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THE FUTURE IS OURS

WOMEN, AUTOMATION AND EQUALITY IN THE DIGITAL AGE

Carys Roberts, Henry Parkes, Rachel Statham and **Lesley Rankin**

July 2019

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ACKNOWLEDGEMENTS

The authors would like to thank Dupe Witherick and Gloria Viedma Navarro at Deloitte for all of their support and for providing extremely useful contacts, information and ideas throughout the research. They would also like to thank the members of the expert panel, whose input into the research was invaluable, as well as Caroline Grey at UIPath. Finally, many thanks to current and former colleagues at IPPR who have helped bring this research to publication, including Catherine Colebrook, Tom Kibasi, Olivia Vaughan, David Wastell and Abi Hynes. All errors remain the authors' own.

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Citation
If you are using this document in your own writing, our preferred citation is:
Roberts C, Parkes H, Statham R and Rankin L (2019) *The future is ours: Women, automation and equality in the digital age*, IPPR. http://www.ippr.org/research/publications/women-automation-and-equality

SUMMARY

Automation – or the substitution of labour for capital – has triggered dystopian visions of mass joblessness, as well as utopian visions of a world with no work. Yet despite the growing capability of robots and artificial intelligence (AI), we are not on the cusp of a 'post-human' economy. Automation will produce significant productivity gains that will reshape specific sectors and occupations. In aggregate, however, these gains are likely to be recirculated, with jobs reallocated rather than eliminated, economic output increased, and new sources of wealth created. The problem, instead, is likely to be one of how income and wealth are distributed. Automation could create a 'paradox of plenty': society would be far richer in aggregate, but, for many individuals and communities, technological change could reinforce inequalities of power and reward.

These changes may well affect men and women differently, because men and women tend to have different jobs in the UK labour market. Our analysis shows that twice as many women as men work in occupations with a high potential for automation (9 per cent compared to 4 per cent of men), and that 64 per cent of jobs in these occupations are held by women. Migrants, and lone parents (typically women) are more likely to hold jobs with high automation potential.

But technology is not destiny. How automation reshapes the economy, and who benefits, will depend on where in the economy automation takes place; who holds power in the economy; who has the 'in-demand' skills in the future economy, and how those skills are valued; who is able to find new roles and withstand periods of unemployment; and how the gains are shared.

This paper argues that automation presents an opportunity to narrow gender inequalities. An acceleration of automation could increase productivity and enable higher pay in currently low-paid roles dominated by women. New jobs will be created that could provide high-quality opportunities for women to take up. Automation could create a society of plenty, both financially and with more time for life outside of the workplace, which could relieve women of the 'double shift' of paid and unpaid work that many face and rebalance unpaid work between genders. But a more gender-equal future will not happen spontaneously. Realising this opportunity will require a managed acceleration of automation, led by those who could be affected by it, including women. This report sets out four propositions for change based on this premise.

1. We should seek to accelerate automation to increase productivity in low-pay sectors. This should be led by workers.

Managed automation poses an opportunity to drive up productivity and pay, and to transform how we value key job roles that have historically been characterised by feminised work performed primarily by women, for low wages. Maximising the benefits of automation will require improving the rate of diffusion of technologies from the minority of frontier firms to the majority of slow-adopting, low-productivity firms in the rest of the economy. It will also require ensuring that both quantity- and quality-driven productivity gains are shared with workers through higher pay. The voices and leadership of women and other workers should be central to a managed acceleration of automation.

To achieve this, we recommend the following.

- A managed acceleration of automation, governed by those affected. If a 30 per cent target of women on boards is not reached by large companies by the end of 2020, legislation should be introduced requiring a 50:50 split by 2025. All large companies should also be required to have two elected employees on their board and remuneration committee.
- A new social partnership body, Productivity UK, that would support firms in the everyday economy to adopt automating technologies, with a strategic focus on low-paid sectors including those that disproportionately employ women.
- Measures to increase pay with productivity, including raising the minimum wage to the real living wage, sector-level collective bargaining, and use of procurement powers to push up wages.

2. We should ensure the benefits of higher productivity are shared by all.

Increasing use of automation in the production process could result in rising financial returns to the ownership of machines – or, more broadly, capital, if the economy becomes more 'capital intensive'. This could lead to the deepening of existing inequalities, because capital is held very unequally across the economy. Women are half as likely as men to hold employee shares, and own on average less wealth in pensions, shares and unit trusts. To ensure that everyone can benefit from returns to capital, we recommend the following.

- An expansion of employee ownership trusts (EOTs), as well as a requirement to include share options in pay gap reporting.
- Extending automatic enrolment, with relatively smaller employer contributions, below the current threshold of £10,000 – potentially benefitting over 1.5 million women who work.
- A Citizens' Wealth Fund to ensure that everyone can benefit from increasing returns to capital even if not in formal, paid work.

Increased productivity could enable not just higher incomes, but also allow us to produce the same amount with less work. This could enable a reduction in working time, potentially relieving the 'double shift' of paid and unpaid work faced by many women and facilitating a more equal balance of unpaid work between genders. We recommend the following.

- An increase in annual leave entitlements, a proportion of which could be in the form of bank holidays, and that we join other European countries in restricting the ability to 'opt-out' of the European Working Time Directive.

3. New jobs in the future must be made accessible to everybody.

As tasks and whole occupations are made redundant, others will take their place. The impact on gaps in pay and conditions will depend on who is able to access the good jobs in the future economy. In particular, roles in tech are both highly paid and occupied primarily by men: just 16 per cent of people working in tech are women. Opportunities in the future economy must be accessible to women. We recommend the following.

- Support for carers to retrain, including 30 hours free childcare entitlement for people who are studying and a returners programme for women re-entering the labour market to work with tech.
- Stronger legislation to ensure good jobs are accessible, through 'use-it-or-lose-it' paternity leave, a requirement for all jobs to be advertised as flexible by default, and requirements on tech firms to demonstrate progress to gender-equal workforces.

- That schools, FE institutions and universities are required to report gender balance at GCSE and A-Level subject choices. Universities should pay a financial penalty for failing to achieve reasonable gender balance in STEM subjects.

4. We must ensure that technologies are not biased against particular groups, including women.

Algorithms offer opportunities to make huge strides in terms of productivity, accuracy and insights, but they also risk magnifying human bias – and error – on an unprecedented scale. To prevent bias in automating technologies that rely on algorithms and data generated by platforms, we recommend the following.

- The Centre for Data Ethics and Innovation is given regulatory powers to inspect audit trails of how anti-discrimination measures have been built in from the design stage.
- The Centre should also assess how the 2010 Equality Act could be strengthened to provide protection against discriminatory practices perpetuated by algorithmic or data bias.

INTRODUCTION

Automation is the substitution of labour for capital, reducing or eliminating the need for people to perform specific tasks in the production process. As well as replacing the need for human labour, it can enhance the capabilities of, and demand for, human effort and ingenuity. From the Industrial Revolution onwards, this process has transformed how we live and work, produce and consume. In aggregate, automation has immensely benefited society.

In recent years, interest has increased regarding the impact automation will have on our society and on economic justice, from dystopian visions of mass joblessness, to utopian visions of a world of plenty in which we do not have to work. Previous IPPR research has set out how the primary potential problem of automation is not mass joblessness, but inequality: society could be far richer in aggregate, but without mechanisms to distribute that wealth more broadly, existing inequalities of power and reward could be entrenched (Lawrence, Roberts and King 2017).

In our economy, those inequalities are not randomly distributed between individuals, but shaped by class, race, age, and gender. This report is concerned primarily with the last of these inequalities, as well as the intersections between gender and other identities and characteristics.

Understanding automation's impact on different groups will be important for policy design, but also in anticipating the political challenges and constituencies in a society with accelerating automation of tasks. The combination of technological change and offshoring of blue-collar jobs, without protection for those workforces, is likely to have contributed to political discontent – as reflected in 'rust-belt' support for Trump as well as support for Brexit in areas of the UK that have experienced economic decline. In the same way, future waves of technological change will reshape political identities and how people feel the economy is working for them.

Through our research we set out to answer how automation could affect men and women differently, and how it could be shaped to create rather than impede gender equality. To do this, we spoke with experts from business and academia, and read widely. We carried out our own analysis of where in the economy there the greatest potential for automation is, and who holds those jobs currently. We looked in more detail at sectors that could both be reshaped by automation and which have highly feminised workforces, and held two focus groups with workers in these sectors.

This paper sets out two key analytical insights and four propositions for change. We argue that automation is unlikely to cause mass joblessness, but will transform work and who gains from the economy. This is likely to affect men and women differently because men and women hold different jobs and hold different amounts of wealth. But we also argue that, if properly directed, automation could facilitate a shift to a more gender-equal future.

WHAT DO WE MEAN BY AUTOMATION?

When we discuss automation, we refer to the use of technology to carry out tasks that previously could only be carried out by humans. In some cases, this will amount to replacement of previous worker effort, and in other cases it will be used to 'augment' or enhance workers in their current roles.

Automation: Includes robotics, cognitive and AI.

Robotics: Includes physical robots (such as drones and robots used for manufacturing) and robotic process automation (technology that automates highly standardised, rule-based routines and transactions).

Cognitive technologies: Include natural language processing and generation (machines that understand language), and machine learning (pattern recognition).

Artificial intelligence (AI): Machines that can make predictions using deep learning, neural networks, and related techniques.

Source: Deloitte 2019

1.
THE EVIDENCE

AUTOMATION IS UNLIKELY TO CAUSE MASS JOBLESSNESS, BUT IT WILL TRANSFORM WORK AND WHO GAINS FROM ECONOMIC ACTIVITY. THIS IS LIKELY TO AFFECT MEN AND WOMEN DIFFERENTLY

A POST-HUMAN ECONOMY?

The growing capabilities of artificial intelligence and robotics have led to claims we are on the cusp of a new machine age that will dwarf previous waves of automation in terms of the scale, speed and scope of the disruption it causes (Brynjolfsson and McAfee 2014; Ford 2015; CitiBank 2016; Susskind and Susskind 2015; World Economic Forum 2015; Avent 2016; Srnicek and Williams 2015). Whereas the technologies that drove automation in the past required clear instructions in controlled environments to substitute for human endeavour, new technologies are now increasingly able to act and problem-solve independently, inferring the appropriate solution or actions on the basis of the external inputs, and 'learning' as they do so. As a result, machines (whether hardware or software) are increasingly able to perform both routine and non-routine tasks, physical and cognitive work. Tasks once thought to be the sole preserve of humans can now often be performed better – and, increasingly, more cheaply – by machines.

Yet, despite the growing capability of robots and AI, there are several powerful reasons to think we are not on the cusp of a 'post-human' economy (Lawrence, Roberts and King 2017). First, whether automation does take place depends not just on technological potential, but on social and economic factors too. For example, if technologies are more expensive than workers, or if firms lack access to capital to fund investment, the adoption of automating technologies will be slowed. Societal factors, such as social acceptability and ethical questions, can also slow adoption. And there are 'engineering bottlenecks', which mean the features of jobs that are in many ways most 'human' – like emotional intelligence, creativity, and perception and manipulation in unstructured situations – cannot currently be automated (Frey and Osborne 2013).

Even where automation does take place, the result will not obviously be mass joblessness. Automation will produce significant productivity gains that will reshape specific sectors and occupations – for example, in hospitality and clerical work as explored in the case studies (chapter 3). In aggregate, however, these gains are likely to be recirculated (Gregory et al 2016). Whether a machine performs all, or some, of the tasks previously performed by workers, it will likely increase labour productivity (measured as the value of output divided by total hours worked). With the aid of machines, workers can then produce the same amount of output as before, but in less time. Whether higher productivity leads to fewer or more labour hours then depends on the level of demand for the product. If demand keeps pace with increased output, employment levels could stay the same, or even grow. For example, David Autor contrasts how technological change led to a dramatic reduction in employment in agriculture in the 20th century, compared to

healthcare, where employment has risen, due to differing levels of demand for the outputs (Autor 2015a).

The historical evidence suggests that, in established industries, the demand response to increased productivity (through greater supply, and so lower prices) is typically not sufficient to counteract the negative impact of these gains on the demand for labour. Rising labour productivity will therefore cause a decline in the numbers of some kinds of jobs in some sectors. But these are likely to be offset by an increase in the demand for labour in other sectors, and in other kinds of jobs, because efficiencies lower prices, freeing up income to be spent in other parts of the economy. It is true that this round of automation will expand the domain of machines to a broader set of tasks previously performed by humans, including cognitive tasks. But the spillover effects of increased productivity, as well as demand for 'human' skills like caring in an ageing population, and increased demand for labour to solve societal problems like the need to decarbonise our economy, will mean that new jobs are likely to be created (see 'Automation and the green economy' in chapter 6).

In the absence of policy intervention, the most likely outcome of automation is an increase in inequalities of wealth, income and power. The economic dividends of automation are likely to flow to the owners of technologies and businesses, and the highly skilled, as income shifts from labour to capital and the labour market polarises between high- and low-skilled jobs (Lawrence, Roberts and King 2017). Automation will therefore create 'winners' and 'losers': the impact on equality will depend on factors such as the ability of particular workers to transition to good jobs in the future economy.

Work will be transformed, not eliminated. An estimated 60 per cent of occupations have at least 30 per cent of activities which could be automated with already-proven technologies (McKinsey 2017). Automation could increase the demand for work in creative, cognitive, planning, decision-making, managerial and caring roles, where humans still outperform machines. Where automation takes place, new roles may be created to design and manage the automation of processes. New jobs and ways of working, often in close partnership with machines, will emerge.

MEN AND WOMEN COULD BE AFFECTED DIFFERENTLY

These changes are likely to affect men and women differently, because men and women tend to have different jobs in the UK labour market.

The literature to date gives different estimates of how susceptibility to automation varies by gender in the UK and globally. The different estimates arise sometimes because of disagreement over technical potential for automation, but more often because the likely impact of automation depends on a complex interplay of factors, and any attempt to model that implies a set of assumptions relating to those factors.

The Office for National Statistics (ONS) estimates that women hold 70.2 per cent of jobs that are at 'high risk' of automation – that is, jobs with the highest proportions of component tasks that could be automated. This interacts with age, partly because as women in particular get older, they are more likely to work in part-time roles, and part time work is more concentrated in job roles at higher risk of automation (ONS 2019).

McKinsey include rates of adoption of automating technologies in their modelling as well as technical potential. Taking a central estimate of adoption rates, based on the rate of technological adoption in the past, they estimate that 22 per cent of women's FTE jobs in the UK could be displaced by 2030, compared to 24 per cent of men's.

PwC argue that, internationally, the impact of automation will affect men and women differently as new waves of automation progress. In the 'algorithmic' wave, which will run to the early 2020s and involve the automation of simple computational tasks and analysis of structured data, they believe slightly more women than men will be affected. During the 'augmentation' wave, running to the late 2020s and involving dynamic interaction between humans and technology for clerical support and decision-making, and the adoption of robots to complete tasks in semi-controlled environments such as moving objects in warehouses, they also suggest that women will face a greater disadvantage. But in the 'autonomous' wave, from the late 2020s to the mid-2030s, we will see automation of physical labour and manual dexterity, and problem solving in dynamic real-world situations that require responsive actions, such as in transport and construction. This wave is likely to impact men substantially more than women, at 34 per cent of jobs versus 26 per cent for women (Berriman and Hawksworth 2018).

The World Economic Forum does not produce specific estimates, but warns that on current trends, women will lose out in an automated economy because they are underrepresented in jobs that are expected to expand and command higher wages. Analysis of LinkedIn profiles suggests that amongst people working in AI globally, only 22 per cent are women (World Economic Forum 2018).

The RSA, rather than looking forward, have looked back over the period since 2011 to see which jobs in the UK economy are expanding, and which are shrinking. They warn that female workers are suffering a 'double-whammy', losing out on the best paid jobs in the 'new economy' as well as bearing the brunt of austerity measures in the public sector. Low-paid roles such as care workers and home carers may be expanding, but retail cashiers and checkout operators have declined by 25 per cent, administrative occupations in the public sector by 35 per cent, and women have missed out on the fastest expanding well-paid jobs like programmers and software developers, of which there are 60,000 more than in 2011 (Dellot 2018).

WOMEN ARE MORE LIKELY TO WORK IN A JOB WITH HIGH POTENTIAL FOR AUTOMATION

We carried out our own analysis of how women could be impacted by automation. For our analysis, we use the estimates of automation potential by granular occupation produced by the ONS (ONS 2019). These estimates are based on the OECD's methodology of assigning individual jobs within an occupation a likelihood of automation using Frey and Osborne's 2013 assessment of technical potential for automation and PIAAC (Programme for the International Assessment of Adult Competencies) data on skills and jobs (Arntz et al 2016). We then match these estimates with data on main occupation in the UK Labour Force Survey: for each individual's stated main occupation, we add in the average automatability associated with that occupation as estimated by the ONS.[1] These figures are based on technical potential for automation, but do not reflect the likelihood of that automation taking place, which will depend on economic and social factors.[2]

1 These ONS estimates are computed based on England data but we assess these to be sufficiently applicable to the UK more widely.

2 The ONS method replicates the OECD approach, incorporating UK data. This builds on Frey and Osborne's work by addressing heterogeneity in automation potential *within* a particular occupation, given that individuals within the same occupation can often perform quite different tasks. For more detail, see Arntz et al (2016). The results suggest much lower levels of automatability, and a smaller 'tail' of highly automatable jobs, than the Frey and Osborne study. This is largely because the authors find that even within occupations assessed to have the greatest susceptibility to automation, workers often perform tasks that are hard to automate – such as those involving face-to-face interaction.

Following this method, **we find that 64 per cent of workers in roles with high potential for automation are women, and 36 per cent are men.**[3] Looking at it another way, **working women are twice as likely to be in 'high potential' occupations than working men**: 9 per cent of women compared to 4 per cent of men.

We identify workers as 'high potential' where their reported main occupation was on average two thirds automatable or more (66 per cent and above), which captures around 6 per cent of all workers. Although there is no clear definition of the score which would constitute 'high potential' jobs, we find that small changes to the cut-off point at which jobs are considered to be at 'high potential' of automation does change the extent to which women are likely to be more affected by automation relative to men. However, in all cases we consider, in the range 64 per cent–70 per cent, we find that women are more likely to be impacted by automation than men.[4]

TABLES 1.1 AND 1.2: WITHIN OCCUPATIONS WITH HIGH POTENTIAL FOR AUTOMATION, MEN AND WOMEN HOLD DIFFERENT ROLES

Male workers in 'high potential' roles

Occupation	Of men in high potential roles, what percentage are in each of the following occupations?
Farm workers	5.8%
Packers, bottlers and canners	9.9%
Cleaners and domestics	15.5%
Vehicle valeters and cleaners	3.9%
Shelf fillers	8.1%
Kitchen and catering assistants	24.4%
Waiters and waitresses	9.6%
Bar staff	11.5%
Other occupations	11.3%

Female workers in 'high potential' roles

Occupation	Of women in high potential roles, what percentage are in each of the following occupations?
Farm workers	1.6%
Packers, bottlers and canners	4.8%
Cleaners and domestics	36.2%
Launderers, dry cleaners	1.6%
Shelf fillers	2.9%
Kitchen and catering assistants	25.8%
Waiters and waitresses	14.1%
Bar staff	8%
Other occupations	5%

Source: IPPR analysis using Quarterly Labour Force Survey data Q1 2018–Q4 2018 (ONS 2019c)
Note: Other occupations for both men and women are: 'weighers, graders and sorters', 'tyre, exhaust and windscreen fitters', 'sewing machinists', 'elementary sales occupations n.e.', 'leisure and theme park attendants'. For women it also includes 'vehicle valeters and cleaners' and for men it includes 'laundrers, dry cleaners and pressers'. These categories needed to be combined due to small sample sizes.

WHO HOLDS THE JOBS WITH THE HIGHEST POTENTIAL FOR AUTOMATION?

We look further into the group of occupations with a high average automatability score to find out more about the people who could be most affected by automation. The occupations that fall into our 'high potential'

3 The data categorises respondents by sex, as 'male' or 'female'. We use 'men' and 'women' to denote sex as more regularly used terms, but recognise the limitations this presents for the analysis of gendered experiences of the UK labour market.

4 The ONS analysis, which incorporates wider factors such as seniority and skills, uses a cut-off of 70 per cent and finds a more stark result, with 70 per cent of jobs categorised as 'high risk' being held by women. We choose a lower cut-off relating to the average score of each occupation as we do not have the same detailed analysis of within occupation automatabilitiy – but our cut-off captures a similar proportion of workers overall. The result is that our estimates are a conservative estimate of the likely automatability of jobs held by women in the UK.

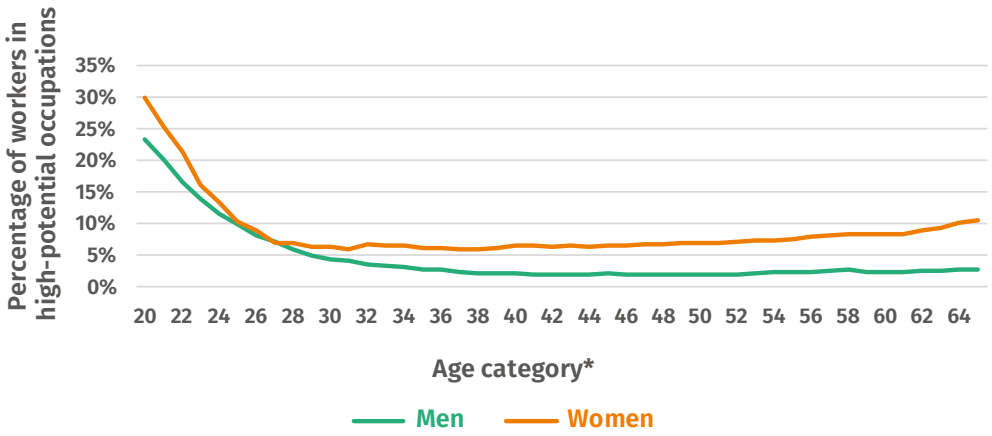
category are listed in tables 1.1 and 1.2. Many of these roles involve a high proportion of physical tasks. Our analysis focusses on occupations with the very highest proportion of tasks which are technically automatable, and thus there may be relatively higher risk of displacement or dramatic change in the future. A far greater range of occupations are likely to see more 'partial' automation – for example, in mid-skilled occupations such as clerical work, though within clerical work particular occupations come close to our definition of 'high potential' (see case studies in chapter 3).

Our results show that within the group with 'high automation potential' jobs, certain groups may face even greater change.

For example, young people are far more likely to be in a job with high potential for automation (see figure 1.1). The potential for automation is similar for both men and women in their mid-20s, but for older workers it is increasingly likely that a job with high automation potential is held by a woman. **Among those aged 61–65, women in work are four times as likely as men in work to be in a job with a high potential for automation**. This difference is likely to reflect both cohort effects, such as change in occupational segregation between cohorts, and age effects, such as the likelihood of taking low-paid work during or following child-rearing.

FIGURE 1.1: BOTH YOUNGER AND OLDER WOMEN ARE MORE EXPOSED TO AUTOMATION THAN MEN OF THE SAME AGE

Percentage of workers in high potential occupations



Source: IPPR analysis using Quarterly Labour Force Survey data Q1 2018–Q4 (ONS 2019c), and 'Probabilities of automation in England' (ONS 2019b)
***Note: The age category refers to workers in the category age and the four years below; for example, age category 65 relates to 61–65 year olds.**

When we look at differences by nation and region, we find that, in some areas of the country, working women are much more likely to be working in jobs with high potential for automation than in other regions. Gender differences are also more pronounced in some areas than others. In the North East, women are 2.2 times more likely to be affected compared to men in that region, whereas in London the differential is much smaller (though still substantial) at 1.5 times.

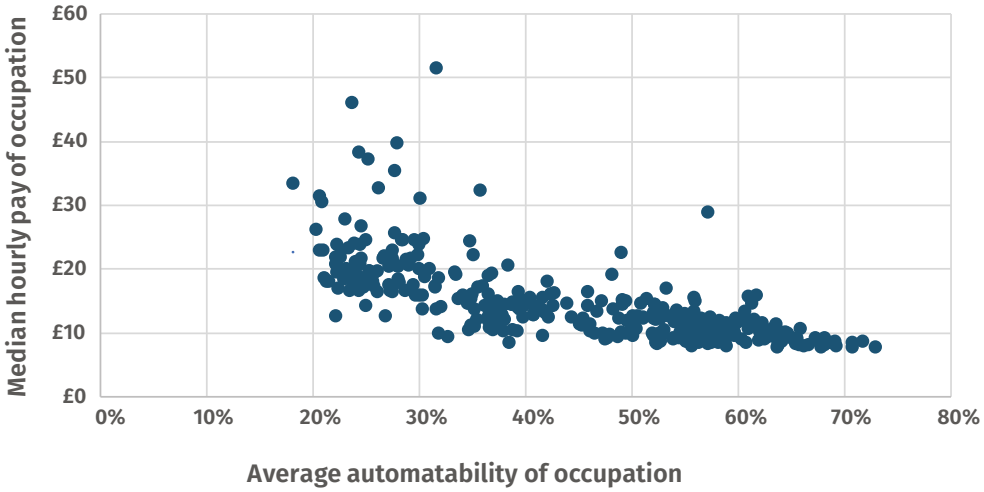
Women in high potential jobs are slightly more likely to be from a BAME background than women across all jobs, but the difference is much more pronounced amongst men. Both male and female migrant workers are over-represented in high potential occupations. Migrants make up 21 per

cent of the whole female workforce, but 29.3 per cent of women in high potential occupations.

A disproportionate number of part-time jobs have the potential to be automated. 14.6 per cent of people working part time have a 'high potential' occupation, compared to 3.3 per cent of full-time workers. The jobs that face the greatest potential changes also tend to be lower paid on average (see figure 1.2).

FIGURE 1.2: JOBS THAT FACE THE GREATEST POTENTIAL CHANGES FROM AUTOMATION ALSO TEND TO BE LOWER PAID

Median hourly pay (£) and average automatability of occupation (%)



Source: IPPR analysis using Annual Survey of Hours and Earnings (ONS 2018b) and 'Probability of automation in England' (ONS 2019b).
Note: Analysis excludes small number of occupations for which median pay was not available due to small sample sizes.

These figures do not present 'risk', as they do not account for non-technical factors in whether a job will be automated, or in how demand might be recirculated following efficiencies and price changes. But what they do provide is an indication of potential for change, both in terms of work available within a particular occupation, and the nature and conditions of that work.

2. THE AUTOMATION OPPORTUNITY

THE CHANGES BROUGHT ABOUT BY AUTOMATION COULD FACILITATE A SHIFT TO A MORE GENDER-EQUAL FUTURE, BUT WILL NEED TO BE SHAPED TO DO SO

Of course, predictions about the transformative effect of automation have been made repeatedly in the past. What is clear is that technology is not destiny. How automation reshapes the economy, and to whose benefit, will depend on the choices society makes, the policies we adopt, and the institutions we create. Our figures refer to jobs with a high technical potential for automation: whether they will indeed see that automation will also depend on factors like investment decisions, and whether increased productivity results in higher wages will depend on wage-setting decisions.

Even when automation does take place, the impact on the economy and on specific groups is not determined. Instead, the impact depends on who is able to access the new jobs, what happens to pay and conditions in the jobs that do stay or which are created, and how the 'plenty' created by higher productivity is distributed and in what form.

Automation presents an opportunity. In times of flux, possibilities for structural change are opened up. If there are new jobs in the economy, there is also the possibility of shaping those jobs to ensure they are accessible to everyone. And, if managed for the common good, automation could help create a society of plenty. Higher productivity levels could enable us to produce more valuable goods and services with less – raising living standards through material and financial means, as well as potentially enabling us to work less while producing the same output.

Without intervention, there is no reason to believe that technology will be shaped and directed towards social or collective goals (Howcroft and Rubery 2019). While technology itself is neutral, the individuals and groups who develop it and look for ways to harness it are not. Without policy intervention, automation risks reproducing and amplifying existing inequalities within the economy. But with democratic oversight of technology through institutions and politics, collective decision-making over our future and policy intervention, new possibilities abound.

This broader argument is as true of gender equality as it is of a broader set of inequalities. Without policy intervention, there are real reasons to fear that automation could exacerbate existing inequalities. But with the right institutions, politics and policy, automation could enable a more gender-equal future.

There are several key dimensions which will determine the impact of automation on gender equality.

WHERE IN THE ECONOMY AUTOMATION TAKES PLACE

Where automation takes place will affect which sectors see productivity improvements, and who gains in wages and profit. Where labour is cheaper than investment in new technologies, there will be a remainder of low-paid jobs, even if those jobs could technically be automated. And because women are overrepresented in low-paid work, and underrepresented in the high-paid growth sectors of the future economy, where automation does take place will have an impact on the gender pay gap, as well as on what jobs women hold in the future.

WHO HOLDS POWER IN THE ECONOMY

How automation occurs and who it benefits will depend on who makes the decisions, and who holds power in bargaining relationships. Productivity growth enables – but does not necessarily lead to – pay improvements. Pay is also a function of bargaining power in the economy. In fragmented sectors – such as social care and, increasingly, the gig economy – workers are less likely to be unionised and to have the bargaining power to ensure they can gain from productivity increases.

WHO HAS THE 'IN-DEMAND' SKILLS IN THE FUTURE ECONOMY, AND HOW THOSE SKILLS ARE VALUED

McKinsey estimate that, by 2030, jobs in Europe and the US could require up to 24 per cent more hours using social and emotional skills, which are typically seen as 'feminine' traits (Bughin et al 2018). But technological skills will experience an even higher increase in demand, with 55 per cent more time spent using these skills (ibid). In our interviews with business leaders, we heard that many tech roles do not require specific formal qualifications, but rather skills such as logic that will be required to work with AI and automating technologies.

Discussions of how men and women will benefit relatively from increased demand for these skills are often framed as if different skills as inherently associated with men and women. But such associations are 'constructed – not fixed – and so the future distribution of work is not fixed either' (Howcroft and Rubery 2018). What matters instead is how we choose to construct and support the learning of skills across genders, and how we value those skills in the future economy. There is a high demand for caring skills currently, with a skills gap for care workers in the UK labour market, and yet those skills are poorly remunerated: to ensure an increase in demand for 'human' skills leads to more equal outcomes will require ensuring those skills are properly valued (see our health and social care case study in chapter 3).

TRANSITION AND RESILIENCE

Accelerated automation is likely to lead to some displacement. Who is most resilient to change and able to transition to new roles will affect how automation affects men and women. For example, women may face greater barriers because caring responsibilities, which are held disproportionately by women, might limit options for women to retrain, or restrict the type of jobs that are available to them.

Our analysis shows that – although across the economy women are more likely to have a graduate qualification and less likely to have low qualification levels – these advantages disappear among the group of those in 'high potential' jobs. And, though women in general are more likely to work in the public sector, which tends to have greater job security, in the 'high potential' group, women are as likely as men to be working in the private sector. When we look at lone parent status – a

characteristic which makes unemployment especially difficult as well as making it more challenging to find employment that fits around caring responsibilities – we see a big difference: women in the 'high potential' group are more than three times as likely as men in the 'high potential' group to be lone parents, and 60 per cent more likely to be a lone parent than women across the whole workforce.

HOW GAINS ARE SHARED

Accelerating automation could also enable us to produce more efficiently. We could collectively choose to reap the rewards not just in greater material wellbeing, but in time for life outside of the formal workplace. Both *who* benefits from the gains and *how* those gains are taken could have an impact on gender equality: women still do 60 per cent more unpaid work than men, often alongside paid work, so may benefit more from reductions in working time that relieve this burden and enable a shift in who performs unpaid labour (ONS 2016).

HOPES AND FEARS

We spoke with people working in two parts of the economy dominated by women: clerical occupations and care work occupations. We heard mixed views on whether automation holds promise or threat for their roles and livelihoods. The clerical workers we spoke to were relatively optimistic about the role that technology could play in improving their jobs, and eliminating mundane and repetitive tasks – particularly bureaucracy. Care workers, on the other hand, were more pessimistic, in part because technologies were seen as a means by which to cut costs and push more work onto overloaded teams. In their work, automation was almost always implemented to drive cost-efficiencies in the context of austerity, rather than to improve a service or support staff to do what was most important to them – the 'human' tasks of relationship building and empathy.

3.
FOUR CASE STUDIES

To better understand how automation is already reshaping women's jobs and how it might do so further in future, we looked at four sectors that have a high potential for complete or partial automation, and/or are characterised by low productivity and low pay.

HOSPITALITY

The hospitality sector employed 2.4 million workers in 2018 – some 7 per cent of total workforce jobs, with employee numbers growing twice as fast as average job growth since 2011 (IPPR analysis of ONS 2019a). Given rising demand and a potentially diminishing pool of labour due to the effects of Brexit, this is one sector where greater automation may be particularly attractive. In addition, our analysis suggests that workers in this sector face the highest automation potential on average of any sector (IPPR analysis of ONS 2019b; ONS 2019c).

Some aspects of automation are already becoming commonplace in this industry. In hotels, for instance, self-service check-in and check-out facilities are enabling consumers to come and go as they please, as pioneered by Premier Inn as early as 2009.[5] Others have gone further, offering an integrated automated system for booking all hotel services, where access to facilities is granted through a key card system.[6] Such use of technology allows for greater convenience and a quality service, while simultaneously enabling hotel workers to take on other tasks which add more value to consumers, and ultimately the economy.

As AI technology develops, digital concierge services such as Hilton's 'Connie' will become more prevalent in this industry, with machine learning algorithms allowing them to continuously improve.[7] While being able to resolve routine requests for information efficiently, more complex requests – requiring emotional intelligence or creativity – can be routed straight through to hotel staff.

More sophisticated monitoring systems could enable a number of efficiencies on the operational 'back office' side as well – for example, enabling cleaners to know which rooms are available to clean, and automated stock management streamlining the purchasing of kitchen supplies without the need for manual checks.[8] In management, increasingly sophisticated algorithms will be able to devise pricing strategies to maximise room occupancy and revenue.

In wider hospitality, there has been some application of automation through mobile apps in bars and restaurants – at Wetherspoons and Pizza Express, for example – which enable people to both order and pay through their phones. This offers both convenience to consumers, and a variety of benefits to firms as well such as more efficient order fulfilment.[9] While jobs like bartending may be seen to be the preserve of humans as they require dexterity, the Makr Shakr –

5 See: https://www.bighospitality.co.uk/Article/2009/01/07/First-self-check-in-only-hotel-launched-by-Premier-Inn

6 See: https://www.genie-phone.com/automation-in-hospitality-hotel-check-in-desk/

7 See: https://newsroom.hilton.com/corporate/news/hilton-and-ibm-pilot-connie-the-worlds-first-watsonenabled-hotel-concierge

8 See: https://www.cleanindiajournal.com/automation-in-hospitality/

9 See: https://buildfire.com/restaurant-mobile-app/

a robotic bartender that can make cocktails to order – demonstrates that it is economic and social factors holding back automation in this role rather than technical capability.[10]

There are limitations to this approach. Humans are inherently social beings, and interaction with people will continue to be valued by the consumers of the future. However, the overall service will likely improve, with humans and machines working together and a greater emphasis possible on the 'personal touch' which we value as a society. In turn, this additional value could translate into higher wages for a set of workers who sorely need a pay rise.

CLERICAL WORK

Clerical work can be characterised as administrative support functions, of which typical tasks include: data entry and management, filing, book-keeping, scheduling, and inventory control. Receptionist, office manager, personal assistant and various specialisms of clerk and secretary are typical roles. In 2017, 10 per cent of workers in the UK were employed in administrative and secretarial jobs (ONS 2018a). The sector is dominated by women, who make up 75 per cent of the administrative and secretarial workforce.

The ONS finds that between 47 (the average for office managers) and 62 (for receptionists) per cent of clerical employees' work has the potential for automation (ONS 2019) Clerical work has already seen significant change, with computer software partially automating roles. For example, emails, digital storage and online information have replaced paper correspondence and filing, as well as phone communication.

The future labour demand for basic cognitive skills is expected to decline, particularly the basic data-input and data-processing skills used by data-entry clerks and typists and other back-office functions. Looking at the US and five European countries, including the UK, McKinsey estimates a 15 per cent decline in demand for these skills by 2030 (Bughin et al 2018). Among these countries, jobs with routine cognitive work, such as clerical support, could account for 52 per cent of women's jobs that have high automation potential (ibid). As such, the automation of clerical tasks may contribute to the 'hollowing out' of mid-skill jobs.

Clerical workers shared their experiences of automation at a focus group conducted for this research in Manchester in May 2019. There was a sense of inevitability around automation, with participants saying, "It is what it is", and saying it was "bittersweet". Many participants mentioned how it had made their work easier and freed up time for other tasks. Several participants stressed the huge amounts of paperwork and administration work that used to be done manually that are now done easily and quickly using digital technology, such as email instead of post. However, no participant expressed a sense of control over how technology was introduced in their workplace, with several saying they had no input into the process: "Staff didn't have a say in it, but it's improved the job, it's made it easier".

Though some participants anticipated job losses, others saw opportunities to become more skilled and progress to more senior roles if lower-value work could be automated, keeping the decision-making and people-oriented tasks: "There's decision-making that will never be done by a robot". Many participants believed work would change to become more "meaningful" and "interesting". Relationship-building and communication with colleagues, clients and service users was mentioned.

10 See: https://www.makrshakr.com/

While many participants reported receiving good training to use the technology in their workplaces, others said that if it were easier and cheaper to get the skills externally, their employers would. Many participants acknowledged the challenge that technology can present to older workers, noting that even when good training is provided, some older people are unable to get to grips with technology. And, when asked how they would respond if their role were automated, participants' reactions differed with their age and gender. We heard from older women that they may not want to look for another role, especially if it meant a big change like going from the public to the private sector, "starting from the beginning". Another woman participant said that her job fits around her three children, who "come first". No men mentioned childcare as influencing their career choices. Younger participants tended to be more optimistic when describing how they would expect to respond to job loss through automation, seeing technology as opening new avenues and opportunities, including better-paid freelance work. One participant said it wasn't a case of "either/or" between the technological and the human, but that together they are a "powerhouse".

RETAIL

The retail industry has been a particularly visible example of the transformative impact that automating technologies are already having on how we buy, sell and interact. Although retail's share of employment has been declining for the past 15 years, the UK's retail and wholesale sector still employs 12.5 per cent of the total UK workforce, and 14 per cent of the female workforce – making it the largest employer of women after health and social care (Gardiner and Tomlinson 2019; ONS 2018; Powell 2018). Analysis of task composition and worker and job characteristics suggests that as many as 2.25 million jobs in the retail sector are at high risk of displacement by automation – the largest of any UK employment sector (Berriman and Hawksworth 2017).

Productivity and pay in the retail industry have improved faster in retail than in many other sectors (Gardiner and Tomlinson 2018). Productivity in the sector has increased by 40 per cent since 2000, and recent evidence has found that national minimum wage rises, including the introduction of the national living wage, have encouraged retail firms to seek out ways to increase productivity (Green et al 2018). Increasing margin pressure – driven by the combination of intensifying competition, the rise of e-commerce and pressure to increase wages – is pushing a growing number of retailers who have exhausted more traditional cost-reduction mechanisms to turn towards automation (McKinsey 2019).

The current investment in automation by retail firms is anticipated to have deep impacts, ranging from more productive supply chains, to hyper-flexible shift scheduling. Major retail-sector employer Tesco have introduced automating technologies to manage shift scheduling, offering workers new levels of flexibility that have been compared to gig-economy roles. The tool enables employees to pick up overtime shifts on the go or at short notice, swap shifts with other employees, or alert their employer of unplanned absences at any time – for example, when a child falls ill overnight. This heightened degree of flexibility has the potential to open up new ways of working, especially to women, who are more likely to work part time and to have caring responsibilities that restrict their working hours. The combination of stable scheduling with apps enabling workers to swap shifts without unnecessary admin has also been shown to increase productivity in a randomised controlled trial in GAP stores (Williams et al 2018).

Meanwhile, Amazon are trialling cashier-less supermarkets in tech-savvy locations in the US, with plans to expand into London, and German e-commerce firm OTTO has recently employed machine-learning technology to enable autonomous

product replenishment. Artificial intelligence is expected to play a growing role in stock management and fulfilment issues across the retail sector, and to shape a new future for customer service (McKinsey 2019).

These transitions raise important questions about the trade-offs involved in investing in emerging labour-saving technologies. The British Retail Consortium, UK retailers' trade association, argues that automation is supporting a transition towards a smaller, more productive, and higher-paid workforce (British Retail Consortium 2016). But the transition to a more automated and more productive retail sector will require a gender-sensitive approach. Key job roles in the retail sector have a high susceptibility to automation – and these tend to be roles dominated by women. The ONS estimates that 65 per cent of retail cashier and check-out operator working time could be automated, and 72 per cent of these jobs are held by women. Similarly 64 per cent of working time in sales and retail assistant roles could be carried out by automation – within which 68 per cent of workers are women (ONS 2019b).

The concentration of women in the retail workforce has in the past been associated with the prevalence of part-time work within the sector. The historically female-dominated industry is, however, becoming increasingly male, and increasingly full time (Gardiner and Tomlinson 2019). Besides the entrance of growing numbers of male workers into traditional retail roles, growing employment in warehousing and couriering roles – within which 83 per cent of UK warehouse workers are male – exposes a particular segment of male workers to displacement through automation (Gardiner and Tomlinson 2019; IPPR analysis of ONS 2019c). Amazon executive Scott Anderson, who leads the company's robotics fulfilment, was recently reported as stating that it would be at least a decade before the retail giant's fulfilment processes were fully automated, pointing to the limitations of current technologies and the superior cognitive abilities of human workers (Bose 2019). The direction of travel, though, is clear.

Recent evidence suggests there is reason to be particularly concerned about the resilience of displaced retail workers. The proportion of workers entering or exiting a given employment sector has increased across the UK economy in recent years, and the retail workforce has been experiencing a particularly high degree of 'churn' (Gardiner and Tomlinson 2019). But whilst the retail sectors' outflow rate is not cause for concern itself, the particularly high rates of outflow into unemployment, and particularly long-term unemployment, warrant attention. If retail workers display comparatively less resilience in the labour market, we can expect further displacement through automation to have more profound economic consequences in the form of rising unemployment.

The structural trends transforming the UK retail industry are not evenly felt across the country. The place-based consequences of the shift towards e-commerce – to a large degree facilitated through automating technologies – are deeply felt. The decline of local high streets, and behind them retail's share of UK businesses and business revenue, is affecting those towns, areas and households dependent on retail much more sharply than in cities, where jobs in faster-growing sectors are found (Holder 2019; Gardiner and Tomlinson 2019). As automation transforms or replaces millions of jobs in the UK retail industry, it raises important questions as to which industries might have capacity to create new, flexible work on the scale required (Fabian Society's Retail Taskforce 2017).

HEALTH AND SOCIAL CARE

The UK health and social care sector (or 'care sector'), which spans adult social care, childcare, and health services, has the largest workforce of any major

industry. It also boasts the UK's largest female workforce, with women workers making up some 98 per cent of UK nursery nurses and assistants, 97 per cent of childminders, 83 per cent of care workers and home carers, and 80 per cent of nursing auxiliaries and assistants (IPPR analysis of NOMIS 2018 and ONS 2019c). As an expanding sector with a predominantly female workforce, how automation affects the care industry will have profound implications for women's work and lives across the UK. McKinsey estimates that 27 per cent of new jobs gained by women by 2030 could be in healthcare, assuming that the gender split of the industry stays constant (Madgavkar et al 2019).

The UK care sector is growing steadily in response to the increasing demand resulting from an ageing population. The social care workforce faces a crisis in the coming years, with an estimated shortage of over 400,000 workers in social care in England alone by 2028 (Dromey and Hochlaf 2018). Productivity improvements in the health and social care sector are typically seen as difficult to achieve, and potentially undesirable where efficiency savings reduce human contact time or are otherwise perceived to reduce care quality. The prospect of embracing automation in health and social care, however, may promise a much needed means of driving up productivity while paving the way towards better quality care (Darzi 2018).

While the UK's health and social care sector is still some way removed from a high-tech future in which robotics and artificial intelligence shape day-to-day client-carer interactions, automation is already transforming how workers in the care sector find work, and how their working lives are organised. The rise of agency-working in social care has facilitated the proliferation of platform and app-based working, including the rapid adoption of shift scheduling technologies within care agencies. For a growing portion of self-employed care workers, such as freelance personal assistants, automation is reshaping working conditions. Recent research points towards growing numbers of workers struggling to juggle atypical working hours, low pay and high childcare costs viewing agency-working as a means of exercising greater choice over shifts and working patterns, which can be critical for those workers who are often reliant on informal caring arrangements (Moriarty et al 2018).

Growing numbers of self-employed workers in the sector are seeking and securing home care work through app-based portals such as Home Touch, and new digital platforms such as Care.com and TaskRabbit, but greater flexibility will have to be balanced with sector-wide efforts to drive up wages and working conditions and ensure quality of care (Bee 2016). Accreditation of care providers by the Care Standards Authority has gone some way towards meeting concerns regarding care quality, but there are new risks, too. While some service users now have access to a marketplace that offers more flexibility in the provision of care services to suit particular needs, a fractured workforce and procurement process pose new challenges for pay and productivity. Low pay and poor conditions experienced by the increasingly precarious social care workforce not only lowers the quality of care provided, but the availability of cheap and flexible labour also disincentivises investment in productivity-enhancing technologies.

Innovation in the social care sector is particularly suited to assistive automation, where human capability can be improved or expanded through supportive technologies. Automating technologies that reduce the administrative burden on workers could free up time for the care and interaction that humans are uniquely placed to provide – but there is limited evidence of this opportunity yet being realised. Care sector workers we spoke with referred to admin and paperwork as their least favourite element of their work, while human interaction with clients was cited as the most rewarding. But they also reported that new tech-driven systems to enable collaboration and monitor outcomes have created new tasks that weren't previously

possible, increasing rather than alleviating the administrative burden on workers, requiring more information input and often proving incompatible with existing systems.

Developing automating technologies offer to enhance care workers' capabilities through assistive automation – for example, in the form of robotic exo-skeletons that fit around care providers' or care recipients' bodies to aid movement, including bending and lifting (Nicholas 2019; Fosch-Villaronga and Özcan 2019). Research with care providers suggests that workers prefer the prospect of working with assistive technologies that can enhance their own ability to perform an extended remit of tasks to working with autonomous robots (Nicholas 2019). Internet of Things technologies, such as networked devices or objects that can interact and send data between each other without a person coordinating, offer radical new possibilities for independent living. As smart homes and care homes deploy voice-activated assistants and sensors to monitor motion, fridge usage or medication, they offer opportunities for vulnerable older or disabled people to live safer and more independent lives. But these technologies also raise questions about privacy and data ethics, and will need to gain the trust of users and care providers before widespread adoption is viable (Mittelstadt 2017).

Paid and unpaid care is systematically undervalued in our labour market and wider society. Low pay is endemic in social care, with half of all care workers paid below the real living wage (Dromey and Hochlaf 2018). The concentration of women in the care workforce contributes to the overall gender pay gap, and this pay gap persists within the sector too, with the average female care worker earning nearly £60 a week less than the equivalent male worker (IPPR analysis of ASHE 2018).[11] Automation could offer a rare opportunity to reassess the social value attached to care, by re-centring the caring skills that humans are uniquely placed to provide, and by utilising productivity gains to free up more time to care.

11 Median pay for full-time workers, excluding overtime.

FOUR PROPOSITIONS

Without intervention, automation could risk deepening inequalities of power and reward. But properly managed and directed, automation could offer a more prosperous economy in which inequalities between men and women are narrowed.

Here, we set out four propositions for how automation can be shaped for gender equality.

4.
A MANAGED ACCELERATION, LED BY WORKERS

WE SHOULD SEEK TO ACCELERATE AUTOMATION TO INCREASE PRODUCTIVITY IN LOW-PAY SECTORS

Jobs that contribute directly towards 'social reproduction' – such as those in health care, education, food services, and social work – have increased markedly as a share of waged labour over the past 50 years. "If we once spoke of manufacturing powerhouses, we must now speak in terms of economies centralised around the reproduction of their workforces" (Hester 2018).[12] Healthcare in particular is expected to grow, as our population ages and comorbidities increase (Darzi 2018).[13] But many of these roles are also low-paid, and disproportionately held by women.

The UK's weak productivity performance is driven by multiple factors, including poor management and marketing, but also low rates of technological adoption (Jacobs et al 2017). Managed automation poses an opportunity to drive up productivity and pay, and to transform how we value key occupations that have historically been characterised by a feminised workforce, and low wages.

Low pay is highly prevalent in occupations at the highest potential for automation, with an estimated three-quarters of workers in these occupations paid less than £9 an hour. In part, this reflects low productivity in these sectors, and the high potential for automation means high potential for productivity gains, enabling sustainable wage increases in these occupations. Embracing automation could help firms move away from a low-pay, low-productivity equilibrium that is not in their own best interests or those of their workers. Furthermore, increasing wages in these low-pay jobs where women are more represented will help to reduce the gender pay gap.

To make sure that productivity gains benefit low-paid workers, who are disproportionately likely to be women, workers should lead any acceleration of automation. Workers should have voice in where automation takes place, how gains are shared, and who benefits from them. This principle is key to our recommendations.

ACCELERATING ADOPTION OF AUTOMATING TECHNOLOGIES

Maximising the benefits of automation will require improving the rate of diffusion of technologies from the minority of frontier firms to the majority of slow-adopting, low-productivity firms in the rest of the economy (Haldane 2017; Andrews et al 2016 and 2015). It is estimated that three-quarters of potential productivity improvements related to automation come from the broader adoption of best practices and technologies, as companies catch up with sector leaders. Only one-quarter is from technological, operational, and

12 See: https://onlinelibrary.wiley.com/doi/full/10.1111/newe.12074

13 The presence of one or more additional conditions co-occurring with a primary condition.

business innovations that go beyond best practices and push the frontier of the world's GDP potential (McKinsey 2015). Yet the diffusion of technologies to the non-frontier economy has, to a considerable extent, broken down, slowing the pace of automation and weakening productivity growth (Andrews et al 2015). For example, over the 2000s, labour productivity among global frontier firms within OECD countries increased at an average annual rate of 3.5 per cent, but only 0.5 per cent in non-frontier firms. In the services sector, productivity of frontier firms grew 5 per cent, but actually fell by 0.1 per cent in non-frontier firms (ibid).

The benefits of automation remain unrealised for several reasons. Many businesses may simply not know how to automate, lacking the technological know-how to understand how their businesses could thrive through greater use of automation. Risk aversion and large up-front costs of investment may deter others, particularly if there is a lack of precedent for the use of automation in the sector, at least locally. There may be concerns around staffing, with the need to ensure appropriate training and 'buy-in' from employees, and this may be particularly the case for less tech-savvy older workers.

In order to accelerate the adoption of automating technologies across low-productivity firms, we propose a new social partnership organisation called **Productivity UK**.

We recommend that such a body would offer the following to firms at subsidised or zero cost, addressing the aforementioned barriers, with a strategic focus on low-paid sectors.

- **Consultancy services on technical implementation of automation:** In practice, this would mean automation experts reviewing business practices, as well as identifying elements of worker's jobs which could be augmented or substituted by automation and the technology options which could achieve that.
- **Support to involve workers in the process of automation:** Our focus groups identified that consideration of workers' views, their knowledge of their roles, and ensuring they understand why and how their roles are changing is key to successful automation.
- **Business loans and potential for equity financing:** Interest-free business loans, with repayment linked to productivity increases, would allow risk to be shared. An alternative could be equity financing, whereby the state shares in some of the increased profit from automation.
- **Providing access to more affordable capital by exploiting the state's bulk purchasing power:** In some markets, there may be opportunities for the government to broker favourable deals on technological solutions to specific labour-intensive tasks. It can then pass on these savings to firms, lowering barriers to adoption.

Productivity UK would be a partnership body governed by a council including representatives of government, businesses, trade unions, public sector enterprises, the further education sector and academic business schools. **At each level it should have 50:50 gender representation.**

Automation solutions that meet the needs of workers in the 'everyday economy' may not yet be widely available. Many of the research and development efforts in the UK have been focussed on the tech and allied sectors, with university partnerships typically working with the higher-skilled better paid sectors of the economy. **We recommend that these partnerships should be extended to sectors in the 'everyday economy', such as care and hospitality (see case studies in chapter 3),** harnessing expertise to push

innovation and productivity in these lower paid sectors, to the benefit of low paid workers and women in particular.

MEASURING PRODUCTIVITY

The modern economy presents several challenges for those wishing to measure output or productivity improvements (Colebrook 2018). Digitisation and the exchange of digital services for non-monetary return – for instance, in data that consumers produce through use of a platform – makes estimating the value brought by new innovations challenging. And, as more activities cross the 'production boundary', GDP can go up without a meaningful increase in productive activity.

A further challenge in productivity measurement arises in the services sector. Services now account for around 80 per cent of economic output (ONS 2017). Sustained productivity improvements appear to be harder to achieve in the service sector compared to manufacturing, and the lower measured productivity of services relative to manufacturing is a key reason for our poor long-term productivity performance (Jacobs et al 2016).

To what extent, however, does this lower productivity growth reflect a measurement problem, rather than a genuine productivity problem? Measuring service sector value added is much more difficult than the equivalent process for manufacturing, mainly because the quality of a service – and therefore its value to the recipient – is more difficult to assess. The market price can provide a guide to the value added in the case of services offered privately. But, in the case of public services such as education and healthcare, there is no market price.

The ONS uses the method proposed in the 2005 Atkinson Review to calculate productivity: it estimates the volume of outputs produced (number of children educated; number of people treated) and calculates productivity as the difference between the growth in this output and the labour inputs used (such as teachers' and doctors' salaries) (ONS 2015). This method creates a significant risk that statisticians will miss vital changes in the quality of services provided – such as through the introduction of new medical treatments, or the use of technology in classrooms. In fact, quality improvements could bring about reductions in measured productivity, if they only appear as more expensive inputs, but don't change the outputs as currently defined.

This has implications for how we measure productivity improvements in service occupations and sectors dominated by women, and whether productivity improvements are considered possible in those parts of the economy as productivity improvements driven by quality increases may go unrecognised. A failure to recognise real quality-driven productivity improvements can also lead to an over-emphasis on cost-cutting measures that lead to a lower-quality service and more stress for workers. This was one of the primary reasons that care workers participating in our focus group feared automation in their work: it was highly associated with cost-cutting measures, rather than a goal of delivering better services or creating better jobs. It is therefore important that better measures of quality-driven productivity improvements are found (Colebrook 2018).

RAISING PAY AND PRODUCTIVITY TOGETHER

Accelerating automation can enable higher pay by increasing productivity. But pay is not purely a function of productivity. In reality, whether workers gain from increases in productivity also depends on bargaining power (CEJ 2018). This extends to both public and private sectors: even if not driven by a profit motive, the state can choose to pay workers less than the social value of their work where bargaining power is weak. And, indeed, it can be argued that reproductive work that often takes place in the public sector, like care, is systemically undervalued (see 'measuring productivity').

While productivity improvements can enable higher pay, so too can higher pay enable productivity improvements. Currently, many of the occupations with high potential for automation are unlikely to be automated soon, because workers in these occupations are low-paid and cheaper than machines. When employers can get extra output by taking on a low-paid worker by the hour, they have little incentive to invest in the equipment or skills which will raise productivity. When wages rise – through a higher minimum wage, for example – firms are forced to find new and more productive ways of organising work and training employees in order to afford the higher pay (Green et al 2018).

To ensure that pay rises together with productivity gains, we recommend the following.

- The extension of sector-level collective bargaining, especially in low-pay and fragmented sectors. There is a strong case for starting with the highly-feminised social care sector – which is characterised by a workforce crisis, growing demand, and high levels of public sector procurement. Government should facilitate **sector-level collective bargaining** in the social care industry, in the first instance, to boost productivity and quality of care through managed automation and improved employment standards.
- Even in a highly fragmented social care sector, the public sector is a major purchaser and therefore can drive standards through contract design. Therefore, building on the Public Services (Social Value) Act 2012, government **procurement** in key sectors, such as adult social care, should be subject to a contractor meeting pay and employment conditions, including, as a first step, payment of the real living wage. This could help drive up working conditions, service quality, and productivity in a key area of public sector procurement.
- To raise productivity and simultaneously ensure workers benefit financially, **we recommend that the minimum wage is raised to the level of the real living wage.**[14]

WOMEN AND OTHER WORKERS SHOULD LEAD THE ACCELERATION OF AUTOMATION

Social partnership will be a key vehicle for bringing together the voices of those workers whose roles stand to be transformed with business and government, in order to manage displacement where it occurs, and to support a just transition towards the high-tech, high-productivity economy of the future.

14 Higher wages may increase the cost of care that the government faces, if productivity improvements result in higher quality rather than quantity.

Workers can identify where genuinely labour-saving automation could occur. We heard repeatedly in our focus groups with people working in the care sector that automation has been a top-down process, and, as a consequence, has typically failed to solve the problems that workers perceive or lighten the load of the most labour-intensive tasks.

- **Employers should consult unions and other staff bodies as they implement automation plans** to identify the best opportunities of automation and ensure it benefits workers, supported by Productivity UK.

But the highest level of company management should also include the voices of those who will be most affected by automation. And when firms consider opportunities and challenges associated with adopting automating technologies, women should be represented. This will require shifts in how companies are governed and who gets a seat at the table.

- Large companies should be given **a target of 30 per cent women's representation on boards by the end of 2020**. If this is not reached, government should introduce a mandatory requirement of 50 per cent women on boards by 2025.
- **Large companies should be required to have at least two elected employees on their boards and remuneration committees.**

5.
SHARED PLENTY

WE SHOULD ENSURE THE BENEFITS OF A HIGHER PRODUCTIVITY FUTURE CAN BE SHARED BY ALL

SPREADING THE FINANCIAL GAINS THROUGH BROADER OWNERSHIP OF FINANCIAL WEALTH

We would expect that increasing use of automation in the production process would result in increasing financial returns to the ownership of machines, or more broadly capital, if the economy becomes more 'capital intensive'. Data show that, in advanced economies, the proportion of national income which flows to workers in the form of labour income has been declining in recent decades, and about half of this can be attributed to technological change (Dao et al 2017). While the UK labour income share has revived somewhat since the 1990s, if automating technologies are able to take on a greater proportion of tasks across the economy, we could see the labour share decline both in the UK and globally. New research also suggests that since the early 1990s the UK economy has seen a significant fall in the sharing of profit with workers (Bell et al 2019).

If capital were equally distributed, rising returns to capital would not deepen inequality. But, if capital is unequally held between individuals, genders and other groups, inequalities will be exacerbated. In a world in which machines can produce more than humans, who owns the machines is of increasing importance. A major goal of public policy in response to automation should therefore be dispersing and pluralising ownership in society, building institutions where the wealth generated by technological change is more widely shared.

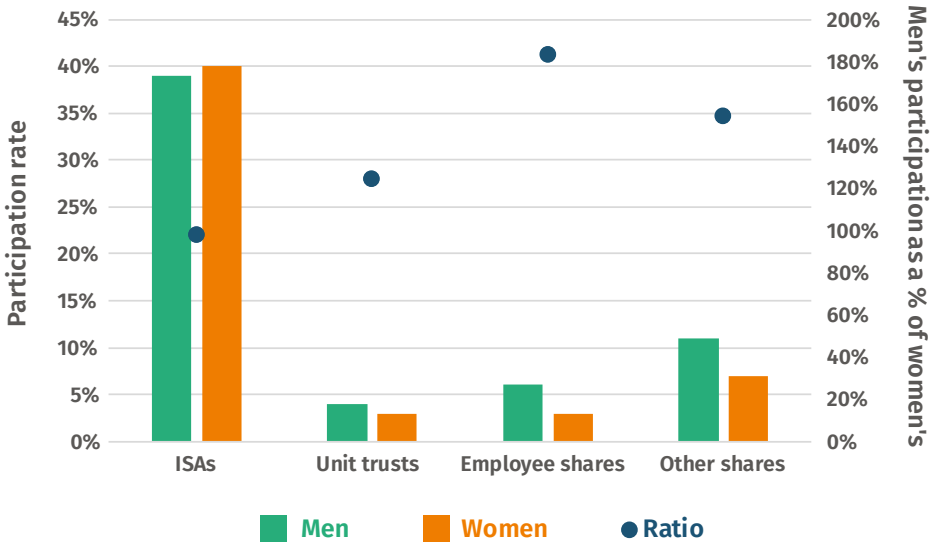
In practice, capital is held indirectly through ownership of financial products such as ISAs, stocks and shares and in the value of pension pots, whose underlying financial performance depends on that of firms. Looking at these different types of capital, we see that women are slightly more likely to hold an ISA, but are less likely to own unit trusts, employee shares or other shares (see figure 5.1). Large swathes of the population do not hold any financial wealth that would benefit from increasing returns to capital at all.[15] Neither the average man nor the average woman (defined as the median) owns a positive sum in the form of financial products such as ISAs, stocks and shares, or trusts.

Among those who do participate, total holdings are larger for men. Figure 5.2 shows the gap for the median man with each type of capital compared to the median woman. The differences are more stark when we look at mean averages, demonstrating that there are more men than women with large holdings (see figure 5.3).

15 We exclude bonds in this measure, as the returns are typically fixed rather than dependent on productivity improvements.

FIGURE 5.1: WOMEN ARE LESS LIKELY TO OWN UNIT TRUSTS, EMPLOYEE SHARES OR OTHER SHARES

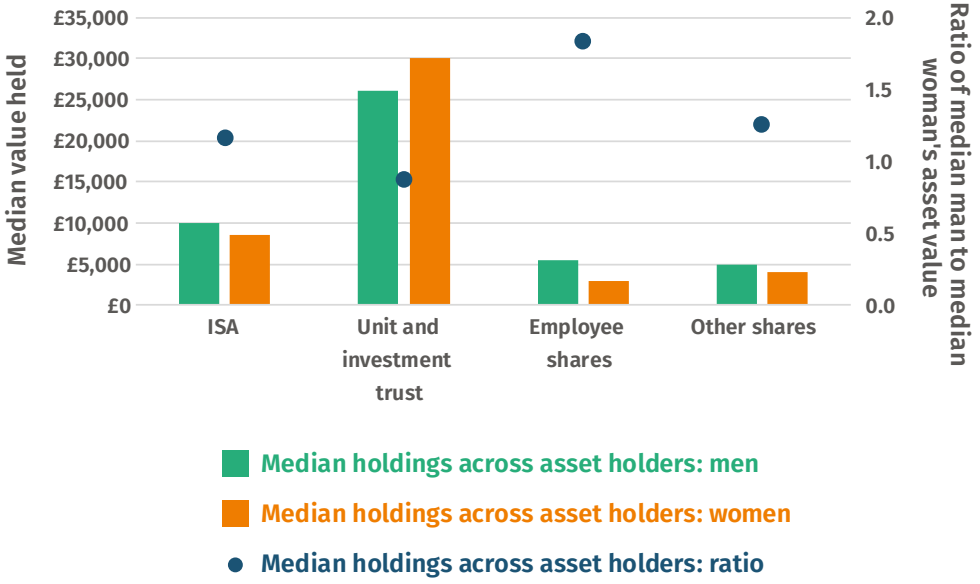
Participation in asset types for men and women



Source: Wealth and Assets Survey Wave 5, 2014–2016 (ONS 2018c)

FIGURE 5.2: AMONG THOSE WHO HOLD CAPITAL, MEN OWN SUBSTANTIALLY LARGER VALUES

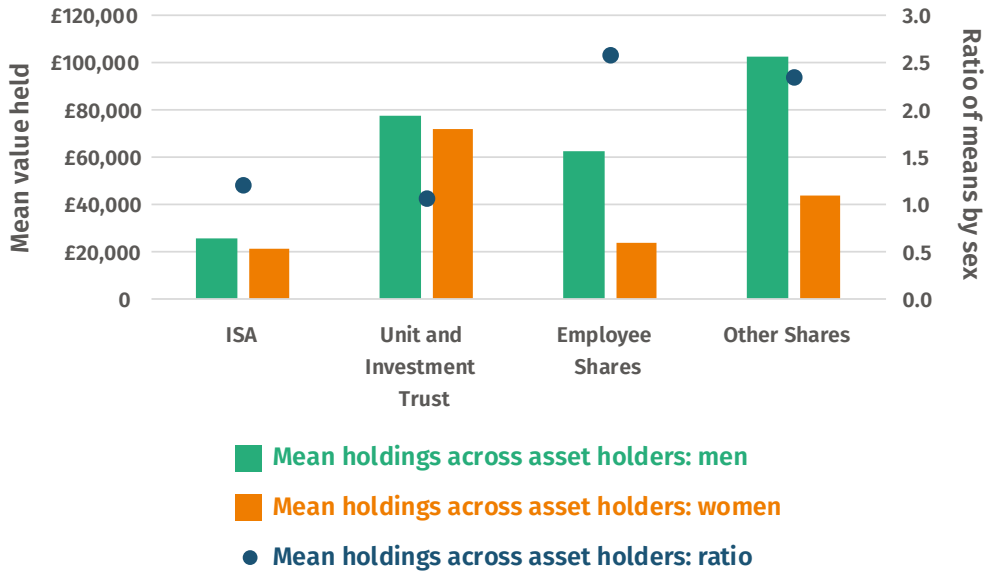
Median value of assets by asset type, for men and women



Source: Wealth and Assets Survey Wave 5, 2014–2016 (ONS 2018c)

FIGURE 5.3: WEALTHY MEN BRING UP THE MEAN AVERAGE ASSET HOLDING

Mean value of assets by asset type, for men and women



Source: Wealth and Assets Survey wave 5, 2014–2016 (ONS 2018c)

There is also a significant gender pension gap. For those aged 35 and above, there are substantive gaps in average holdings across all pension types, and in particular for occupational and personal pensions; in the former the gap stands at 91 per cent for Defined Benefit schemes and 73 per cent for defined contribution schemes for those aged 45–54. For younger people, the picture is more mixed, with smaller gaps and in the case of private pensions a negative gap for those under 35 (ONS 2019d).

To ensure that returns to capital are shared more broadly, with women and especially those on low incomes, we recommend three major mechanisms to expand ownership of financial capital.

Expanding participation in pensions

We would expect the pension gap to narrow over time, as historic differences between labour market participation and pay have reduced. The introduction of auto-enrolment has helped to ensure greater participation in pensions, with 87 per cent of eligible employees now participating in a workplace pension compared to 55 per cent in 2012 (DWP 2018). But two groups still miss out: the self-employed, and those earning less than £10,000 (FT 2019). While we estimate that around 9 per cent of men earn less than £10,000 per year, for women this figure is as high as 23 per cent (IPPR analysis using ONS 2019c). Excluding low earnings from auto-enrolment therefore widens the gap in pension wealth between men and women.

To help people on very low earnings the majority of whom are women and ensure they share in returns to capital, we recommend that the government extend automatic enrolment to those earning less than £10,000 per year to all earning £6,136, the current lower level of qualifying earnings for opting-in, and above. To make this more affordable for these workers we propose that employees are required to make a relatively lower percentage contribution on a sliding scale such that employees earning £6,136 would contribute 0 per cent. Concurrently there should be a reduction in the lower earnings limit. While this will still leave a gap in total contributions as a proportion of wages between low earners and others, it

could benefit over 2 million workers, three quarters of which are women.[16] Further to this, **we recommend that employers using self-employed labour are required to make contributions to individuals' pensions**, to both ensure gains are shared with low-paid self-employed people and avoid creating further incentives for the use of bogus self-employment contracts.

Expanding employee ownership

Employee ownership provides a route by which people can benefit from productivity increases in their workplace and have a voice in how automation is adopted as well as how benefits are shared. For employers, it can help create buy-in among the workforce to seek and adopt productivity improving measures. Currently, however, men are twice as likely as women to hold employee shares, and overall rates are very low, at 6 per cent of men and 3 per cent of women (IPPR analysis of ONS 2018c). Furthermore, among those who do hold employee shares, there are big differences in the value of those shares. The median man with employee shares owns a value of £5,500, whereas the median woman with employee shares holds a value of £3,000. The mean average is even more stark, suggesting that some men have very large holdings of employee shares.

These differences in participation and in the value of holdings arise because employee ownership schemes are concentrated in a few sectors, and among directors and managers. In total, only around 5 per cent of private companies offered an employee share ownership scheme in 2014, whether tax-advantaged or not, with larger businesses and those operating in financial intermediation, real estate and business services sector most likely to offer them (Inter-University Centre 2014). And, of the estimated £62.4 billion of employee share ownership of public companies in 2014, the bottom 90 per cent of households held only £3 billion, with company directors receiving the majority of employee share issuances. To ensure that everyone can have a stake in their workplace, **we propose that the government should seek to expand employee ownership and employee share ownership on a gender-equal basis**. We propose two mechanisms to achieve this.

First, employee ownership must be extended to more junior roles, as well as to sectors and firms without a history of employee ownership which employ many women. To do this, **we propose (as IPPR has elsewhere), an expansion of Employee Ownership Trusts (EOTs),** established in 2014, through tax incentives for firm owners and investors. EOTs are share capital funds held in trust for the benefit of all employees in a company. They enable a business owner to be exempted from capital gains tax if he or she sells a minimum 51 per cent stake in the company to the trust. The trust therefore effectively gains a controlling interest in the company on behalf of the employees and can pay out dividends to them (for further details, see Lawrence and Mason 2017).

Second, to ensure firms consider the gendered impact of their share ownership schemes, and to drive the spreading of share ownership to more junior roles where women are often over-represented, we propose **the government should set clear targets for equal rates of share ownership for men and women within the firm**. A first step to achieving this would be to include share ownership schemes within the scope of gender pay gap reporting.

A Citizens' Wealth Fund

The expansion of ownership of financial capital shouldn't stop at the workplace. Those who are unable to work or who do work outside of the formal workplace should also benefit from increased prosperity as a result of

16 Based on IPPR analysis of Labour Force Survey, individuals who could benefit identified where reported income from main job would be between £10,000 and £6,136 per annum based on reported weekly amounts (ONS 2019c)

automation. An automated future could create a paradox of plenty: we would be wealthy in aggregate, with a reduced need to use human labour, but with a problem of unequal income distribution. Expanding access to capital income could help address this problem by providing income unconnected to work. **To expand the ownership of capital to everybody, we propose a collectively owned Citizens' Wealth Fund.**[17]

The fund would hold assets on behalf of citizens. It could be capitalised through a range of sources, including taxation and sales of and income from assets. It would operate at arms-length from government, but be collectively owned and democratically governed to meet minimum social criteria, as well as to earn a return. The fund would invest in firms both in the UK and around the world. By doing so, it could directly capture the profit generated as firms become more productive through the use of automating technologies.

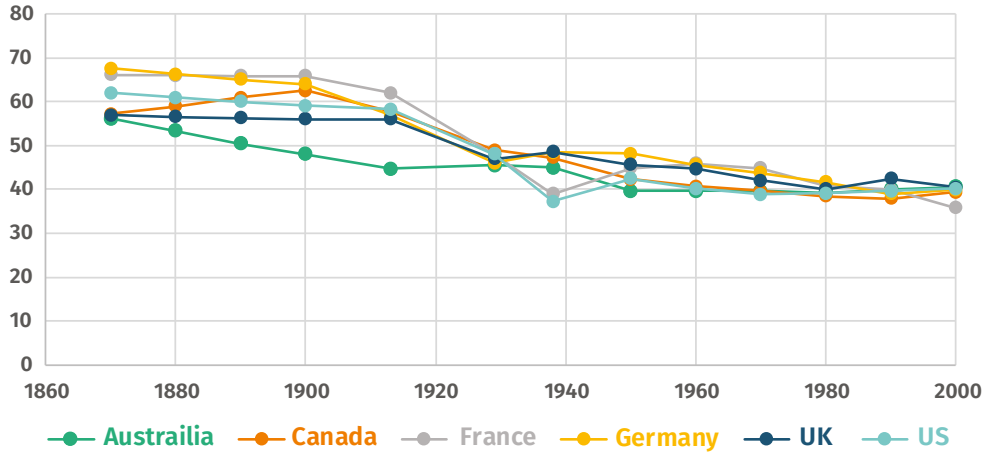
The returns would be used initially to grow the fund. But, once the fund had reached sufficient size, the returns could be used for other purposes. This could include direct cash pay-outs. For annual pay-outs to be sizeable, the fund would need to be extremely large, and IPPR has therefore previously advocated for a 'universal inheritance' received at the age of 25, which could be worth £10,000 with currently identifiable funding mechanisms. An alternative use of the returns is investment in public services and social infrastructure, which would benefit women, who disproportionately use and are supported in their unpaid work by these services (Lansley et al 2018).

USING PRODUCTIVITY GAINS TO REDUCE WORKING TIME

Increased productivity could enable higher labour incomes and higher capital incomes. But if automation enables us to produce the same or greater value of goods and services with less labour input, we could also choose to use those new efficiencies to reduce how much we work, rather than increasing how much we produce.

FIG 5.4: WORKING HOURS HAVE FALLEN DRAMATICALLY SINCE THE 1900S

Weekly work hours for full-time production workers in non-agricultural activities



Source: Huberman and Minns (2007)

17 See Lawrence M and Roberts C (2018).

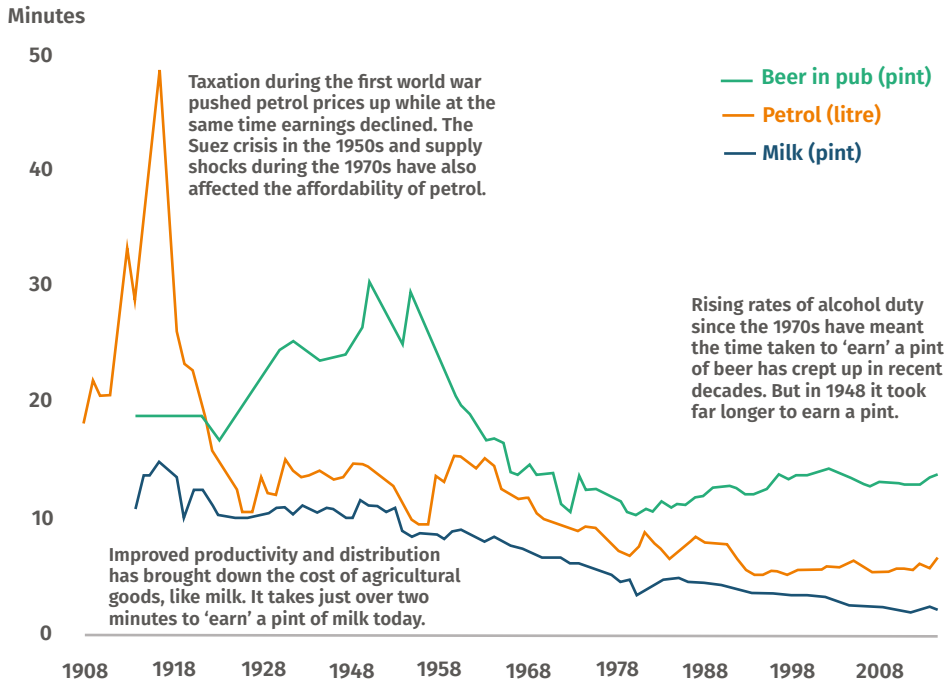
John Maynard Keynes predicted in 1930 that, by the beginning of the 21st century, his grandchildren would work as little as 15 hours a week (Keynes 2013). Historically, a combination of technological change and worker bargaining has delivered a reduction in working hours in the past (see figure 5.4).

Yet average weekly hours amongst full-time workers have been between 37 and 38.8 since 1992 (ONS 2019). That Keynes' vision of reduced working time has not materialised is not to say that he was 'wrong'. Instead, productivity has been allocated to a variety of other ends.

Firstly, incomes and material living standards have risen hugely since Keynes' time: today we consume more. Average earnings have risen far faster than the price of essential goods over the past century, with the exception of housing. It now takes fewer hours of work to buy the same goods, and yet we're still working relatively long hours (see figure 5.5).

FIGURE 5.5: AVERAGE EARNINGS HAVE RISEN FASTER THAN PRICES, PARTICULARLY SINCE THE SECOND WORLD WAR, REDUCING THE TIME IT TAKES TO 'EARN' MOST CONSUMER GOODS

Number of minutes someone on the average wage would need to work in order to earn the money to buy certain goods



Source: House of Commons Library (2012)

Second, productivity gains have disproportionately flowed to those at the top, rather than reducing working hours for the many. Between 1979 and 2012, only 10 per cent of overall income growth went to the bottom half of the income distribution, and the bottom third gained almost nothing (Bailey et al 2015).

Economists typically show working hours to be a result of individual choices in response to prices and wages. In classical labour supply models, individuals choose an allocation of consumption and leisure. If they choose to work less, and increase their leisure time, this decreases their consumption as they will earn less.

There are several reasons to look beyond this picture of labour supply from a public policy perspective. First, there is no single preferred trade-off between leisure and consumption. In fact, different groups who face different constraints on their time may trade so called 'leisure' and 'consumption' very differently. Cultural values, as well as whether they have sources of income outside of employment, or can command a high wage will affect how an individual values leisure and consumption in relative terms (Attanasio et al 2018). For example, a woman who has caring responsibilities for multiple family members is likely to value 'leisure' time more highly. Someone who does not earn enough to pay for essentials is likely to value further consumption much more highly than additional leisure time, without a simultaneous rise in their income.

Second, we are very far from an economy in which everyone can choose their number of working hours, the predictability of those working hours or the time of day in which they work. In fact, insecure and unpredictable work has been on the rise. Therefore, many people would be unable to reduce or increase their hours by one or two hours a week – instead perhaps only being able to choose how many days they work, or, in whether they work at all. And, where pay is low, or when competition for jobs is strong – scenarios made more likely if job losses due to automation occur - individuals may be less able to choose lower hours as it could impact their income or access to work (Rubery 2019).

Third, powerful norms determine how many hours we work and mediate the extent to which any individual has 'choice' over their hours. It is not that 37.5 hours per week is an intrinsically optimum number of hours to work, or that we have reached that norm by chance: rather, we have reached that norm through bargaining and legislation.

These factors suggest good reasons for intervention to facilitate a reduction in working hours, even beyond what the average person would individually choose. Further policy arguments in favour of doing so are to increase wellbeing, enable time for family caregiving, to boost aggregate demand by freeing up time to spend on leisure activities, and reduce the carbon footprint of our daily lives (Stronge and Harper 2018). We do not assess all of these arguments here, or their potential conflicts, but instead argue that a reduction in working time is an important aspect of an agenda that is emancipatory for those who do the bulk of unpaid work, because it could reallocate paid labour, relieve caregivers of the pressures of the 'double shift' of paid and unpaid work, and be a necessary step to a reallocation of feminised unpaid work without commodifying that work. Automation presents an opportunity to reconsider the purpose of work and how we use our time.

There has been recent interest in the proposal for a four-day week (Stronge and Harper 2018; TUC 2018; NEF 2019). A 20 per cent reduction in working hours is substantial and requires a phased plan for how to reach it. A four-day week is also not an arrangement of working time that will suit everybody equally: a shift to a four-day week may be less useful to the parent wanting to pick up their child from school than a flexible allocation of hours off, for instance. And those who do not currently work five days a week (of whom the majority are women) would not stand to benefit under some versions of the proposals.

To reduce working time equitably, **we recommend an increase in annual leave entitlements, a proportion of which could be in the form of bank holidays.** Increased annual leave entitlements provide a mechanism by which to phase-in reductions in working hours over time, benefitting part-time workers as well as full-time, and ensuring recipients have flexibility over how they use the additional hours. This change would be welfare-improving for the typical UK worker, as we know that annual leave is valued highly: a recent paper has assessed that the average UK worker would be willing to pay 35 per cent of their

hourly pay to gain 28 days paid annual leave as well as 16 weeks occupational sick pay, compared to no holiday or sick pay (Datta 2019).

Increases in productivity could enable faster additions to annual leave entitlements. Indicative analysis suggests that a 2 per cent real increase in productivity could be sufficient for an additional week of leave for workers, keeping output constant.[18] But increased annual leave entitlements could also stimulate faster adoption of productivity-enhancing measures by employers. In order not to incentivise the bogus classification of workers as self-employed, and to ensure 'workers' receive these rights as well as employees, this recommendation would need to be accompanied by strong enforcement of employment rights.

Another instrument to reduce working time is the European Working Time Directive. The WTD performs a powerful norm setting role: the introduction of the directive helped to reduce the number of UK employees working 48 or more hours per week by 700,000 over a 10-year period (TUC 2003). We are one of only five countries in the European Union that allow the unrestricted opt-out by individuals of the WTD. This affects not only those who genuinely want to work more, but also means that others must work more hours to compete in the workplace. To bring the UK into line with other European economies such as Germany and France, **we propose that the ability to opt out of the European Working Time Directive is restricted.**

The above mechanisms will enable the steady reduction of working time through national legislation. But employers can and should go further where they are able, and unions should also consider reductions in working time as well as increases in pay. This could include, for instance, the provision of sabbatical rights, carers' leave, and annual leave entitlements. Such benefits could help attract a more diverse talent pool, including women.

18 This would be additional pro-rata entitlement for part-time workers. Analysis uses LFS data (ONS 2019c) to estimate the proportionate reduction in working hours implied by an additional week of annual leave, and so the proportionate increase in productivity needed to keep output constant, but working less.

6.
EQUAL OPPORTUNITIES

NEW JOBS IN THE FUTURE ECONOMY MUST BE ACCESSIBLE TO EVERYONE

As described above, jobs will both be destroyed and created by automation. Other factors will also open up new employment opportunities: for example, an ageing population is likely to increase demand for care, and the need to decarbonise our economy could also produce new jobs, enabling skills and time to be repurposed for social ends (see 'Automation and the green economy' in this chapter).

The impact on women will depend not just on whether women's jobs are automated, but also who has access to the best opportunities in the future economy. At present, women are more likely to work in low-pay, low-productivity work, and men more likely to work in high-paying, high-productivity work such as technology and manufacturing. Women are far less likely than men to occupy senior and management roles.

McKinsey estimates that, in mature economies, net job growth will be concentrated in two occupations: professional, scientific and technical services; and healthcare (Madgavkar et al 2019). In many countries, including the UK, women are overrepresented in care services – which tend to be low-paid, and underrepresented in higher-level professional, scientific and technical services. While the shift to a green economy could create net job growth, existing jobs in sectors like energy and engineering are dominated by men. Of course the current pattern of gendered occupations is not fixed. In recent years, women have in fact benefitted more from new, high-skill roles across the OECD. But large-scale disruption caused by automation could enable a return to the practice of giving men priority in the labour market, risking hard-fought gains in gender equality (Rubery 2019).

Assuming the adoption of automating technologies follows a similar path to previous waves of technological change, 8–29 per cent of women in UK may need to transition to a new role by 2030, compared to 10–33 per cent of men (Madgavkar et al 2019). But women may face specific barriers in terms of making the transition to a new job role – for instance, because of barriers to learning due to time constraints associated with having informal caring responsibilities for dependents.

If women are less able to access and transition to new jobs, wage inequalities could deepen. Historically, new occupations have commanded higher wages: in 1990 and 2000, new occupations in the US were associated with a 30 per cent wage premium compared with existing roles (Lin 2009). We see this dynamic play out in tech occupations currently. Tech jobs are expected to grow, and are well-paid relative to jobs across the economy. Just 16 per cent of workers in UK tech are women, and of women in work in the UK, just 1 per cent work in tech roles, compared to 5 per cent of the male workforce.[19]

19 IPPR analysis of Labour Force Survey data (ONS 2019c). We define 'tech jobs' as occupations with occupation codes 2133–2139.

Active intervention is required to ensure women can access the well-paid new jobs in the economy, and transition between jobs when they are displaced.

THE SKILLS SYSTEM SHOULD MEET THE NEEDS OF WORKERS THAT ARE SUSCEPTIBLE TO AUTOMATION

The skills and labour of workers susceptible to automation should be reoriented and deployed where there are real needs in the economy. This will require a supportive and responsive adult skills system. Demand for technological, social and emotional, and higher cognitive skills will rise between now and 2030 (McKinsey 2019). While some jobs will require specific and formal qualifications, skills like logic will also be important in being able to work with machines.

To ensure the skills system meets the needs of workers who will be displaced, including women, it will need to be based on granular labour market information – to understand how well the current skills in the labour market will be able to supply the needs of the new economy, including those determined by industrial strategy. This information should feed into the design of both the skills system and the UK's industrial strategy.

A focus on resilience and transferable skills will also be important. While skills demands are changing more quickly as a result of technological change, working lives are getting longer. A skills system that is alive to these changes – and agile enough to respond – will be required to ensure that workers are ready for changes in work throughout their careers, and to ensure that progression is possible.

The cost of reskilling, upskilling and lifelong learning for the future economy – which includes green jobs – will be expensive, and the cost of retraining should be borne between employers and the government. **The current apprenticeship levy should be converted into a 'productivity and skills levy'**, which would be redeemable by participating companies for a wide range of initiatives (Dromey et al 2017). In addition to wider skills funding reform, a 'Technology Displacement Fund' could support workers displaced by technology to be retrained and supported back into new opportunities in the labour market.

Women, who disproportionately provide informal care, face specific barriers to retraining. Ensuring that everyone can access jobs in the new economy will require well-funded care services, so that people with caring responsibilities are able to retrain, search for employment, and take jobs that may be greater distances away from where they live (McKinsey 2019). Women's disproportionate tendency to look for jobs more locally to their home, associated with caring responsibilities, may contribute to the gender pay gap (Joyce and Keiller 2018). A first step would be to offer **the full 30 hours of free childcare to people who are retraining.** A further measure would be a specific **returners programme run by government and business to support parents re-entering the labour market to upskill** to use and work with new technologies.

JOBS IN THE NEW ECONOMY MUST BE ACCESSIBLE TO WOMEN

Skills are not the only barrier to women taking up the new jobs in the economy. Structural factors, including the unequal division of unpaid work between genders, also present a barrier. It is often easier to work part-time in lower-paid occupations: 44 per cent of women choose low-skilled work for this reason (Alakeson 2012). Currently only 4 per cent of workers in tech are in part-time roles, compared to the far-higher rate of 26 per cent of jobs across the UK economy. Jobs in the new economy will need to be made accessible to all genders.

In addition, cultural barriers to participation in tech jobs and STEM more broadly will need to be broken down. A US study has shown that women are deterred by recruitment strategies used by technology companies, which involve gender-imbalanced presenter roles, 'geek culture' references, overt use of gender stereotypes, and other gendered speech and actions (Wynn and Correll 2018). Research also shows women's code is rated less favourably when their gender is known (Terrell et al 2016). In a global survey of women in technology, only 8 per cent had not experienced gender bias in the workplace, and the top three barriers to women in the industry were: a lack of female mentors, a lack of female role models, and limited networking opportunities (ISACA 2017).

- **Technology businesses should demonstrate progress towards a gender-balanced workforce in order to win public sector contracts.** Just 16 per cent of people working in tech roles in the UK are women. The government should take decisive action by requiring companies to demonstrate progress towards equal representation of men and women workers as a condition of being able to apply for public sector contracts.
- **Government should legislate to ensure good jobs in the economy are equally accessible to men and women.** This should include measures to normalise the combination of work and caring responsibilities for men as well as women – for example, by changing shared parental leave to include a period of 'use it or lose it' paternity leave. Since 2015, the UK has had a policy of shared parental leave, whereby parents can share up to 50 weeks of leave, 37 weeks of which is paid. The initiative has so far been hindered, however, by very low take-up. International evidence demonstrates that non-transferable 'use-it-or-lose-it' paternity leave – as an alternative to optional shared leave – encourages fathers to take more leave (Ben-Galim et al 2014), enabling mothers to take less time out of the labour market relative to men, levelling the playing field.

  Further legislation should include a mandatory requirement for all jobs to be available and advertised on a flexible and potential job-share basis, except with good reason. By requiring employers to advertise jobs as flexible by default, or else demonstrate why a job cannot be worked flexibly, we can begin to shift norms in job design, thereby expanding the availability of high-quality part-time work for those seeking to balance work and care. In addition, many fathers still feel marginalised from flexible working, and men may be penalised for seeking work-life balance enabled by more flexible or part-time working (Gatrell et al 2014; Metcalf and Rolfe 2010). Making jobs flexible by default could enable more men to work flexibly, which could help to balance care responsibilities between genders. Flexible working could also help older workers affected by automation and unable or unwilling to reskill to reduce hours without leaving the labour market (Round 2017).

Businesses can go further

Businesses can go further than the minimum standards required by legislation, and doing so could help attract and retain diverse talent. This will be particularly relevant for STEM sector organisations wishing to diversify their workforces.

- **Remote and flexible working:** New technologies make remote working more possible. This could be particularly helpful for people with caring responsibilities, as it allows for a more flexible combination of paid and unpaid work (McKinsey 2019). However, we heard in our focus groups that many people consider new flexible working options to be a double-edged sword, as boundaries between work and non-working life can become blurred and lead to an 'always on' culture. Above all, flexible working rights should be about choice, not compulsion.

- **Going further than the statutory minimum on leave entitlements:** For example, some companies now offer the option of taking unpaid leave including sabbaticals, and enhanced parental and carers' leave packages.[20]
- **Diversifying the workforce:** In real world settings, the following practices have been shown to reduce the gender pay gap, one of the drivers of which is occupational segregation:
  - include multiple women in shortlists for recruitment and promotions
  - use skill-based assessment tasks in recruitment, rather than relying only on interviews
  - encourage salary negotiation by showing salary ranges
  - introduce a more structured approach to progression. Unstructured interviews are more likely to allow unfair bias to creep in and influence decisions (GEO 2019).
- **Boards should lead organisational culture change processes:** Many sectors dominated by men, including some STEM sectors, are plagued with a poor working culture that reduces productivity and increases staff turnover. To attract and retain women in these sectors, it is not sufficient to ask women to 'lean in': a culture change within organisations is required. Measures that can lead to positive culture change include:
  - making the board more diverse (see chapter 4)
  - fostering a culture of bottom-up and top-down engagement
  - protecting whistleblowers
  - measuring and reporting indicators of culture, checking all HR processes align with desired behavioural norms and values (CIPD 2016).

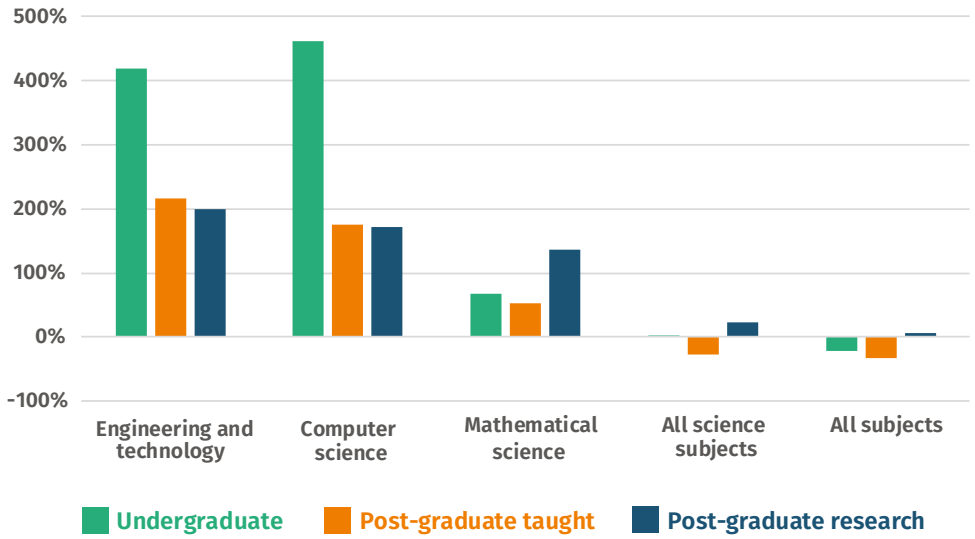
PROMOTING SKILLS FOR AUTOMATION AMONG GIRLS AND YOUNG WOMEN IN THE EDUCATION SYSTEM

As well as ensuring high-quality work for those currently in the labour market, education needs to be geared towards fostering skills for the future. From a young age, children are exposed to stereotypes of appropriate occupations for men and women. This manifests at secondary school level – at age 16, for example, when girls choose A Level subjects that preclude them from engineering careers, despite out-performing boys in age 16 science examinations (WISE 2018; Silim and Crosse 2014). Parents' lack of awareness of STEM careers and teachers' biases contribute to these decisions. This post-16 'leak in the pipeline' carries through to underrepresentation at university. Although there is a minimal gender enrolment gap for undergraduate science degrees overall, the gap widens in certain subjects, including engineering and technology, and computer science, to over 400 per cent (see figure 6.1).

20 See, for example, Deloitte's family friendly policies: https://www2.deloitte.com/uk/en/pages/careers/articles/family-friendly-policies-professional.html

FIGURE 6.1: THERE IS A SUBSTANTIAL GENDER 'ENROLMENT GAP' FOR CERTAIN SUBJECTS SUCH AS ENGINEERING, COMPUTER SCIENCE AND MATHEMATICS

Enrolment gaps for select subjects, UK, 2016/17



Source: IPPR analysis using Higher Education Enrolment Statistics, UK, 2016/17 (HESA 2019)

- **Schools, FE institutions and universities should be required to report gender balance in subject choices above GCSE level.** This self-assessment would highlight any significant discrepancies in participation, making it more likely that schools will address it as a priority. Universities should face a penalty if they fail to recruit near equal men and women to key STEM courses where there is currently underrepresentation of women.
- **Technology skills should be mainstreamed in primary, secondary and university education.** Awareness of careers in tech and automation could also be raised, along with equality and inclusion training for teachers, and connecting students with role models and mentors. Business should play an active role in this, with companies above a certain size required to actively promote STEM subjects in schools and universities. For example, Royal Mail has been working with Sheffield Hallam University Business School on the content of its business curriculum and ensuring university students have the skills to go on to tech roles and roles enhanced by automation.

AUTOMATION AND THE GREEN ECONOMY

There is a closing window to avert catastrophic environmental breakdown, threatening the conditions upon which human needs can be met (IPCC 2018). A socioeconomic transformation to a society that is sustainable, just and prepared is urgently needed. Globally, half of emissions are attributed to the richest 10 per cent of people (Oxfam 2015). In the UK, per capita emissions of the wealthiest 10 per cent are up to five times higher than those of the bottom half (ibid). Socioeconomic and environmental issues must therefore be tackled together (Laybourn-Langton et al 2019). This need is reflected in calls for a 'Green New Deal' and a 'Green Industrial Revolution' – policy programmes that propose a large-scale transition to a sustainable economy, with high levels of public investment and job creation.

The transition to a green economy could, if done well, provide a future source of employment to replace jobs that may disappear as a result of automation, as well as replacing those lost in carbon-intensive industries. Recent research suggests a global transition to a low-carbon economy could lead to a net employment gain of 37 million jobs globally by 2030 (NCE 2018). In the UK, the government has projected that low-carbon growth could support up to 2 million of what it describes as 'green collar' jobs in the low-carbon economy by 2030 (BEIS and Perry 2018). Meanwhile, IPPR analysis has found that up to 46,000 low-carbon power sector jobs could be created by 2030 in the north of England alone, and as many as 100,000 by 2050 in the North across the low carbon economy as a whole (Emden and Murphy 2018).[21]

Depending on the quality of these jobs, and whether or to what extent these are accessible to women, this could either improve or worsen gender inequality. To this end, IPPR has argued that a key objective of what is called a 'just transition'[22] should be an inclusive and diverse workforce (including gender diversity) (Emden and Murphy 2019). Moreover, wider demands for a Green New Deal have placed social and economic justice issues such as these at the heart of their proposals. For example, the US resolution for a Green New Deal specifically mentions the gender pay gap (US House Senate 2019).

Much of the narrative around new 'green collar' jobs focus on technical roles in sectors traditionally dominated by men.[23] For women to benefit equally from the new jobs created, barriers to women working in these sectors will need to be dismantled. Women have repeatedly demonstrated they have valuable skills to contribute in the fight to rapidly decarbonise the economy (UNFCC no date). For it to be effective, gender considerations must be mainstreamed throughout the just transition (ECBI 2018).

Automating technologies will also be an important component in the shift to a decarbonised, green economy, both in terms of building infrastructure like public transport and efficient housing stock, but also in making our consumption and production more efficient. For example, automation and AI in farming allows far more precision in the use of water, pesticides and other resources which could have significant environmental resource benefits, and the widespread use of smart grids and small-scale energy generation will require the use of AI to maximise efficiency (Brown 2018). There is therefore potential for automation, including AI, to increase environmental efficiency as well as for new jobs in the green economy to be high-productivity and to enable humans to work with machines.

However, many of the technologies that are most promising in reducing the carbon-intensity of human activity also rely on resources extracted from around the world. More broadly, automating technologies across the economy also rely on natural resources that are often extracted in exploitative conditions, and which are finite. For example, extractive industries mining resources necessary for batteries and renewable

21 It should be noted that the 37 million jobs from NCE 2018 is a net figure, while the figures for the UK and the north of England are gross.

22 A 'just transition' is defined by the International Trade Union Congress [ITUC] as one which "provides and guarantees better and decent jobs, social protection, more training opportunities and greater job security for all workers affected by global warming and climate change policies" (ITUC 2018a) Just Transition Centre. https://www.ituc-csi.org/just-transition-centre

23 For instance, women make up just 14 per cent of the total workforce in the broad sector category 'mining, energy, water, electricity and air conditioning supply' – the second lowest of any STEM industry (WISE 2017). There is little indication that the low-carbon energy sector is much more diverse (Emden and Murphy 2019).

energy technologies can displace local people without compensation, as well as pollute local environments (Agusdinata et al 2018).

As policymakers seek to accelerate automation and the adoption of green technologies, they should also consider the impact on global communities. A transition which relies on exploitative labour in the global south and the unsustainable use of global resources and natural commons by countries such as the UK, with existing colonial and industrial debts, would not be a just transition (Mahony and Endfield 2018). Circular economy principles should be part of the solution to this, ensuring that resources are kept in the economy as long as possible, reducing the need for further extraction (Ellen MacArthur Foundation no date). But in other cases, we may need to evaluate whether those technologies can be used, or if we need to find new technologies that use resources more efficiently.

7.
THE GHOST IN THE MACHINE

WE MUST ENSURE THAT TECHNOLOGIES ARE NOT BIASED AGAINST PARTICULAR GROUPS, INCLUDING WOMEN

Algorithms are playing a fast-expanding role in how we interact with people, products and services. While visions of an algorithmic economy tend to be cast in terms of objective, neutral, data-driven efficiency, algorithms reflect the values, perspectives and biases of the humans who design and shape them, whether as coders or (often unwitting) consumers.

As predictions and choices previously made by humans are increasingly undertaken by algorithms, a new realm of economic power has emerged. Algorithms offer opportunities to make huge strides in terms of productivity, accuracy and insights, but they also risk magnifying human bias – and error – on an unprecedented scale. Policymakers cannot stand idly by whilst a new digital infrastructure is built around us. Proactive intervention will be needed to ensure that foundational protections – including from direct or indirect discrimination – are extended to the outcomes these algorithms power. There are multiple component parts that contribute to the introduction and perpetuation of biases in models and the outcomes they shape, and hence an adequate solution will require multi-faceted action.

First, there is the human workforce that designs, encodes and develops models that aim to reflect and predict the complex social world. Besides the robust business case for building more diverse teams to create better products that appeal to broader audiences, less diverse firms are less likely to be aware of the ways in which their own biases might be reflecting in the products they create, or the outcomes they deliver. Without a more diverse workforce – including more women – working in a rapidly growing sector with rapidly expanding power to shape our interactions and rapidly increasingly financial gains, new technologies will encode and perpetuate a narrow normative view of our social and economic world, to our collective disadvantage.

Second, the data on which models are trained will, by its very nature, reflect the historic biases of the people interacting and making choices within it. To build a future in which these biases are not carried forward in perpetuity – and on a far greater scale – will require deliberate effort to recognise and redress biases in our data, and the models that learn from them.

Third, there is the risk that the models themselves introduce new forms of bias. From the case of the Amazon hiring algorithm that came to systematically disadvantage women applicants on the basis of historic applications from men having been more successful, to proxies for race or ethnicity that drive decisions to deny access to credit of a loan, the black box calculations that are driven by AI and machine learning require close attention and active regulation.

The UK government has already shown ambition and leadership by establishing the Centre for Data Ethics and Innovation (CDEI) as an advisory body, but urgent action is required to ensure that this new institution is equipped with the resource and appropriate powers to meet the challenges of the algorithmic economy.

- Those making use of machine learning and algorithmic decisions should have a duty of care to ensure their algorithms do not perpetuate historic forms of discrimination, or introduce new ones.

  To ensure this is followed, **the CDEI should be given regulatory powers to inspect audit trails of how anti-discrimination measures have been built in from the design stage,** with auditing conducted on the basis of a referral system, open initially to cases where algorithmic bias has the potential to yield large-scale impact. The CDEI's remit should include requiring companies and public institutions to keep audit logs of the data they feed into algorithms and to be prepared to explain their algorithms and the outcomes they produce to the public on request.

- The CDEI should convene **an expert group to assess if, and how, the Equality Act (2010) could be strengthened to provide protection against discriminatory practices** perpetuated by algorithmic or data bias. This should include an assessment of the most effective means by which algorithms could be subject the Equality Act and how best regulation might ensure anti-discrimination measures are built in at design stage. Advice should further seek to clarify the responsibilities of service providers where models are developed by third parties.

8. CONCLUSION

Automation offers the opportunity to reshape how we work and how we share the benefits, for a more gender-equal future. Automation could raise pay for low-paid women and enable a reduction in working hours that could relieve women of the 'double shift' of paid and unpaid work. With intervention, everyone – including women – can share in the productivity gains that automation brings, and access the good jobs in the future economy.

But this positive vision of the role of automation in our economy will not happen of its own accord. Instead, it will require shaping who has power over decisions that determine where automation takes place, how benefits are used, and who gains. To do this, we argue that the four following propositions should be pursued.

1. We should seek to accelerate automation to increase productivity in low-pay sectors. This should be led by workers.
2. We should ensure the benefits of higher productivity are shared by all, both financially and in time for life outside of the workplace.
3. New jobs in the future must be made accessible to everybody.
4. We must ensure that technologies are not biased against particular groups, including women.

Our four propositions set out how automation can narrow gender equalities rather than exacerbate them, by rebalancing power and voice towards workers who will be affected, and ensuring everyone has the means for success in the future economy.

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