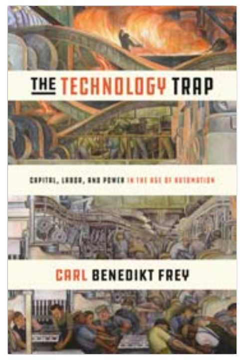


Idea underpinning this book: attitudes toward technological progress are shaped by how people's incomes are affected by it.

The spread of every technology is a decision, and if some people stand to lose their jobs as a consequence, adoption will not be frictionless.

The objective here is to provide perspective, and perspective we get from history.

Three generations of working Englishmen were made worse off as technological creativity was allowed to thrive. And those who lost out did not live to see the day of the great enrichment.

One reason economic growth was stagnant for millennia is that the world was caught in a technology trap, in which labor-replacing technology was consistently and vigorously resisted for fear of its destabilizing force.

LAMPLIGHTERS

Their profession had existed since the first streetlights were inaugurated in London in 1414, but it was about to become a distant memory. As the New York Times noted in 1924, "**The lamplighting business in the great metropolis has been victim of too much progress.**"

Early electrification just made the job easier, as lamplighters no longer had to carry long torches to ignite the lamps. (..) Simplification was merely a step toward automation.

One lamplighter could at best attend to some fifty lamps per night. Now, several thousand lamps could be switched on by one substation employee in seconds.

Economists estimate that over **80 % of the income differences between rich and poor countries can be explained by differential rates of technology adoption.**

In 1965, when the first electronic computers entered offices, Eric Hoffer warned in the New York Times that "a skilled population deprived of its sense and usefulness would be the ideal setup for an American Hitler."

Since the pioneering work of **Jan Tinbergen**—the first winner of the Nobel Prize in Economics—economists have tended to conceptualize technological progress in a purely augmenting way. According to the augmenting view of progress, new technologies will help some workers more than others but will never replace labor, meaning that workers cannot see their wages fall as technology progresses.

Daron Acemoglu and **Pascual Restrepo** provides a helpful formal model for understanding periods of falling wages, as well as times when wages are growing for everyone, by conceptualizing technological progress as either enabling or labor replacing.This book looks at the historical record through the lens of their theoretical framework.

A new job was created for someone to make the new invention. But the someone was "another fellow": making the invention required a different breed of worker. Both the Industrial Revolution and the computer revolution primarily created jobs for another fellow, whose skills could not have been more different from those of the displaced worker.

Gavin Wright, the economic historian, reckoned that "**in the limit we could devise an economy in which technology is designed by geniuses and operated by idiots**."

We seem to have devised an economy designed by geniuses to be operated by other geniuses.

A **common misconception** is that automation is an extension of mechanization. Automation has replaced precisely the semiskilled machine-tending jobs that mechanization created, which once supported a large and stable middle class.

As **Daron Acemoglu** and the political scientist **James Robinson** point out in Why Nations Fail, economic and technological development will move forward only "if not blocked by the economic losers who anticipate that their economic privileges will be lost and by the political losers who fear that their political power will be eroded."

Unless all individuals accept the verdict of the market outcome, the decision whether to adopt an innovation is likely to be resisted by losers through non-market mechanism and political activism.

PART I
THE GREAT STAGNATION

Preindustrial technologies and their effects on people's standard of living.

Preindustrial Progress

A summary of advances in technology from the invention of agriculture some 10,000 years ago up until the dawn of the Industrial Revolution.

For hunter-gatherers, because no one was able to accumulate any meaningful surplus, there were no assets to establish ownership over.

The growth of crops and the cultivation of animals changed that (...) This in turn enabled people to accumulate significant food surpluses, which led to the development of the concept of ownership and new forms of social organization for the protection of property rights.

Pliny the Elder describes **iron** as *the most precious and at the same time the worst metal for mankind - used for good, but also and for war, murder and robbery.*

— —

Technological advances in classical times typically served the public sector, rather than private interests. Instead of promoting technological development to increase productivity, leaders focused on advancing public works that helped them gain popularity and safeguarded their political power.

— —

Roman leaders regarded war, politics, finance, and agriculture as the only activities to which they might put their hands. (..) the advances made in mechanics (...) were largely a set of ancillary inventions to support construction and hydraulic engineering efforts. As far as we can tell, these devices did not have any meaningful impact on private-sector productivity.

Antikythera mechanism, an astronomical computing machine used to predict astronomical positions and eclipses reveals the astounding technological creativity of Hellenism.

"The reason why the classical period failed to produce the machines of the Industrial Revolution was lack of economic incentive. The wealthy could afford handmade items, and slaves could not afford to buy anything that wasn't a necessity."
J.D. Bernal Science in History, 1971

"The **Emperor Tiberius**, when a man had invented unbreakable glass. Instead of rewarding the inventor for his creativity, Tiberius had the man executed, fearing the possibility of angry workmen rebelling."

"When **Emperor Vespasian** was approached by a man who had invented **a device for transporting columns** to the Capitoline Hill, Vespasian refused to use the technology, declaring: "How will it be possible for me to feed the populace?"

The stocking-frame knitting machine, invented by the clergyman William Lee in 1589—faced considerable opposition, too. Queen Elizabeth I refused to grant Lee a patent, claiming: "*Thou aimest high, Master Lee. Consider thou what the invention could do to my poor subjects. It would assuredly bring to them ruin by depriving them of employment, thus making them beggars."*

Privy Council commanded the abandonment of ***a needle-making machine*** *in 1623 and ordered the destruction of any needles made with it. Similarly, nine years later, Charles I banned the casting of buckets, suggesting that it might ruin the livelihoods of the craftsmen that were still making buckets the traditional way.*

Charles I banned ***the casting of buckets*** *in 1632, suggesting that it might ruin the livelihoods of the craftsmen that were still making buckets the traditional way.*

As **Wassily Leontief**, winner of the Nobel Prize in Economics, once joked, "**If horses could have joined the Democratic party and voted, what happened on farms might have been different.**" Horses might have used their political rights to bring the spread of the tractor to a halt.

Catch-up growth, which rests on adopting existing technologies invented elsewhere, is fundamentally different from growth that rests on expanding the frontiers of technology into the unknown, and this book focuses on the latter.

The technology is not a soloist but part of an ensemble. It interacts with institutions and other forces in society and the economy, which explains why the rise of economic inequality has been less dramatic in other industrial nations over the past three decades.

Preindustrial Prosperity

The trade, not Schumpeterian growth of our modern age, based on labor-saving technology, was the engine of progress

Typical unskilled Roman worker earned just about enough to purchase a minimal subsistence basket,

The great geographical discoveries—following the explorations of da Gama, Columbus, Magellan, and others—constituted the beginnings of an era of **sustained Smithian growth**. Trade emerged.

(...)

The economic structure of Britain was in many ways still a legacy of the Neolithic revolution, but the parallel rise of international trade meant that a growing share of the population benefited from growth.

This expansion was key to subsequent economic development. Middle-class families worked in occupations that required them to acquire skills rather than spend all of their time on costly leisure activities, while landed families could rely on income from capital to cultivate their refined taste for leisure and literature.

Because the investments parents make in their children's education and upbringing hinges upon the work they are expected to do, the bourgeoise's work ethic was typically effectively transmitted to the next generation along with the "spirit of capitalism."

(..)

The "**bourgeois virtues,**" as the economic historian Deirdre McCloskey has called them, consisted of **thrift, honesty, and diligence.**

Although the preindustrial world clearly did experience some technology-driven growth, it played only a secondary role in shaping the divergent economic trajectories in Europe.

Technical ideas need to be translated into **reliable blueprints and prototypes**, which in turn need to find an application in production, to have any impact on productivity and prosperity.

The **preindustrial era did not suffer from a shortage of imagination, it suffered from a shortage of realization**. Leonardo da Vinci—the paradigmatic inventor of the preindustrial world—made drawings of hundreds of inventions, but he made hardly any effort to turn them into functioning prototypes.

(...)

Joseph Schumpeter believed that for a given technology to be adopted, some kind of need must exist. This was also the view of **Thomas Malthus**, who reckoned that *"necessity has been with great truth called the mother of invention. Some of the noblest exertions of the human mind have been set in motion by the necessity of satisfying the wants of the body."*

Growth derived from things for which the Greeks and Romans are famous, including organization, trade, order, and law. Such institutions can take an economy a long way

Middle Ages

The *Domesday Book* of 1086, lists 5,624 water mills (2 mills for every 100 households)

Water mills would remain a prime source of energy in Britain even throughout the Industrial Revolution. (..) The late Middle Ages has indeed been described as a "medieval industrial revolution based on water and wind."

A clock in a town was motivated by prestige and not by economic needs—towns did not forecast any of the benefits clocks would bring in the long run, or what can be seen ex post as an economically efficient application. Consequently, the economic use of clocks was a slow process of adoption.

Lewis Mumford has gone so far as to suggest that ***not the steam engine but the mechanical clock was the machine that made the industrial age.*** (...) ***Karl Marx*** *and* ***Max Weber*** *were right in thinking that clocks had an enormous impact on the evolution of capitalism.*

Printing made the tyranny of geography all the more apparent, prompting people to cluster together and increasing urbanization. Thus, like the computer revolution, the revolution in printing, if anything, made the world less flat.

"Why Were There No Riots of the Scribes?," Uwe Neddermeyer argues that the reason is simple: for the most part, the scribes benefited from the arrival of the printing press.

- one reason **resistance to labor-replacing technologies was so feeble in the twentieth century** was that workers for the most part had good alternative job options,

Why Mechanization Failed

Why the trade was the driver? What stopped the technologies of the Industrial Revolution?

Rent-seeking monarchs and other so-called economic parasites found it easier to extract revenue from others than to take part in productive activities, which required hard work.

Relative importance of science to the productive economy kept growing throughout the late eighteenth and nineteenth centuries, and became indispensable after 1870, with the so-called **second Industrial Revolution**."

Another explanation: it was only after the **Glorious Revolution** of 1688–89, when the English Parliament gained supremacy over the crown, that **the preconditions for the Industrial Revolution were established.**

European monarchs did not just fail to encourage industrial development, they actively blocked it.

- **Francis I**—the last emperor of the Holy Roman Empire, clearly feared the political consequences of technological progress and did his utmost to keep the economy agrarian. In his mind the establishment of factories would replace workers in the domestic system and concentrate the poor in cities, where they could organize and rebel against the government. (...) Consequently, railroad carriages in the Habsburg Empire were long drawn by horses.

- **Tsar Nicholas I** similarly feared that the spread of the mechanized factory in Russia could undermine his leadership. As in the Holy Roman Empire, railroads were not considered just a revolutionary technology, but also an enabling technology for revolutions. Thus, the only railroad built before 1842 ran between Saint Petersburg and the imperial residences at Tsarskoe Selo and Pavlovsk; information about railroads was even censored in Russian newspapers.

- **British governments** tried to block the spread of replacing technologies, too. Even in the seventeenth century, Charles I issued a proclamation against the diffusion of gig mills. But things changed after the Glorious Revolution.

The strong commitment of the government to supporting innovators is further underlined by legislation passed in 1769 that made the destruction of machinery punishable by death.

Ahead of it's time

Submarine: the Dutch engineer Cornelis Drebbel built **the first navigable submarine** and demonstrated it to **King James I** in **1624**, more than two centuries before the technology would be put into use. But although it was tested several times in the Thames, the vessel didn't generate sufficient enthusiasm for the idea to be further developed.

Sophisticated silk-throwing machine—which almost a century later inspired John Lombe to travel to Italy to discover the precious secret. However, like most machines described in the technical literature, they did not become standard equipment in Renaissance Europe.

PART II
THE GREAT DIVERGENCE

A whirlwind tour of the Industrial Revolution in Britain.

The Factory Arrives

On the technologies that made the Industrial Revolution, showing that nearly all of them served to replace workers.

People gradually lost ownership of the means of production and their autonomy over the pace of work,

Iron, Railroads, and Steam
The aggregate economic impacts of the steam engine were negligible before 1800. The available data suggest that a total of 2,400–2,500 steam engines were built in the eighteenth century.

(...)

A number of other significant technologies were also required, including new and better gears, gauges, couplings, and so on. This series of inventions eventually culminated in George Stephenson's Rocket—the steam locomotive that would be used for travel on the first public and fully steam-powered railroad between Liverpool and Manchester.

(...)

the total savings associated with the railroads in the range of 6.0–10.0 percent of GDP in 1865;

the main benefits of the railroad came **long after its invention**. The economic significance of those benefits grew especially from 1870s onward,

The full benefits of the Industrial Revolution took **more than a century** to be realized.

The Industrial Revolution

The hollowing out of middle-income artisan jobs, causing a great divergence which explains why industrialization brought so much conflict.

Marx contended that "the worker makes use of a tool; in the factory, the machine makes use of him,"

(...)

an economist might wonder why citizens would ever voluntarily agree to participate in the industrialization process if it reduced their own utility.

(...)

In contrast to preindustrial monarchs who sought to halt worker-replacing technological progress for fear of social unrest, Parliament passed an act in 1769 that made the destruction of machines a felony punishable by death. (...) Attempts to hinder the diffusion of machines by political means failed.

Worker-replacing technology was the key determinant of the probability of unrest.

Ned Ludham movement (**Luddism**)
The movement began in the lace and hosiery trades early in February 1811 in the Midlands triangle formed by Nottingham, Leicester, and Derby. Protected by exceptional public support within their communities, Luddite hands conducted at least 100 separate attacks that destroyed about 1,000 frames (out of 25,000), (..) **the smashing of machinery was an expression of dissatisfaction with deteriorating incomes** (..) In 1812 and 1813, more than thirty Luddites were hanged.

Captain Swing riots (1830)
more than two thousand riots across Britain that solely targeted agricultural machines. 492 machines were destroyed, the vast majority of which were threshing machines. Again, the British government took a stern line and ordered the army as well as local militias to take action against any rioters; 252 death sentences were passed, though some sentenced to death were instead deported to Australia or New Zealand.

In the period 1840–1900, output per worker increased by **90%** and real wages by **123%**: the great divergence between labor and capital income in Britain was followed by an episode of compression.

The most convincing explanation is that technological change became **increasingly labor-augmenting** instead of labor-replacing,

Determining when technological progress became augmenting is hard. Real wages started to grow after 1840, suggesting that there was an inflection point around that time.

...it was only after machines had become more standardized that factory workers could threaten to leave their jobs if they were not paid for their skills.

PART III
THE GREAT LEVELING

With the Second Industrial Revolution, America took over technological leadership

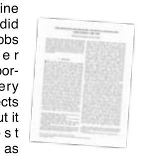
Production - Flourisihing

The technological changes that accompanied the Second Industrial Revolution.

The Luddites, who opposed technological change, proved very wrong, insofar as new, higher-paying opportunities for work opened up to replace the ones they lost.

America's great inventions of the period 1909–49 were predominantly of the enabling sort. Some jobs were clearly destroyed as new ones appeared, but overall, new technologies boosted job opportunities enormously.

The internal combustion engine and electricity did more to create jobs than other technologies. Labor-saving machinery had similar effects on productivity, but it did not boost employment by as much.



„In a world where enabling technologies create an abundance of new and better-paying jobs, even replacing technologies are not too bad for labor."

Rising educational attainment allowed the vast majority to switch into better-paying and less hazardous jobs, making ordinary Americans the prime beneficiaries of progress.

(...)

Technology itself made everyone better off, to the point where members of Karl Marx's proletariat became firmly middle class.

1851 Crystal Palace Exhibition in London. As one visitor observed, "Nearly all American machines did things that the world earnestly wished machines to do.... Most exciting was Samuel Colt's repeat-action revolver, which was not only marvelously lethal but made from interchangeable parts, a method so distinctive that it became known as the American system."

(...)

The assembly of a Model T took around twelve man-hours in 1913. A year later the same car could be assembled in one and a half hours, while electrification allowed for similar time savings in the production of individual components.

Household revolution
the iron (first introduced in the market in 1893), vacuum cleaner (1907), washing machine (1907), toaster (1909), refrigerator (1916), dishwasher (1929), and dryer (1938) (...) replaced the housewife in an array of unpaid tasks, which allowed women to take on paid jobs in industry, contributed to a rapid expansion of the American labor force,

Taming the Bicycle (Mark Twain)
„Get a bicycle. You will not regret it, if you live.". The arrival of the safety bicycle with its smaller wheels, and the subsequent invention of the pneumatic bicycle tire, eventually brought about the golden age of cycling in the mid-1890s: "People went cycle mad; the bicycle industry appeared to be an El Dorado, and there was a rush to engage in it."

While the twentieth century clearly saw the spread of some replacing technologies, most progress was of the enabling sort.

Employment in automobiles grew 765 percent faster than total manufacturing employment over the first three decades after the industry emerged.

Return of the Machinery

How machinery anxiety returned temporarily, as parts of the workforce struggled. America perhaps had the most violent labor history.

1930, **William Green**, president of the American Federation of Labor: *„workers in thousands have been turned out without jobs, and without future employment in the craft in which they have invested their all."*
The same message comming from **Friedrich Engel** assertion that industrialists "grow rich on the misery of the mass of wage earners."

The Industrial Revolution had shown that society as a whole could gain from technological progress over the long run but that mechanization could bring a painful period of transition for some.

The honor of starting the technological unemployment debates belongs to Secretary of Labor **James J. Davis**. 1927 speach: *„every device that lightens human toil and increases production is a boon to humanity. It is only the period of adjustment, when machines turn workers out of their old jobs into new ones, that we must learn to handle them so as to reduce distress to the minimum.... (...) We must not in any way restrict new means of pouring out wealth."*

The automation debate
In America, the first comprehensive inquiry into the employment effects of automation was undertaken in 1955, when twenty-six leaders of labor, industry, and government testified before a **Congressional subcommittee**. The subcommittee concluded that "*all elements in the American economy accept and welcome progress, change, and increasing productivity," but that "no one dare overlook or deny the fact that many individuals will suffer personal, mental, and physical hardships as the adjustments go forward."*

Automatic elevators, came to the conclusion that automatic elevators were fully five times safer than manually operated ones.

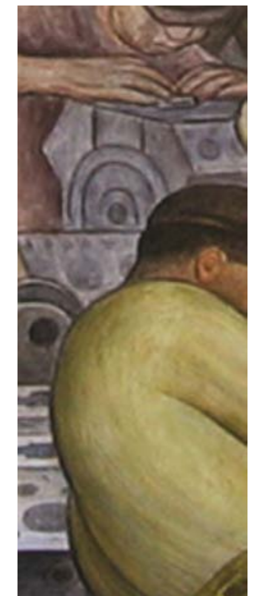
Much like artificial intelligence today, the first computers did not have any meaningful impact on labor markets even in the 1960s. The effect on employment was not felt before the 1980s.

Lyndon Johnson: "*technology is creating both new opportunities and new obligations for us....*". Automation, he argued, could be the "*ally of our prosperity if we will just look ahead, if we will understand what is to come, and if we will set our course wisely after proper planning for the future*."

Automation then remained a major popular issue through the mid-1960s.

Office employees think the broad impact of office automation is to eliminate jobs and regard the methods changes as temporarily disruptive, but they often welcome change and rarely reject mechanization as such. Attitudes toward change appear to depend on the ability of the individual to deal effectively with change and on the skill with which the organization manages the change. (...)
when new tasks and duties were created, workers often felt a sense of increased responsibility, although they sometimes worried about inadequate training. (...) attitudes in large part depended on whether the technology augmented or replaced workers' skills.

Mechanization **made workers' skills more valuable in existing tasks and created many entirely new ones, thereby increasing the bargaining power of labor** and allowing workers to earn better wages.



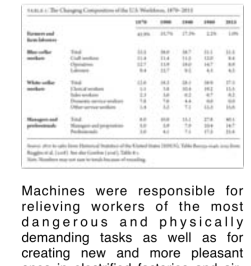
Triumph of Middle Class

Why labor didn't oppose machines in the way it did in the nineteenth century? The social contract of the twentieth century.

Instead of raging against the machine, workers and trade unions battled to maximize their gains from progress. From the perspective of trade unions, mechanization was a way of achieving many of the benefits their members demanded, including higher wages, shorter hours, and earlier retirement.

Technology = a Garden of Eden
Walter Reuther, who had spent a large part of his career leading the union of American automobile workers, was evidently not opposed to mechanization. His attitude was simply that people's purchasing power must grow in tandem with the productive capacity of American industry. Reuther was also a vocal proponent of a guaranteed annual income. In an interview, he said that he looked forward to "the day when the worker would spend less time at his job and more time working on a concerto, a painting or in scientific research." He confidently predicted: "Technological advances will make that possible.... In the future an auto worker may only work 10 hours at the factory. Culture will become his main preoccupation. Working for a living will be sort of a hobby."

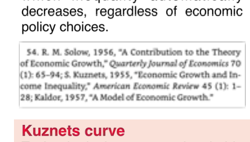
If workers are able to shift into less hazardous, more enjoyable, and better-paying jobs, any distress will be short-lived.



Machines were responsible for relieving workers of the most dangerous and physically demanding tasks as well as for creating new and more pleasant ones in electrified factories and air-conditioned offices.

Equal Gains
The period 1900–1970 has rightly been regarded the "the greatest levelling of all time.

In the 1950s, **Robert Solow** advanced a model of a balanced growth path, in which progress delivered equal benefits for every social group. (..) **Simon Kuznets** advanced his hugely optimistic theory of economic progress in which inequality automatically decreases, regardless of economic policy choices.

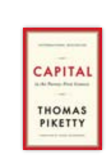

54. R. M. Solow, 1956, "A Contribution to the Theory of Economic Growth," *Quarterly Journal of Economics* 70 (1): 65–94; S. Kuznets, 1955, "Economic Growth and Income Inequality," *American Economic Review* 45 (1): 1–28; Kaldor, 1957, "A Model of Economic Growth."

Kuznets curve

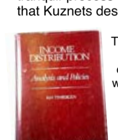
Technological progress inevitably brings about an episode of increased inequality, but all economies have to do to achieve shared prosperity is wait for the cycle to complete itself. This was the cheerful message that Kuznets brought to the annual meeting of the American Economic Association—of which he was president—in Detroit in 1954, where he first outlined his thesis.

He demonstrated that inequality had declined in the later stages of industrialization.

Kuznets's assertion seems hard to reconcile with the post-1980 experience. (..) The **reemergence of growing inequality** seems difficult to reconcile with the Kuznets curve—a point that has been forcefully made by the economist Thomas Piketty.



According to him, the period observed by Kuznets was one of statistical abnormality. In the normal state of capitalism, Piketty argues, the return to wealth exceeds the overall growth rate of the economy, causing wealth-to-income ratios to rise and thus increasing income inequality, as wealth is highly unequally distributed. (..) 2 world wars and the Great Depression served to destroy the riches. The great leveling was the result of violence, economic collapse, and radical political change, not the tranquil process of structural change that Kuznets described.



The leading explanation for the great levelling comes from pioneering work by **Jan Tinbergen** that conceptualized patterns of inequality as a **race between technology and education**

Enabling technological change and the expansion of education provided the principal forces for convergence.

(...)

the race between technology and education does a good job of explaining trends in the labor market over the first three-quarters of the twentieth century. But such models only apply when technological progress is of the enabling sort.

PART IV
THE GREAT REVERSAL

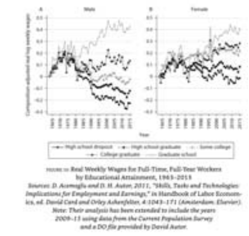
The era of computers

Decent of Middle Class

The age of automation was not a continuation of twentieth-century mechanization. On the contrary, it was a complete reversal of it.

Daron Acemoglu and Pascal Restrepo have recently argued that the wage trends are best understood as a **race between enabling and replacing technologies**. In a world of enabling technologies, the view of progress as a **race between technology and education holds**.

The "great reversal" trend:

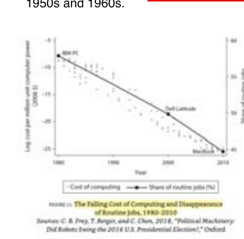


The age of automation came with a new division of labor: tasks can now be divided between humans and computers. Before the advent of the first electronic computer in 1946, the distinction between humans and computers was meaningless. Humans were computers.

Prior to the age of artificial intelligence (AI) computerization was largely confined to routine work. The simple reason is that **computer-controlled machines have a comparative advantage over people in activities that can be described by a programmer using rule-based logic.** A mortgage underwriter, for example, decides whether a mortgage application should be approved on the basis of explicit criteria. Because we know the "rules" for obtaining a mortgage, we can use computers instead of underwriters.

As automation progressed, more complex and creative functions became more plentiful. Computers, as **Norbert Wiener** declared, made possible "more human use of human beings" reducing the "dehumanizing nature of routine work" (**Harry Braverman**)

Beginning of computerization: **1982**. Now we know that the consequence was not widespread technological unemployment, as many had predicted in the 1950s and 1960s.



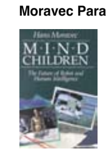
Office automation and organizational restructuring have led secretaries to assume a wide range of new responsibilities once reserved for managerial and professional staff.

Although computers have taken over an ever-growing share of routine work, labor has retained its comparative advantage in other domains. One reason is because of what the economist David Autor has called "**Polanyi's paradox**." (1966)

"We know more than we can tell."

Humans constantly draw upon large reservoirs of tacit knowledge that we struggle to articulate and define even to ourselves, making it exceedingly hard to specify it in computer code.

Moravec Paradox (1988):

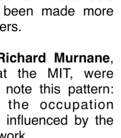


"it is hard for computers to do many tasks that are easy for humans, and conversely, computers can do many things that we find exceedingly difficult"

Many of the skills that are hard to automate because of Moravec's paradox have not been made more valuable by computers.

Frank Levy and **Richard Murnane**, two economists at the MIT, were among the first to note this pattern: hollowing-out of the occupation structure is heavily influenced by the computerization of work

The 2004 book describing the source of the „Cognitive Divide"

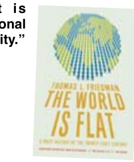


Drifting Apart

The communities that have seen jobs disappear. As America has become increasingly polarized along economic lines, it has also become more politically polarized.

The computer revolution has caused to the demise of many of the factory cities that industrialization once gave rise to.

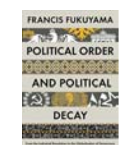
"The higher-tech the economy, the more it relies on people who can improve and exploit the technology, which creates many openings for people whose main asset is their exceptional cognitive ability."



Ironically, it is precisely the technologies that futurists once believed would flatten the world that have made it more uneven: digital industries have overwhelmingly clustered in cities with skilled populations.

Politics of Polarization

Why citizens who have seen their wages fall have not demanded more compensation and the growing populist appeal.



"The higher-tech the economy, the more it relies on people who can improve and exploit the technology, which creates many openings for people whose main asset is their exceptional cognitive ability."

Populism and identity politics have been fueled by diminishing economic opportunity for the unskilled and the lack of a political response to their concerns.

THE DISCIPLINED SELF
The working class was always more than an economic category—it was a **cultural phenomenon**, too. In the manufacturing era, industrial male workers had to find ways of taking pride in monotonous toil on a factory's assembly line. Their solution, the sociologist **Michèle Lamont** has convincingly argued, was to construct an identity as "**the disciplined self.**" It took discipline to get up early each morning, go to a factory, and perform the same routine job hour after hour, day after day.

FAIRNESS CONCERNS
Inequality is more problematic when it occurs due to unfair competition. When a better technology makes an old one obsolete, nobody has reason to complain: "Banning the light bulb because candle makers would lose their jobs strikes almost everyone as a silly idea."

Technological progress has been a source of ceaseless churn in the labor market for more than two centuries. But, as Rodrik writes, *"when we expect the redistributive effects to even out in the long run, so that everyone eventually comes out ahead, we are more likely to overlook* ***reshufflings of income****. That is a key reason why we believe that technological progress should run its course, despite its short-run destructive effects on some."*

If people believe that they will eventually be made better off by technological progress, they are more likely to accept the churn. But if citizens do not see their incomes improve over several decades as their alternative job options gradually fade, they are more likely to resist the force of technology.

(..)

While Engels's pause came to an end eventually, and ordinary people were much better off in the very long run, many of those who lost their jobs to machines never saw the gains from growth.

„**Our industry must innovate without losing the human touch."**

85% of Democrats and 86% of Republicans thought that automation should be limited to dangerous or unhealthy jobs.

Governments in the nineteenth century did not see technology as an unstoppable force. Rather, they had to use considerable force to make sure that the Luddites and other groups were unable to block mechanization. And the working class didn't view mechanization as inevitable either.

(..) there is nothing to ensure that technology will always be allowed to progress uninterrupted. It is perfectly possible for automation to become a political target. (..) there is nothing to ensure that technology will always be allowed to progress uninterrupted. It is perfectly possible for automation to become a political target.

PART II
THE FUTURE

The examination of the prototypical technologies coming out of the labs

Artificial Intelligence

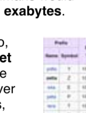
The trends and how predominantly replacing technologies will continue to worsen the employment prospects for the already shattered middle class.

AI allows us to unravel Polanyi's paradox. The fundamental difference is that instead of automating tasks by programming a set of instructions, we can now program computers to "learn" from samples of data or "experience."

As billions of people interact online, they leave digital trails that allow algorithms to tap into their experience.

Researchers at the University of California, Berkeley estimate that **the information contained in all books worldwide is around 480 terabytes,** while a text transcript of all the words ever spoken by humans would amount to some **5 exabytes**.

According to Cisco, **worldwide internet traffic** will increase nearly threefold over the next five years, reaching **3.3 zettabytes per year by 2021**.



A dramatic shift in AI-related publications, from computer science journals to application-oriented outlets.
In 2015, the authors estimate, nearly two-thirds of all AI publications were outside the field of computer science.

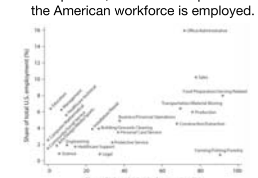
ADOPTION OF TELEPHONE?
An early article in Scientific American argued that it was a silly invention, for which people would find little use: *"The dignity of talking consists of having a listener, and it seems absurd to be addressing a piece of iron."*

Until recently, computers had a comparative advantage in tasks involving routine rule-based activities, while humans did better at everything else.

Herber Simon, Noble Price Laureate of 1975 for predicting **the future of work**. He did not lay out an explicit framework, he got things spectacularly right by looking at trends in technology. He was right to think that computers would take over many routine factory and office jobs.

1960 "The Corporation: Will It Be Managed by Machines?,"

Automatability of jobs based on 20.000 unique task descriptions.
final sample covered 702 occupations, in which 97 percent of the American workforce is employed.



"our algorithm predicted that 47 percent of American jobs are susceptible to automation"

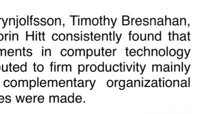
a widespread misconception is that automation is coming for the jobs of the skilled.(...) the labor market prospects of the unskilled will likely continue to deteriorate, unless other forces counteract that trend.

Amara's Law

"We tend to overestimate the effect of a technology in the short run and underestimate the effect in the long run."

Indeed, Amara's Law has been a good guide to the trajectories of technological progress in the past.

Erik Brynjolfsson, Timothy Bresnahan, and Lorin Hitt consistently found that investments in computer technology contributed to firm productivity mainly when complementary organizational changes were made.


68. See, for example, T. F. Bresnahan, E. Brynjolfsson, and L. M. Hitt, 2002, "Information Technology, Workplace Organization, and the Demand for Skilled Labor: Firm-Level Evidence," *Quarterly Journal of Economics* 117 (1): 339–76; E. Brynjolfsson, L. M. Hitt, and S. Yang, 2002, "Intangible Assets: Computers and Organizational Capital," *Brookings Papers on Economic Activity* 2002 (1): 137–81; E. Brynjolfsson and L. M. Hitt, 2000, "Beyond Computation: Information Technology, Organizational Transformation and Business Performance," *Journal of Economic Perspectives* 14 (4): 23–48.

About **70%** of the productivity acceleration in the years 1996–99, relative to that in the period 1991–95, has been attributed to computer technologies.

The adoption of **AI will require not only improvements in the technology itself, but significant complementary investment and plenty of experimentation to exploit its full potential.** During this phase, history tells us, **the economy goes through an adjustment process with slow productivity growth.**

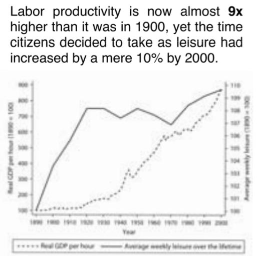
Steam engine example?
James Watt's steam engine delivered its main boost to productivity some eight decades after it was invented. When John Smeaton examined Watt's invention, patented in 1769, he declared that *"neither the tools nor the workmen existed that could manufacture so complex a machine with sufficient precision."* Complementary skills had to be developed to perfect the technology. But ten years later, the combined genius of Matthew Boulton and Watt saw his engine a commercial success.

Work and Leasure

In the public mind, there is a widespread dystopian belief that the rise of brilliant machines will ruin working people's lives by causing wages to fall and unemployment to rise. By contrast, an equally common utopian belief is that technology will herald a new age of leisure, where people will prefer to work less and play more. Neither of these beliefs is new. And over the long run, both have so far been proven wrong, or at least vastly exaggerated.

Keynes was optimistic about the long run. Technology, he argued, **would solve mankind's economic problems and deprive us of our purpose of subsistence.** Instead, our main concern would become how to occupy our leisure. In a century, Keynes predicted, people would enjoy a **15-hour** workweek.

Labor productivity is now almost **9x** higher than it was in 1900, yet the time citizens decided to take as leisure had increased by a mere 10% by 2000.



An average American worker in 2015 who merely wishes to maintain the average income level of 1915 could do so by working just 17 weeks per year, aided by modern technology. But most citizens do not find this trade-off desirable. Instead, their demand for new goods and services has risen along with productivity. As labor-saving technology has given us the means to do more with less, most of us have preferred to take on other productive tasks instead of opting for more leisure.

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Whether workers prefer shorter hours to additional income depends upon their judgment as to the relative worth of leisure and income.

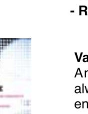
After a century of staggering advances in mechanization and soaring productivity, it is quite remarkable how little time Americans take in leisure.

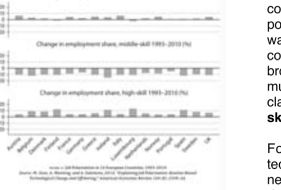
Frederic Bastiat in his brilliant 1850 essay, "**That Which Is Seen, and That Which Is Not Seen**," he wrote: *"In the department of economy, an act, a habit, an institution, a law, gives birth not only to an effect, but to a series of effects. Of these effects, the first only is immediate; it manifests itself simultaneously with its cause—it is seen. The others unfold in succession—they are not seen: it is well for us, if they are foreseen*." With regard to machines, substitution is the observable first-order effect.

Skills

Almost half of employment growth between 1980 and the Great Recession happened in new types of work.

„There's never been a better time to be a worker with special skills or the right education, because these people can use technology to create and capture value. However, there's never been a worse time to be a worker with only 'ordinary' skills and abilities to offer, because (..) technologies are acquiring these skills and abilities at an extraordinary rate."





The dynamic of job growth at the top and the bottom of the skill and income distribution has contributed to the growing divide between college and high school graduates **reinforced by education and computerization.**

In 2017, the International Monetary Fund (**IMF**) published a report showing that "*technological advancement, measured by the long-term change in the relative price of investment goods, together with the initial exposure to routinization, have been the largest contributors to the decline in labor income shares in advanced economies*."
Computer technologies have shrunk the size of the middle class, put downward pressure on unskilled workers' wages, and reduced labor's share of income. And, as the experience of the Industrial Revolution illustrates, even when new jobs are being added, it can take a long time for workers to acquire the necessary skills to successfully move into the newly emerging jobs. (..) When **replacing technologies** make the skills of existing workers redundant, they reduce the earning capacity of significant parts of the population. Though new tasks may be spun off in the process, new skills take time to learn and are often seen in workers' wages only years later.

The Road to Riches

Some strategies and pathways to help people adjust.

"Even assuming that the ingenuity of scientists and engineers will always generate new ideas to relay the old ... **there is no assurance that those men charged with utilizing these ideas will do so intelligently** [and] there is no assurance that **noneconomic exogenous factors**—above all, man's incompetence in dealing with his fellow-man—**will not reduce the whole magnificent structure to dust.**"

"The future of democracy in developed countries will depend on their ability to deal with the problem of a disappearing middle class."

If current trends continue in the coming years, the divide between the winners and losers to automation will become even wider.

Governments diffused the threat of revolution from below by expanding the franchise, creating a welfare state, and building an educational system that eased adjustment to the accelerating pace of change. Thus, quite naturally, the coming AI revolution has prompted calls for a capitalist reinvention of similar magnitude.

In a world that is becoming increasingly technologically sophisticated, rising returns on skills are unlikely to disappear and likely to intensify.

Automation then represents a double whammy. Where machines have replaced middle-class workers, the demand for local services has also suffered.

We have been here before. We should recall **Maxine Berg's** noting of the "*unprecedented demands for mobility, both geographical and occupational*," that accompanied the Industrial Revolution. (...)

Engels's pause eventually came to an end, as enabling technologies came to the rescue and workers acquired new skills. But by that time, three generations of ordinary Englishmen had seen living standards decline.

Engel's pause

Early period of the industrial revolution, when, due to great technological upheaval, the livelihood of a large number of people worsened before society began to prosper in the longer term

To avoid the technology trap, governments must pursue policies to kick-start productivity growth while helping workers adjust to the onrushing wave of automation. Addressing the social costs of automation will require major reforms in education,

the solid performance of the U.S. economy and the expansion of education over the first three-quarters of the twentieth century were not coincidental.

Areas of focus:
- **Education**
- **Retraining**
- **Wage Insurance**
- **Tax Credits**
- **Regulation**
- **Relocation**

Value of proximity
Any digital communication must always be planned on at least one end, which means that the type of random interactions that occur in a workplace cannot happen at distance. Rather, the **value of proximity** will probably increase. (...) **The curse of geography** is likely to intensify.

Final Thoughts

Current economic trends must continue indefinitely (..) while it is possible that we are at the cusp of a wave of enabling technologies that could reinstate labor in new jobs more broadly, that is unlikely to provide much relief to people in the middle class **unless they have the right skills**.

For more than thirty years now, technological change has created few new jobs that do not require a college degree. In a world that is becoming increasingly technologically sophisticated, new jobs are unlikely to open up.

(..)

the recession unmasked the steady decline in the wages of the middle class, which helps explain the relatively recent rise of populism.

(..)

People who lose out to automation will quite rationally oppose it, and if they do, the short-term effects cannot be seen in isolation from the long run.

If technology fails to lift all boats in the coming years, broad acceptance of technological change cannot be taken for granted. People have higher expectations than at the time of Engels's pause. They have the right to vote. And they are already demanding change.

(..) regardless of what the future of technology holds, it is up to us to shape its economic and societal impact.