AI and inequality: How smart machines exacerbate demographic bias and inequality

A presentation at the Centre for the Study of Living Standards / Centre d'étude des niveaux de vie (Ottawa, Canada)

18 Mar 2019

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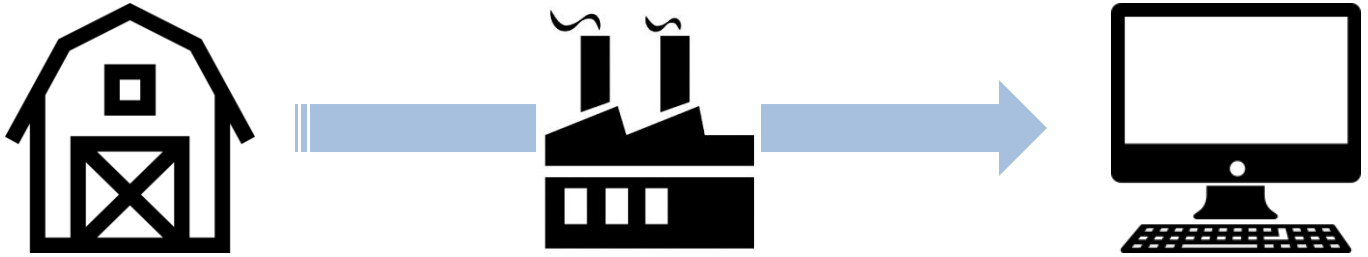
CSLS
Centre for the Study of Living Standards
Centre d'étude des niveaux de vie

AI and inequality

How smart machines exacerbate demographic bias and inequality

- How does AI generate riches, redistribute wealth and distort the labour market in multicultural societies?

- How will AI distort off-shoring and upend the traditional development model?



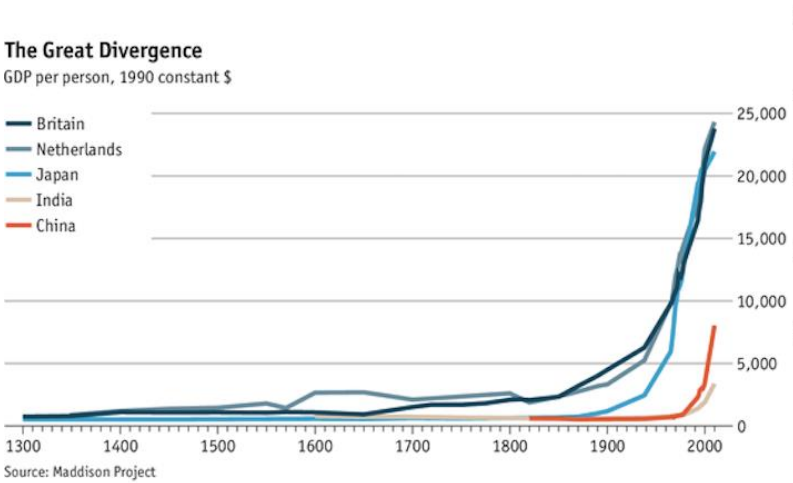
- As AI displaces humans from their jobs, economic value will be transferred from labour to capitalists, particularly the "super-elites". In an era where capital is mobile and labour is less so, AI will exacerbate already-high levels of inequality if left unmanaged

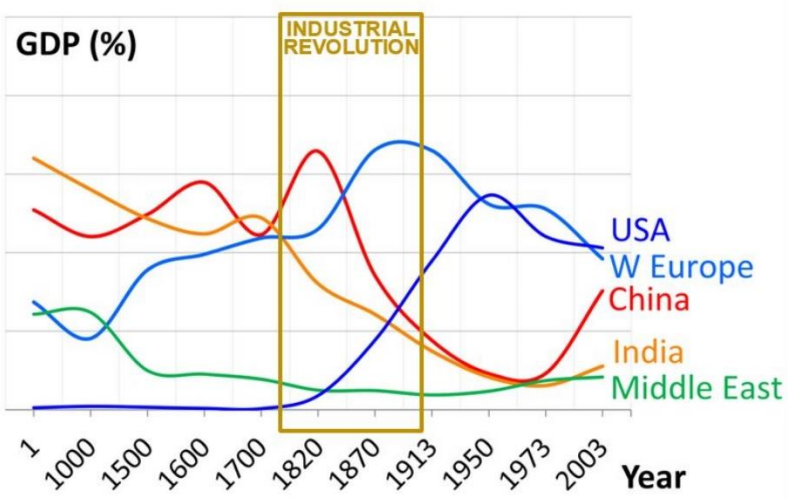
"As automation substitutes for labour across the entire economy, the net displacement of workers by machines might exacerbate the gap between returns to capital and returns to labour… This will give rise to a job market increasingly segregated into 'low-skill/low-pay' and 'high-skill/high-pay' segments, which in turn will lead to an increase in social tensions."
– *Klaus Schwab, 2016*

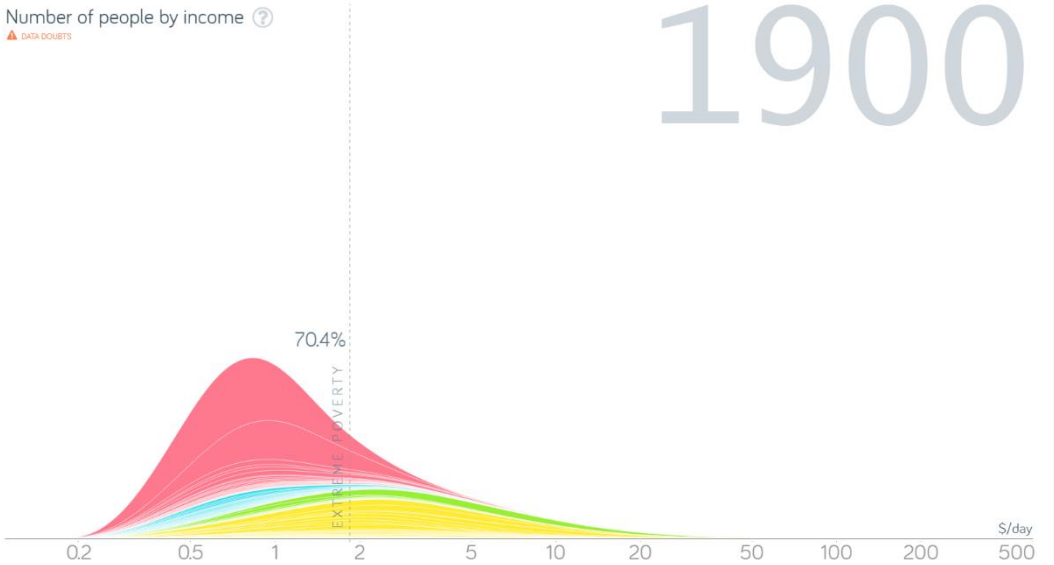
"[Economic inequality] is one of the main challenges posed by the proliferation of artificial intelligence and other forms of worker-replacing technological progress."
– *Anton Korinek & Joseph Stiglitz, 2017*

Inequality at the global level

"Great Divergence" b/w the West vs the rest after (1st) Industrial Revolution



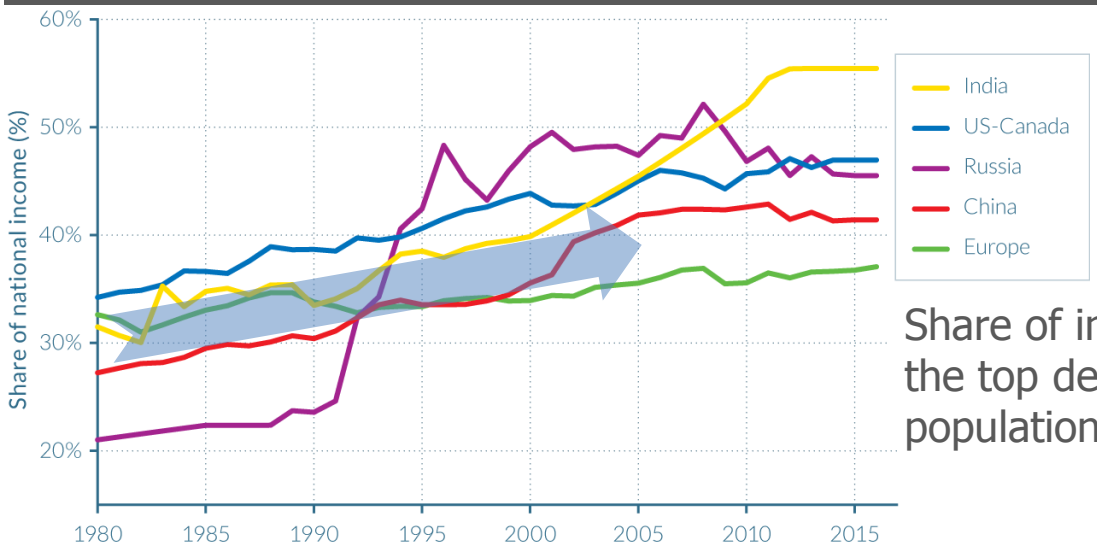




Source: Economist, Freemanpedia, Gapminder

Inequality at the national level

Inequality is growing in most countries (even as it has fallen globally)

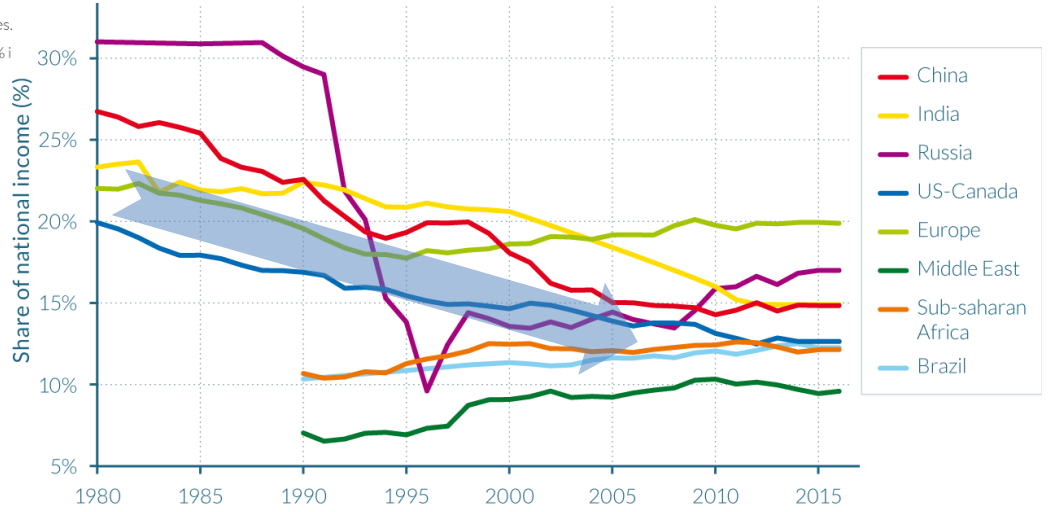


Share of income by the top decile of the population since 1980

Source: WID.world (2017). See wir2018.wid.world/methodology.html for data series and notes.

In 2016, 47% of national income was received by the top 10% in US-Canada, compared to 34% i

Share of income by the bottom half of the population since 1980



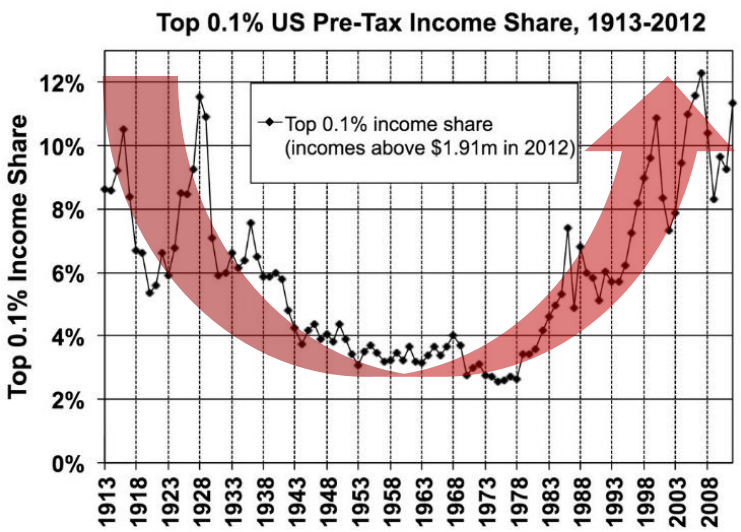
Source: WID.world (2017). See wir2018.wid.world/methodology.html for data series and notes.

In 2016, 12% of national income was received by the Bottom 50% in Sub-Saharan Africa.

Source: WID.world

It was not always this way

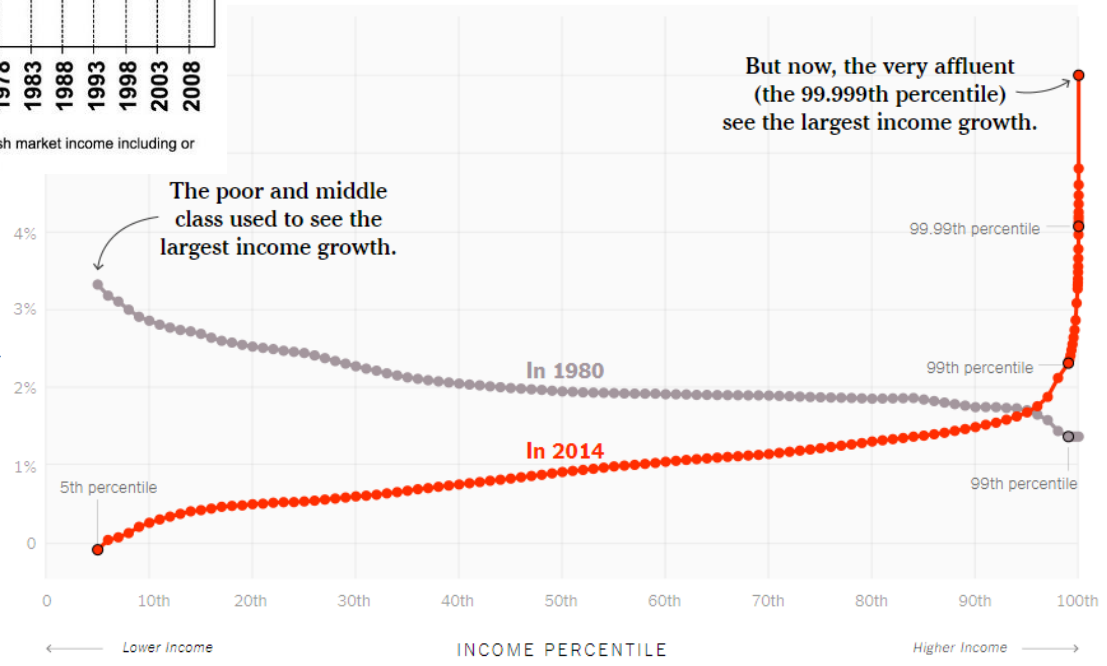
Inequality low in Bretton Woods era; now returning to level of Gilded Ages



Source: Piketty and Saez, 2003 updated to 2012. Series based on pre-tax cash market income including or excluding realized capital gains, and always excluding government transfers.

Inequality was high just before the Great Depression; then came the golden era led by the welfare state

"Our broken economy, in one simple chart"

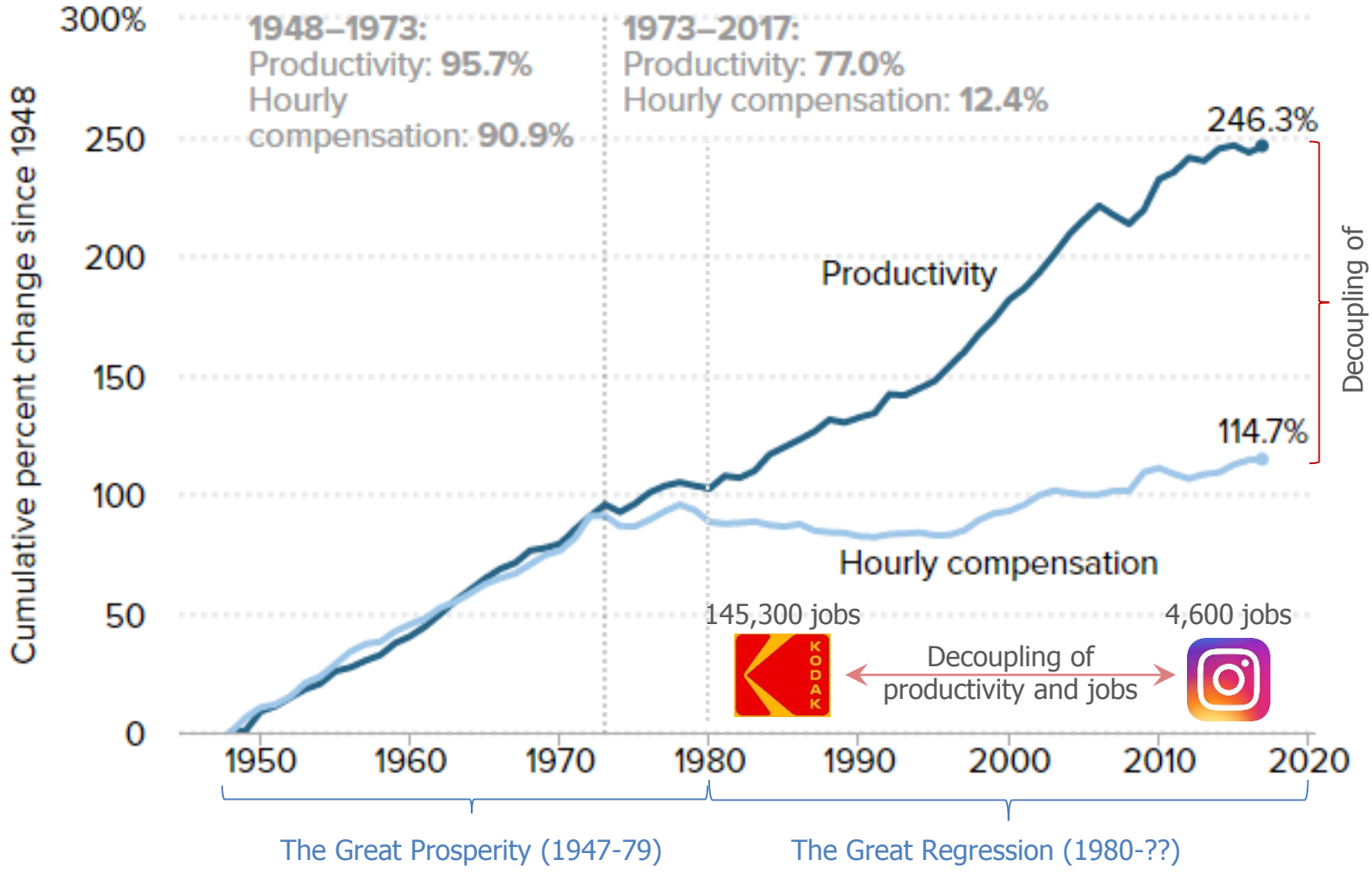


Note: Inflation-adjusted annual average growth using income after taxes, transfers and non-cash benefits.

Source: Piketty & Saez (2015), New York Times

Driven (partly) by productivity/labour-wage gap

Technology and globalisation ➔ decoupling of jobs and wealth

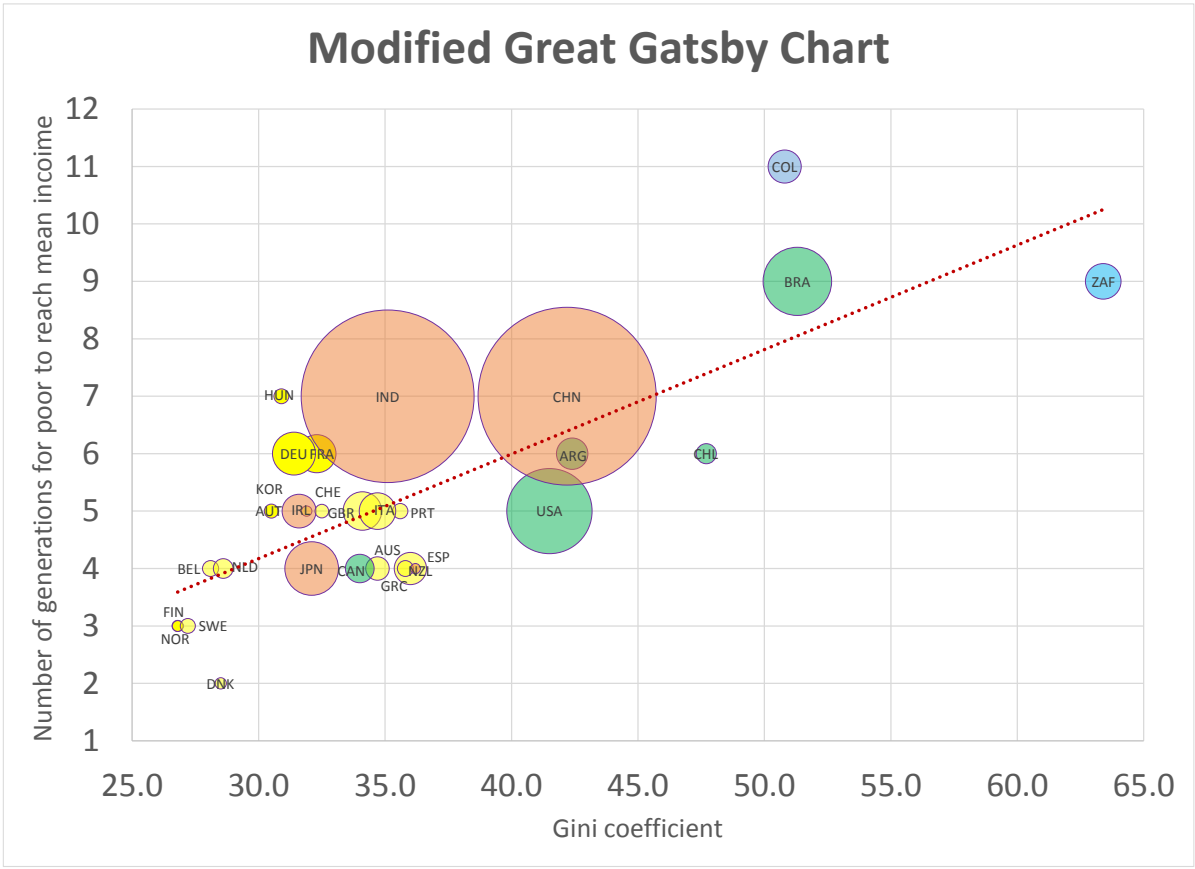


The real median income of US households has barely changed over the past 2 generations, yet the country is much wealthier now. Where did those gains go?

Source: Economic Policy Institute, Yahoo! Finance

Inequality inconsequential if we have mobility

But we have inequality without mobility (Great Gatsby Curve (modified))

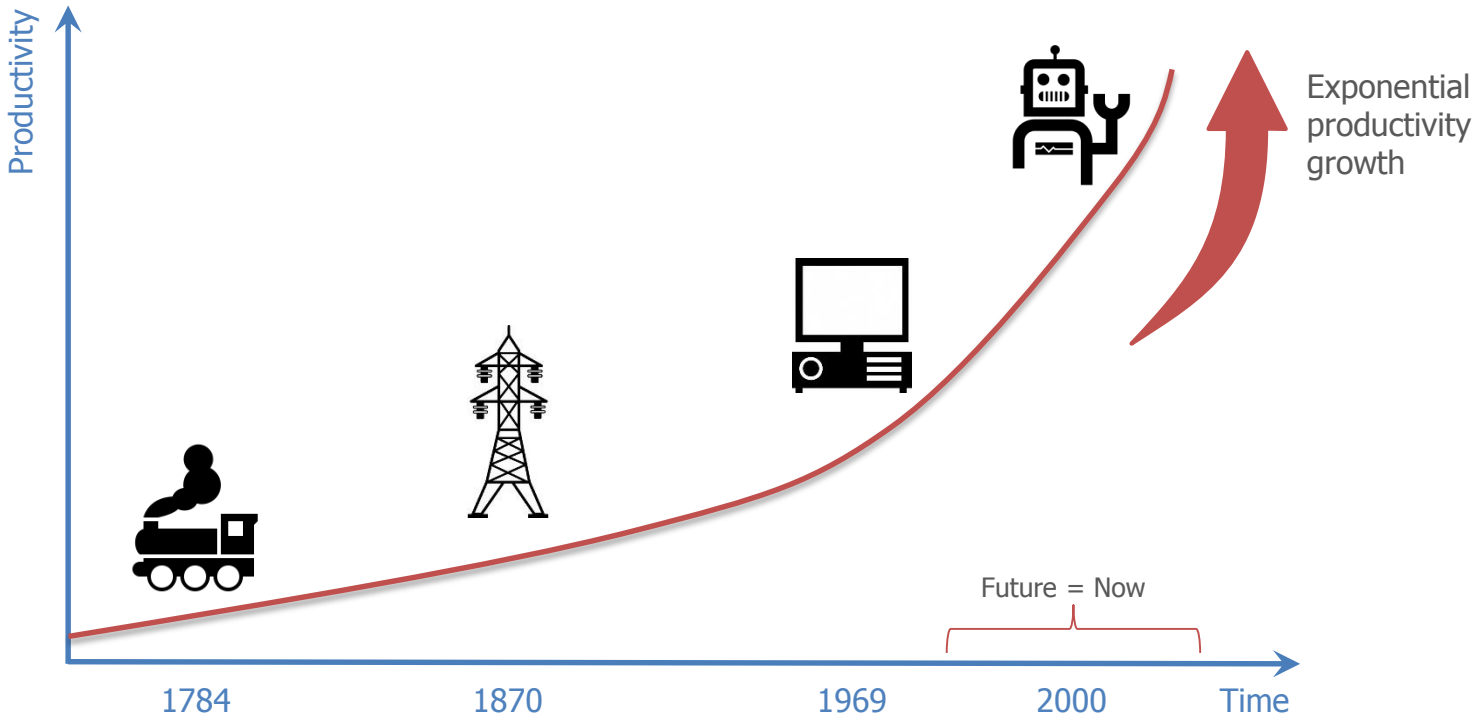


"[I]nequality represents the greatest societal concern associated with the 4th Industrial Revolution. The largest beneficiaries of innovation tend to be the providers of intellectual and physical capital – the innovators, shareholders, and investors – which explains the rising gap in wealth b/w those dependent on capital versus labour."
– *Klaus Schwab, 2016*

Source: OECD, UNPD, World Bank

First Industrial Revolution ➔ Great Divergence

We are now embarking on the Fourth Industrial Revolution (AI, BD, robotics)



1st Ind. Rev'n
- Mechanisation
- Water power
- Steam power

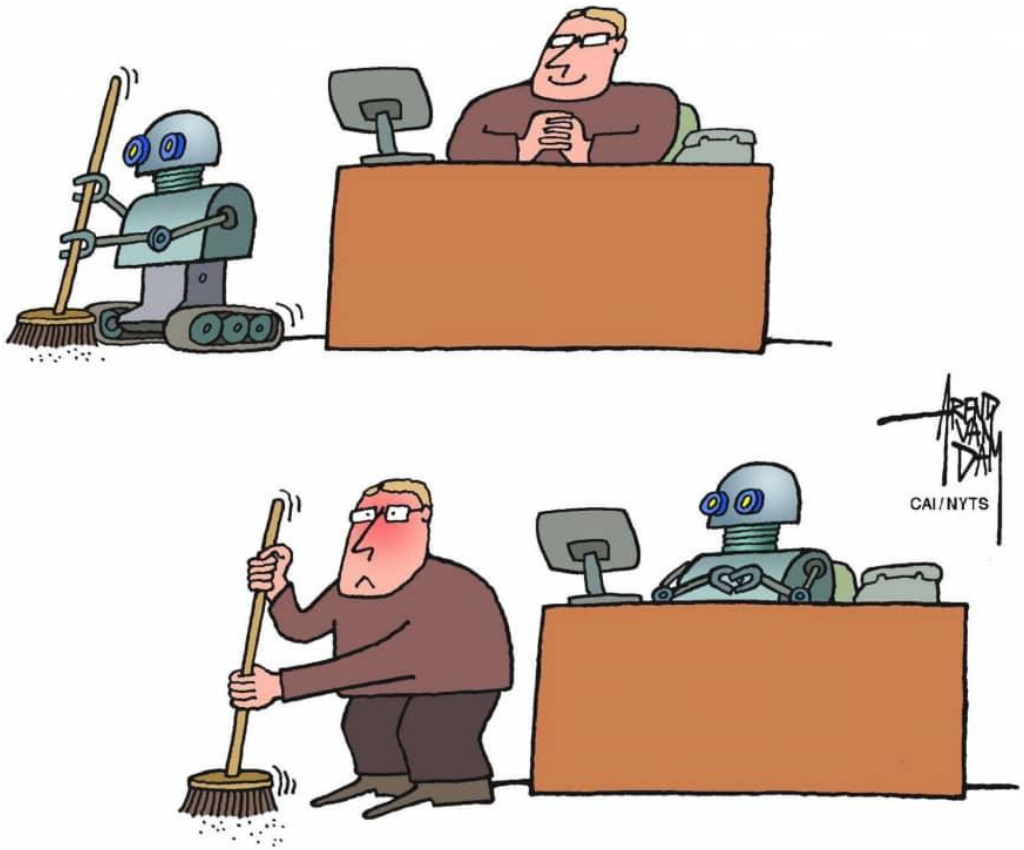
2nd Ind. Rev'n
- Mass production
- Assembly line
- Electricity

3rd Ind. Rev'n
- Automated production
- Electronics
- Computers

4th Ind. Rev'n
- Artificial intelligence
- Big data
- Robotics

Robots are supposed to serve us…

But many think they could end up hurting rather than helping us



- McKinsey report suggests that between 400 million to 800 million jobs worldwide could be automated by 2030
- AI and smart machines will lift productivity and allow us to do and consume things previously never possible. But millions of people will need to either switch jobs, upgrade their skills, create their own value or will have to leave the job market

The AI job creation/destruction score card

Wide range on expectations, but all are certain of big changes

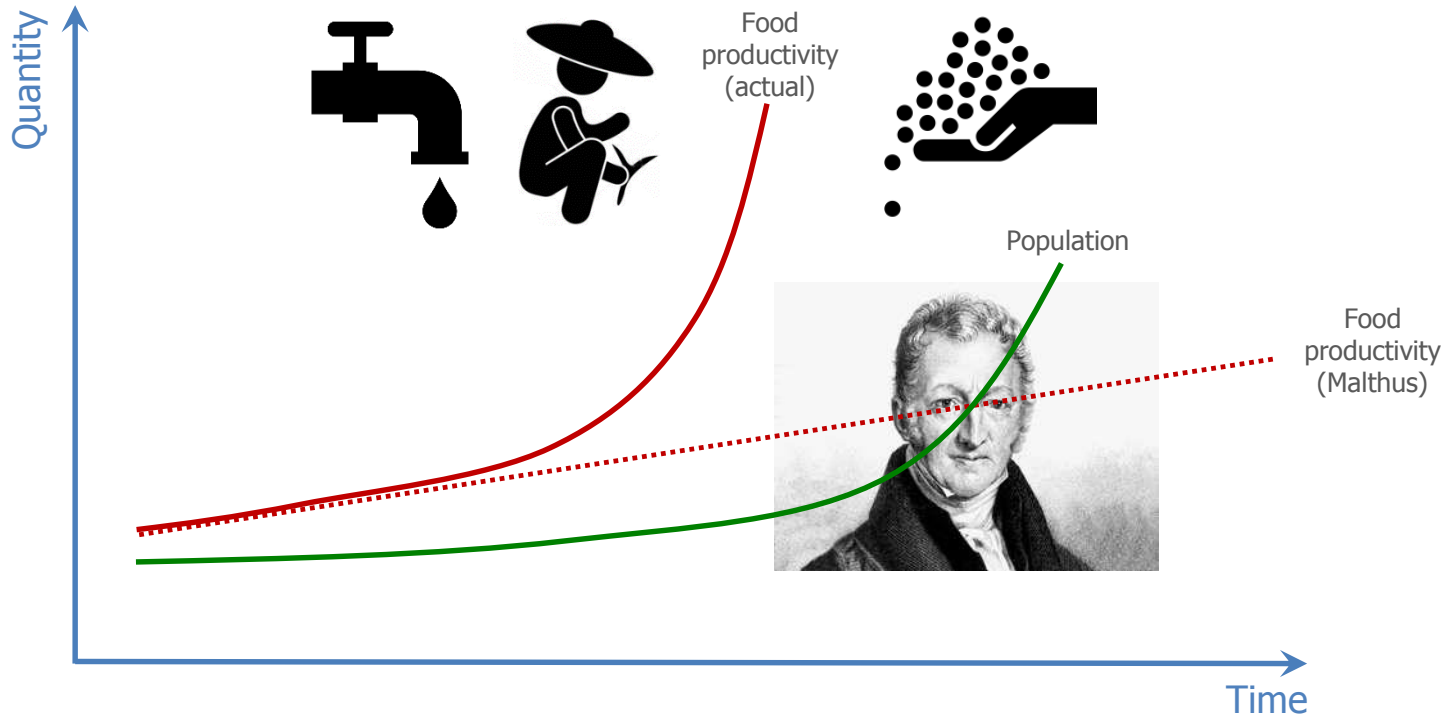
Date	Geography	Creation	Destruction	Net	Source	Released
2016	Global	900k to 1.5M		N/A	Metra Martech	2013
2018	USA	~3M	~14M	-11M	Forrester	2017
2020	Global	1M to 2M		N/A	Metra Martech	2013
2020	Global	2.3M	1.8M	+0.5M	Gartner	2017
2021	G20+	2M	7.1M	-5.1M	WEF	2016
2021	Global	1.9M to 3.5M		N/A	IFR	
2021	USA		~9M (6%)		Forrester	2016
2022	Global		1B	N/A	Thomas Frey	2012
2022	Global	133M	75M	+58M	WEF	2018
2025	USA	~14M	~24M	-10M	Forrester	2016
2025	USA		3.4M	N/A	ScienceAlert	2017
2027	USA	14.9M	24.7M	-9.8M	Forrester	2017
2030	Global		2B	N/A	Thomas Frey	2013
2030	Global	555M to 890M	400M to 800M	-245M to +490M	McKinsey	2017
2030	USA		~58M	N/A	PWC	2017
2035	USA		80M	N/A	BOE	2015
2035	UK		15M	N/A	BOE	2015
~2035	OECD		30%		PWC	2018
~2040	USA		47%		Oxford	2013
	UK		13.7M	N/A	IPPR	2017
N/A	OECD		9%; 14%	N/A	OECD	2016; 2018
	USA		~14M	N/A	OECD	2016

Source: MIT Technology Review, IPPR, OECD, Oxford

Is the sky really falling?

Not the first time that we thought humanity's fate was headed for disaster

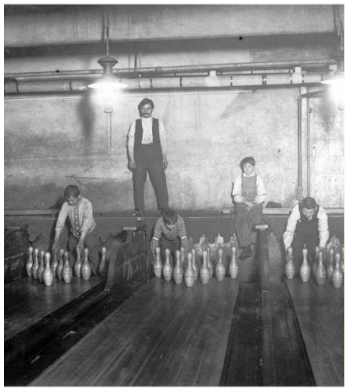
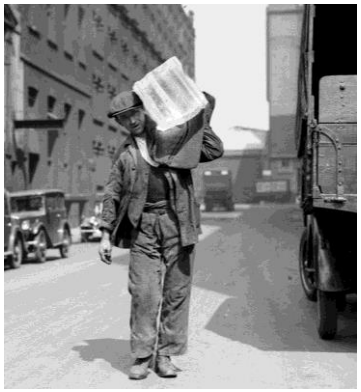
The Malthusian theory of growth underestimated human ingenuity. In the USA today, 1 farmer is able to feed 154 people. (Or maybe Malthus will be proved right in that technology will not produce enough *jobs* for a growing population?)



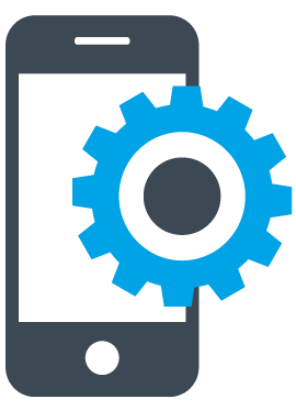
A natural resource-based economy faces scarcity and limitations, but a knowledge-based economy – where data and information are the primary products – has no limit for growth.

Technology kills jobs – that is inevitable

But it will also create news ones as part of creative destruction

- Swiss watch industry is an example of superior technology that threatened jobs (and an entire industry) which, on paper, should have seen it collapse. Instead, the industry re-invented itself and is doing even better than before
- Will AI be more like alarm clocks (job destroying) or ATMs (job enhancing)?
- Many jobs churn within a 60-90 year cycle (Wyatt & Hecker, 2006)

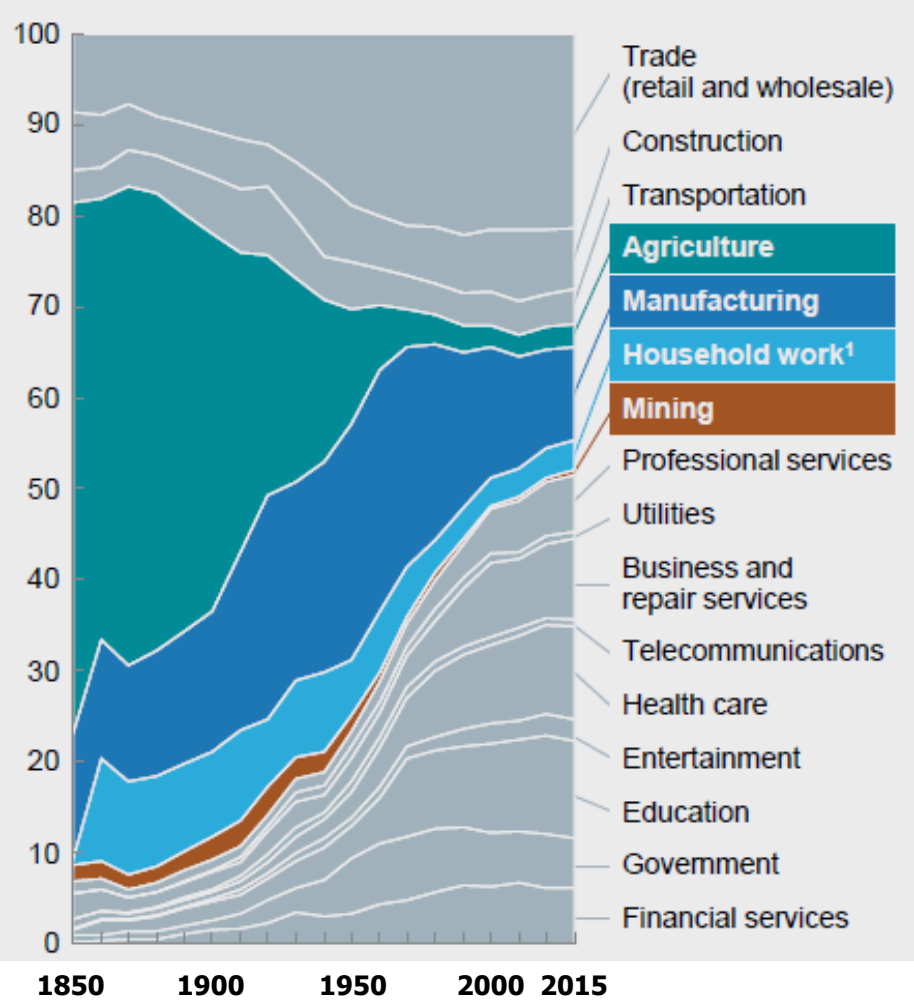



Wyatt, Ian D. and Daniel E. Hecker. "Occupational changes during the 20th century." Monthly Labour Review, BLS, 2006

Technological progress has hitherto benefited us

"Displaced" farmers have moved into more productive sectors

Share of total employment by sector (USA)

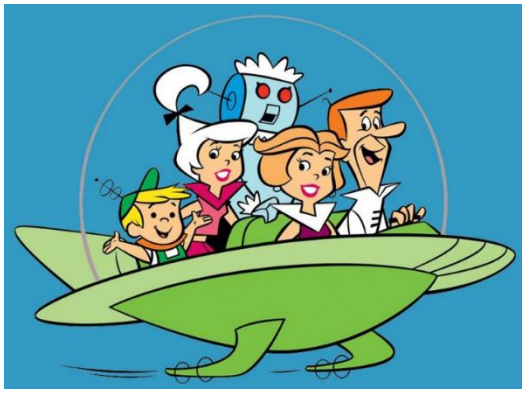


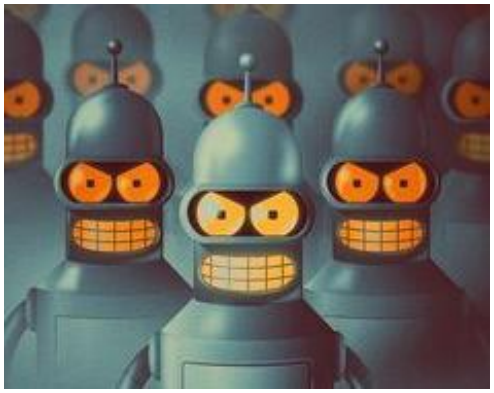
- Prior to the Industrial Revolution 98 percent of humans were (subsistence) farmers
- Farming was a physical job that relied on strength and the ability to do repetitive tasks on the field
- Now less than 2 percent of the (US) workforce is employed on a farm, yet the country produces a surplus of food with a fraction of the labour
- The "displaced" farm labourers ended up finding more productive and valuable work to do with their time

Source: McKinsey Global Institute

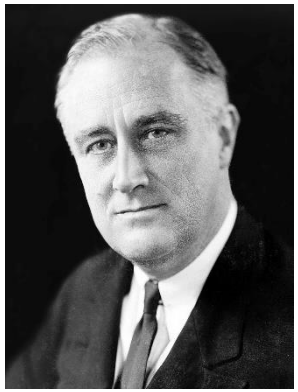
But is this time different?

Will AI bring the 2-hour workweek or the Apocalypse?

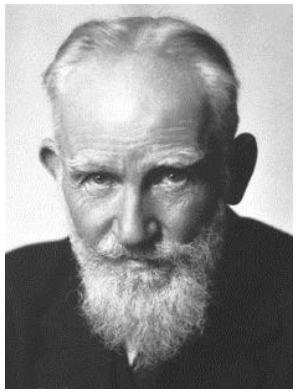




"Prediction is difficult, especially about the future."
– *Niels Bohr*



"There are about as many opinions as there are experts."
– *Franklin D. Roosevelt*



"If all the economists were laid end to end, they'd never reach a conclusion."
– *George Bernard Shaw*

AI's impact on job losses will be uneven

Some jobs are more susceptible to automation

Probability of job automation by occupation (UK)

Probability	SOC code	Occupation
0.9900	41-9041	Telemarketers
0.9900	23-2093	Title examiners, abstractors, and searchers
0.9900	51-6051	Sewers, hand
0.9900	15-2091	Mathematical technician
0.9900	13-2053	Insurance underwriters
0.9900	49-9064	Watch repairers
0.9900	43-5011	Cargo and freight agents
0.9900	13-2082	Tax preparers
0.9900	51-9151	Photographic process workers and processing machine operators
0.9900	43-4141	New accounts clerks
0.9900	25-4031	Library technicians
0.9900	43-9021	Data entry keyers
0.0028	29-1125	Recreational therapists
0.0030	49-1011	First-line supervisors of mechanics, installers and repairers
0.0030	11-9161	Emergency management directors
0.0031	21-1023	Mental health and substance abuse social workers
0.0033	29-1181	Audiologists
0.0035	29-1122	Occupational therapists
0.0035	29-2091	Orthotists and prosthetists
0.0035	21-1022	Healthcare social workers

Highly likely to be automated (rote tasks)

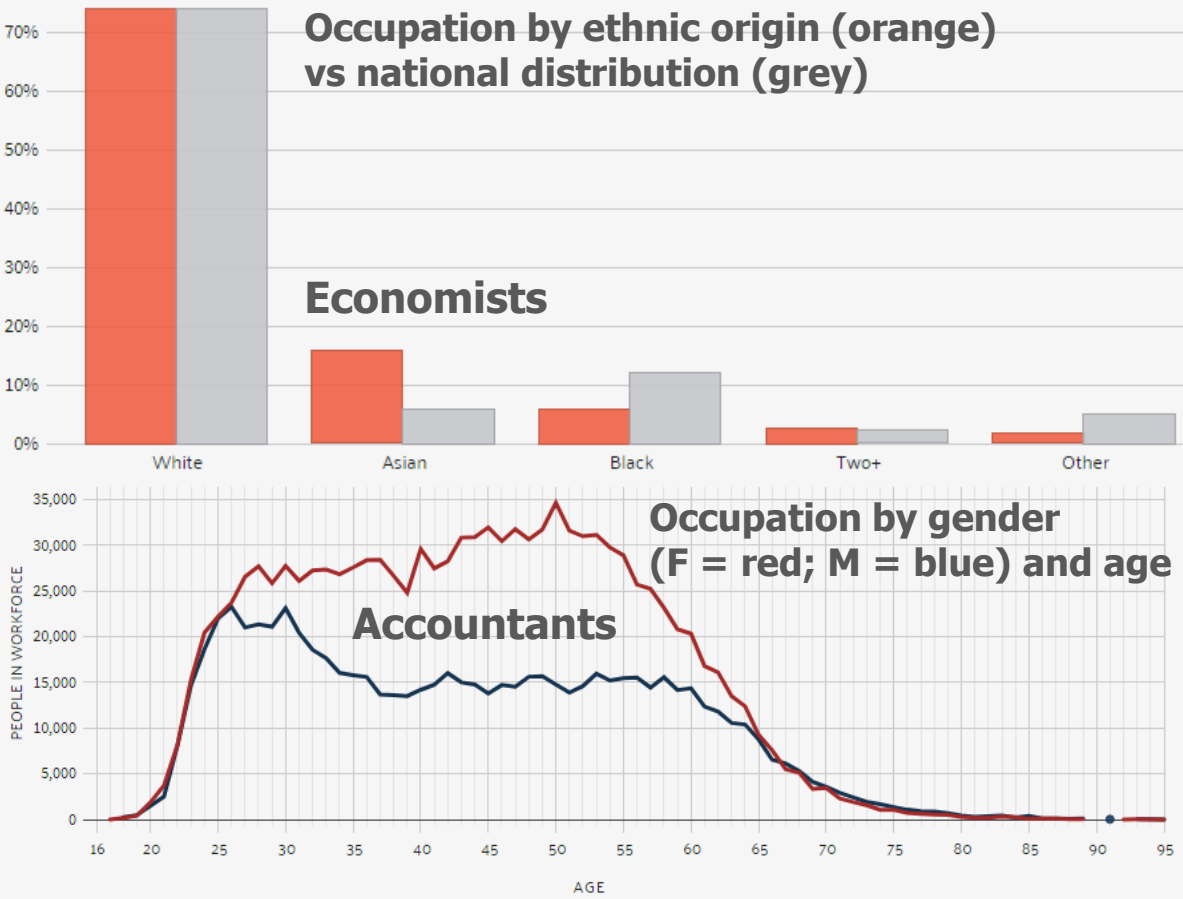
Highly unlikely to be automated (personalised)

In about 3 in 5 occupations, it is expected that at least 1/3 of the associated tasks/activities could be automated, freeing up human labour to pursue other (more valuable) tasks.

Source: Oxford University

Sectors and occupations have demographic bias

Therefore job losses spurred by AI will have demographic bias



Many occupations have demographic biases in age, gender, ethnicity/race, language, etc. Just as much they may have different educational profiles and fields of specialisation(s) which themselves have a demographic bias.

Discussions of the demographic impact of AI have been mute, but there are clear patterns in jobs by race/ethnicity. Employment shocks will thus show bias:

- 1 in 5 nurses in California are Filipino; 1 in 4 overseas nurses is Filipino
- Over 90 percent of truck drivers in Canada are white males; 2/3 of American truck-drivers are white males

Sources: Data USA

AI's impact across countries will be uneven

Its impact will vary by wealth/development and industry structure

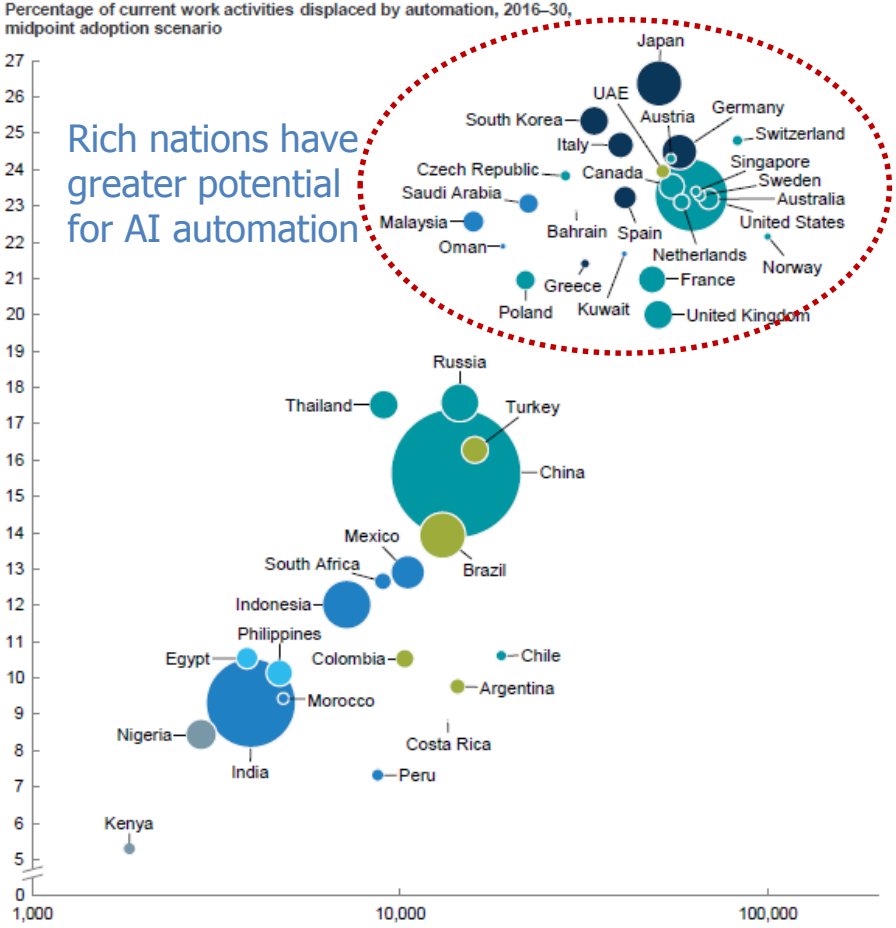
Impact of automation varies by a country's income level, demographics, and industry structure

Size = FTEs potentially displaced, 2030 (million) — 25

Color = Average age (projected), 2030: <25; 25–30; 30–35; 35–40; 40–45; 45–50

Percentage of current work activities displaced by automation, 2016–30, midpoint adoption scenario

Rich nations have greater potential for AI automation



SOURCE: World Bank; Oxford Economics; McKinsey Global Institute analysis

Jobs of the future: Employment growth and decline by occupation

Net impact of automation and seven catalysts of labor demand, 2016–30
% change (+/–), step-up labor demand, midpoint automation[1]

% change: -35 or less; -25 to -34; -15 to -24; -5 to -14; Within ±5; 5 to 24; 25 to 49; 50 to 99; 100 or more

Occupation groups (% of labor force across 6 focus countries)	Example occupational categories[2]	United States	Germany	Japan	China	Mexico	India
Care providers 1–9	Doctors						
	Nurses, physicians assistants, and pharmacists						
	Childcare workers						
	Community and social workers						
Educators 1–5	School teachers						
	Education support workers						
Managers and executives 2–5	Executives						
	Managers						
Professionals 2–19	Account managers						
	Engineers						
	Scientists and academics						
	Legal support workers						
Technology professionals 0–2	Computer engineers						
	Computer specialists						
Builders 5–11	Architects, surveyors, and cartographers						
	Construction workers						
	Crane and tower operators						
Creatives 0–1	Artists and designers						
	Entertainers/media workers						
Customer interaction 10–25	Personal care workers						
	Food serving workers (hosts)						
	Sales workers (retail and online)						
	Hotel and travel workers						
Office support 3–18	Computer support workers						
	Financial workers (procurement, payroll, etc)						
	Administrative assistants						
Other jobs, predictable environments 15–29	Production workers						
	Material moving machine operators						
	Agricultural graders and equipment operators						
	Food preparation workers						
	General mechanics						
Other jobs, unpredictable environments 9–42	Specialized mechanics and repair						
	Emergency first responders						
	Machinery installation and repair workers						
	Agricultural field workers						
	Building and grounds cleaners						

1 Midpoint of earliest and latest automation adoption in the "step-up" scenario (i.e., high job growth). Some occupational data projected into 2016 baseline from latest available 2014 data.
2 A complete version of this heat map with all occupation groupings is in Chapter 3.

SOURCE: US Bureau of Labor Statistics; McKinsey Global Institute analysis

Source: McKinsey Global Institute

AI technological change will favour rich countries

Already-rich nations better prepared to capture AI's productivity gains

Automation Readiness Index

Intelligence Capital Index

- The countries most prepared for the AI revolution are advanced economies, possibly creating a second Great Divergence vis-à-vis the rest of the pack as they capture the productivity gains of AI while LDCs become laggards
- The AI gold rush will be won by large enterprises (Amazon, Google, Huawei, Microsoft, Tencent) just as much as by powerful nations
- The only non-rich nations are China and India. Both are undergoing rapid growth (catching up to their intrinsic levels). Moreover, they both benefit from a large population (as talent is normally distributed with a given dispersion) with a high-performing student elite

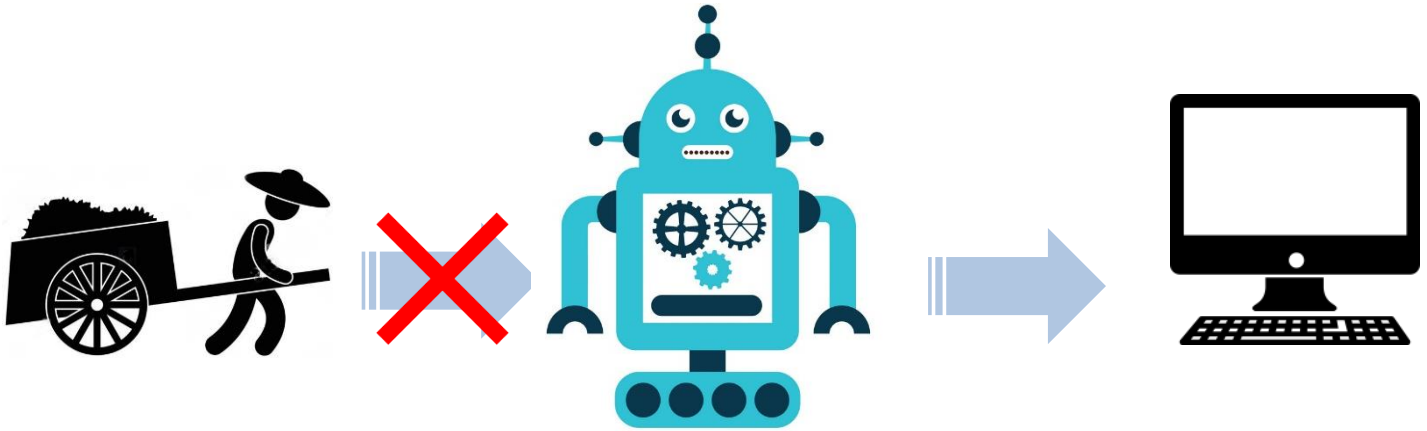
Number of AI firms

Top AI talent

AI might lessen growth opportunities of EMs

Robots might kill low-cost/low-wage advantages of developing economies

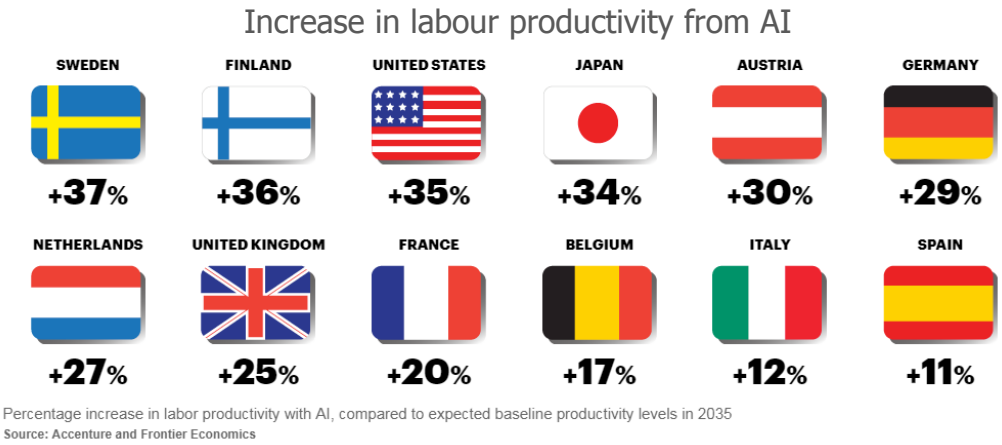
When multinational corporations were searching for low-cost manufacturing options in the 1960s they helped spur the development of the Asian Tigers



- In the 21st century intelligent robots will become cost-effective alternatives to low-cost labour in emerging economies, thus obviating a channel of growth for developing nations
- In fact, smart machines may drive on-shoring of jobs that that had previously been off-shored

Rich countries set to reap productivity gains

Bias in favour of rich countries and against EM ➔ Second Great Divergence?

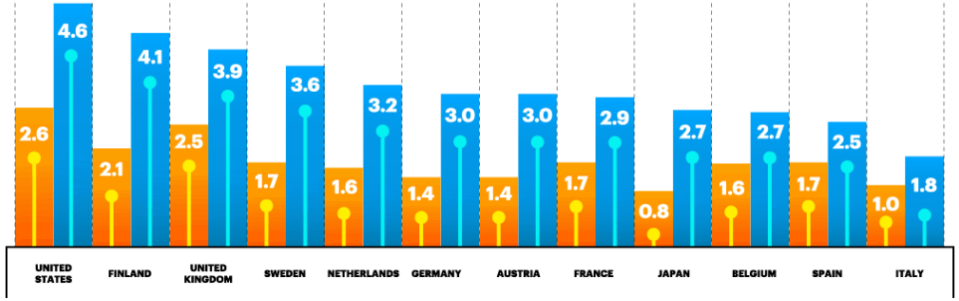


Percentage increase in labor productivity with AI, compared to expected baseline productivity levels in 2035

Source: Accenture and Frontier Economics

DOUBLING DOWN ON GROWTH

By acting like a capital-labor hybrid, Artificial Intelligence offers the ability to amplify and transcend the current capacity of capital and labor to propel economic growth. Our research reveals unprecedented opportunities for value creation.



Annual growth rates in 2035 of gross value added (a close approximation of GDP), comparing baseline growth in 2035 to an artificial intelligence scenario where AI has been absorbed into the economy

Source: Accenture and Frontier Economics

- Will the Fourth Industrial Revolution see a Great Divergence redux between AI-enabled nations and those that are not?
- Or will it present an opportunity for developing countries to leapfrog to the frontier?

Source: Accenture

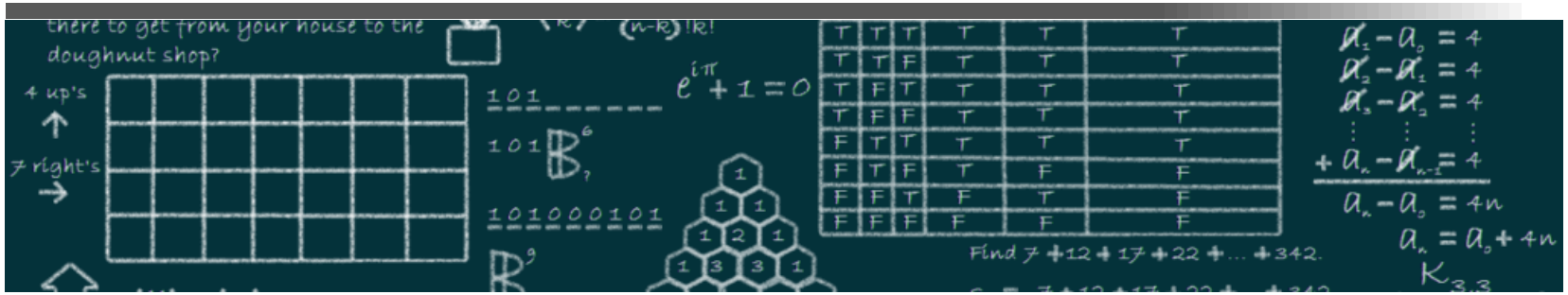
AI might thus exacerbate migration pressures

A rising tide of migrants for a world with less jobs for them

- The forces behind international migration will grow over time, fed by both global climate change and the macro inequalities of AI
- Micro inequalities of AI, on the other hand, will stress low-skilled migrants who will find employment opportunities unavailable for them as low-skill jobs are increasingly done by smart robots. (This is the case in Germany, where most of the migrants who came in do not have the skills required for the German economy)
- Migration (even when desired by the host) has been fraught with difficulties at the best of times (especially in certain geographies). New dynamics will stoke even more tensions

AI might exacerbate/perpetuate market biases

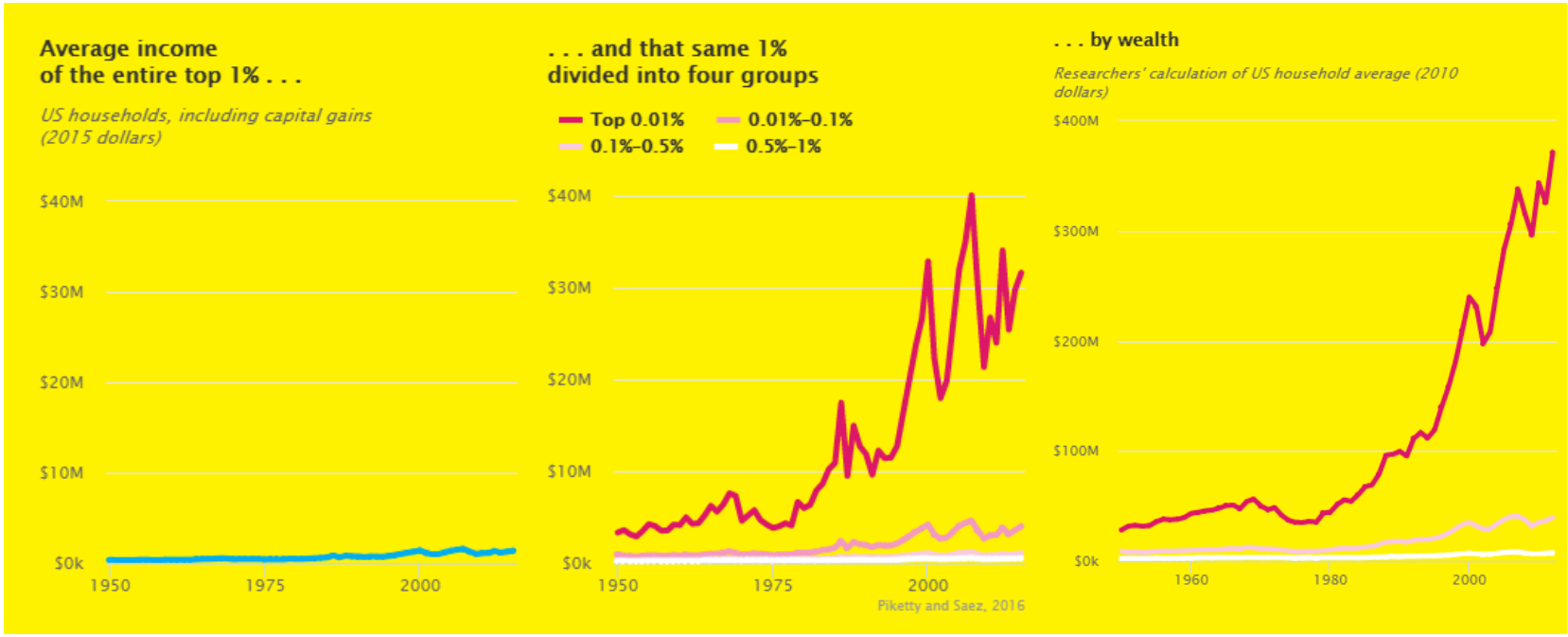
AI only as smart as its human programmers

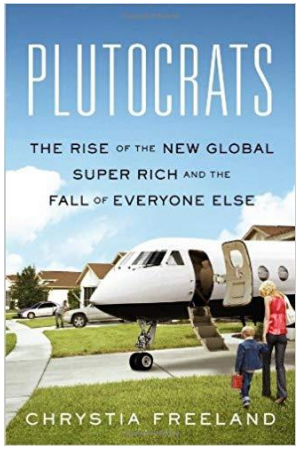


- AI analytics (Big Data) likely to yield the "valedictorian" solution, rather than to produce game-changing innovation. (Valedictorians rarely are societies' innovators. Would an HR-algorithm ever recommend to hire a dropout?)
- In fact, many of the great innovations/inventions happen by chance and based on seemingly contrarian solutions and chance. For example, no statistical algorithm would have ever suggested Dubai in the 1970s to aspire to become a travel hub and tourist destination. Likewise, all "wise" economic advisers in the 1960s told Korea to pursue its ginseng business and that its ambition to be a leader in heavy industry was foolhardy
- Algorithms may reinforce current biases, especially if they use historical data to infer future outcomes or derive their solutions; they would thus create self-fulfilling prophecies, entrench bias and increase inequality

Financial benefits of AI captured by super elite

Huge gains in wealth but they have accrued only to (super) capitalists



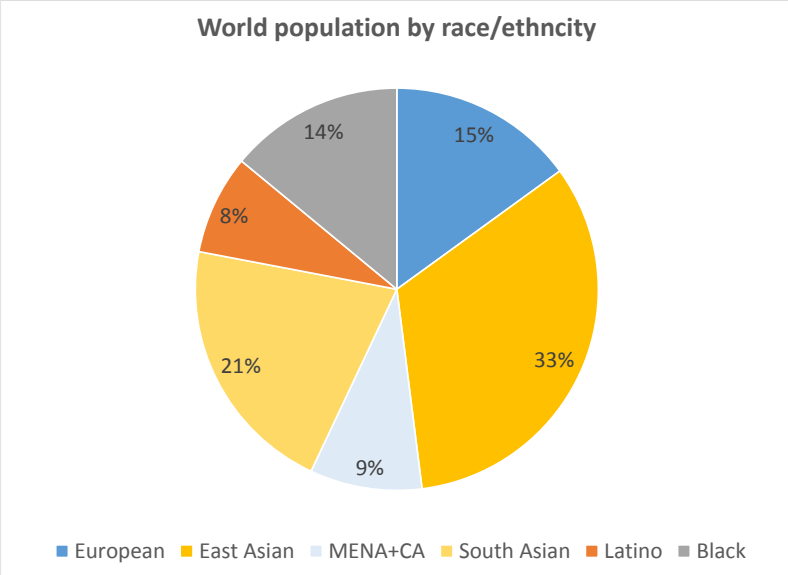


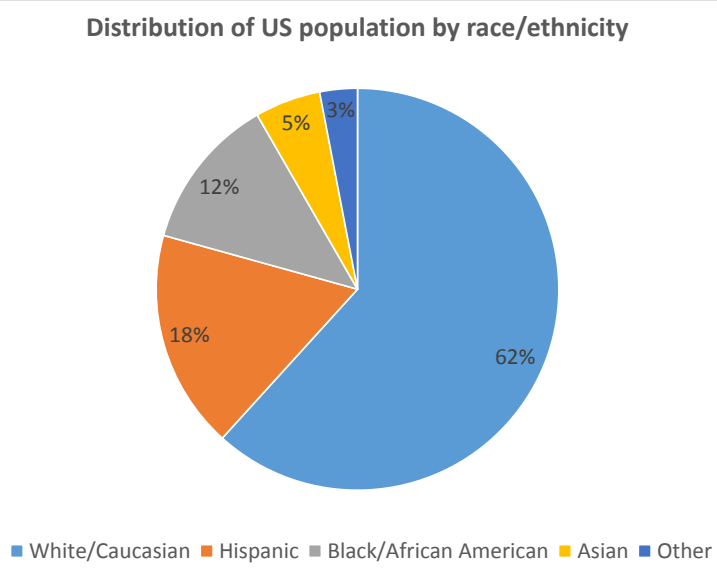
- 3 richest Americans wealth > the bottom 50% of the country
- 42 richest persons in the world own more wealth than the global bottom half (3.7 billion)
- World's billionaires' (2,208 of them) net worth > GDP of Germany*
- Surplus from innovations go to innovators, a small group thus capturing large amounts of wealth (e.g. Bezos ($112B), Gates ($90B), Zuckerberg ($71B), Page ($49B), Brin ($48B))

*Sources: Forbes, Oxfam, University of Chicago; * This makes a comparison of stock vs flow*

Income & wealth have a demographic bias

Demographic bias across and within countries





- Super-elites are not a reflection of the general society in multicultural societies. Even supposedly successful multicultural societies such as Toronto show a large demographic discrepancy between the elite and the general population (and even vis-à-vis the casual elite)
- The elite are drawn from a population that is more homogeneous and with a different set of politics (less in favour of redistributive policies)
- On a global scale, such discrepancies can be overlooked by society, but when communities live side by side and large discrepancies arise it may engender social discontent

Source: Forbes, Statista, UNPD

AI ➔ visible inequality in multicultural societies

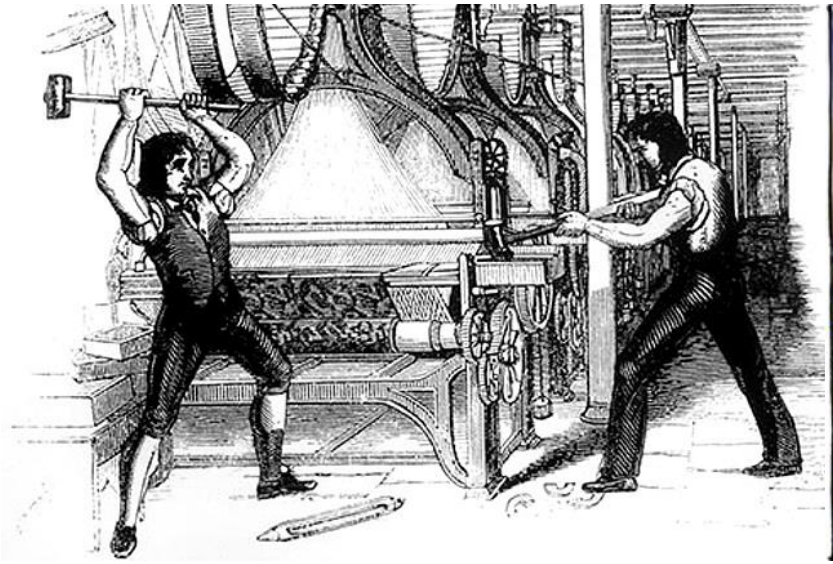
Employment outcomes and financial gains from AI tied to community groups

Multi-pronged demographic bias of AI:

- The jobs that AI will displace (or enhance) have a demographic bias (age, gender, ethnicity, language, etc.)
- AI algorithms risk perpetuating current biases as the algorithms are designed by humans with their own inherent biases, and the algorithms are likely to rely on historical data which will perpetuate institutional biases
- Differences in uptake/usage of AI technologies by groups, which are correlated with income and education (Integer Group, 2018)
- A knowledge-based economy favours certain skills and attributes, namely those that can think creatively and are numerate
- Monetary gains from AI will accrue to capital owners (few) while unemployment will be borne by labour (masses)

AI technology is not Pareto improving

Although society gains (in productivity), a large segment will be worse off

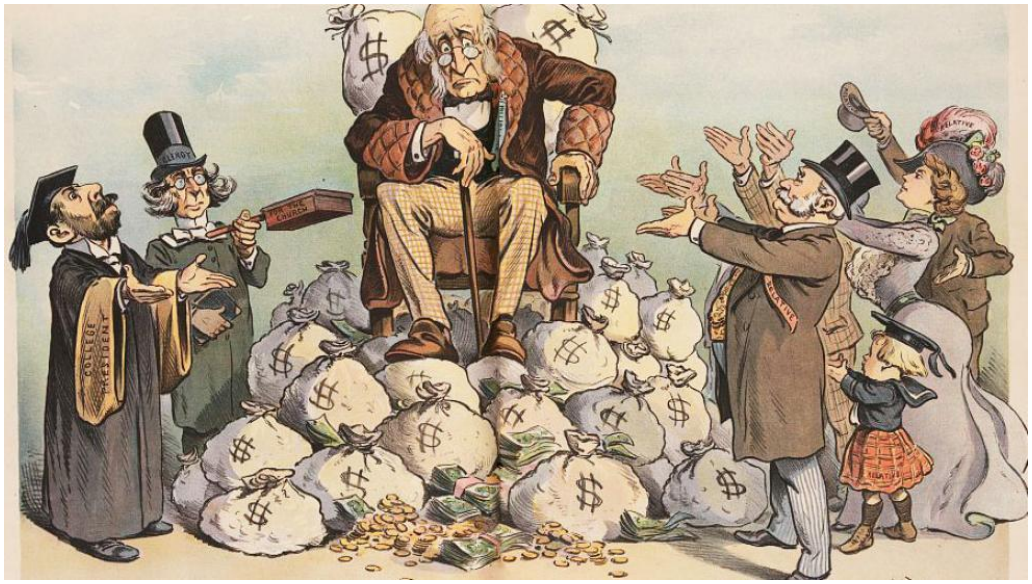


- How to compete with machines that do not sleep, do not require benefits, do not unionize and do their jobs without complaint?
- Is the yellow vest phenomenon a modern-day Luddite movement?
- "There are clear parallels to the situation today in that a significant fraction of the workforce may not have the skills required to succeed in the age of AI… [W]ithout adequate redistribution, it makes sense for workers to resist [AI] innovation."
  Korinek & Stiglitz, 2017

Even if AI is Pareto improving…

Comparative allocations and relative outcomes matter

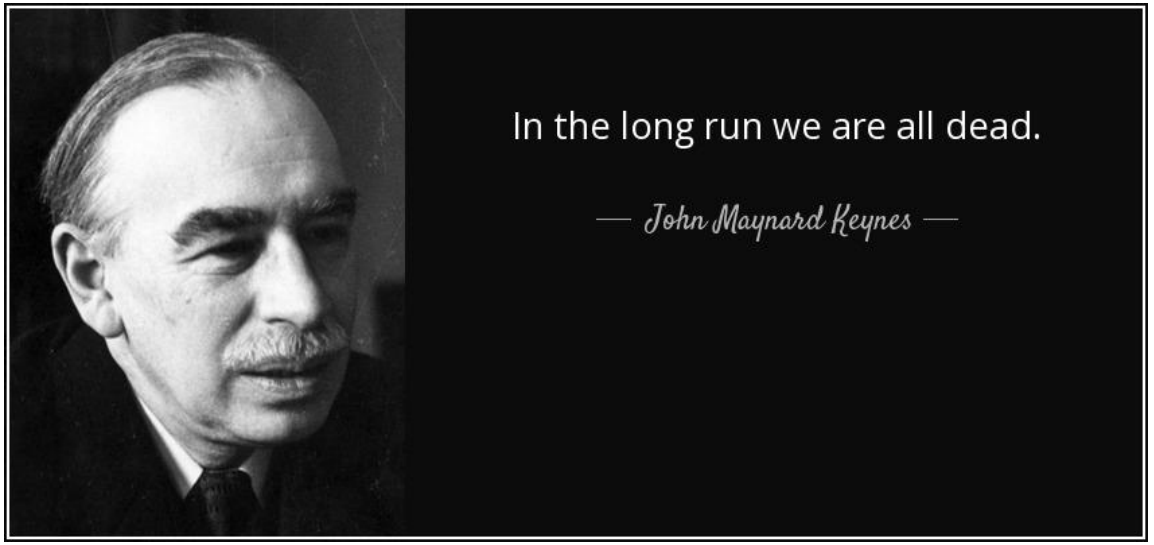
- Pareto improving policies do not make anyone worse off in absolute terms, but they still may represent socially undesirable outcomes that lead to greater relative disparities. But in theory there exists a set of transfers from beneficiaries to losers that makes all better off
- But we have already seen that winners are reluctant to share their prosperity (perhaps under the misguided lens of our meritocracy), and have enacted laws and implemented institutions to guard their privileged position
- Moreover, any redistribution policy would be fraught with group politics as people fight for their perceived fair share of the pie



AI will benefit society in the long run...

"[But] in the long run we are all dead." (John M. Keynes, 1923)

- Cold comfort to those negatively affected by AI that the technology/change benefits society. Not all displaced workers will be able to retrain and transition to other jobs. Moreover, many will transition to a lower-paying job or one with a skills mismatch. In the long run society will move towards a more productive and efficient outcome, but as John Keynes famously said: "In the long run we are all dead."
- "No matter what the long-run implications of AI are, it is clear that it has the potential to disrupt labour markets in a major way, even in the short and medium run, affecting workers across many professions and skill levels."
  -- *Korinek & Stiglitz, 2017*



Source: Stiglitz (2017)

Left unmanaged AI will exacerbate inequality

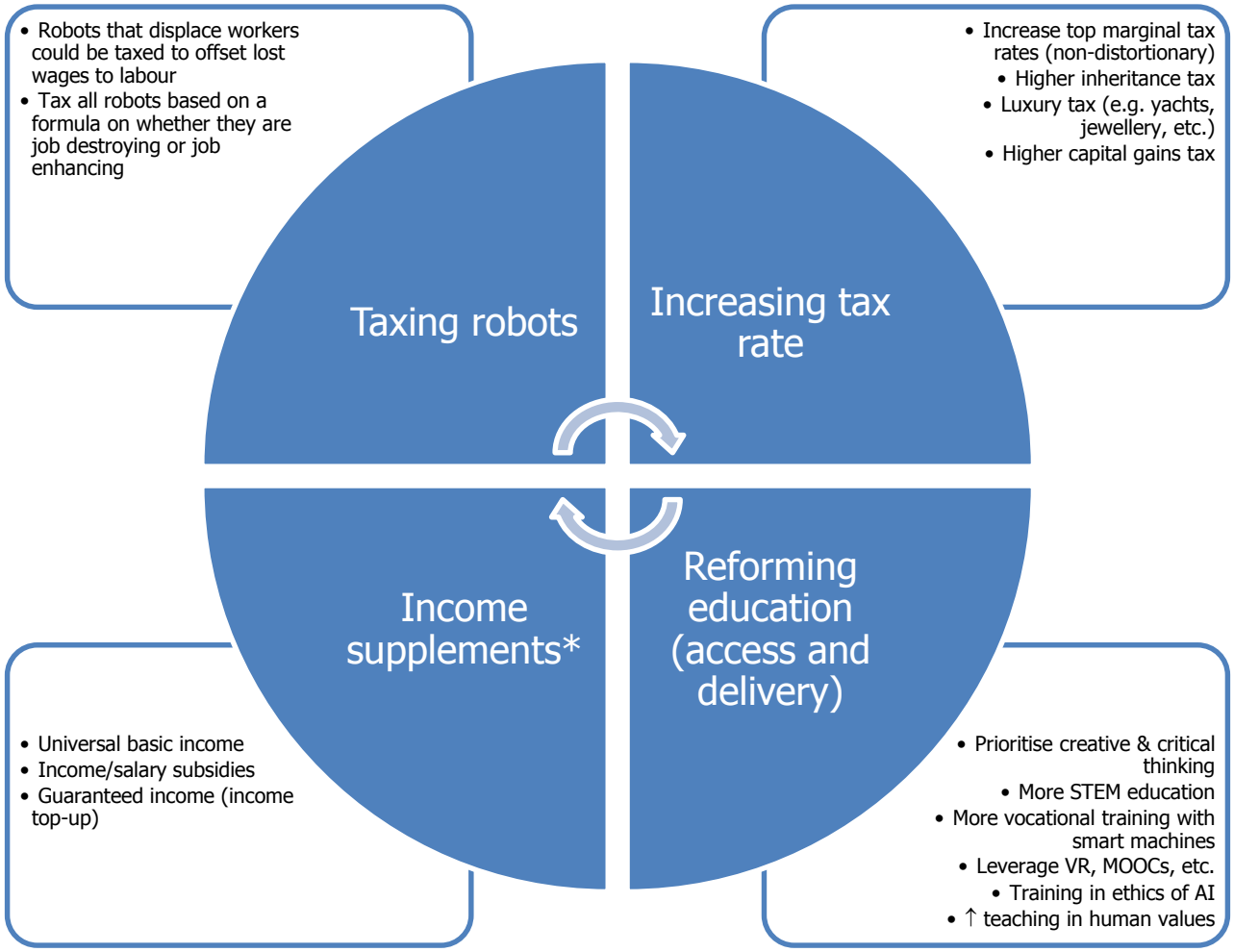
And the inequality will have a distinct demographic bias

- Technological unemployment is a scary fact and reality for many. The growing and highly visible nature of the inequality that will arise from AI will stoke already-high levels of social discord
- Populism, anti-globalisation, etc. are all symptoms of discontent by the people. AI, if left unmanaged, will only exacerbate these tensions
- A large population of people with no real prospects in life, especially among men, has invariably been a recipe for disaster (i.e. war) in the past

"Of men and mayhem: Young, single, idle males are dangerous. Work and wedlock can tame them." Economist January 23, 2016

Left unmanaged AI will strain society

Leaders must find policy solutions before it further destabilizes us



Conclusion

To fully capture the benefits of AI will require good policy & management

- AI is the driver of the so-called Fourth Industrial Revolution which will unleash large productivity gains propelling the world to unprecedented riches
- However, the gains to society will be uneven, with winners and losers from the technology, even as the gains are expected to be (much) larger than the losses
- Labour will lose and capitalists will win as AI technology will generate productivity gains through automation and replacing human labour with computer smarts
- Certain occupations and tasks are more susceptible to AI technology. Since there are demographic biases in the labour market, the expected AI-generated job displacements will likewise show a demographic bias. These disparities will be highly visible, especially in multicultural societies, and may cause discord
- AI will upend traditional paths of economic development. Low-skill/low-wage jobs are less likely to be offshored and instead done at home by AI technology. This will limit growth opportunities for developing countries
- Already-rich capitalists will be the winners from the AI revolution; but the true winners are not merely the so-called 1 percent. Rather, they are the "super-elites", the 0.01 percent (i.e. the 1 percent of the 1 percent)
- Just as there are demographic biases associated with many of the jobs prone to AI encroachment, so too is there a demographic bias in who comprise the super-elites of society (and thus will reap the gains of AI)
- AI will exacerbate already-high levels of inequality if left unmanaged, so it behooves policy makers to enact sound policies to harness its benefits