were built much more gradually, and in a contested manner, at the beginning of the 20th century.
- On the technology side, the direction of technology charted in the second half of the 19th century continued, especially as US manufacturing electrified and modernized with the introduction of "engineer-managers" and "white-collar" workers.
- There was rapid automation, but this was not the only focus of new technology.
- Critically, there were choices that produced new tasks both for blue-collar and white-collar workers, with associated training and high wages.
- Agriculture was mechanized rapidly, but there was sufficient employment growth from industry and services during this time period.
- Inequality rose, however, in part because the labor movement was still ineffective.
- New Deal was critical here, as it changed the balance between capital and labor.

Towards Shared Prosperity (continued)

- A broadly balanced direction of technology that combined automation, mass production, and new tasks, together with some degree of worker empowerment, laid the foundations of the post-war period of shared prosperity.
- Output and TFP growth was unusually rapid, but even more strikingly, wages for lower-skill workers grew as fast or even sometimes faster than those at the top.
- As US technologies spread, other industrialized nations followed a similar trajectory.
- The contest over technology continued. There was a lot of concern over automation, and unions negotiated with companies in order to ensure the introduction of new tasks and adequate worker training as automation went on.
- UAW declared in 1965:

  "We offer our cooperation in a common search for policies and programs that will insure that greater technological progress will result in greater human progress."

- In practice, they fought with companies, especially GM, to ensure that automation did not eliminate jobs and machine operators for the automated, numerically controlled machinery would acquire additional skills and there would be new tasks on the shop floor.

Digital Technologies

- Then everything changed, starting either in the mid-1970s or more clearly in the 1980s, as the data I showed earlier demonstrates.
- What happened?
- The two pillars of shared prosperity came undone.
- Businesses organized against regulations and also against the labor movement. Labor lost part of its bargaining power.
- Technology went much more in an automation direction, as the data I presented earlier suggests.
- Why?
- The proximate answer is digital technologies. But the deeper answer is that there was a lot of choice about how digital technologies came to be used.
- Early computer innovators and hackers were anti-authoritarian (and very anti-IBM), and wanted to use digital technologies for greater decentralization and autonomy of workers. For example, in the words of one such innovator, "Industrial approach is grim and doesn't work: the design motto is 'Designed by Geniuses for Use by Idiots', and the watchword for dealing with the untrained and unwashed public is KEEP THEIR HANDS OFF!"'

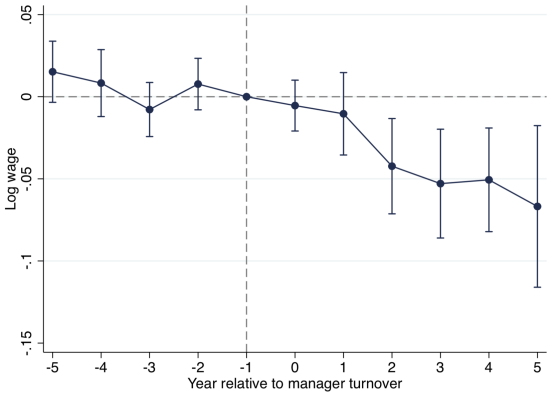
Digital Technologies (continued)

- Why were digital technologies used predominantly for automation?
- A combination of three factors: (1) Institutional changes plus Friedman doctrine; (2) Lack of countervailing powers from the labor movement; (3) A new vision in the tech sector that replaced the early hackers' viewpoint with one that focused on using "software designed by geniuses to reengineer the corporation", which often meant reduce reliance on low-skill workers.
- That this was a choice can be seen both from the transformation of the tech sector during this era, and also from distinct choices that different countries made.
- For example, German and Japanese manufacturing automated rapidly, but at the same time attempted to keep humans in the loop, by introducing new technical tasks and retraining workers. Not so in the US.

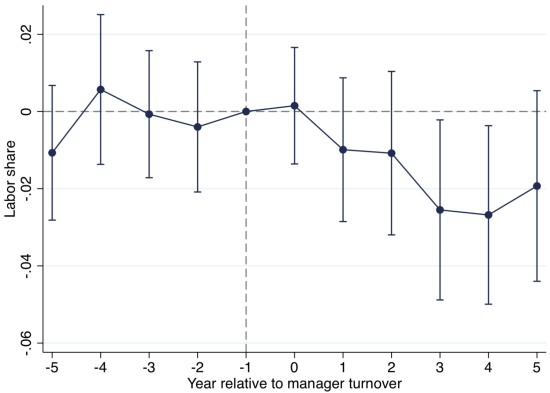
Bonus Material: Digital Technologies and Ideologies

- One place where we see the combination of Friedman doctrine and emphasis on reengineering the corporation is in business schools.
- Can we shed light on these issues from the experience of managers trained in business schools?
- Acemoglu, He and le Maire (2022): business school-educated managers pay lower wages, stop sharing rents, and have significantly contributed to the decline in the labor share and slowdown of median wages.

Bonus Material: Event Study Estimates of Wage and Labor Share in the US



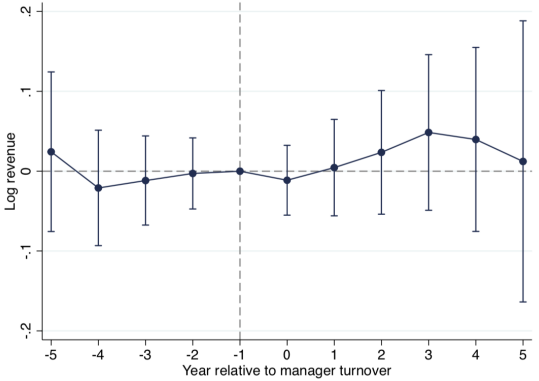
(a) Wage



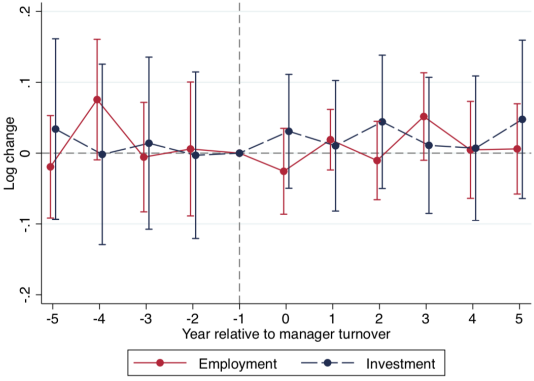
(b) Labor Share

- The average wage is lower by 6.7% and the labor share (in sales) by 1.8 percentage points five years after the appointment of a business manager. This explains about 20%

Bonus Material: Business School Managers Are Not More Productive

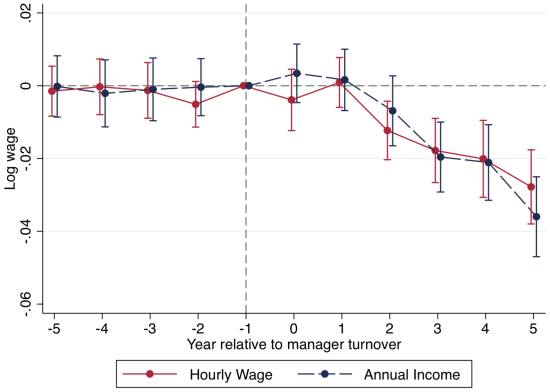


(c) Output

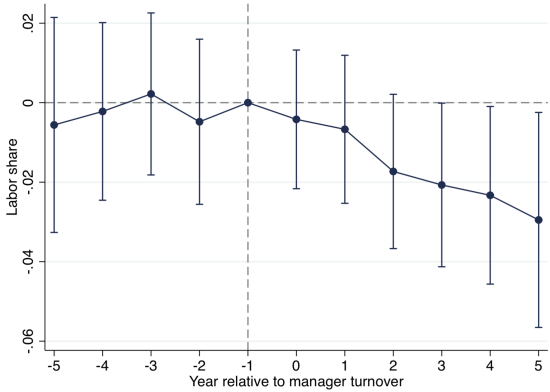


(d) Employment and Investment

Bonus Material: Event Study Estimates of Wage and Labor Share in Denmark



(a) Wage

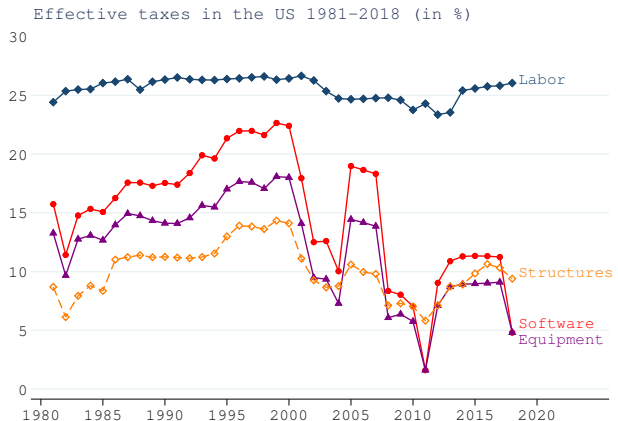


(b) Labor Share

- The average hourly wage is lower by 2.8%, the average annual income by 3.6% and the labor share in value-added 2.9 percentage points five years after.

Digital Technologies (continued)

- Even if the Friedman doctrine, the weakening of collective bargaining ability of workers, and the new digital vision were the most important factors, policy changes supported automation as well.
- Particularly, the US tax code moved towards (implicitly) subsidizing the types of capital most often used in automation.



Thinking about the Future: Artificial Intelligence

- AI is the next phase in these developments.
- We argue that the framing of AI is misleading. What we should strive for is not machine intelligence but **machine usefulness** — how useful machines are to humans.
- In fact, human skills are quite diverse, and AI or other digital technologies can only outperform humans in a limited range of tasks.
- This makes AI-based automation often "so-so", with all the costs that that involves — displacement and low productivity gains.
- But harvesting of huge amounts of data can still be profitable for companies.
- One domain in which this is well illustrated is the modern panopticon: AI-based worker monitoring.
- Monitoring, at the margin, is a **rent-shifting activity**, so does not boost productivity, but reduces wages.
- AI-based real-time scheduling, including zero-hour contracts and "clopening", are likewise rent-shifting activities that do not increase productivity by much.

Artificial Intelligence (continued)

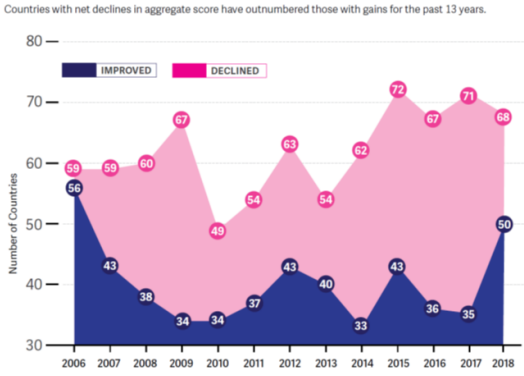
- Machine usefulness is not a chimera.
- It has been very successful when tried in the past.
- The use of machines, including digital ones, to produce new tasks is one example.
- Pioneers of this approach included Norbert Wiener, Douglas Engelbart, and JCR Licklider.
- But equally important is the use of digital tools to provide better information to human decision-makers.
  - Before it was overtaken by digital advertisement, the Internet was a model of this.
- Another application of machine usefulness is to create new platforms in which people with different needs and competencies are brought together.
  - Robert Jensen's study of fisheries in Kerala provides a vivid illustration of how digital tools can be highly productive and beneficial to workers when used in this way.
  - So is M-Pesa and Airbnb.
- So why don't we have more effort towards machine usefulness?
- Some of it is economic incentives from businesses (even if it is not productive, worker monitoring can increase profits). But some of it is also a vision issue: the tech sector is very much gripped by the Turing vision, where the motivation for many bright researchers and entrepreneurs is to reach human parity and as many tasks as possible.

Implications for the Developing World

- If there is indeed a much greater focus or even excessive bias towards automation, this has major implications for the developing world.
- Automation technologies will spread to the emerging world (and have already started doing so).
- Even more importantly, automation in the developed world will change the international division of labor: deindustrialization in the South from automation in the North.
- But automation technologies are **inappropriate technologies** for the developing world — they economize on the factors that are abundant in the developing world: labor, especially semi-skilled labor.
- They will increase inequality between the North and the South, as well as within the emerging world (Acemoglu and Zilibotti, 2001).
- Future of work in the developed world is thus intimately linked to future of growth in the developing world.

Democracy Breaks

- We also have a democracy crisis.



Democracy Breaks (continued)

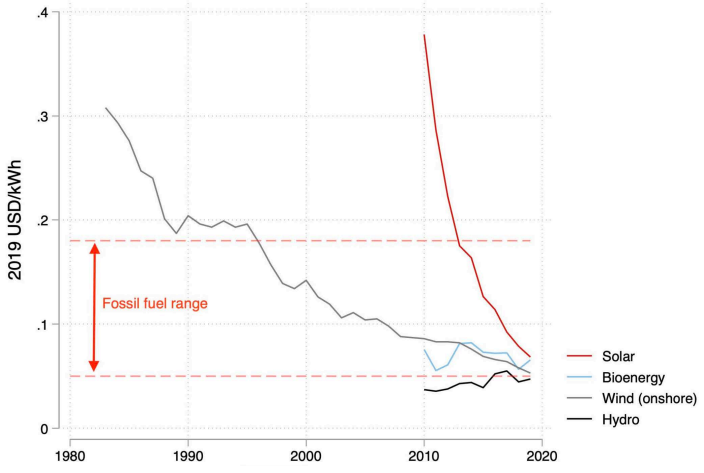
- This cannot all be blamed on digital technologies, but they have been a contributing factor.
- Once abundant data are available and the basic tools to process them are at hand, these create incentives for misbehavior on the part of both:
  1. Authoritarian and semi-democratic governments: China being the leading example, which not only extensively uses data collection in order to shore up the system, but also exports these technologies to other authoritarian governments (Berja, Kao, Yang and Yuchtman, 2020).
  2. Large companies that have a way of monetizing data — that is where the business model of Google and Facebook, based on individualized digital ads comes in.
- In fact, there are many parallels between China and Google/Facebook model of using data as a way of controlling and influencing people.
- Worse, this is yet another example of so-so technologies: not much productivity gains, but huge distributional effects.
- It also provides an answer to a key question: If AI (as opposed to machine usefulness) is not so productive, why is there so much enthusiasm towards it?
- Potential answer: because of digital ads and control.

Redirecting Technology

- Can it be done?
- Yes, the direction of technology is highly malleable. This is doubly so for digital technologies.
- Digital technologies are "general-purpose" and can be used for many things, several of them human complementary—rather than excessively automating or just focused on monitoring.
- How to do that?
- We argue that lessons from the progressive era are still broadly applicable:
  - Develop a counter narrative to the prevailing vision.
  - Organize countervailing powers.
  - Develop specific policy solutions that leverage social movements, government regulations and market incentives.

An Example: Renewable Energy

- There have been big advances in renewables.



Source: IRENA

Can This Be Done For Other Technologies?

- We argue yes and provide some specific ideas both on the organization of countervailing powers and specific policy proposals.
- But not easily $\cdots$