

Current Controversies No. 62

ROBOCALYPSE NOW?

Why we shouldn't panic about
automation, algorithms and artificial
intelligence

By Len Shackleton
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Summary

1. It is claimed that robots, algorithms and artificial intelligence are going to destroy jobs on an unprecedented scale.
2. These developments, unlike past bouts of technical change, threaten rapidly to affect even highly-skilled work and lead to mass unemployment and/or dramatic falls in wages and living standards, while accentuating inequality.
3. As a result, we are threatened with the 'end of work', and should introduce radical new policies such as a robot tax and a universal basic income.
4. However the claims being made of massive job loss are based on highly contentious technological assumptions and are contested by economists who point to flaws in the methodology.
5. In any case, 'technological determinism' ignores the engineering, economic, social and regulatory barriers to adoption of many theoretically possible innovations. And even successful innovations are likely to take longer to materialise than optimists hope and pessimists fear.
6. Moreover history strongly suggests that jobs destroyed by technical change will be replaced by new jobs complementary to these technologies - or else in unrelated areas as spending power is released by falling prices. Current evidence on new types of job opportunity supports this suggestion.
7. The UK labour market is currently in a healthy state and there is little evidence that technology is having a strongly negative effect on total employment. The problem at the moment may be a shortage of key types of labour rather than a shortage of work.

8. The proposal for a robot tax is ill-judged. Defining what is a robot is next to impossible, and concerns over slow productivity growth anyway suggest we should be investing more in automation rather than less. Even if a workable robot tax could be devised, it would essentially duplicate the effects, and problems, of corporation tax.
9. Universal basic income is a concept with a long history. Despite its appeal, it would be costly to introduce, could have negative effects on work incentives, and would give governments dangerous powers.
10. Politicians already seem tempted to move in the direction of these untested policies. They would be foolish to do so. If technological change were to create major problems in the future, there are less problematic policies available to mitigate its effects – such as reducing taxes on employment income, or substantially deregulating the labour market.

Introduction

There is growing concern – almost a moral panic - that innovative technologies threaten jobs on an unprecedented scale. Some analysts suggest that approaching half of all current occupational roles may be at risk in coming decades from robotics, algorithm-based decision-making and artificial intelligence.

This could mean widespread unemployment and falling wages as people compete for a diminishing pool of jobs. Today's cutting-edge technologies, unlike many earlier episodes of innovation, threaten to make workers redundant across the whole range of skills and education. But the impact is thought likely to fall more quickly on many of those at the bottom of the occupational hierarchy, potentially worsening inequality.

This has led to political support for radical new policies, including a 'robot tax' to slow down the process of change and the introduction of a universal basic income which would support citizens in a world where employment opportunities were very limited and poorly paid.

This paper examines the plausibility of prophecies of massive job loss. It then considers the prospects for new occupational roles being created to replace old jobs. This involves discussing the impact of creative destruction on economies in the past, assessing the current state of the UK labour market and pointing out the conditions necessary for maintaining a constant flow of new employment in the future.

The paper also critically examines the new policy proposals, which involve a dramatic expansion of the state's already considerable role in the labour market. There are problems with these approaches that their advocates downplay or are unaware of, possibly because they are being pushed on ideological rather than pragmatic grounds.

The future is uncertain. But we should not be pushed into premature and damaging policy interventions on the basis of fears, phantoms and panics. Should real problems emerge with technological unemployment, there are more conventional policies which could mitigate them. Arguably, some of these policies should be adopted anyway, whatever our concern over long-term employment prospects.

New technologies and jobs in economic thinking

There is a long history of interest in the impact of technology on the labour market among economists and other social scientists. One early worrier was David Ricardo. In the third edition of his *Principles of Political Economy and Taxation* (1821, 1951) he notoriously changed his mind about the benefits of technical progress, adding a new chapter 'On Machinery'. In this chapter Ricardo set out his view that investment in machines switched resources to 'fixed capital' from what the classical economists called 'circulating capital' – the fund which they believed necessary to pay wages. He persuaded himself that this would impoverish the working classes and bring growth to an end: 'I am convinced that the substitution of machinery for human labour is often very injurious to the interests of the class of labourers'.

Two or three decades later, Karl Marx (1845/6) took a positive view of a distant future following the replacement of capitalism by socialism, and ultimately by communism. This would be accompanied by the development of the means of production to such an advanced stage that abundance would make possible the end of the division of labour. We would be able, Marx averred, 'to hunt in the morning, fish in the afternoon, rear cattle in the evening, criticise after dinner ... without ever becoming hunter, fisherman, herdsman or critic.' Nearly 175 years later we're still waiting for this bucolic vision to materialise.

John Maynard Keynes was born the year Marx died. Keynes's (1930/1972) predictions in his essay 'Economic Possibilities for our Grandchildren' have not been more obviously correct than those of his predecessors. We are, metaphorically, now Keynes's grandchildren or great-grandchildren, but few would claim that we have 'solved the economic problem' as he expected. In his essay he predicted that we would by now be in a leisured society where those who work only do so for about fifteen hours a week and we have sufficient material goods to enable us to concentrate on the

finer things of life, Bloomsbury-style, turning up our noses at the 'somewhat disgusting morbidity' of trying to make money.

If we move away from these fanciful long-term predictions, what do today's more mundane economics textbooks tell us?

First, that technical progress is the major source of economic growth and productivity, and thus of real wage increases and improved living standards. Trying to hold back technical change is costly and probably ultimately pointless, as government controls inevitably tend to be undermined by private initiative.

Second, there is an automatic adjustment process to economic disruption, whether from shifts of product demand or a change in the way goods and services can be produced. For example, if new technology makes it economically sensible to replace labour by machines, the prices of goods will tend to fall (or profits rise in short run, leading to new entry and then falling prices). Spending power is released as households benefit from falling prices, and new businesses are set up as consumption patterns consequently change. In principle, producing what is newly consumed employs displaced workers. If there are rigidities – such as people having the wrong skills, or there is occupational and regional immobility, possibly amplified by the effects of excessive regulation – this can lead to increased frictional and structural unemployment, which can persist for longish periods. But, ultimately, employment rises again and unemployment falls.

This is certainly what has happened in the past. We have at least as high a proportion of the population gainfully employed as there was fifty or even a hundred years ago. Average working hours may have fallen, but this is more a product of choice resulting from rising real wages and living standards rather than being driven by a shortage of work resulting from technological change.

Economists can point to many 'false alarms' in the past. In the early 1960s, President Kennedy set up a commission to consider the problems of technological unemployment, and there have been many hundreds of books and articles appearing regularly on this theme ever since. One such was Jeremy Rifkin's best-selling *The End of Work* (1995), which envisaged a world where automation and 'the information age' boosted output and

productivity, but workers displaced by machines would lack the purchasing power to participate fully in society. This 'under-consumptionist' approach echoed Ricardo's fears nearly two centuries earlier. More than twenty years later, however, there are as yet few signs of a major problem along the lines Rifkin sketched.

‘This time it’s different’: is technology developing faster than we can adapt?

New technologies

In the past our economy has adjusted to massive technical change– the agricultural and industrial revolutions, steam power, electricity, the internal combustion engine¹ – and new jobs have materialised to replace those lost to machines. But can we assume this will continue indefinitely? Increasingly, it is argued that new developments resulting from ever more powerful computers and the proliferation of accessible data are going to lead to jobs being lost on a wholly new scale.

Three main areas of job-destroying innovation are usually mentioned.² First, the spread of automation and robotics to new areas of production, transport and extraction (Ford 2015). There is nothing fundamentally novel about this. It is the development of a process of automation that has been going on for more than a hundred years. But whereas automatic production processes in the past were based on machines designed to perform a limited range of tasks and confined to one location, modern robots can be programmed and reprogrammed to carry out a much wider range of task. They can absorb and interpret large amounts of information, and are frequently mobile rather than fixed in one place. They move around warehouses to locate, collect and rearrange goods. They can operate inside a nuclear power plant or underwater. As drones, they carry out complicated tasks over long distances, replacing pilot-led missions in war zones, for example. They can plant crops, and tend to and harvest them. They check for illegal drugs and bombs. They can distinguish ripe from unripe fruit, and pick accordingly. They can dispense pharmaceutical prescriptions without error. Giant 3D printers can make houses out of concrete. In all these areas there is certainly great potential for replacing human labour.

1 Robert Gordon (2012) argues that these changes had a greater impact on productivity, employment and lifestyles than the changes associated with the development of computing and the internet.

2 Another, less-discussed, area with potential for replacing humans is blockchain technology, which can be used for example to confirm transactions in important areas which are now the prerogative of solicitors or notaries (OECD 2018 pp 15-16).

Second, the growing use of algorithms to make decisions (for instance, granting credit and issuing permits, routing journeys or deliveries) and to enable individuals to gain information or complete processes on line (for example, booking hotel rooms or theatre tickets) rather than in person or in writing. Obvious areas for algorithms to displace jobs exist in retailing and routine financial services. There is also a plan to use algorithms, rather than human phone operators, to deal with 16 million non-urgent NHS 111 medical enquiries by 2020.³

Third, the development of artificial intelligence (AI) or machine learning, using large amounts of data. 'Big data' analysis can use computing power to uncover hidden patterns, correlations and other insights - and use these insights to mimic human processes such as learning and problem-solving. AI is used in a variety of commercial contexts, from recruitment and monitoring of staff to assessing applications for loans. It lies behind facial recognition software. AI is also increasingly being used in medical diagnostics, where it has a better record in recognising malignant tumours than human radiographers, and where there is the potential to draw on patterns in an enormous amount of data to suggest appropriate therapies for individual patients.

Possible job losses: the Frey and Osborne methodology

Various attempts have been made to quantify the likely impact of these new technologies on the existing pattern of jobs. These attempts usually involve classifying attributes of jobs and assessing which of these could be replaced by machines or algorithms. Generally speaking, jobs that involve routine tasks remote from consumers are seen as most at risk, by contrast with those where manual dexterity, adaptability, interpersonal communications and direct physical proximity to idiosyncratic clients and customers are significant (Autor and Dorn 2013).

Carl Frey and Michael Osborne (2013) have been the most prominent amongst researchers attempting to quantify technological threats to existing jobs, with a particular focus on machine learning and mobile robots. Their approach was to take information about the task content of 70 US occupations covered in the O*NET database.⁴ They asked an Oxford University machine learning expert workshop to classify these occupations, on the basis of this task analysis, on their potential to be fully automatable 'over some unspecified number of years, maybe a decade or two' (p. 38).

3 <http://www.theweek.co.uk/artificial-intelligence/91144/nhs-111-inquiries-to-be-handled-by-ai-leaked-report-suggests> accessed 13 April 2018.

4 This stands for Occupational Information Network, a free online database aimed at helping jobseekers and businesses, originally sponsored by the US Department of Labor amongst others. It is updated from time to time: Frey and Osborne used the 2010 iteration.

Then they looked at the relationship between the subjective estimates made by these experts and various key or ‘bottleneck’ attributes (such as the degree of manual dexterity) of the occupations.

They found a robust statistical relationship between the existence or non-existence of particular attributes and the experts’ assessment of the occupation’s potential for automation. They then used these objective attributes to provide a probabilistic estimate of automating each of 702 occupations included in the database. Some examples of their assessment of occupations are given in Table 1. The probability of an occupation disappearing ranges from nearly 100% for insurance underwriters to less than half of one per cent for surgeons or occupational therapists.

Table 1: Percentage risk of automation, selected occupations

HIGH RISK (> 70%)	
Insurance underwriter	99
Nuclear power reactor operator	95
Accountant/auditor	94
Technical writer	89
Underground/tram driver	86
MEDIUM RISK (30-70%)	
Dental hygienist	69
Commercial pilot	55
Economist	43
Judge/magistrate	40
Detective	34
LOW RISK (30%>)	
Public relations executive	18
Air traffic controller	11
Psychologist	0.4
Surgeon	0.4
Occupational therapist	0.4

Frey and Osborne then combined these estimates of probability with data on the numbers employed in each occupation. They came to the headline conclusion that 47% of all jobs in the USA are at ‘high risk’ of automation. Other analysts have used the same methodology with similar broad results in a number of countries. In the UK, the Bank of England produced estimates for the UK which are shown in Table 2. The rather lower proportion of jobs at high risk of disappearing in the UK than in the US reflects a range of factors including differences in the occupational structure in the two countries.

Table 2: Current employment by percentage risk of automation

RISK OF AUTOMATION	USA	UK
Low (<33%)	33	37
Medium (33-66%)	19	28
High (>66%)	47	35

Source: Frey and Osborne (2013), Haldane (2015)

The OECD’s task-based critique

However, work by OECD analysts suggests that the Frey and Osborne methodology considerably exaggerates the degree to which jobs can be automated. They point out that ‘workers’ task structures differ remarkably within occupations’ (Arntz et al. 2016 p.12). Rather than everybody within an occupation performing the same range of tasks, as Frey and Osborne’s approach seems to assume, there is considerable specialisation within an occupation.⁵ Furthermore the task content of an occupation may differ considerably in content between countries.

In general, the OECD team argues, we need to look at the tasks which people actually perform rather than those constituting a generic description of the occupation of the kind used by O*NET. They therefore use individual-level data drawn from the Programme for the International Assessment of Adult Competencies (PIAAC).

⁵ Take economists, judged by Frey and Osborne to have a 43% probability of being automated out of existence. In practice, some economists work primarily with forecasting models where indeed they could largely be replaced by computer algorithms and artificial intelligence. But other economists are employed on cost-benefit analysis, commenting on trends, evaluating policies, refining regulation, investigating competition breaches, teaching, giving advice to clients... and so on. These tasks are much less susceptible to automation. Moreover, technological innovations free economists from much routine work and are increasing their productivity, at least as measured by the quantity (the quality can be debated) of articles, reports and briefings produced. So the demand for their skills may well grow over time.

Using the PIAAC data leads to a dramatic reduction in the proportion of jobs thought to be at risk. The OECD team's analysis leads it to conclude that for the USA the proportion facing a high risk of automatability is only 9% - although marginally higher, at 10%, for the UK. Table 3 shows the risk for different OECD countries.

Table 3: Share of jobs at high risk of automatability: OECD analysis

COUNTRY	SHARE AT RISK (%)	COUNTRY	SHARE AT RISK (%)
Austria	12	Japan	7
Belgium	7	Korea	6
Canada	9	Netherlands	10
Czech Republic	10	Norway	10
Denmark	9	Poland	7
Estonia	6	Slovak Republic	11
Finland	7	Spain	12
France	9	Sweden	7
Germany	12	UK	10
Ireland	8	USA	9
Italy	10		

Source: Arntz et al. (2016)

The limits of 'technological determinism'

The authors of the OECD study add that even these lower figures are likely to exaggerate the real threat to employment. They point out (Arntz et al. *ibid.* p. 21) that 'experts tend to overestimate the potential of new technologies', as Autor (2015) also notes. Moreover the 'utilisation of technologies clearly lags behind the technological possibilities' and Frey and Osborne's vague talk of 'maybe a decade or two' before jobs can be automated gives little indication of the speed of change.⁶

The McKinsey Global Institute (2017) has some useful thinking on the difference between theory and practice when replacing humans in the production process. One point they make is that technical feasibility

⁶ As Gordon (2012) points out, it takes a very long time before all the possibilities of new technologies come to fruition: they don't all occur at once.

in principle has to be translated into specific design, and this can be much more difficult than anticipated. Robot manipulation of objects, for example, is still much less rapid and clumsier than human beings. Many jobs which robots could theoretically do, like fixing a leak in a pipe, often involve working in limited spaces in unusual and awkward situations, and perceiving various alternative possibilities. To design a plumber robot with the flexibility of a human would be a very difficult task. Relatedly, many tasks rely on 'creative intelligence', the ability to improvise in new situations where there are insufficient 'big data' to form a firm judgment. Many roles also rely on 'social intelligence' – being aware of others' responses, and being able to negotiate agreement rather than simply produce an 'ideal' solution to a problem.

Another very important point they make is that economists must always remember cost. Unless the new technology is cheaper than old-fashioned reliance on people, it probably won't happen. Neither Frey and Osborne nor the OECD has much to say on this, particularly about the need for and expense of complementary investments. For instance we need high-powered broadband access and high levels of household take-up in order for public services to be fully internet-based. And platoons of driverless lorries, much touted recently and currently being trialled with government support,⁷ are likely to need substantial investment in motorway and road redesign before they can safely be introduced.

Labour markets may adjust to technology in ways which are not easily foreseeable. Jobs may be redesigned or split up as new complementarities are discovered. The supply of skills may change as individuals, far from helpless victims of change, react to employment trends. In some cases, wages and contracts may adjust to make new technologies less attractive. Demand conditions for goods and services will also alter as tastes change. So an exclusive concentration on cost may itself be misleading, because quality will change as well – perhaps for the better, perhaps for the worse. For example, consumers may come increasingly to value personal contact with a human rather than a machine and be willing to pay a premium for such contact. Alternately, the quality may be so much better as a result of automation that demand for products increases, and with it the demand for the residual human element in the process.⁸

7 https://www.theregister.co.uk/2017/08/25/lorry_platooning_dft_trl/ (accessed 13 April 2018).

8 Autor and Dorn (2013) develop a formal analysis which shows that the impact of a technological innovation on wages and employment depends on the relation between the elasticity of substitution in production of a good/service between capital and labour and the elasticity of substitution in consumption between the good/service and alternatives.

Moreover, what appears to make economic sense may run into regulatory or social acceptance barriers which will slow down the process of adoption or even prevent it entirely. For example, would regulators find it acceptable for all company accounts to be prepared by computer algorithms without an individual taking responsibility? And would, say, pilotless commercial aeroplanes be acceptable to the security authorities and the general public?

Even if an innovation is acceptable in principle, the reality of political pressures make technological change a complicated and contested process. The opposition to Uber from London cab drivers, or the long-running dispute about driver-operated train doors, or the UK fracking saga, illustrate this very clearly. And we are already seeing a backlash against the accumulation of personal data by Facebook and other social media, and the use of algorithms to target voting messages in the UK referendum and the US presidential election.

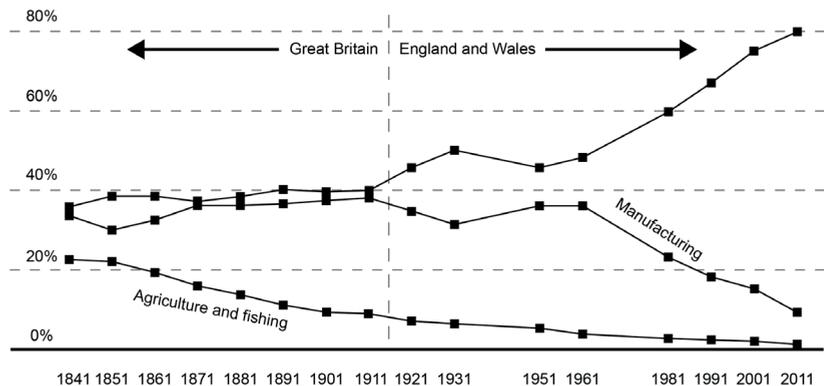
Finally, we need some humility when forecasting the future, which always turns out differently from that which experts predict. Technologies which seem to promise much often disappoint, while unheralded changes turn out to be much more significant.

As Peter Theil, the co-founder of PayPal, is said to have remarked 'we wanted flying cars, instead we got 140 characters'. It is now slower to fly from Los Angeles to San Francisco than it was thirty years ago (because of security and other regulatory issues), but we can tweet our thoughts about this to the entire planet in nano-seconds. And, as Tim Harford has pointed out, the futuristic 1982 movie Blade Runner may be set in 2019, but the main character rings a replicant from a payphone in a bar, mobile phones apparently not yet having been invented.

New Jobs for Old: A positive view of future employment possibilities

The occupational structure is never static. In 1841, when the first modern census took place,⁹ over 20% of the working population was engaged in agriculture, with a similar proportion working as domestic servants. Nowadays such jobs occupy 1-1.5% of the workforce. Chart 1 shows the broad changes over time: manufacturing, although producing more output in value terms than ever before, now employs slightly under 10%, down from over 35% in the 1840s.

Chart 1: Share of Employment by Sector, England and Wales 1841-2011



Source: Office for National Statistics

At a lower level of detail, many jobs in 1841 were dependent on the 'horse economy', including 97,000 blacksmiths, 12,000 coach makers and

⁹ The census began in 1801, but was initially based on headcounts from a variety of sources. It was in 1841 that systematic data about all household members began to be collected.

15,000 saddle makers. Most of these jobs disappeared with the growth of the railways (which in 1841 had less than 3,000 employees) and, later, the motor car. Yet other jobs took their place. Some existing jobs were to grow considerably in numbers – there were only 97 mathematics teachers in 1841, for example – but most of today's jobs could never have been imagined by even the most far-sighted of early Victorians.

Creative destruction and the labour market

Most people are intuitively aware of these long-run changes. Few work in the same job as their parents, let alone their grandparents, although that was the lot of most people in the past. But discussion of job creation and destruction needs to be informed not just by these long-run changes, but also by awareness of the huge amount of 'churn' in the job market even in the short run.

Headlines concentrate on net changes in the number of jobs – we may be told that there are so many more or less people in employment than last year, for example. But the reality is that our economy creates and destroys millions of jobs every year in an endless process of change, and net changes are only a part of the picture.

A study for the Department for Business Innovation and Skills (Anyadike-Danas et al. 2011) has shown that, over the period 1998-2008, private sector employment grew on average by 170,000 a year, a small proportion of the total workforce. However on average as many as 28% of all jobs in the private sector were created or destroyed each year. 1,300,000 jobs were lost as (many small) businesses were closed, while a further 1,200,000 were lost as employment contracted in surviving businesses.¹⁰ Yet, at the same time, 920,000 jobs were created by new businesses, and existing firms added an extra 1,750,000 on average.

It follows that a net increase in jobs – necessary if the numbers seeking work are growing – can be brought about in four ways. One, by a decline in the rate at which businesses are closing. Two, by a decline in the jobs shed by continuing businesses. Three, by an increase in the number of

¹⁰ These are jobs lost rather than individuals losing them. People exit the workforce for a variety of reasons (illness, childbirth, retirement, death, study) or simply change jobs. If they are not replaced, jobs disappear, but this is not the same as individuals 'losing' jobs. Redundancies – involuntary job losses – are currently at close to record lows.

new businesses. Four, by an increase in employment in existing firms. On balance, a moderately high turnover of jobs is probably a good thing: it is often associated with people moving from low-productivity activities to higher-productivity activities, thus boosting total output. But politicians are tempted to meddle when they see an increase in jobs being lost, jobs being created usually being less visible. For instance, we constantly see our politicians responding to calls for subsidies to existing businesses, protective tariffs, enhanced employment protection, tighter regulation, robot taxes and so forth.

Yet by intervening in such ways to shore up existing jobs, they may deter the creation of new ones as expanding firms find it more difficult to recruit, or face greater competition from subsidised businesses, or suffer from costly new regulation or retaliatory tariffs imposed by other countries.

The UK job market today

The UK labour market has performed well recently. With a long run of substantial net job creation, the working age employment rate is now at a historic peak of around 75% while unemployment has fallen to less than 4.5%. Far from there being insufficient jobs, many are predicting a shortage of workers in the medium term, especially should immigration fall post-Brexit.

Technology is certainly making some jobs unnecessary, as Table 4 suggests. Since the beginning of the 21st century, process operative and metal trades numbers have fallen sharply, and much of this is probably the result of replacing labour with more sophisticated machines. Similarly, the decline in administrative occupations reflects the growing use of computing applications and the internet.¹¹

¹¹ Of course many jobs disappear not as a result of technical change but because of shifts in consumer taste, foreign competition or regulatory interventions. As an example of the latter, it has recently been reported that Britain's last lion-tamer is out of a job as Defra has refused him a licence. No wild animals will be allowed in circuses from 2020. <http://www.bbc.co.uk/news/uk-england-43545030> (accessed 13 April 2018).

Table 4: Percentage change in employment 2001-2017, selected occupations

GAINS	% increase	LOSSES	% decrease
Care workers and home carers (778,000)	38.2	Process operatives (271,000)	-35.8
Information tech & telecom professionals (922,000)	41	Admin occupations: finance (769,000)	-10.2
Sports and fitness occupations (188,000)	123.8	Admin occupations: records (426,000)	-34.8
Conservation and environment professionals (56,000)	180	Secretarial & related (664,000)	-32.7
Health professionals (563,000)	118.2	Metal forming, welding & related (82,000)	-53.4
Artistic and literary occupations (416,000)	101.9	Printing trades (50,000)	-53.7
Business, finance etc. associate professionals (737,000)	66.7	Metal machining, fitting, instrument making (320,000)	-24.2
Hairdressers and related (282,000)	56.7	Sales & retail assistants (1,095,000)	-9.3
Childcare & related personal services (851,000)	49.6	Travel agents (32,000)	-46.7
Animal care and control (108,000)	170	Vehicle trades (273,000)	-2.8

Notes: April-June of years. Figures in brackets are April-June 2017 levels of employment.

Source: Author's calculation from ONS.

This picture is broadly similar in other developed countries. But this does not mean that large numbers of workers are being forced out of the workforce, as critics sometimes imply. As Autor and Salomons (2018) report, drawing on a study of 28 industries in 18 OECD countries from 1970 to 2007, new technology has not been employment-displacing overall. New jobs have been created to offset the loss of old ones.

Nor is it the case that the new jobs are largely low-quality, poorly-paid work. On the contrary, the average skill content of UK jobs continues to rise. And if we take the three highest-paying occupational categories¹² (managers

¹² Out of 9 major occupational categories. Individuals in the three leading occupational groups earn considerably more an average than the mean income for the country as a whole.

and senior officials, professional occupations and associate professional and technical), their share of total UK employment has risen from 42% to 45% over the last ten years.

New employment

The interesting story about Britain's job creation is the eclectic mix of new employment. It includes jobs, such as IT professionals, which are complementary to the types of technical innovation discussed so far. There are also jobs which only became possible as a result of the same innovations – such as app or web designers, social media managers, or those running businesses facilitated by the internet.

There is also scientific and technological development occurring in fields where no jobs existed before – for instance nanotechnology, biotechnology and genetic engineering. These are entirely new and rapidly growing areas of highly-skilled and well-paid employment with job titles varying from electron microscopy field engineer to biomedical engineer to genetic counsellor.¹³ The literature about the threat to existing jobs is largely silent on these new job-creating technologies.

But many jobs using well-established skills are also growing rapidly, as Table 4 shows. An ageing population is leading to an expanding demand for care workers and home carers. Rising female participation in the workforce is boosting the demand for childcare. Increased leisure and spending power coupled with changing tastes has led to an expansion of art and media-related occupations, hairdressers, beauticians, fitness instructors and tattooists. None of these jobs is likely to be threatened by robots or algorithms any time soon.

Many such new jobs are in small businesses, or amongst the self-employed or 'gig economy' workers. One reason why these jobs have grown rapidly in the UK is that, despite decades of growing employment legislation, the UK labour market is still less regulated than many other countries in Europe.

To keep new jobs coming we therefore need to look critically at proposals for tighter regulation, such as those recently put forward by Matthew Taylor (2017) in his government-sponsored review of new employment practices.

¹³ <https://www.engineering.com/jobs/biomedical-engineering/> and https://uk.jora.com/Genetic-Counsellor-jobs?gclid=EAlalQobChM1ZnO8L6P2gIVVEAbCh1afQBIEAAAYAAAEgKq_D_BwE (accessed 13 April 2018).

We should also be looking for ways to reduce existing regulation: for example, in relation to occupational licensing, where barriers to entry reduce mobility and job opportunities (Shackleton 2017).

Do we need new policies?

It is difficult to conclude from the available evidence and analysis that we face an imminent ‘robocalypse’, with huge numbers of jobs disappearing without replacement in a short period of time. Nevertheless it is worth considering what to do should such an eventuality occur. This section analyses policies that have been suggested to mitigate the threat to employment and living standards.

A robot tax?

Fear of the potential for robots to replace humans has led to interest in the idea of a ‘robot tax’. Such a tax has been considered (though rejected) by the European Parliament.¹⁴ And it has been seriously proposed by Bill Gates, who foresees a shortfall in income tax as jobs disappear and would like to see the proceeds of a robot tax used to retrain workers and expand employment in health care and education.¹⁵

This suggestion in part reflects a view that ‘the few’ owners of large capitalist corporations are going to make massive profits from automation, while reducing ‘the many’ to penury. This narrative plays well on the left. Jeremy Corbyn has expressed interest in a robot tax, arguing that ‘robotics could make so much of contemporary work redundant. That is a threat in the hands of the greedy, but what an opportunity if it’s managed in the interests of society as a whole’.¹⁶

No country has yet imposed such a tax, but South Korea – which appears from Chart 2 to have the world’s highest incidence of industrial robots – is reported¹⁷ to have removed the tax breaks it gives to most investors for further investment in robotics.

¹⁴ <https://www.reuters.com/article/us-europe-robots-lawmaking/european-parliament-calls-for-robot-law-rejects-robot-tax-idUSKBN15V2KM> (accessed 13 April 2018).

¹⁵ <https://qz.com/911968/bill-gates-the-robot-that-takes-your-job-should-pay-taxes/> (accessed 13 April 2018)

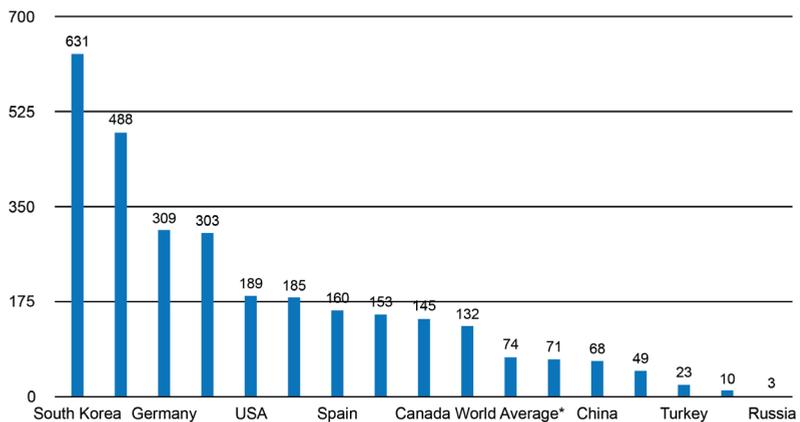
¹⁶ <https://www.telegraph.co.uk/news/2017/09/26/jeremy-corbyn-plans-tax-robots-automation-threat-workers/> (accessed 13 April 2018).

¹⁷ <https://www.telegraph.co.uk/technology/2017/08/09/south-korea-introduces-worlds-first-robot-tax/>

Robots are likely in the near future to replace jobs only in a limited range of industrial activities - manufacturing, extraction, transport and energy. These sectors taken together only employ around 15% of UK workers. Even a robot tax which was 'successful' in slowing adoption in these sectors would not necessarily slow down technical innovation in artificial intelligence, for example.

Implementing a robot tax could be far more difficult than people imagine. For a start, if we ignore the stereotypes of Robbie the Robot or C3PO, defining a robot is rather difficult. One accessible definition¹⁸ is 'a physical machine that's usually programmable by a computer that can execute tasks autonomously or automatically by itself'. This, however, might cover everything from aeroplane autopilots to 'smart home' heating and lighting systems. Where should the line be drawn?

Chart 2: Number of installed industrial robots per 10,000 employees in manufacturing, selected countries, 2016



*based on 44 countries

Source: International Federation of Robotics

The International Federation of Robotics (IFR) uses an impenetrable ISO technical definition of an industrial robot as an 'automatically controlled, reprogrammable multipurpose manipulator programmable in three or more axes'. This is the basis of the international comparisons shown in Chart

¹⁸ Offered by roboticist Kate Darling of MIT. See <https://www.wired.com/story/what-is-a-robot/> (accessed 13 April 2018).

2, although the IFR admits that countries interpret this definition, perhaps unsurprisingly, in different ways.

A glance at this chart suggests that the UK cannot seriously be argued to have an excess number of robots just yet. The 44 countries for which the IFR has data have an average of 74 installed robots per 10,000 employees in manufacturing: the UK has only 71 and is the only G7 country to have less than the average. Indeed, the IFR argues with some plausibility that the UK needs many more robots to boost its mediocre productivity record.¹⁹ And even critics who reject the need for widespread adoption of robots, and would be happy with a tax, would surely want to make exceptions for robots which, for example, made surgery more accurate and safe, or enabled bomb disposal, or could travel into areas of high radiation or other danger to humans. Again, where should the line be drawn?

A universal basic income?

There is growing interest in the idea of a universal basic income (UBI) or 'citizen's income'. This is not really a new concept. It has its origin in the 18th century (Davies 2017). Although there are variations in the way that it is specified, the dominant element in the versions currently being pushed is that all citizens should receive an unconditional payment from the government in addition to any income received from elsewhere.

People could in principle choose (assuming the payment was at or above a subsistence level or they had other income) to live a life of leisure or pursue hobby interests. More positively, they could use it to support caring for children or older family members, or unpaid work with a charity, work 'in the community' or in political activity. The Royal Society of Arts (Painter and Thong 2015) sees a UBI as a way of unleashing citizens' hitherto-suppressed creativity.

More prosaically, people could use the UBI as a top-up to regular paid work, or perhaps as offering some security while taking on insecure 'gig' or zero-hours work and self-employment or starting a small business.

¹⁹ <https://ifr.org/ifr-press-releases/news/robot-density-rises-globally> (accessed 13 April 2018).

Given the possible ways it could be used, it is unsurprising that the UBI has received support from across the political spectrum. The left (Jeremy Corbyn and Shadow Chancellor John McDonnell) has seen it as an anti-poverty device that also offers alternatives to capitalist employment.²⁰

The right has argued that it offers a simplified alternative to the complicated and bureaucratic welfare state, an alternative which could reduce or eliminate the 'poverty trap' associated with means-tested welfare benefits²¹, and restore independence and self-esteem to the poor (Murray 2008). Some on the right have also argued that if there was a UBI, we could relax minimum wages and other forms of employment regulation in order to boost employment.²²

Greens, meanwhile, see it as opening up the possibility of 'sustainable' lifestyles which do not depend on ever-more-frantic efforts to boost consumption.²³

None of these arguments depends on concern about the loss of jobs through technological change, though this fear clearly adds impetus to the case for a UBI. So too does the widely-propagated belief – mistaken in the case of the UK (Belfield et al. 2017) – that inequality is increasing sharply.²⁴

The idea is certainly being taken seriously (Colombino 2015). Although no country has yet introduced a fully-fledged UBI, there have been several small-scale experiments in the United States, Canada, India and other parts of the world. A larger-scale experiment has been taking place in Finland, where those unemployed aged 25-58 received an unconditional payment of 560 euros a month, which they kept even if they got a job. Other trials are taking place in a number of Dutch cities. Four Scottish

20 <http://www.independent.co.uk/news/business/news/universal-basic-income-policy-under-consideration-by-uk-labour-party-shadow-chancellor-john-a6878856.html> (accessed 13 April 2018).

21 The UBI is related to the negative income tax, and in certain forms may have an identical impact.

22 <https://www.cato-unbound.org/2014/08/11/robert-h-frank/lets-try-basic-income-public-work> and <http://www.cityam.com/280881/universal-basic-income-could-price-worth-paying-cut> (accessed 13 April 2018).

23 <https://policy.greenparty.org.uk/assets/files/Policy%20files/Basic%20Income%20Consultation%20Paper.pdf> (accessed 13 April 2018).

24 It is claimed that coming technological employment, while impacting across the economy, will have a greater effect on low-skilled workers. OECD calculations suggest that the jobs of less than 5% of those with degrees are at high risk, as against 40% of those with lower secondary education (Nedelkoska and Quintini (2018).

councils have been given funding for pilot schemes. Meanwhile, Alaska has had something resembling a (smallish) universal basic income since 1982, in the form of a 'Permanent Fund Dividend' initially based on oil revenue. This payment, available to any Alaskan resident who applies for it, is currently around \$2000 per year.

If such a scheme were to be implemented in the UK on a large scale, what would be the implications? First, the cost would be considerable. Some naïve schemes are predicated on scrapping all existing welfare benefits and using the funds to provide a UBI. But this would not provide enough to live on. In the UK, we currently spend about £250 billion on broadly-defined welfare benefits (including the state pension, which accounts for about 45% of this expenditure). The amount could be slightly higher or lower, depending on exactly how eligibility was defined, but this sum would suggest a UBI of a little under £4000 per year. However, 12 million people currently receive state pensions, and the basic pension is £6359, rising to £8296 under the new arrangements. Nearly 5 million people receive housing benefit, averaging about £5000 per year, while the 2.5 million ill or disabled people on Employment and Support Allowance collectively cost about £45 billion in state support. It is difficult to see that it would be politically possible in the short to medium term to deprive all these people of their current entitlements, especially when a UBI scheme would involve giving the same flat 'citizen income' to millionaire citizens. In order that none of these groups lose out significantly when introducing a UBI, we would have to spend considerably more than we currently do on welfare – perhaps an extra £100 billion – or else cut back the UBI to a much lower level, when it would achieve very little.

Some argue we should instead push the UBI up to a much higher figure. Ed Miliband has suggested around £10,000 per year, which would mean the cost would rise to about £580 billion, well over twice what we currently spend on welfare.²⁵ This would reduce the numbers of people who would lose out by scrapping existing benefit schemes, but there would still be difficult cases. Remember that the maximum even a single person in London with no dependents can receive in benefits in a year is currently £15,400. Families normally have higher caps, and some people with extreme disabilities can have very high levels of payment. This suggests that even with a very expensive UBI we would still need a bureaucratic system of means and eligibility testing, which would negate some of the advantages of the concept.

²⁵ The much higher levels of tax or borrowing which this would entail may make such a high UBI politically implausible. But in 2016 Switzerland voted in a referendum proposing an even higher level of UBI. Although the proposal was defeated, nearly a quarter of the electorate voted in favour.

How would people react to a 'free' income? Economists point out that a UBI would produce income effects and substitution effects, both of which tend to suggest that labour supply would be reduced. Provision of a non-work income is generally assumed to increase the demand for leisure, while higher marginal tax rates (a likely consequence of introducing a UBI) make an extra hour of work less attractive. Would a UBI therefore mean that large numbers of people would want to give up paid work? If so, the scheme would rapidly become unaffordable as the tax levied on those still working would have to rise further.

Fans of UBI argue that the evidence from small pilot schemes, from microsimulation²⁶ studies and even from a study of lottery winners (Marx and Peeters 2008) indicates only small impacts on labour supply – although the effect is slightly greater for women than for men. They are probably correct, although no studies cover the effects of real-world, full-scale, economy-wide schemes with large UBI payments, which have never been tried.

But there are other concerns. One is the acceptability of such a scheme on moral grounds: is it right that we should be obliged by law to contribute taxes to support people who are under no obligation to seek paid work or give anything back to society? We have no experience of what this kind of society would be like in the long term. Current generations might continue to work normally, but would we gradually see a decline in the work ethic amongst the young?

Families or households, rather than individuals, are what we are generally most concerned with when discussing poverty, while the UBI and similar schemes focus on individuals. As the UBI would go to all citizens – including children, though possibly at a reduced rate – there will at best be a lot of rather pointless transfers. A single earner in a family would have to pay significantly higher taxes so that the state can pay their partner and children. But might this not also tend over time to undermine the responsibility of people to their families?

Rather than all this being an issue for sociologists, political savants and policy wonks to ponder, what does the general public think? Already there is hostility to welfare claimants,²⁷ even though they face eligibility hurdles

²⁶ Behavioural microsimulation is widely used to assess likely effects of tax or benefit reforms using large data sets containing detailed information on choices, constraints and personal characteristics of a large sample of individuals and households. The data are used to develop a statistical model that aims to predict choices individuals and households will make in the event of a reform.

²⁷ Including many who are themselves on low incomes (Taylor et al. 2017).

which in many cases are quite high. To make 'free money' available apparently without strings to a much larger constituency, many of whom may be painted as 'undeserving', would surely be something of a gamble. In particular, would a UBI be available to recent migrants, or just current citizens? If migrants are to be excluded, then there would have to be some sort of back-up welfare provision to cover those who otherwise face destitution, so again we may end up with a more complicated rather than a simpler system. If they are included, and depending on the size of the UBI, this acts as a magnet to potential future immigrants. This is unlikely to be popular.

But possibly an even greater problem arises, paradoxically, if the scheme were seen as acceptable, even desirable, by a majority of the population. If all willingly receive the benefit, there could be a constant tendency for politicians to seek electoral support by offering higher and higher levels of payment until the scheme becomes unsustainable.

Moreover, whatever the intentions of idealists promoting the scheme, it is difficult to believe politicians would easily resist the temptation to impose particular patterns of behaviour as a precondition of receiving this 'citizen's income'. Bossy politicians who know what is best for us are a fact of modern life. Nowadays they possess, or potentially could possess, far too much information about how we live our lives. Already there is the ominous precedent of China's 'social credit' scheme, where citizens are awarded privileges – or have them taken away – for their public and private activities, monitored in ways never previously possible.²⁸

Universal basic services

An alternative to the universal basic income has been proposed by University College London's Institute for Global Prosperity.²⁹ This is to provide 'universal basic services' including free housing, food, transport and communications. It is again something which has been welcomed by politicians, with Labour's John McDonnell having a working group looking at this proposal.³⁰

The Institute's supporters would like to see a doubling of the existing social housing stock by building 1.5m new homes, offered free to those in most

28 <https://www.independent.co.uk/news/world/asia/china-surveillance-big-data-score-censorship-a7375221.html> (13 April 2018)

29 https://www.ucl.ac.uk/bartlett/igp/sites/bartlett/files/universal_basic_services_-_the_institute_for_global_prosperity_.pdf (accessed 13 April 2018).

30 <https://universalbasicservices.org/2018/02/25/labour-announce-ubs-for-next-government/> (accessed 13 April 2018).

need. A 'food service' would provide one third of meals for 2.2m households deemed to experience food insecurity each year, while free bus passes would be made available to everyone, rather than just the over-60s. The proposals also include access to basic phone services and the internet. The BBC licence fee would be abolished, with the BBC being funded out of general taxation. This 'social wage' would all be paid for by cutting the personal income allowance to £4300 a year.

The proponents of this scheme, including economist Jonathan Portes, argue that their scheme would be cheaper than a UBI (they claim it would cost 'only' about £42 billion) and would avoid any work disincentive effects. They see the proposals as an extension of the principles underlying the National Health Service and the education system. This itself should ring an alarm bell: neither institution has the full confidence of the electorate, while both suffer perpetual 'crises' and display continuous demands for more funding from trade unions and other interested parties.

Professor Portes offers a surprisingly weak economic case for state provision of basic services, invoking such concepts as public goods, externalities and economies of scale in the manner of a student essay, but with little detailed reasoning. Nor is there much detail on the working of the scheme. How would the extra 'free' housing be allocated? And what would be the consequences for people in existing forms of social housing? How would subsidised food be organised? Would it, as seems almost inevitable, involve controls on food prices? Would only certain types of approved food – low fat, low-sugar – be available? Moreover, if it takes the form of food vouchers, will we have elaborate mechanisms to prevent these being traded for alcohol and drugs, as has happened with comparable schemes in the USA?

It is surprising to see economists such as Professor Portes blithely ignoring the benefits of the price mechanism. Generally speaking, people prefer to spend money as they wish rather than have things given for 'free'. Some 'free' services are of no use to many individuals who differ from the norm. Free transport is of little use if you're bedridden or live out in the country and rarely wish to travel.³¹ Free television licences bring little benefit to people who are deaf or blind, or maybe just do not care for *Flog It*, *Top of the Pops 1983* or *Celebrity Master Chef*. People in these circumstances

³¹ A point seemingly lost on Jeremy Corbyn, who has recently promised that a Labour government would provide 'free' bus travel for all under-25s – or the Conservatives who are extending the Young Person's Railcard to everybody under 30.

would be unequivocally better off with an equivalent cash payment. One-size government provision of services definitely does not fit all.

Robot taxes, the universal basic income or the provision of universal basic services are, then, politically-driven proposals which have little to do with observable levels of technological unemployment in the UK labour market. Should job losses become a serious problem, there are things which could be done within a more conventional policy framework. Indeed, some of these probably ought to be done anyway, regardless of the current employment situation.

We can make employing people cheaper, for instance by reducing regulation in a variety of ways. One obvious example is the minimum wage system, which the Institute of Fiscal Studies has recently argued may be artificially encouraging the automation of low-skilled work.³² In addition, we know that income tax and national insurance contributions make workers more costly to hire and reduce their net income after tax, making work less attractive. Rather than making work more expensive, we should aim to reduce employment-related taxes by cutting government expenditure and switching the burden of taxation to environmental damage taxes or land value tax, which do not distort employment decisions.

³² <https://www.ifs.org.uk/publications/10287> (accessed 13 April 2018)

Conclusions

Concern over new technology has many of the characteristics of a moral panic (Ungar 2001): fears over rapid change, limited facts and a great deal of speculation, misleading assertions (for instance about allegedly rising inequality), interest groups with their own agenda, and simplistic solutions which put the blame on vague groups (the rich, big corporations, the technocratic elite).

We need to remind ourselves that new technology offers us improved living standards and a higher quality of life, as it has in the past. There seems to be little evidence at the moment that job displacement is moving faster than the economy's ability to develop new types of employment. There is too little understanding of the way in which economies work to absorb the benefits of technical progress and generate new ways for people to earn a living. The predictions being made of large-scale unemployment or dramatically falling wages are based on highly contentious assumptions and are contested by economists who point to flaws in the methodology.

This insistence that technological change inevitably leads to job loss ignores the engineering, economic, social and regulatory barriers to adoption of many theoretically plausible innovations. And even successful innovations are likely to take far longer to materialise than is being suggested.

More importantly, history strongly suggests that jobs destroyed by technical change will be replaced by new jobs complementary to the new technologies – or in unrelated areas, as spending power is released by falling prices. Current evidence on shifting employment patterns and new types of job opportunities supports this suggestion.

The UK labour market is currently in a healthy state and there is little evidence that technology is having a strongly negative effect on employment

prospects or the quality of jobs. Problems at the moment seem to be related to a shortage of many types of labour rather than a shortage of work to do.

However, technophobic panic is already tempting policy-makers to consider untested policies that are often being pushed by political activists for reasons which have little to do with a threat to existing jobs and rather more to do with anti-capitalist prejudice and utopian fantasy.

These radical policies could potentially be very damaging to the UK. A tax on robots would be difficult to impose, and if adopted unilaterally would deter many socially useful innovations and drive investment and employment abroad. A universal basic income would be very expensive to operate if it offered most people a benefit equivalent to the existing social welfare net, and largely pointless if it did not. It could in either case have all sorts of unforeseen consequences. Provision of universal basic services, too, is an ill-thought-out recipe for massive new state intervention and restriction of consumer choice.

The best way to future-proof employment opportunities is to make it easier to start businesses, to encourage a wide range of possible employment contracts, to reduce the powers of vested interests in existing occupations, to cut taxes on employment rather than raise them, and to increase self-responsibility rather than reduce it by perpetuating the myth that we are helpless against the coming robocalypse.

References

- Anyadike-Danes, M., K. Bonner and M. Hart (2011) Job Creation and Destruction in the UK: 1998-2010. Department for Business Innovation and Skills https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/32244/11-1326-job-creation-and-destruction-uk-1998-2010.pdf (accessed 13 April 2018).
- Arntz, M., T. Gregory and U. Zierahn (2016) 'The Risk of Automation for Jobs in OECD Countries: A Comparative Analysis' OECD Social, Employment and Migration Working Papers 189.
- Autor, D. (2015) 'Why Are There Still So Many Jobs? The History and Future of Workplace Automation' *Journal of Economic Perspectives* 29, 3, 3-30.
- Autor, D. and D. Dorn (2013) 'The Growth of Low-Skill Service Jobs and the Polarization of the US Labor Market' *American Economic Review* 103(5), 1553-1597.
- Autor, D. and A. Salomons (2018) 'Is automation labor-displacing? Productivity growth, employment, and the labor share.' BPEA Conference Draft, Spring. Available at: https://www.brookings.edu/wp-content/uploads/2018/03/1_autorsalomons.pdf (accessed 13 April 2018).
- Belfield, C., R. Blundell, J. Cribb, A. Hood and R. Joyce (2017) 'Two decades of income inequality in Britain: the role of wages, household earnings and redistribution'. *Economica* 84, 334, 157-179.
- Colombino, U. (2015) 'Is unconditional basic income a viable alternative to other social welfare measures?' IZA World of Labor. Available at: <https://wol.iza.org/uploads/articles/128/pdfs/is-unconditional-basic-income-viable-alternative-to-other-social-welfare-measures.pdf?v=1> (accessed 13 April 2018)

Cribb, J., R. Joyce and A Norris Keiller (2018) Will the rising minimum wage lead to more low-paid jobs being automated? Institute for Fiscal Studies Observations.

Davies, S. (2017) Basic Income, Labour, and the Idea of Post-Capitalism' *Economic Affairs* 37, 3, 442-458.

Ford, M. (2015) *The Rise of the Robots: Technology and the Threat of Mass Unemployment*. London: One World.

Frey, C. B. and M. A. Osborne (2013) 'The Future of Employment: How Susceptible are Jobs to Computerisation?' Oxford Martin School Working Paper <http://www.oxfordmartin.ox.ac.uk/downloads/academic/future-of-employment.pdf> (accessed 13 April 2018).

Gordon, R. J. (2012) 'Is US Economic Growth over? Faltering Innovation Confronts the Six Headwinds'. National Bureau of Economic Research Working Paper 18315. Available at: <http://www.nber.org/papers/w18315.pdf> (accessed 13 April 2018).

Haldane, A. (2015) 'Labour's Share'. Speech given to TUC. 12 November. Available at <https://www.bankofengland.co.uk/-/media/boe/files/speech/2015/labours-share.pdf> (accessed 13 April 2018).

Keynes, J. M. (1930/1972) 'Economic Possibilities for our Grandchildren' in *Essays in Persuasion*. London: Macmillan for the Royal Economic Society.

Marx, A., and H. Peeters. 'An unconditional basic income and labor supply: Results from a pilot study of lottery winners'. *Journal of Socio-Economics* 37:4 (2008): 1636–1659..

Marx, K. (1845/6) *The German Ideology*. Available at <https://www.marxists.org/archive/marx/works/1845/german-ideology/> (accessed 13 April 2018).

McKinsey Global Institute (2017) *A Future that Works: Automation Employment and Productivity* https://www.mckinsey.com/~media/McKinsey/Global%20Themes/Digital%20Disruption/Harnessing%20automation%20for%20a%20future%20that%20works/MGI-A-future-that-works_Full-report.ashx (accessed 13 April 2018)

Murray, C. (2008) Guaranteed Income as a Replacement for the Welfare State. Foundation for Law, Justice and Society. Available at <http://www.fljs.org/sites/www.fljs.org/files/publications/Murray.pdf> (accessed 13 April 2018).

Nedelkoska, L. and G. Quintini (2018) 'Automation, Skills Use and Training' OECD Social, Employment and Migration Working Papers 202. Available at: <https://www.oecd-ilibrary.org/docserver/2e2f4eea-en>.

OECD (2018) Transformative Technologies and Jobs of the Future: Background Report for the Canadian G7 Innovation Ministers' Meeting. Available at: <http://www.oecd.org/innovation/transformative-technologies-and-jobs-of-the-future.pdf> (accessed 13 April 2018).

Painter, A. and C. Thong (2015) Creative Citizen, Creative State: The principled and pragmatic case for a Universal Basic Income. Royal Society of Arts. Available at: <https://medium.com/pathways-to-universal-basic-income/creative-citizen-creative-state-a3cef3f25775> (accessed 13 April 2018)

Rifkin, J. (1995) *The End of Work*. New York: Tarcher/Putnam.
Taylor. M. (2017) *Good Work: The Taylor Review of Modern Working Practices*. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/627671/good-work-taylor-review-modern-working-practices-rg.pdf (accessed 13 April 2018)

Taylor, E. , C. Saunders and M. Toomse-Smith (2017) *Social and political attitudes of people on low incomes 2017 report*. Joseph Rowntree Foundation. Available at: www.natcen.ac.uk/media/1492994/social-and-political-attitudes-of-people-on-low-incomes-2017-full-report.pdf (accessed 13 April 2018)

Ungar, S. (2001) 'Moral panic versus the risk society: the implications of the changing sites of social anxiety' *British Journal of Sociology* 52,2, 271-291.

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