# What will cause the next global economic crisis?

Introduction

Historically, the global economy has undergone three structural transformations. The industrial revolution replaced agriculture with manufacturing. Mass production then followed, allowing services to grow. More recently, the digital revolution has aided manufacturing productivity, but impacted more on services (Figure 1). The coming age of robotics, artificial intelligence and automation (RAIA) will reinforce these trends. Some even envisage a scenario where AI passes a 'technological singularity' (Kurzweil 2005) triggering a chain reaction of self-improvement and explosive growth to enter the "Robonomics" era when AI-enhanced machines depose humans as a productive factor (Ivanov 2017).

Figure 1: Distribution of US labor share (%) by sector, 1840-2010
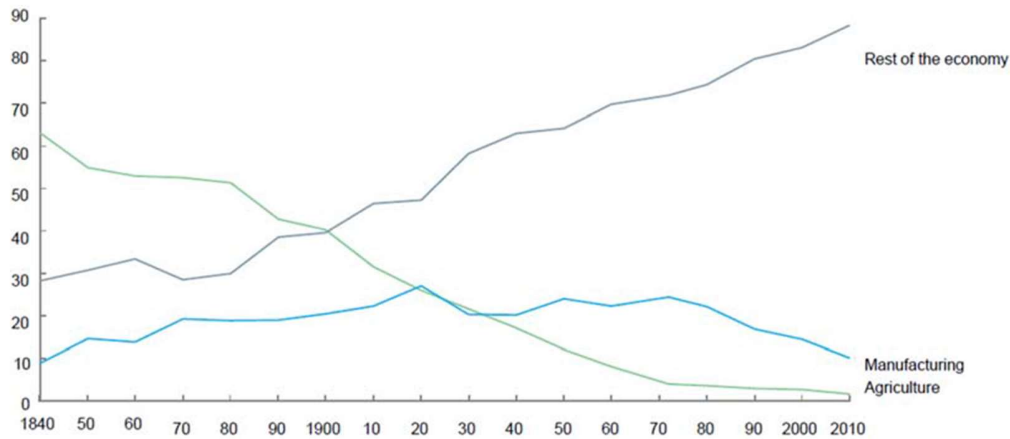
Source: McKinsey (2017)

Each stage of past development caused hardship on the individual level, but employment in growth sectors absorbed those displaced and living standards improved overall. Some think it is different this time. They believe insufficient jobs will materialise to replace RAIA-induced losses, so unemployment will grow, stoking social unrest.[1]

This essay contends such a view is overly-pessimistic. Long-run gains from new technology are unpredictable and invariably underestimated, so enough jobs should surface for those determined to work. But these may not match the skills of job-seekers, nor suit their income aspirations if the job openings are predominantly low-skill/low-pay. Growing inequality also seems highly probable, perhaps posing the greatest future challenge.

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[1] Even Nobel Laureates can [1]be unduly pessimistic regarding future unemployment trends. Leontief (1983) compared the prospects of humans to horses, saying "over the next 30-40 years many people will be displaced, creating massive problems of unemployment and dislocation. … In the last century, there was an analogous problem with horses. They became unnecessary with the advent of tractors, automobiles, and trucks. … So what happened to horses will happen to people, unless the government can redistribute the fruits of the new technology."

Labour Demand

Economic analysis has adapted to the digital age in several ways. More attention is given to technology in growth models, such as allowing productivity gains from R&D to favour skilled labour over unskilled labour.[2] Labour economics now focuses on skills rather than education/human capital, and on "tasks" rather than "jobs", with jobs viewed as bundles of tasks, repackaged when circumstances require (Autor 2013). Because AI targets jobs with predictable environments (since algorithms must cover every eventuality), recent refinements distinguish between manual and cognitive routine processes compared to non-routine tasks/jobs, thus prompting the concept of "Routine-Biased Technical Change" (Acemoglu and Autor 2011). This framework emphasises complementarity between RAIA and certain types of labour, and predicts job growth in both tails of the distribution, at the expense of middle-range workers. A "U-shaped curve" for skills emerges, alongside increased polarization (Autor et al. 2003).

The impact on particular jobs depends on whether they are (i) RAIA complements/substitutes; (ii) routine. Routine jobs – cognitive or manual/blue-collar – will contract, reducing opportunities for average-skilled workers while raising demand for highly qualified and low-skilled people. In industrial robotics, repetitive/codifiable manual tasks are most at risk. Elsewhere humans will retain a comparative advantage for many simple physical tasks. In contrast, for non-routine cognitive tasks, high-skilled labour is more affected – negatively (for substitutes) or positively (for complements).

Regarding specific occupations, Frey and Osborne (2017) list telemarketers, cashiers, legal assistants and taxi drivers among those most at risk. Drivers are noteworthy because large numbers are employed and the threat from self-drive vehicles is substantial and imminent.[3] Jobs least likely to be automated involve specialized "human-oriented" or creative services: social workers, doctors, primary-school teachers. Overall, Frey and Osborne estimate 47% of US jobs are vulnerable over the next 20 years.

New employment opportunities fall into six broad categories:

(1) New-technology sector. RAIA has already generated new types of jobs in genetic sequencing, nano-technology and high-speed financial trading. Speech/language processing, predictive analytics etc. offer prospects for further job opportunities.

(2) Production spin-offs. RAIA application to established areas will generate opportunities for remote medical diagnoses, financial advice, home security etc.

(3) Demand spin-offs. Automation lowers costs, so price reductions release income to spend elsewhere. RAIA could also release resources by making certain expenditures redundant. Crime-prevention measures could become unnecessary if security cameras, facial recognition and AI-aided sentencing reduce crime; or medical resources conserved if individuals get medical warnings earlier, avoiding hospitalisation.

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[2] Referred to as "Skill-Biased Technical Change": see, for example, Acemoglu (1994).
[3] According to US Census data (reported on NPR website, February 5 2015), "Truck, delivery, and tractor drivers" was the most common job category in 29 of the 50 States in 2014.

(4) Repackaging tasks. Jobs are redefined (and renamed) to redeploy redundant workers (e.g. "bank cashiers" become "account advisors"; "secretaries" become "receptionists/-assistants").

(5) Insourcing. Robots undermine low-wage nation advantages, so proximity benefits (e.g. punctuality) may overtake cost factors, returning manufacturing to high income countries such as the US that was lost due to globalisation (e.g. fashion garments).[4]

(6) Demographic trends. Ageing populations, wealthier households, consumer fads etc. generate new employment opportunities – mainly low-wage/low-productivity service jobs – irrespective of RAIA.

For these reasons (especially (6)), employment growth will be concentrated in: health/care; education; hospitality/leisure; household and personal services.

The economic consequences of paradigm shifts (e.g. climate change) are almost impossible to assess with confidence, since new analytical and empirical frameworks are needed to proceed beyond pure speculation. Unsurprisingly, predictions about the overall employment impact of RAIA differ widely (Table 1). A recent study paints an especially optimistic scenario in which RAIA creates 133 million jobs globally over five years to offset 75 million destroyed (World Economic Forum 2018).

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[4] This is already happening with shoe production in Germany (Weiner 2017). Insourcing could reverse the decline in manufacturing in countries such as the United States, but may cripple the development of countries dependent on manufacturing exports.

Table 1: Empirical studies at country level

Source	Coverage, sector, period	Results
Frey & Osborne, 2013	USA, All sectors 10-20 years	About 47% of total employment in the United States is at risk of being replaced by automation in the next 20 years.
Bruegel blog & Bowles, 2014	EU-28, 10-20 years	In the next decades, EU countries will lose between 47% (Sweden) and over 60% (Romania) of the workforce because of advances in technology (This study has replicated the Frey and Osborne work).
OECD (Arntz et al., 2016)	21 OECD Countries	On average, 9% of the work in the 21 OECD countries analyzed is automatable. The share of workers with the highest probability of being replaced by automation is higher in Germany and Austria (12% of the labour force) and lower in Estonia, Finland, Belgium and Korea (6-7%).
Citibank (Frey, Osborne, & Holmes, 2016)	Over 50 Countries and Regions	The average of the places subject to automation rises to 57%, with peaks of 69% in India and 77% in China.
World Economic Forum, 2016	15 major developed and emerging economies	The effect will be the creation of two million new jobs, compared to seven that will disappear, with a net negative balance of over five million jobs. Italy comes out with a draw (200,000 created and as many lost places), better than other countries like France and Germany. At professional group level, losses will be concentrated in administrative areas (4.8 million destroyed) and production (1.6 million). According to the research, the financial, management, IT and engineering sectors will partially offset these losses.
ILO (Chang & Huynh, 2016)	ASEAN-5, 20 years	56% of employment is at high risk of automation (32% at medium risk, and 12% at low risk).
World Bank, 2016	In the coming decades	2/3 of all jobs could be susceptible to automation in developing countries.
PWC, 2017	Major developed Economies, 2030	The study estimates that the UK (30%) has a lower proportion of existing jobs at potential high risk of automation than the US (38%) and Germany (35%), but more than Japan (21%).
McKinsey Global Institute, 2017	46 countries (about 80% of the global workforce)	Less than 5% of occupations can be fully automated; about 60% of them can have 30% of the automated activities. These percentages affect about 1.2 billion workers and $ 14.6 trillion wages. China, India, Japan, and the United States make up more than half of these workers and wages. The drive for automation of global productivity could be 0.8-1.4% each year in the coming decades.

Source: Lovergine and Pellero (2018).

A clearer – and more informative – consensus emerges regarding the evolution of the sector/skill distribution. New RAIA-related jobs will be swamped by jobs created in low-productivity, human-centered occupations for reasons listed above.[5] The productivity dimension is important because secular stagnation associated with declining productivity is already of concern: US labour productivity growth rose from 1.5% (1974-1994) to 2.9% (1995-2004) but then subsided to 1.2% (2005-17) (BLS 2013).

Labour Flexibility

If full employment becomes unachievable in the RAIA era, job-sharing and reductions in working hours will partly help. However, some suggest the full employment goal should be abandoned, viewing unemployment due to human-robot replacement as an attractive prospect, with humans free to use time more rewardingly. People certainly fear loss of employment income, but may worry less if adequately compensated by "RAIA dividends", akin to the Alaska Permanent Fund.[6]

Assuming full employment remains feasible, structural transformation can still cause transition problems for displaced workers and workforce entrants alike. The critical issue is moulding individual abilities to match the needs of an RAIA economy – more STEAM skills;[7] more creativity; more person-to-person skills. Retraining (and job-switching) will become common throughout adulthood. However, three factors will ease the transition:

- Modern generations readily embrace new-technology, perceiving opportunities rather than threats.
- Geographical relocation may be unnecessary, unlike in the past when unemployment and job prospects prompted US mass migration northwards and westwards.
- Most new employment will not be in high-tech jobs requiring advanced skills; on the contrary, low-skill jobs will increasingly dominate, perhaps leading perversely to most employees being overqualified for their jobs.

Longer-term, there are more difficult challenges. High-skill/high-pay jobs are usually easy to fill, but lower-skill jobs are often stigmatised. Measures are therefore needed to repair the image of such jobs, e.g. renaming "cooks" as "chefs". The gig-economy will also grow, with many people reliant on stopgap jobs lacking the benefits (healthcare, pensions) linked with full- time posts. Maintaining tax revenue will also be challenging in a gig-economy.

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[5] And because high-tech firms employ relatively few workers. For example, Google has only about 55,000 employees, less than 10% of the number employed by AT&T at its peak (Thompson, 2015).

[6] Every citizen in Alaska gets $1,000-$2,000 p.a. from the oil-bankrolled Fund. Andrew Yang, 2020 Presidential candidate, models his "Freedom Dividend" due to automation on the Alaska Permanent Fund claiming "because it's oil money, there's no stigma attached, it's not a rich to poor transfer, and it's wildly popular in a conservative state. [...] So what we have to do is we make it a right of citizenship for all Americans and do what they are doing in Alaska with oil money, with technology money for everyone around the country."

[7] STEAM = Science Technology Engineering Maths plus Arts.

Distributional Concerns

One inevitable consequence of RAIA is increasing inequality in market incomes as employment polarises into high-skill/high-wage and low-skill/low-wage jobs. This will exacerbate trends which have already resulted in median real-wage stagnation for a generation in economies such as the US, and to the "decline of the middle-class" which have together fuelled social discontent with inequality unprecedented since the Great Depression (Pressman 2007). These distributional shifts cause economic concerns as well as social turmoil: low-income households have a higher propensity to consume, so rising inequality hampers efforts to maintain aggregate demand.[8]

Combating rising inequality will be difficult, given the aversion to redistributive taxation and fears that high taxes will cause the best workers to migrate abroad. An increasingly popular proposal is a basic income programme which separates income from work, ensuring that all humans have minimally adequate resources regardless of their employment status (Sheahen 2012). Such a plan would require a total revamping of the tax and benefit system in most countries, unimaginable in current circumstances, but conceivable if the social order breaks down as technology eliminates manual and blue-collar jobs, lowers incomes, and creates a permanent underclass of unemployable people. If intelligent machines take care of most work and provide robot-owners (possibly including the state) with unimaginable wealth, widespread redistribution of RAIA-surplus could result in a utopian world of increasing output, employment for all job-seeking humans and unlimited numbers of robots.[9]

Conclusions

Robot/AI evolution will eliminate certain jobs, but compensate by creating RAIA-related jobs, raising productivity elsewhere, and releasing resources for other purposes. Opinions differ on whether there will be a net gain from new technology, as has historically been the case. Optimists see a cornucopia of opportunity and benefits, with technology freeing humans who do not wish to work from day-to-day drudgery. From this perspective, RAIA offers the best chance of reversing recent stagnant productivity and growth in advanced economies. In contrast, pessimists worry that full employment will not be feasible in future, and a permanently unemployed underclass will emerge within a dystopian gig-economy, stoking inequality and social unrest. Either way, the current job structure will mutate, demanding enhanced skills and lifetime flexibility, at least for those in RAIA-related jobs, although perversely overall employment will likely shift to low-skill occupations. The latter will favour social and interpersonal attributes which may not match well with some job-seekers. Lastly, growing inequality in market incomes seems certain, prompting demands for redistributive mechanisms previously anathema in most countries.

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[8] Robinson (1956) warned of this long ago in her vision of a futuristic capitalistic economy with a robot-dominated industrial sector.

[9] Globalisation is now so entrenched that the impact on other countries cannot be dismissed. RAIA may enable insourcing by advanced countries using their technology advantage to offset higher wages. World Bank (2016) estimates two-thirds of all jobs in the world are susceptible to automation in developing countries in the longer run. Developing nations are also at risk from massive first-mover advantages (especially network effects) for high-tech firms in advanced countries (plus China). This could lead to global disruption which dwarfs the problems faced within the US and deflates the expectation that technological advances improve wealth and living standards all round.

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