

Andrew G Haldane: Labour's share

Speech by Mr Andrew G Haldane, Executive Director and Chief Economist of the Bank of England, at the Trades Union Congress, London, 12 November 2015.

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The views are not necessarily those of the Bank of England or the Monetary Policy Committee. I would like to thank William Abel, Simon Caunt, Jeremy Franklin, Edward Hall, Philip King, Priya Gupta, Alex Mitchell, Rachana Shanbhogue, Bradley Speigner and Tom Smith for their help in preparing the text. I would also like to thank James Bell, Oliver Burrows, Melissa Davey, Gareth Ramsay, Stephen Seawright and Sebastian Walsh for their comments and contributions.

General Secretary. It is a great privilege for me to be invited to speak to you.

In the early nineteenth century, the unions were struggling to cope with the on-going impact of the Industrial Revolution on jobs and wages. They came together in the 1860s to present a united front and face down the threat of legislation to curtail workers' rights. The TUC was born. The first meeting of Congress, in 1868, debated wage inequalities, workers' hours, technical education and threats to jobs and workers' rights (London Metropolitan University (2015)).

Almost 150 years on, Congress today represents more than 5.8 million workers across all sectors and regions of the UK. The 147th Congress was recently held in Brighton. The topics it debated may have a familiar ring: wage inequalities, workers' hours, technical education and threats to jobs and workers' rights. As Mark Twain almost said, labour market history, if not repeating itself, has certainly rhymed.

This should come as no surprise. As in the mid-19th century, this is a time of huge change in the jobs market. Rarely a day passes without concerns about job prospects in some of the UK's most iconic industries, from steel to oil and gas to cars. And rarely a week passes without evidence of jobs and industries being fundamentally reshaped by globalisation and technology, be it the digital economy, the sharing economy or even the Second Machine Age.

There is no shortage of explanations for these searing developments. They are part *cyclical*, as the global economy continues to recover from a financial crisis which is likely to be the most costly since the Great Depression. But these changes are also in part *structural* given tectonic shifts in demography, inequality and technology, to name but three.

None of these challenges is of course entirely new either. My own interest in economics was spawned in the early 1980s by just such a challenge. At that time, more than 3 million people were unemployed in the UK, or almost 12% of the working population. In Yorkshire, where I grew up, the unemployment rate peaked at close to 13%, hit by a double whammy of deep recession and a contraction in steel, textiles and coal-mining.

Unemployment at that stage was not for me a statistic. Nor was it the bloodless theorising I would go on to study at university. For my family, it was real. For many communities and regions it was a blight, social every bit as much as economic. Across the country, it depressed the everyday lives of millions of adults, some of whose sons and daughters I knew as friends. And it was a blight that affected not one generation, but many.

It was that experience as a teenager that led me to commit to economics, and to public service, as a way to understand, and perhaps try and correct, that economic and social blight. And more than thirty years on, those are the same reasons I remain committed to better understanding, and perhaps hoping to improve a fraction, the functioning of the economy to this day.

Those wrenching developments in the UK labour market in the early 1980s have been repeated throughout history, since at least the Industrial Revolution. The cycles and shifts in

jobs and wages, and attempts to moderate them, are as old as civilisation itself. Today's cycles and shifts in the labour market are, in some respects, an echo of that past.

As in the past, technology is changing the quantum and nature of work, displacing some jobs while creating others. As I will discuss, through each of the Industrial Revolutions innovation has disrupted the number and nature of jobs. Often, it has led to a so-called "hollowing out" of mid-skilled workers and a widening wage gap across the economy.

Yet, in other respects, this time *may* be different. Technology *may* be set to change jobs and wages more fundamentally than in the past. Job displacement and creation *may* come thicker and faster than ever previously. "Hollowing out" *may* become more pervasive. And gaps between those with and without skills, or with and without jobs, *may* widen as never before. Or that, at least, is the picture some have painted.

These issues have fundamental implications for the functioning of industries and economies and the well-being of families and societies. They also, of course, have fundamental implications for the TUC and for policymakers like me. So after reviewing labour market developments, historically and prospectively, I want to conclude with some reflections on policy, including monetary policy.

Good news, bad news

Let me start with a review of recent developments in the labour market. There is plenty of good news to report here, with a boom in jobs and, to a lesser extent, wages in the UK. Yesterday's labour market data confirmed that picture. But there are also strong cross-currents at work, often rooted in longer-term structural shifts in the labour market, which offer a more worrying window on the world of work.

- In the immediate aftermath of the global financial crisis, there were understandable fears that unemployment would rise rapidly. At the start of 2009, the Monetary Policy Committee (MPC) was forecasting that the UK unemployment rate would rise into double figures, equivalent to over the 3.4 million people. In the event, the unemployment rate in the UK peaked at 8.5%, or 2.7 million people.
- Since 2013, the UK unemployment rate has fallen sharply, to a rate of 5.3% or 1.8 million people. This fall in unemployment is considerably faster than the MPC, and other outside forecasters, had predicted. At the start of 2014, the MPC forecast that the unemployment rate today would be more than a percentage point higher than its current rate (Chart 1).
- The main reason for this striking fall in the unemployment rate has been very strong rates of new job creation. Since 2010, more than 2 million new jobs have been created in the UK. The lion's share of these new jobs – around two-thirds – have been full-time positions and in highly-skilled professions (Chart 2). The level of employment is at a forty-year high.
- This rise in the demand for workers has been met, in part, by increased participation in the workforce. Participation by women has picked up strongly and is now close to its all-time highs. So too has participation by those aged over 50, in part taking advantage of more flexible working practices and removal of the official retirement age.
- The other end of the age spectrum has also seen improvement. The percentage of 18–24 year olds who are not in employment, education or training – the so-called "NEETs" – has fallen sharply from close to 17% to below 13%. That is its lowest rate in a decade (Chart 3).

- These improvements in the labour market have also been reasonably well dispersed across the UK. Unemployment has fallen in every UK region since 2012, by at least 2 percentage points.
- Last, but by no means least, aggregate pay across the economy has begun to rise. A year ago, Mark Carney told the TUC that “Britain deserved a pay rise”. Today, I am delighted to say it has had one. Aggregate pay across the whole economy is growing at around 3% year-on-year, compared to less than 1% a year ago.
- In inflation-adjusted terms, the picture is even more heartening. Real pay is rising at over 3% year-on-year. A year ago, it was *falling* by around 0.4% (Chart 4). Real wages are rising at their highest rate for 8 years and, encouragingly, some of the fastest rates of real wage growth have been among the lowest paid.

These developments have in large measure been driven by the recovery in the UK economy over the past few years. But let me now add some cross-currents to this fast-flowing employment stream. Many of these cross-currents will be familiar to the TUC’s membership. They pose some real challenges, economically and societally.

- Rates of unemployment still remain high among some cohorts and in some regions. Unemployment rates among those aged 18–24 is still over 13%, 8 percentage points above the national average. Unemployment rates in some parts of the UK, such as the North East and Northern Ireland, remain several percentage points above the national average. And those unemployed for more than one year remain above their long-term average.
- Even among those with a job, there remains a sizable number who wish to work longer hours than are currently available to them. Surveys suggest three and a half million people would like to work for longer, or around 10% of the working population (Chart 5). On average, they wish to work an extra 11 hours per week. These people are not unemployed, but they are *under-employed*.
- Another dimension of under-employment is the extent to which people are using their skills in the workplace. Under-utilised skills are as much an economic waste as under-utilised time. At present, there are around 5 million people whose skills are mismatched, or are over-qualified, for the job they are doing. This number has increased by two percentage points since the start of the crisis.
- Even for those who have found work, levels of job security appear to be lower than in the past. Around 6.4% of all employees in the UK are on temporary contracts. Rates of self-employment have risen from 12% a decade ago to around 15% now. For some firms and workers, those trends are a welcome sign of job flexibility. But not for all. Around a third of temporary contract workers would prefer a permanent contract. Since 2011 the reported incidence of zero-hours contracts has risen rapidly, from 0.6% to 2.4% of the working population (Chart 6). What may be welcome flexibility for a company may be unwelcome insecurity for its workforce.
- While participation rates in the UK workforce have increased, in some cases they remain low by international standards. Female participation in the UK labour market remains well below our European neighbours, such as Germany, the Netherlands and Sweden. And compared to these same countries, the fraction of NEETs in the UK is almost twice as high.
- Finally on wages, real wages have yet to return to their pre-crisis peak. Rather, they are still 6% below that level. Since the crisis, we have seen one of the largest and longest squeezes on wages since at least 1850 (Table 1).
- Indeed, since the crisis real wages have fallen faster even than UK productivity, which itself has been extra-ordinarily weak having flat-lined for the past six years.

Put differently, labour's share of the national income pie has fallen since 2009, from around 58% to 53% (Chart 7).

- That squeeze on real wages has been even more acute for some. Declines in median real wages among the young have been roughly twice as large as among the old. And workers in sectors such as construction, health and social work have seen far-larger declines in their take-home pay (Chart 8). In short, many workers in the UK have *not* in fact had that pay rise.
- Partly in consequence, the number of people earning less than the living wage is currently estimated to be around 5.8 million. That is 700,000 people more than in 2013. That fraction ought to shrink in future, once the statutory National Living Wage is introduced. The Bank itself is already a London Living Wage employer.
- The New Economics Foundation has recently constructed a summary measure of the number of secure jobs which allow for a reasonable standard of living (NEF (2015)). From 2011 to 2014, despite the number of people in employment rising sharply, the proportion in secure and well-paid jobs declined by around 2 percentage points. It currently stands at a remarkable 19.2 million people.

So how do we make sense of these rather disparate patterns? By looking through a historical lens, I want to try to provide some perspective on these current trends and, more speculatively, their implications for *future* jobs and wages.

The “lump of labour” fallacy

Over the longer run, technology may be the single most important force shaping the fortunes of jobs and wages. That has meant, through the ages, the relationship between technology and jobs has been a recurring, and sometimes contentious, one. Debates on the potentially negative impact of technology on jobs – so-called technological unemployment – go back at least to the invention of the wheel (Woirol (1996)).

Certainly, the Ancient Civilisations of Greece and Rome wrestled with the problem of how to deal with the consequences of workers displaced by technological advance. The responses then included large-scale public work programmes and income support policies for the needy. Indeed, they have an eerie echo in many of today's public policy debates.

The debate about technological unemployment really picked up pace in the 19th century, with the blossoming of the Industrial Revolution in Britain. Then, it spilt over into the streets with worker protests and machine-breaking, most notably by the Luddite movement. These fears about technological displacement gathered intellectual support from no less a figure than the classical economist, David Ricardo (Ricardo (1821)).

Yet the intellectual tide was by no means in one direction. It was accepted that technological advance could damage *some* workers in the *short run*. But its benefits to *most* workers in the *longer-run* were felt likely to dominate. In the middle of the 19th century, that view came to prominence through such figures as John Stuart Mill (Mill (1848)) and Karl Marx (Marx (1867)), two unlikely intellectual bedfellows.

The technology debate was re-stirred in the 1930s, at the time of mass unemployment during the Great Depression. In his essay, “Economic Possibilities for our Grandchildren”, Keynes predicted on-going technological advance and workers being replaced by machines (Keynes (1930)). Yet far from being a threat, Keynes viewed this as a huge opportunity. He predicted that, by 2030, the average working week would have shrunk to 15 hours. Technology would give birth to a new “leisure class”.

Debates on the relationship between jobs and technology stirred again during the 1960s in the US, during the 1970s in advanced economies, and again in the 1980s and 1990s in the UK and parts of Europe. In each case, the prompt was rising rates of unemployment. And in each case, this debate subsided as unemployment rates fell.

Moving into the 21st century, this debate has once again been re-kindled. The prompt this time has not so much been rising rates of unemployment. Rather it is been the rapid emergence of smart machines, jet-propelled by modern computing. These machines are different. Unlike in the past, they have the potential to substitute for human brains as well as hands (Autor et al (2003), Manyika et al (2013)).

In *Race Against the Machine* and *The Second Machine Age*, Eric Brynjolfsson and Andrew McAfee paint a persuasive picture of robot-fuelled growth in productivity and an accompanying reshaping of the role and nature of work (Brynjolfsson and McAfee (2011, 2014)). Whether this vision is utopian or dystopian, it poses a fundamental challenge to the relationship between jobs and technology, to which I will return.

The economics of these debates, which I hope is not too bloodless, is relatively straightforward. There are two opposing effects at work. The first is the substitution or *displacement* effect. Labour-saving technologies displace workers, almost by definition. Capital substitutes for labour, machine for man. If there is a “lump of labour” to be allocated across a fixed pool of jobs, technology will raise unemployment, other things equal.

This being the real world, other things are of course never equal. As cheaper capital displaces labour, goods and services become cheaper, raising real incomes across the economy. That boosts the demand for *new* goods and services and new industries to supply them. To complete the loop, displaced labour then switches to meet this new demand, lowering unemployment. These are the income or *compensation* effects of technological progress. They are what make the “lump of labour” a fallacy.

Which of these two effects – displacement or compensation – wins out? Ultimately, this is an empirical question and we have several hundreds of years of empirical evidence as a test-bed. Perhaps unusually, these historical data tell a remarkably consistent story.

- Since 1750, there has been a steady and continuous stream of labour-saving technologies which have boosted economy-wide productivity, as measured by output per unit of labour inputs (Chart 9). On average since 1750, growth in UK labour productivity has been around 1.1% per year. That means the productivity of our economies has improved by around a third each generation, a massive leap forward.
- This improvement in labour productivity has not, over the medium term, caused any reduction in employment. In the UK, the employment rate today as a proportion of the total population is around 50%, very similar to levels in the early 19th century (Chart 10). Over time, the employment share has fluctuated around a stationary average. The same is true in other countries.
- The effects of technology *have* been felt, at least to some degree, in hours worked, as Keynes predicted back in the 1930s. In the UK, the average working week has fallen from 50 hours a century ago to around 30 hours today (Chart 11). Nonetheless, this fall-off has fallen well short of Keynes’ prediction of a 15-hour week. The “leisure classes” are no more numerous today than a century ago.
- Shifts in population – through changes in birth/death rates or through immigration – have also had no obvious impact on employment. The relationship between population growth and the employment share is, if anything, positive (Chart 12). This, too, is evidence of the compensation effects of population growth – higher output and demand – outweighing any displacement effects in the jobs market.
- As technology has boosted productivity and incomes, its fruits have been harvested by workers, typically in the form of higher wages. Since 1750, the upwards march of productivity has largely been matched by the upwards march of real wages (Chart 13). Since the Industrial Revolution, the former has risen on average by 1.1% per year, the latter by 0.9% per year.

- The same pattern was evident prior to the Industrial Revolution. Then, the absence of technological progress led to productivity flat-lining. The real incomes of workers similarly flat-lined (Chart 13). Over the course of the past millennium, perhaps longer, technological progress has held the key to rising worker wages.
- Acting in parallel to this secular rise in labour incomes has been a secular rise in workers' skills. Levels of educational attainment have risen dramatically since the middle of the 19th century (Chart 14). As machines displaced man in conducting manual tasks, man has kept one-step-ahead of the machine by continuously skilling-up to meet the new demands of new industries for new products.
- With rates of employment steady, and with real wages rising in line with productivity, labour's share of the national income pie is little different today than in the 18th century (Chart 15). In other words, the suppliers of both labour and capital have shared, in roughly fixed proportions, in the fruits of higher incomes.
- Moreover, workers with different skills have benefitted broadly equally from these gains. The distribution of wages is little different today than at the dawn of the Industrial Revolution (Chart 16). In other words, technological progress has not obviously widened income inequalities.

Viewed over the sweep of history, then, there is essentially no evidence to suggest technology has damaged jobs and plenty to suggest it has boosted wages. Technology has enriched labour, not immiserated it. Mill was right; Ricardo was wrong. Labour is not dead wood to be carved up between tasks. It is a tree whose trunk and branches have lengthened and thickened with time. The "lump of labour" fallacy is just that.

Industrial revolution and "hollowing-out"

Or is it? Looking more closely at past phases of rapid technological change paints a more nuanced picture. Each phase has eventually resulted in a growing tree of rising skills, wages and productivity. But they have also been associated with a "hollowing out" of this tree. Indeed, this hollowing-out has widened and deepened with each new technological wave.

Economic historians tend to partition the growth timeline into three distinct phases: the first Industrial Revolution, the era of steam engines and spinning jennies, commencing in the middle of the 18th century; the second, the era of mass industrialisation, commencing in the second half of the 19th century; and the third, the era of information technology, commencing in the second half of the 20th century (Haldane (2014)).

These industrial revolutions each brought about a remarkable re-shaping of the jobs landscape (Chart 17). The employment share of agriculture and other primary activities has fallen from around 50% in 1700 to around 1% today. Secondary activities, notably manufacturing, rose to 45% of employment at the end of the 19th century, before falling to around 10% today. Meanwhile, the employment share of services has roughly doubled each century since 1700, to reach around 80% today.

These dramatic shifts are even more striking at an occupational level. Chart 18 plots employment in four occupations since 1870: agricultural labourers, telephonists, accountants and hairdressers (Deloitte (2015a)). The relentless upwards march of the accountant and hairdresser, at the expense of the downtrodden (but presumably better-coiffed) farmer, is one of the lesser-known societal power struggles of the post-Industrial Revolution period.

But transition on this scale is not costless, with complex shifts in the pattern of skilled employment and wages. In its first phase, the Industrial Revolution appears to have led to a shift towards *unskilled* employment as "the artisan shop was replaced by the factory and later by the assembly line" (Acemoglu (2008)). The share of unskilled UK workers doubled between 1700 and 1850, from around 20% to 40% (Chart 19). The same was true, somewhat later, in the US (Katz and Margo (2013)).

Later in the 19th and into the 20th centuries, the demand for *high-skilled* workers also began to rise. Rising incomes created a demand for new goods and new, more complex and technical, ways of producing them. That increased the demand for operatives, engineers, mechanics and managers, in addition to hairdressers and accountants.

Between 1850 and 1910, the share of skilled workers in US manufacturing rose from 3% to around 12% (Katz and Margo (2013)). The share of low-skilled jobs also increased, from around 58% to 65%. Over the same period, the share of mid-skilled workers shrank from 40% to 23% (Chart 20). In other words, there was a “hollowing out”, or U-shape, in the pattern of employment – the hollowing-out, in effect, of the artisan.

By the middle of the 19th century, aggregate real wages were rising in the US and UK. Yet despite increased demand for their services, unskilled workers do not seem to have shared in this pay rise. Higher demand for their services was more than matched by increased supply, both from child labour and from displaced artisans as they moved down the skill spectrum (Clark (2010)). As a result, their pay appears to have flat-lined.

At the high-skill end, the supply of workers was also increasing as some workers skilled-up (Clark (2010), Wallis (2014)). Despite that, there is evidence the skill premium for clerks and other professionals rose through the 19th century. The net effect of these complex shifts was thus to widen the distribution of wages between skilled and unskilled workers (Katz and Margo (2013)). Income inequality rose.

The pattern of labour’s share of the national income is also interesting. This appears to have fallen in the first part of the 19th century (Allen (2009)), as Chart 21 illustrates. Workers do not appear to have enjoyed the early fruits of the Industrial Revolution. That perhaps explains why David Ricardo entered the fray at this time.

In the event, these concerns proved ephemeral. With a lag, the rising tide of productivity and incomes lifted all boats, whatever their level of skill. Inequalities in wages started shrinking and labour’s share of income began to rise, returning to their levels at the end of the 18th century. If the first part of the 19th century had seen substitution effects dominate, the latter half saw compensation effects in the ascendancy.

Moving into the 20th century, and the third industrial revolution, these emerging patterns in jobs and wages have become clearer. Technology appears to be resulting in faster, wider and deeper degrees of hollowing-out than in the past. Why? Because 20th century machines have substituted not just for manual human tasks, but cognitive ones too. The set of human skills machines could reproduce, at lower cost, has both widened and deepened.

Chart 22 shows the employment pattern in the UK over recent years, ranking professions’ skills by their average pay, while Chart 23 shows the picture for a set of countries over a similar period. They tell a striking and consistent story of mid-skill jobs being lost, counter-balanced by employment gains at the high-skill and, to lesser extent, low-skill segments of the workforce. The U-shape, or “hollowing out”, has deepened and widened.

What has happened to these displaced mid-skill workers? Some appear to have “skilled-up”, typically through higher or further education. In the UK, total numbers in higher education have increased from around 130,000 in 1970 to over 2 million today. In the US, total numbers in higher education have increased from 2.4 million just after the Second World War, to over 20 million today. As in the late 19th century, this skilling-up has enabled workers to keep one-step-ahead of the machine.

But some displaced workers have not been on the up-escalator. They appear instead to have “skilled-down”, typically by taking a job for which they are over-qualified. They have become not unemployed but “under-employed”. Rates of under-employment have risen and are at significant levels (Table 2). Across the EU, rates of under-employment average around 15%. As in the early 19th century, by adding to the unskilled pool of labour, this will have dampened unskilled wage growth.

These switching patterns of employment demand and supply would be expected to show up in wages. UK evidence shows no clear pattern (Salvatori (2015)). But US evidence is more conclusive. It suggests that wages at the top end of the skill spectrum have risen, in some cases significantly. But there is little evidence of that having happened at the lower-skill end (Autor (2015)). In other words, only the higher-skilled appear to have gained in both employment and wage terms.

A rising skill premium is consistent with the well-documented widening gap between the top 1% and 0.1% of income earners and the rest over recent years (Piketty (2014), Atkinson (2015)) (Chart 16). In the words of Tyler Cowen *Average is Over*, with a widening bifurcation between a high-skilled elite and everyone else (Cowen (2013)).

By itself, a widening distribution of incomes need not imply any change in labour's share of national income: in the past, technology's impact on the labour share appears to have been broadly neutral. But this time could be different. There is evidence, across a number of countries, of the labour share having fallen over recent decades (Chart 24). Even in the UK, the labour share has glided south, if more slowly than elsewhere, over recent years.

The relationship between productivity and real wages tells a similar story. Across a number of countries, there is recent evidence of real wages falling short of productivity (IMF (2015)). In the US, this has been evident since at least 1970, with average real wages rising 0.6 percentage points per year more slowly than productivity (Chart 25). In the UK, that gap has averaged 0.3 percentage points per year since 1990. For median wages, these gaps are larger still (Chart 26).

Over time, these gaps can accumulate into big income differences. Had US real wages tracked productivity since 1970, the median worker today would be 40% better off. Had UK wages tracked productivity since 1990, the median worker today would be 20% better off. Unlike earlier phases of rapid technological change, labour has not shared equally in the fruits of recent great leaps forward – or at least not yet.

A number of explanations have been put forward for these falling labour shares, including the falling relative cost of capital goods and globalisation (OECD (2012)). A third explanation, related to the first two, is technological change. As machine has substituted for man across a greater number of tasks, and as hollowing-out has intensified, the balance of bargaining power has swung against labour. That would tend to show itself as labour securing a smaller slice of the income pie, as we have seen.

In sum, the third industrial evolution appears to have resulted in an intensification of trends already fledgling in the first two: a hollowing-out of employment, a widening distribution of wages and a fall in labour's income share. The key question is what happens next? A re-run of the 19th century, with productivity gains eventually boosting wages and the labour share? Or, different than in the past, a permanent re-shaping of the labour landscape?

Race against the machine

A number of authors have recently argued, persuasively, that it is the latter. Based on past patterns, it is argued that information technology may be poised for exponential growth, as its full fruits are harvested. Indeed, we may be on the cusp of a fourth Industrial Revolution or *Second Machine Age* (Brynjolfsson and McAfee (2014), Ford (2015)).

Its defining feature would be that new-age machines will be thinking as well as doing, sensing as well as sifting, adapting as well as enacting. They will thus span a much wider part of the skill distribution than ever previously. As robots extend their skill-reach, "hollowing-out" may thus be set to become ever-faster, ever-wider and ever-deeper. Or that, at least, is the picture some have painted.

How much wider and deeper? Research by Carl Benedikt Frey and Michael Osborne has tried to quantify this hollowing-out, by assigning probabilities to certain classes of job being

automated over the course of the next few decades. Their work was initially done for the US, but has recently been extended to the UK (Frey and Osborne (2013), Deloitte (2015b)).

Using this methodology, the Bank has recently done its own exercise for the UK. Table 3 classifies jobs three ways in the US and UK – high (greater than 66%), medium (33–66%) and low (less than 33%) probability of automation. It also shows the fraction of employment these jobs represent. Chart 27 provides a more granular breakdown of these jobs.

For the UK, roughly a third of jobs by employment fall into each category, with those occupations most at risk including administrative, clerical and production tasks. Taking the probabilities of automation, and multiplying them by the numbers employed, gives a broad brush estimate of the number of jobs potentially automatable. For the UK, that would suggest up to 15 million jobs could be at risk of automation. In the US, the corresponding figure would be 80 million jobs.

The BBC website contains a handy algorithm for calculating the probability of your job being robotised. For an accountant, the probability of vocational extinction is a whopping 95%. For a hairdresser, it is 33%. On these numbers, the accountant's sun has truly set, but the relentless upwards ascent of the hairdresser is set to continue. For economists, like me, the magic number is 15%. At first I found that number disconcertingly high. But in fact it puts me in the lower third of "prone" professions.

Another perspective on hollowing-out comes from looking at how automation might affect the distribution of skills and wages in the economy. Chart 28 ranks job-types by their median wage rate and plots this against their probability of automation. This probability rises strikingly as we move down the wage/skill curve. Those most at risk from automation tend, on average, to have the lowest wage. In other words, technology could act like a regressive income tax on the unskilled. It could further widen income disparities.

I do not want to make this sound like a counsel of despair. All of these projections, like those of Ricardo and Keynes previously, may be far too pessimistic. The lessons of history are that rising real incomes have ridden to the rescue, boosting the demand for new goods from new industries requiring new workers. During previous phases of technological growth, workers have moved up the income escalator by "skilling up", thereby keeping one-step-ahead of the machine.

And some have argued that this pattern is set to repeat itself in future. Humans will adapt their skills to the tasks where they continue to have a comparative advantage over machines (Autor (2015), Mokyr et al (2015)). One source of such advantage is that Artificial Intelligence (AI) – the machine brain – differs in several important respects from human intelligence – the human brain.

AI uses the law of large numbers to solve problems and learn, sifting multiple permutations for a solution. All AI problems are, in effect, big data problems involving long strings of ones and zeros; they are digital. The brain, by contrast, is more analogue in its configuration, processing and problem-solving. Solutions are often condensed down to a small number of learned behaviours or heuristics.

These differences become clear with a task such as learning a language. This is one where huge strides have been made by machines over the past decade (Pratt (2015)). That rapid-learning has not come from computers feasting on the classics like a college student. Rather, it has arisen from them devouring the whole library in one digital mouthful, then seeking matching patterns in the text and syntax. Language, paradoxically, has become a numbers not a words game.

These different approaches to problem-solving are important when defining where humans may have the edge. This appears to be in tasks requiring high-level reasoning – large logical

leaps of imagination rather than repeated small experimental steps. It is in tasks where the focus is on cognition and creativity, rather than production and perception. And it is activities where EQ trumps IQ¹, where social capital is scored as or more highly than financial capital.

To bring that down to planet earth, no-one anytime soon is I think going to choose a robot to cut their hair – I told you the hairdressers were safe. Nor are they likely to choose a robot to look after their young children or elderly parents (tempting as that can sometimes sound). When it comes to forecasting the economy, I can quite believe a thinking machine might over time displace me. But it is less likely an “Andy Robot” will be giving this lecture to the TUC even a decade from now.

Even if this diagnosis is right, it nonetheless may suggest a fundamental reorientation in the nature of work could be underway. We may already be seeing early signs of that in the move towards part-time working, temporary contracts and, in particular, self-employment. Some have speculated that these seismic shifts could result in the emergence of a “new artisan” class : micro-businesses offering individually-tailored products and services, personalised to the needs of customers, from healthcare and social care, to leisure products and luxuries. This really will be Back to the Future.

Yet the smarter machines become, the greater the likelihood that the space remaining for uniquely-human skills could shrink further. Machines are already undertaking tasks which were unthinkable – if not unimaginable – a decade ago. The driverless car was science fiction no more than a decade ago. Today, it is scientific fact. Algorithms are rapidly learning not just to process and problem-solve, but to perceive and even emote (Pratt (2015)).

As digital replaced analogue, perhaps artificial intelligence will one day surpass the brain’s cognitive capacity, a tipping point referred to as the “singularity” (Stanislaw (1958))). Brad DeLong has speculated that, just as “peak horse” was reached in the early part of the 20th century, perhaps “peak human” could be reached during this century (DeLong (2014)). In the words of Marc Andresen, in future there could be two types of worker – those who own the robots and those who work for them.

If these visions were to be realised, however futuristic this sounds, the labour market patterns of the past three centuries would shift to warp speed. If the option of skilling-up is no longer available, this increases the risk of large scale un- or under-employment. The wage premium for those occupying skilled positions could explode, further widening wage differentials. And labour’s share of the pie could fall even more dramatically than in the past. On this view, the tree could become hollowed-out to the point that it may no longer be able to support itself.

This too may sound like science fiction. Yet in a survey of almost 2,000 (admittedly self-selecting) technologists and economists in 2014, the Pew Research Center found that almost half thought AI and robots would cause a significant and persistent displacement of labour in future (Pew Research Center (2014)). Maybe Ricardo and the Luddites had a point after all, albeit two hundred years too early.

Public policy implications

If one of these scenarios were to play out, its implications for the economy and society, for industries and individuals, would be massive. So, if only on insurance grounds, it would be prudent to give some thought to what role policy might play in cushioning that impact, both in the short (cyclical) and longer (structural) run.

¹ IQ refers to a measure of intelligence known as the “Intelligence Quotient”. EQ refers to a concept called the Emotional intelligence Quotient.

Of the longer-term solutions, let me briefly discuss three: *relax*, *retrain* and *redistribute*. The path of least commitment would be to *relax* and follow, over the course of the next century, the path Keynes charted a century ago – a world of progressively shorter working weeks, where mini-breaks become maxi-breaks.

Whether that path is desirable, for individuals or societies, is less clear. Work delivers significant non-pecuniary, as well as pecuniary, benefits (Freeman (2008)). Studies show it really isn't just about the money. Work creates a sense of personal worth and social attachment. Its loss serves as a personal and societal blight, the like of which I experienced in 1980s Yorkshire. There is evidence the loss of work worsens public health (McAfee (2015), Case and Deaton (2015)). Life among the leisure classes may be less attractive than it superficially sounds.

Maybe those costs will be small and fleeting. Maybe attitudes will change as we grow accustomed to life in leisure class. Maybe “zero hours contracts” will take on a whole new aspirational meaning. Maybe I am lacking imagination in thinking a life of loafing, surfing and gaming could be fulfilling. Nonetheless, I doubt this is quite what Keynes had in mind as the economic possibilities for our grandchildren.

If lower hours are not a full answer, *retraining* workers in line with their comparative advantage might be. One important dimension of this is education. School education has tended to focus on developing the core cognitive competences – for example, reading, writing and arithmetic. Smart machines have long since surpassed humans in their ability to do the first and third of these. And they are fast catching-up on the second.

That begs the question of whether there are other skills where humans' comparative advantage is greater. For example, humans are known to possess an equally-important class of *non-cognitive* skills – self-confidence, self-esteem, relationship-building, negotiation skills, empathy. In studies of children, these non-cognitive attributes have been found to be as, if not more, important than cognitive competences in enhancing jobs, incomes and well-being (Heckman (2007)).

In a world in which machines came to dominate tasks involving core cognitive processing, the importance of, and skill premium attached to, non-cognitive skills is likely to rise. The high skill – high pay jobs of the future may involve skills better measured by EQs than IQs, by jobs creating social as much as financial value. Yet our education system, at present, has a strongly cognitive slant. Perhaps in future that will need to change, with as much effort put into cultivating social CVs as academic ones.

On *redistribution*, if the past repeats itself Mark Twain-style, the gap between skilled and unskilled workers could further widen as hollowing-out intensifies. This could bring pressures to reallocate income from rich to poor, from owners to workers (Brynjolfsson and McAfee (2014)). It could also mean the gap between capital (those who own the robots) and labour (those who work for them) shares could widen further. If so, that may require a rethink of the relative roles of capital and labour, not least when it comes to running public companies.

At present, owners of capital have the whip hand – no longer literally, but legally – when it comes to running public companies. That is why shareholders are often called, quite misleadingly, the “owners” of a company. This model of corporate governance has served the world well for over a century. But, today, it may not always make for the best outcomes, either for companies themselves or for wider society (Haldane (2015)). And a further tilt in the balance of power in favour of capital could make that situation worse.

There are already corporate governance models which strike a somewhat different balance. Interestingly, many of today's largest and most successful technology companies are in private hands. Even for those technology companies which have gone public, ownership and control has often been separated from financing through dual-class share listings which retain voting rights for the founders and workers.

These alternative models of corporate governance offer a different balance of power between capital and labour. Indeed, the distinction between the two is blurred: the owners of, and workers for, the robots are in effect one and the same. These governance structures may allow a more equitable distribution of robotic rents and generate greater value for the companies themselves and for wider society.

Turning to the nearer-term, what if any implications do these labour market trends carry for the economy and monetary policy? Last week, the MPC set out its view in the quarterly *Inflation Report*. This painted a picture of solid UK growth, alongside subdued price pressures. The UK is growing roughly at trend, but inflation is 2 percentage points below target. The picture among other advanced economies is not greatly dissimilar.

The UK inflation picture is relatively easy to explain, at least in an accounting sense. The lion's share of inflation's weakness is accounted for by external factors – weak world prices and a strong exchange rate. These factors are themselves in part a reflection of weak world demand, pushing down the prices of oil and other commodities. The impact of external disinflationary pressures on UK inflation is thus likely to be persistent.

Nonetheless, in time these external pressures should wane. What will then determine UK inflation is the evolution of domestic costs, specifically labour costs. The UK labour market has been hard to read over the past few years. In common with other forecasters, the MPC has consistently been surprised by the weakness of wages, given the strong cyclical bounce in job creation. It has over-predicted the path of wages in recent years (Chart 29).

There are a number of possible explanations for this wage weakness. One is that there is simply greater labour market slack in the economy than we have estimated. Another is that the narrowing of slack is having less impact on wage pressures than in the past – the slope of the so-called Phillips curve is flatter. There is international evidence of the Phillips curve having flattened over recent decades (IMF (2006, 2013), BIS (2014)).

That might arise because technology has made it easier and cheaper than ever before to substitute labour for capital, man for machine. That is the very essence of the *Second Machine Age* hypothesis. It would manifest itself in weaker than expected wage growth and a secular fall in the labour share of income, both of which we have seen in a number of countries.

The central projection in the November *Inflation Report* assumes the labour share reverts over time to its historical mean, with the fruits of productivity harvested by labour and capital in line with their historical shares. And because wages have lagged behind productivity for several years, this implies the labour share is currently at a cyclical low, but would be expected to mean-revert in the period ahead.

This pattern is embodied in the MPC's forecasts, with wages projected to outpace productivity in the next few years (Chart 31). Put differently, growth in unit wage costs is expected to pick up and the labour share to rise fairly sharply (Chart 32). That path is certainly plausible if cyclical factors are the key drivers of the low labour share.

But there may be alternative forces at play. If substitutability between labour and capital is higher than in the past, labour's bargaining power and share of income might be commensurably lower, as we have seen across a number of countries before and after the crisis. So how different might the MPC's projections look if the labour share was, say, flat rather than rising over the next few years?

Charts 32 and 33 show the path of wage growth and inflation that would imply. Wage growth is weaker, averaging around 3¼% rather than 4½% at the year three point. So too is consumption given weaker take-home pay, though this is largely offset by stronger company profits and higher investment, leaving aggregate output little altered.

The upshot is a materially lower path for inflation than contained in November's *Inflation Report*: inflation reaches around 1.6% at the two-year horizon and remains around these

levels. That would put the balance of risks squarely towards a more protracted *undershoot* of the inflation target, even without any draught from external prices and demand.

Holding flat the labour share may be too strong an assumption if the UK continues its cyclical rebound. Nonetheless, even the rise in wage growth seen through this year appears to have subsided somewhat over recent months. Shorter-term measures suggest annualised rates of pay growth of around 1 to 1.5% in Q3, down from 2.5 to 3% in Q2. Wage growth appears to be fizzling.

And, of course, those are not the only potential downside risks facing the UK. World events have added to those downside skews over the past few months. There is now rather more convincing evidence of a gentle slowing in the UK and world economies since the summer. In the UK, this gentle slowing has been apparent since the middle of 2014. It leaves growth, in the UK and globally, little more than trend.

Growth could accelerate in the period ahead, with the cost of credit at historically very low levels. Since the crisis, however, the pattern of UK output has been shaped less by the cost of credit today than by uncertainty about demand tomorrow. It was that uncertainty which cratered world demand in 2008. It was that uncertainty which flattened UK growth during the euro-area crisis of 2011–12. And it was the relief rally after that euro-area uncertainty abated which caused UK growth to bounce back during 2013–14.

Uncertainty about demand is, once more, on the rise. Given its source – the third in a triplet of crises, this time afflicting the emerging market economies – I do not expect that rise in uncertainty to be temporary. I expect its impact to be greater in today's world of post-crisis traumatic stress and could more than offset the cost of capital accelerator, as we have already seen repeatedly since the crisis.

Against that backdrop, my view is that the case for raising interest rates is still some way from being made. Whatever the reason, the economic aircraft appears to be losing speed on the runway. That is an awkward, indeed risky, time to be contemplating take-off. Meanwhile, inflationary trends do not at present give me sufficient confidence that inflation will be back at target, even two years hence.

Growth has slowed towards trend in the UK, US and globally. And speed limits matter. Any further loss of momentum would risk taking growth *below* trend, widening the output gap and adding to downward pressures on already-weak prices. My personal view is that, in the current environment, a rate rise would increase unnecessarily the chances of the economy falling below critical velocity, thereby extending the period inflation remains below target.

For those reasons, I have continued to vote to leave rates unchanged, with a neutral stance on the future direction of monetary policy. Now more than ever in the UK, policy needs to be poised to move off either foot depending on which way the data break.

General Secretary. I have covered 250 years of labour market developments in 40 minutes. Perhaps a robot could have done it in half that time or twice as well. Perhaps “Peak Andy” has been reached. Either way, these are issues I know the TUC will want to take seriously in its words and actions over the next 150 years, as it has over the past 150 years.

Thank you.

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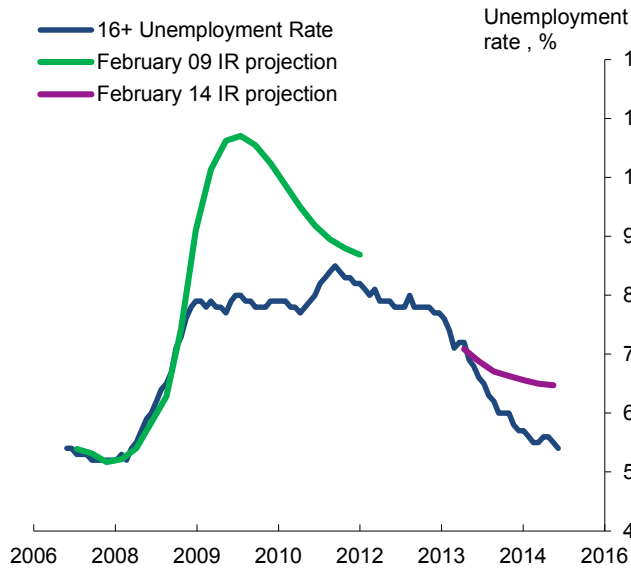
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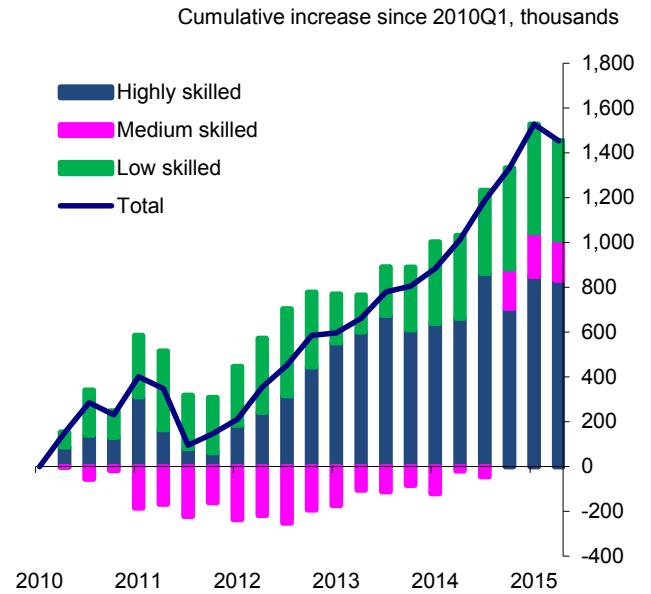
Appendix

Chart 1: Unemployment rate and projections



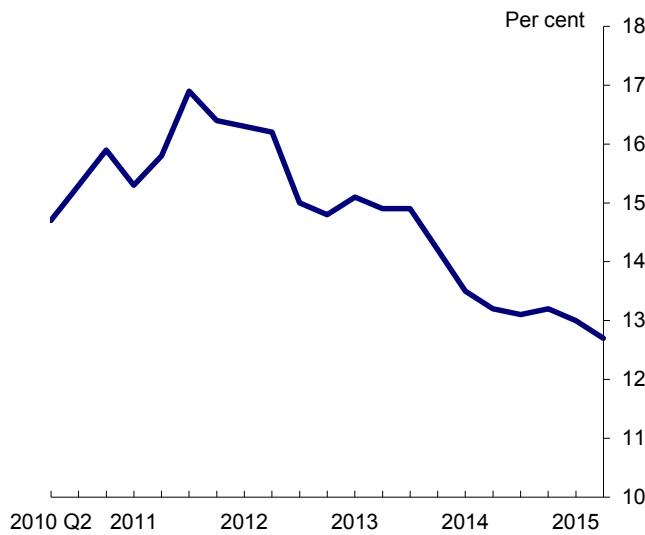
Source: ONS and Bank calculations

Chart 2: Cumulative Employee growth by skill level



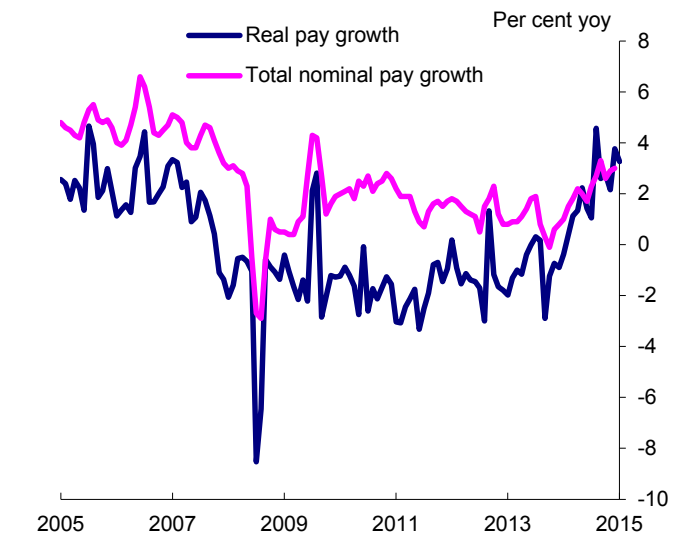
Source: ONS and Bank calculations

Chart 3: Percent of 18–24 year olds not in employment, education or training



Source: ONS Labour Force Survey

Chart 4: Nominal and Real total pay growth



Source: ONS and Bank calculations

Chart 5: Percentage of people in employment who would like to work longer hours

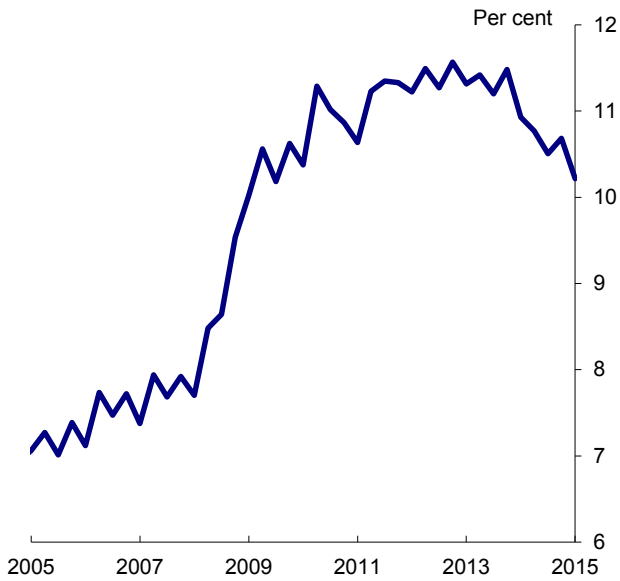
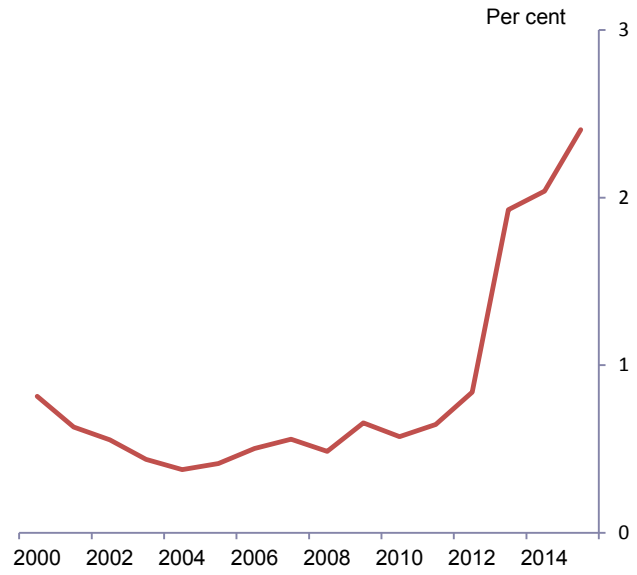


Chart 6: Percentage of people in employment on a zero hours contract



Source: ONS Labour Force Survey
 Notes: Responses to the Labour Force Survey can be affected by respondents recognising the term “zero-hours contract”. It is not possible to say how much of this increase is due to greater recognition of the term.

Chart 7: Fall in the labour share since 2009

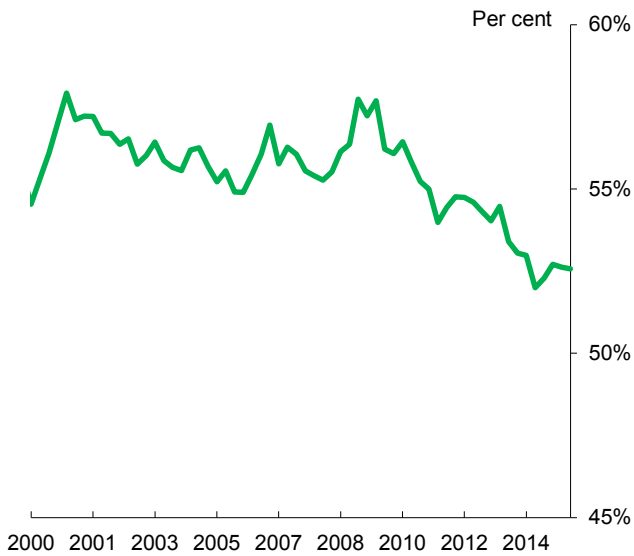


Chart 8: Median real pay decline by sector since 2009

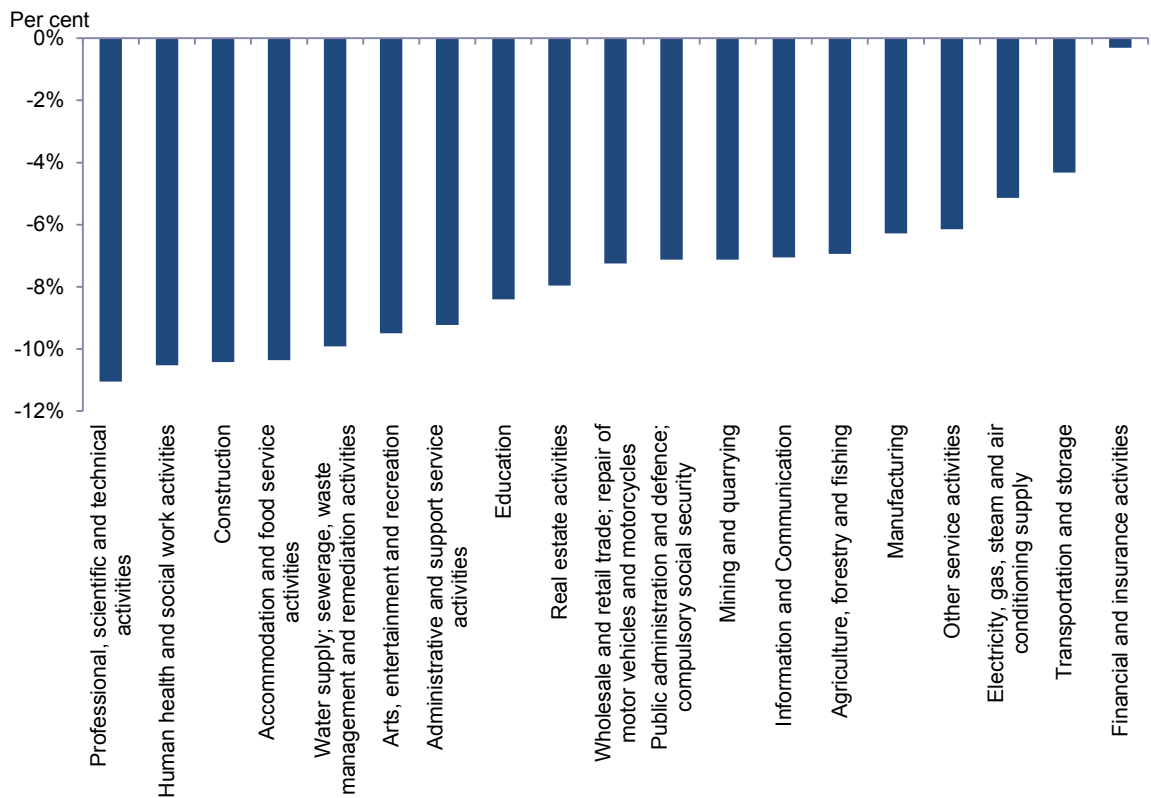
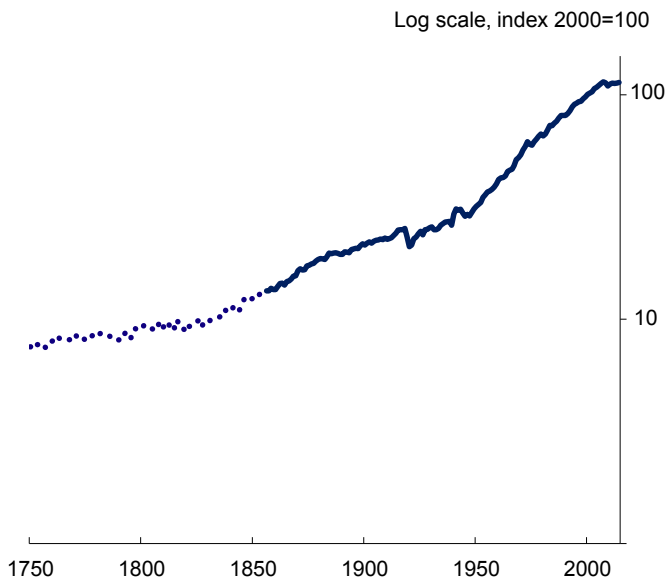


Table 1: Comparison of major earnings crises in UK history

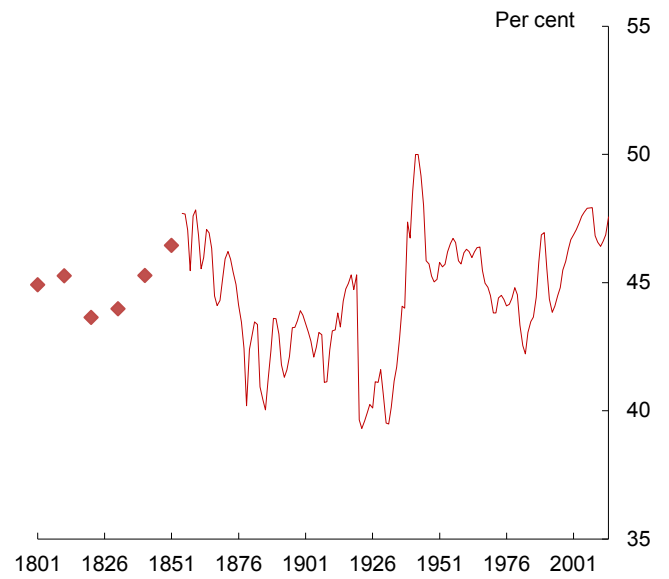
	1874–78	1921–23	1976–77	2007–14
Duration (years)	2	4	2	7
Depth (%)	-10	-1.7	-8.2	-6.6
Recovery (%)	12.8	0.6	4.5	N/A
Total change over seven years (%)	1.2	-1.1	-4	-7.9

Chart 9: Labour productivity since 1750, log scale



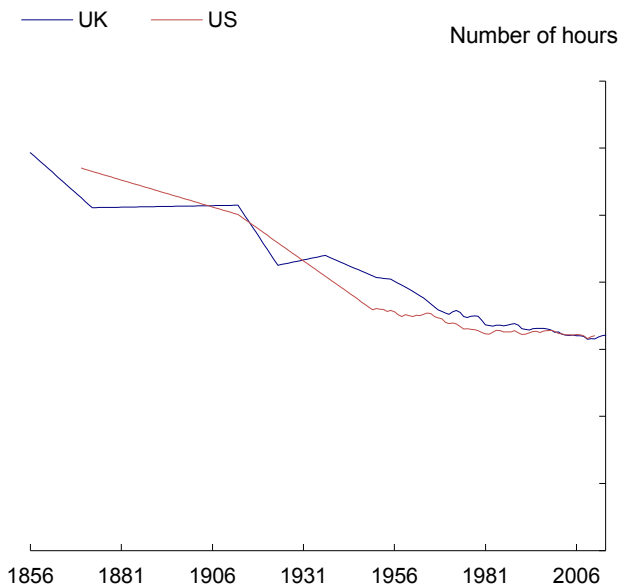
Source: Hills, Thomas and Dimsdale (2015)

Chart 10: Employment ratio in the UK, since 1801



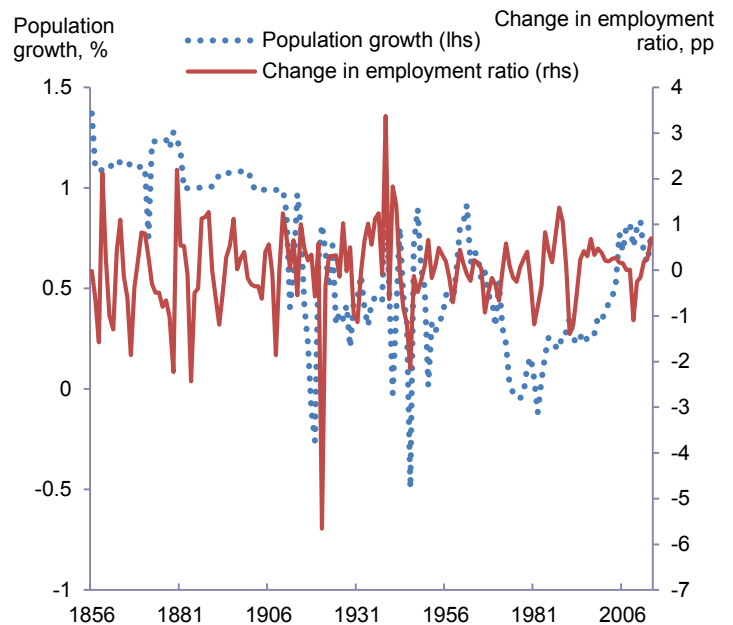
Source: Hills, Thomas and Dimsdale (2015), Deane and Cole (1967)

Chart 11: Average weekly hours worked UK and US, since 1856



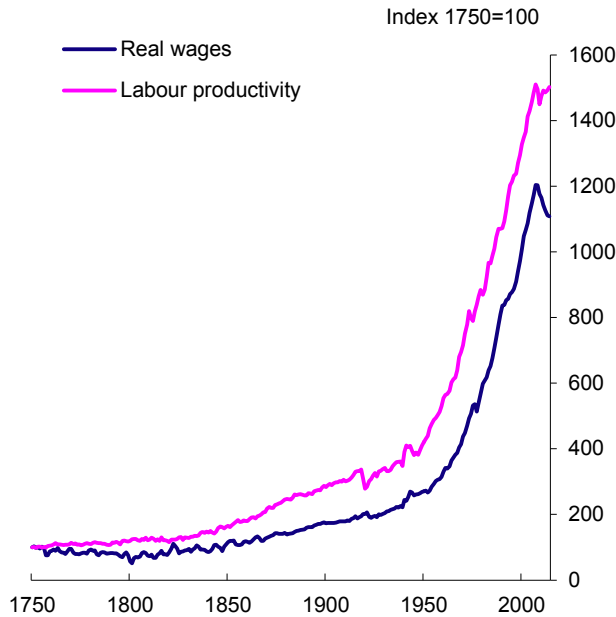
Source: Feenstra, Inklaar and Timmer (2013); St Louis FED and Maddison (2011); Hill, Thomas and Dimsdale (2015)

Chart 12: Population growth and change in employment share



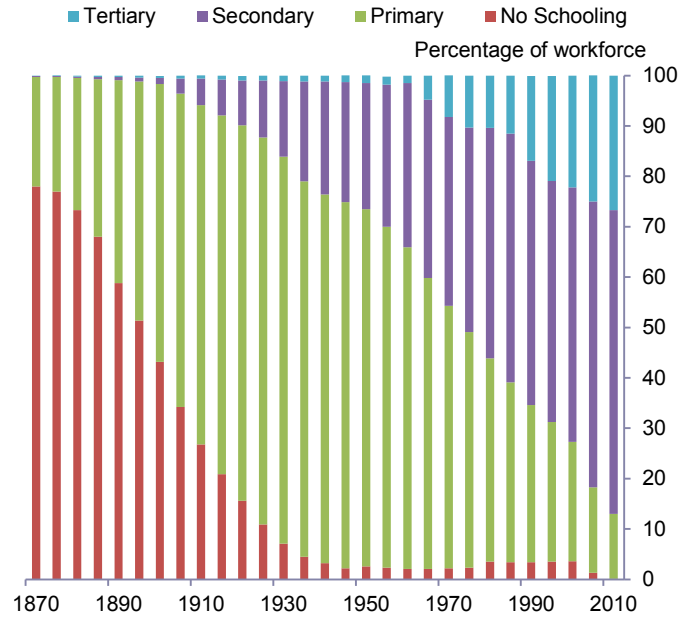
Source: Hills, Thomas and Dimsdale (2015)

Chart 13: Labour productivity and real wages, since 1750



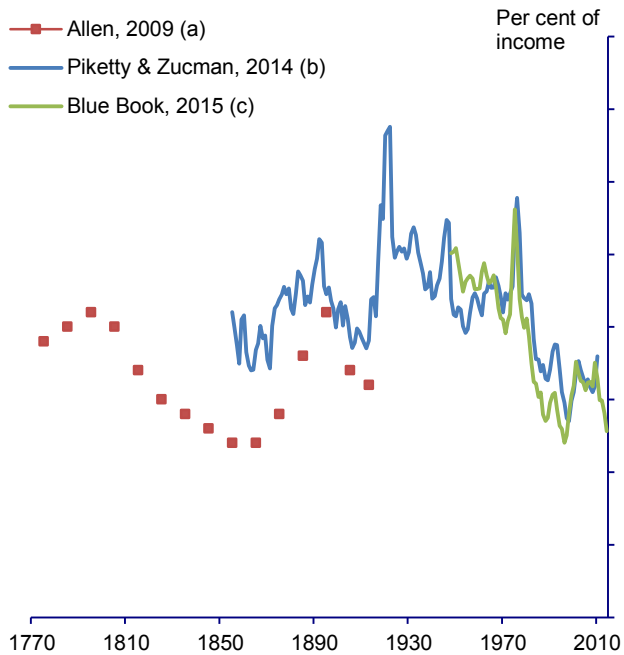
Source: Hill, Thomas and Dimsdale (2015)

Chart 14: Global participation in education, since 1870



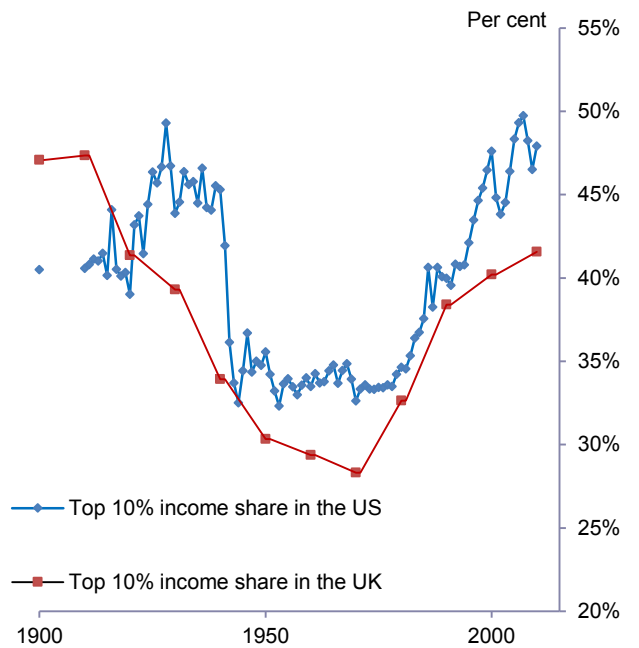
Source: Barro and Lee (2015)

Chart 15: The UK labour share of income, since 1770



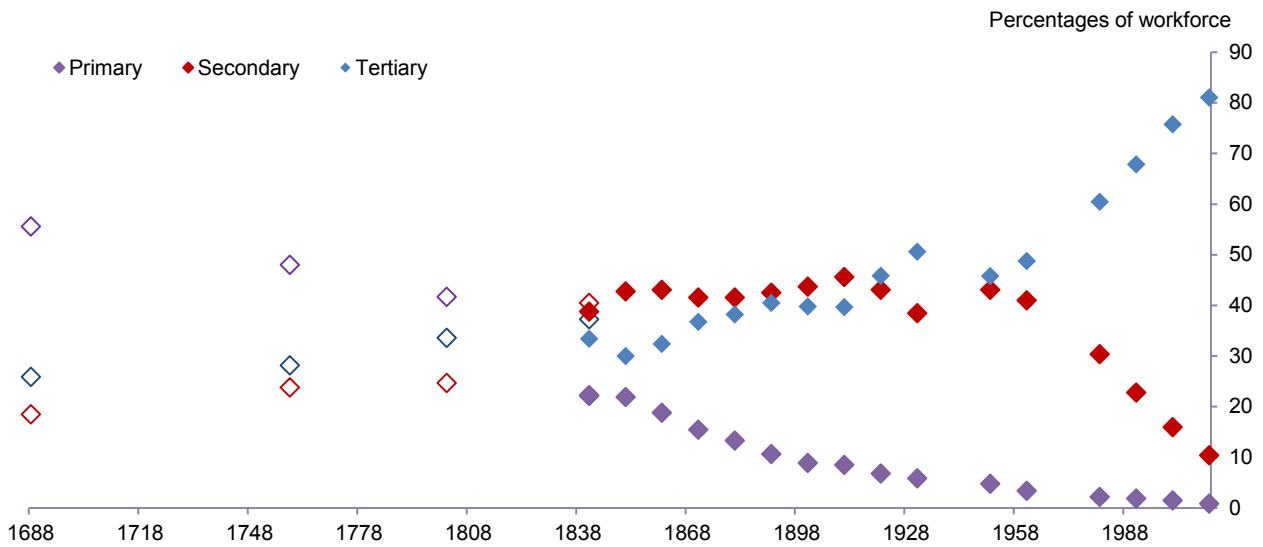
Source: Allen (2009); Piketty (2014); Piketty and Zucman (2014)
 Notes: (a) Taken from Allen (2009) and Piketty (2014). (b) Constructed using data reported in the supplementary tables to Piketty & Zucman (2014). (c) These data are consistent with the ONS Quarterly National Accounts Q2 2015 release. Self-employed labour income is imputed differently than series (b) due to data availability.

Chart 16: Long run inequality



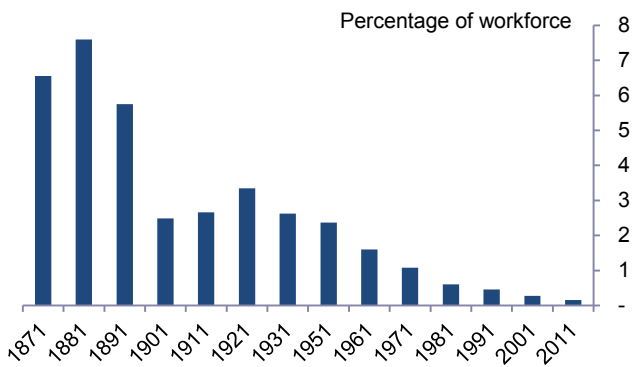
Source: Piketty (2014)

Chart 17: Share of employment by sector, since 1688

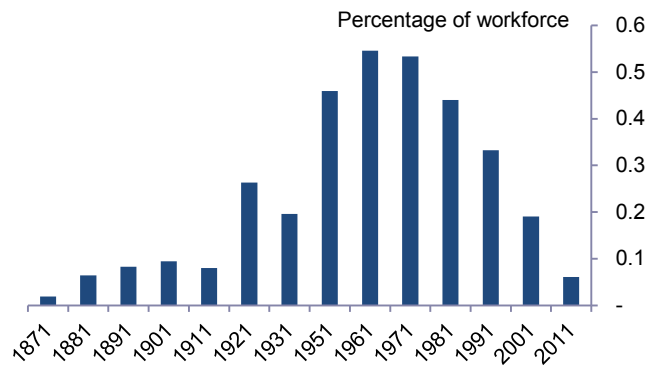


Source: Shaw-Taylor and Wrigley (2013); ONS; Bank calculations.

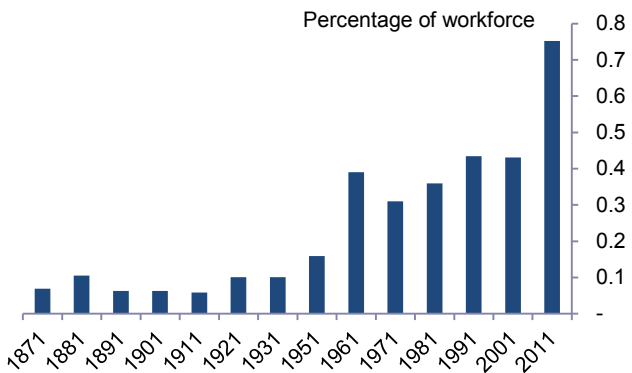
Chart 18: Percentage of workforce by job type
Agricultural Labourers



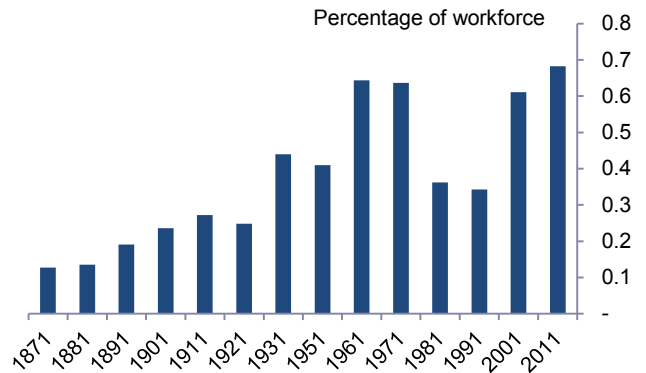
Telephonists and Telegraph Operators



Accountants

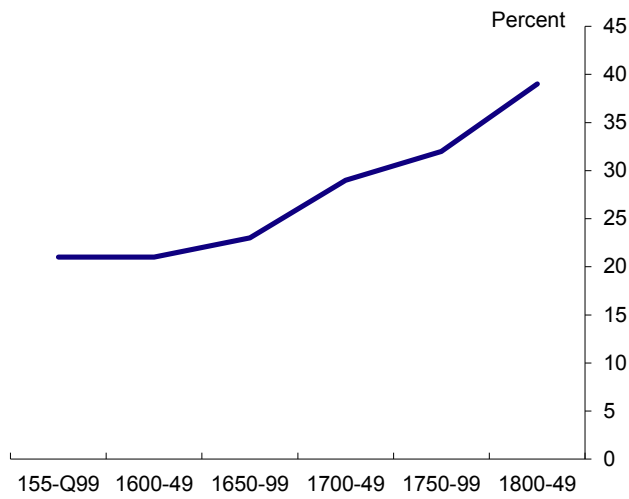


Hairdressers



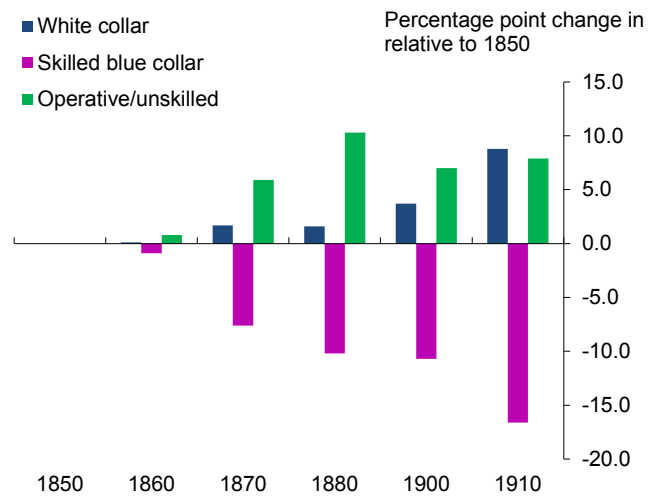
Source: Deloitte (2015)

Chart 19: Share of unskilled workers in the UK, 1550–1849



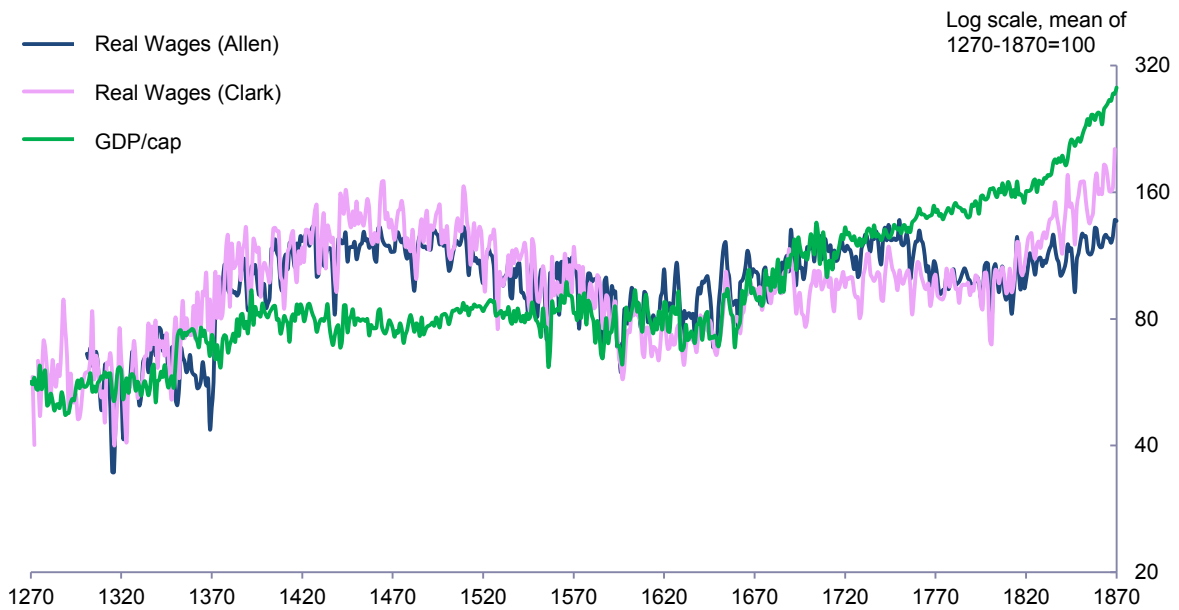
Source: de Pleijt and Weisdorf (2014)

Chart 20: Employment shares in US manufacturing, 1850–1910



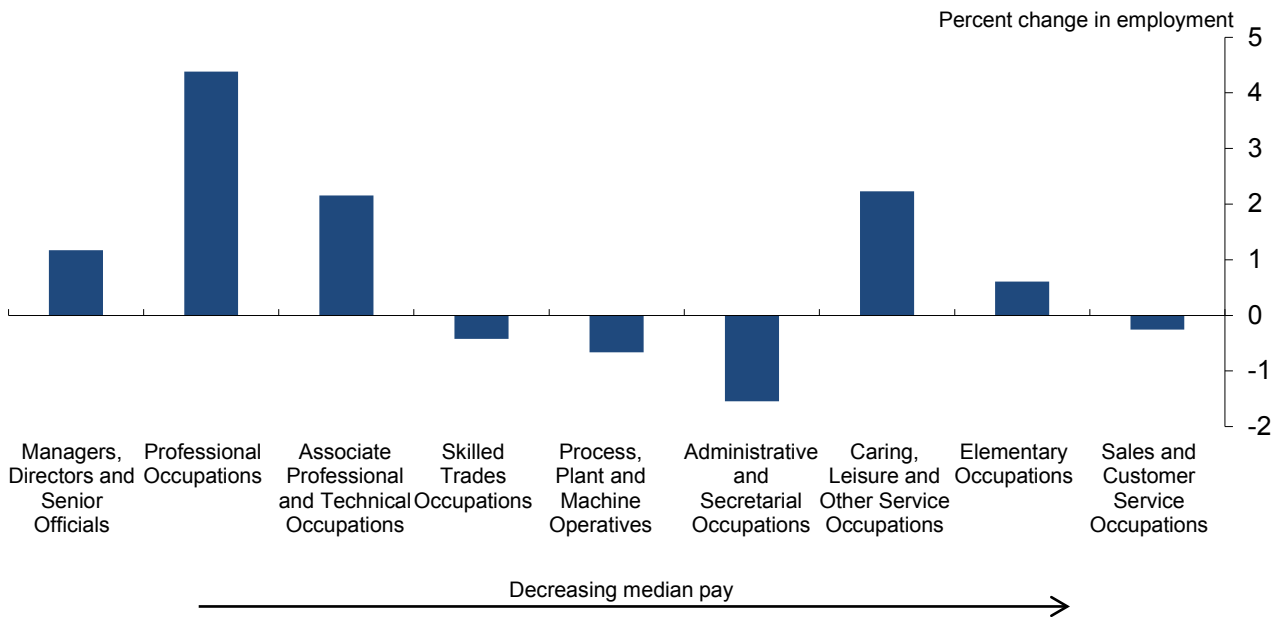
Source: Katz and Margo (2013)

Chart 21: Average real wages of unskilled building workers and GDP per capita, since 1270



Source: Broadberry, Campbell, Klein and van Leeuwen (2015); Clark (2005); Allen (2001)

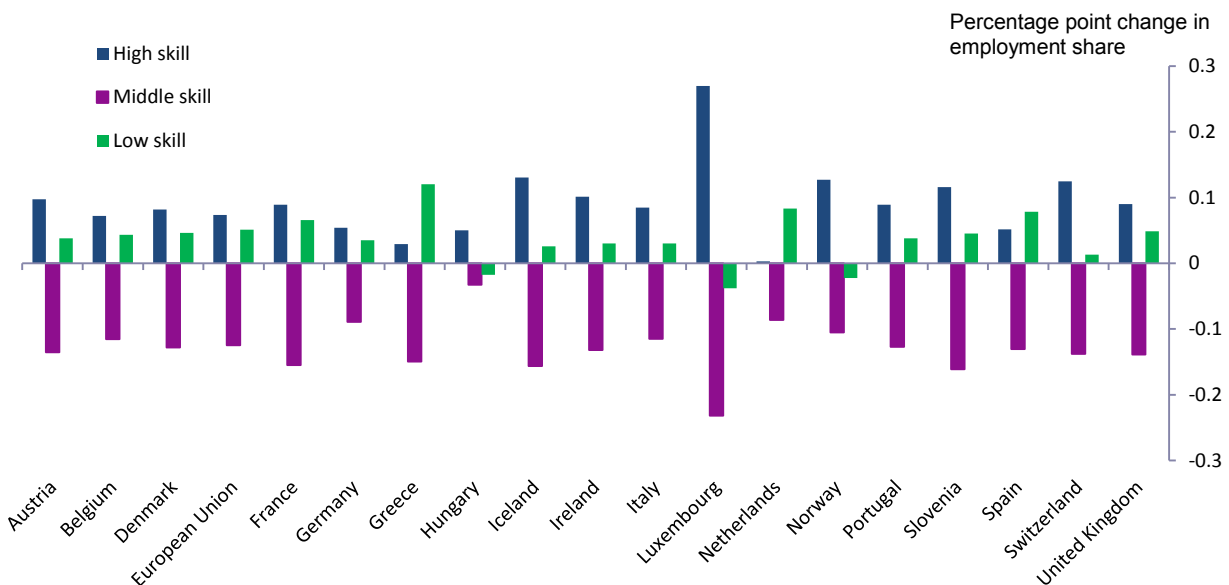
Chart 22: Change in employment shares, 2004 – 2014



Source: ONS

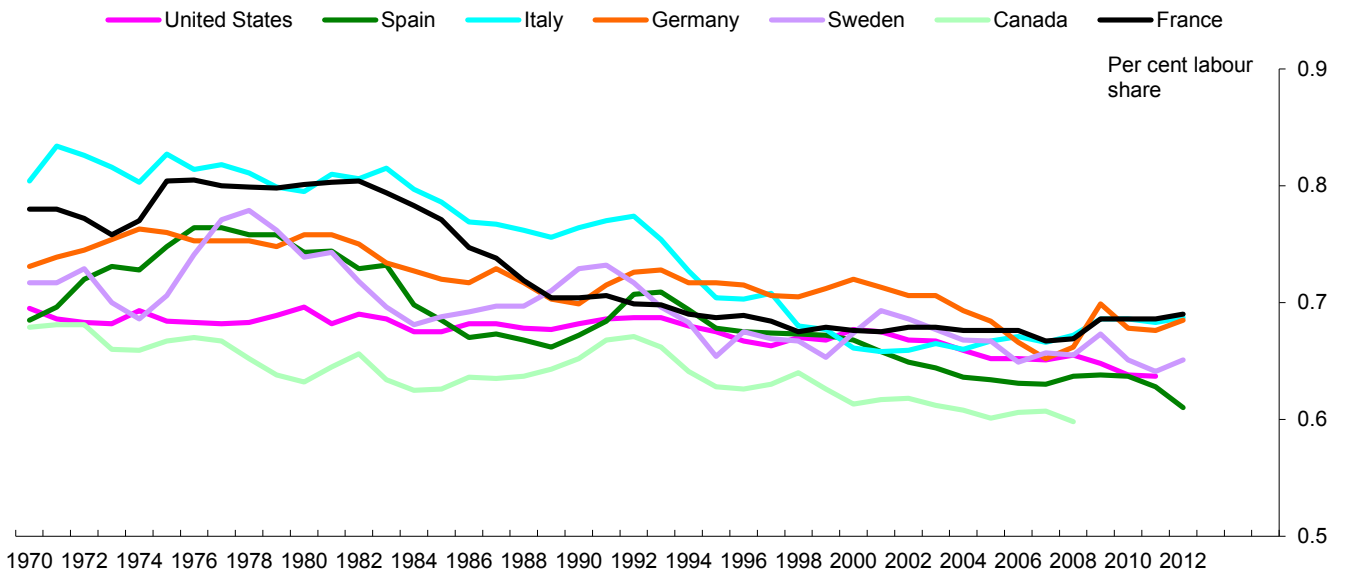
Notes: This chart shows the percentage point change in employment as a share of total employment. Occupations are ordered according to decreasing gross weekly median pay in 2004.

Chart 23: Change in employment share of different occupational groups, 1996–2014



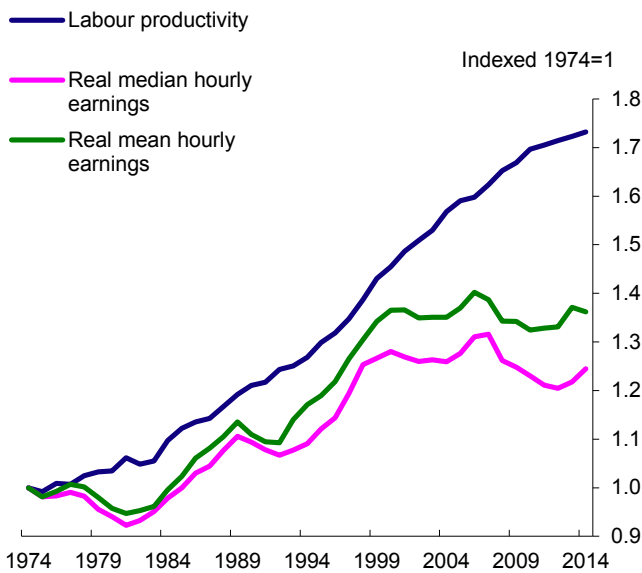
Source: Eurostat

Chart 24: Labour share across countries, since 1970



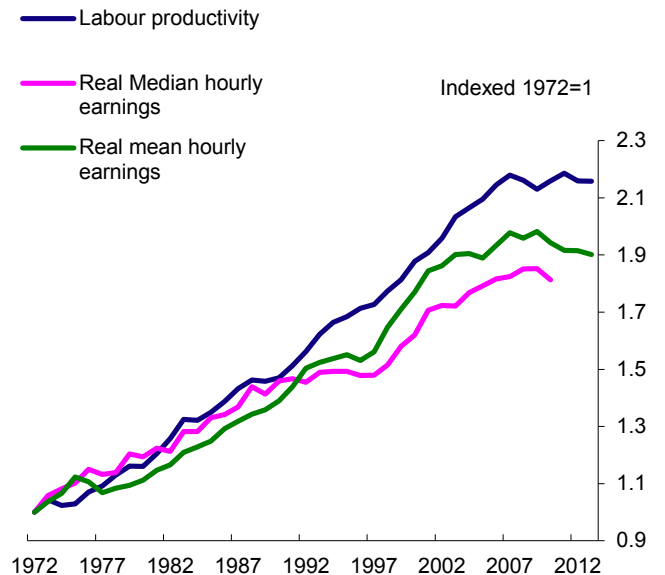
Source: OECD

Chart 25: Labour productivity, mean and median real wages in the US, since 1974



Source: Pessoa and Van Reenen (2013); St. Louis FED; Bank calculations

Chart 26: Labour productivity, mean and median real wages in the UK, since 1972



Source: Pessoa and Van Reenen (2013); Bank calculations

Table 2: Underemployment across countries

	Underemployment in 2013 (percent of workforce)
UK	15
France	13
Germany	14
Spain	25
EU Average	14

Source: OECD

Notes: This table shows the percentage of the workforce who hold a qualification that is more advanced than that required for the profession they are in, split by country.

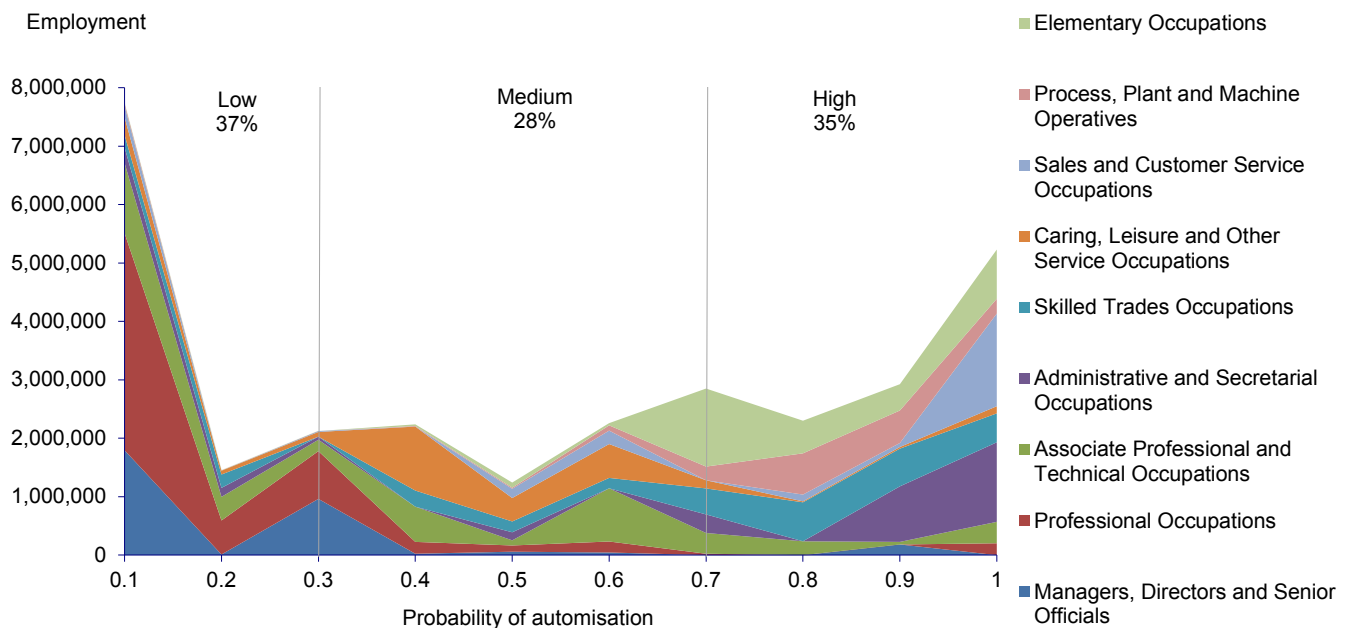
Table 3: Percent of employment at risk of automations

Risk of automation	US (Frey and Osborne (2013))	UK
Low (<33%)	33	37
Medium (33–66%)	10	28
High (>66%)	47	35

Source: Frey and Osborne (2013); Bank calculations.

Notes: The UK probability of automation figures are based on estimates in Frey and Osborne (2013) matched against UK occupations.

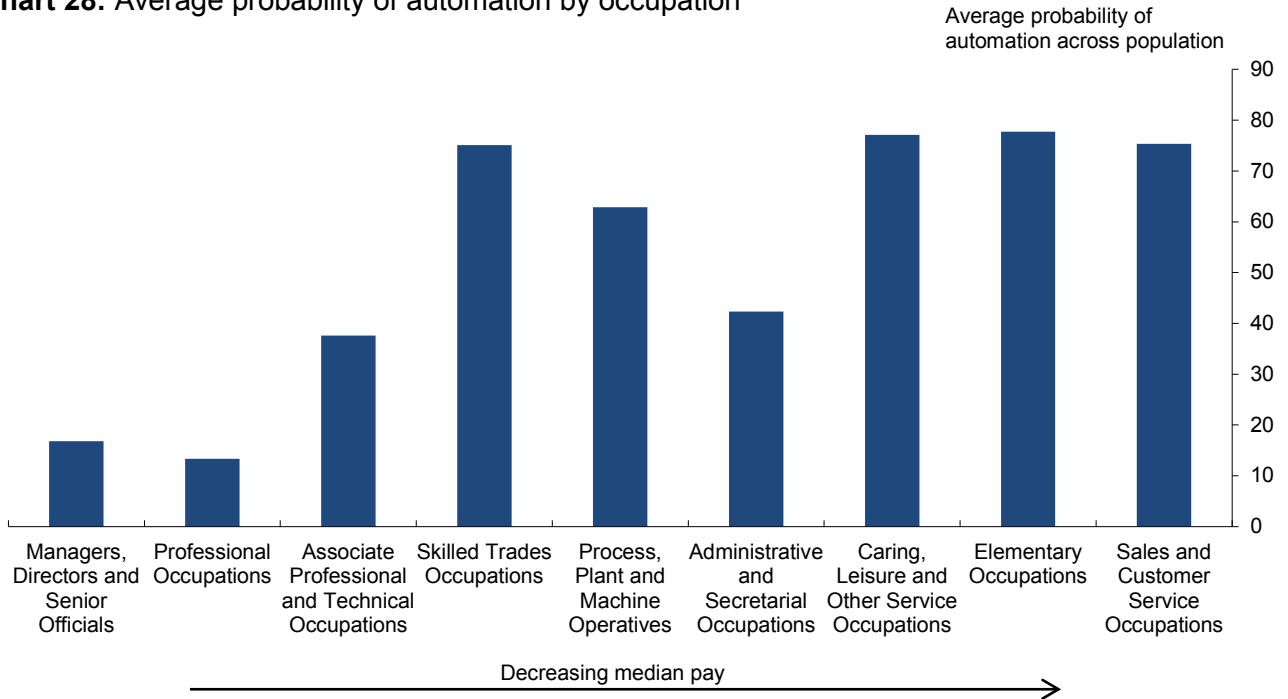
Chart 27: Distribution of occupational employment in the UK by probability of automation



Source: Frey and Osborne (2013); Bank calculations

Notes: This chart shows the probability of automation based on estimates in Frey and Osborne (2013) matched against UK occupations

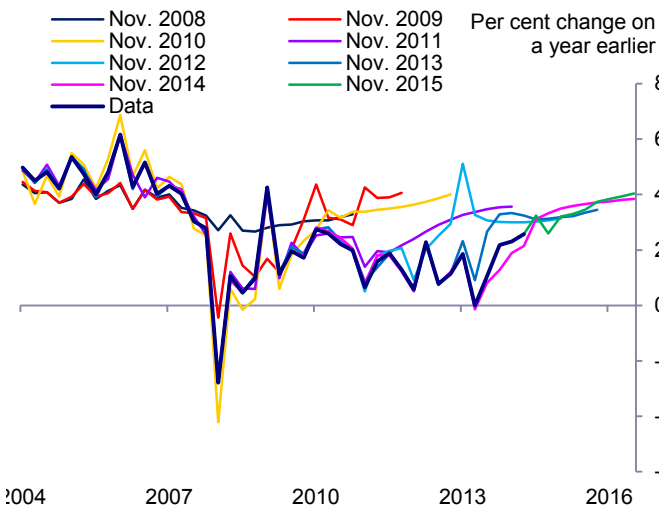
Chart 28: Average probability of automation by occupation



Source: ONS; Frey and Osborne (2013); Bank calculation

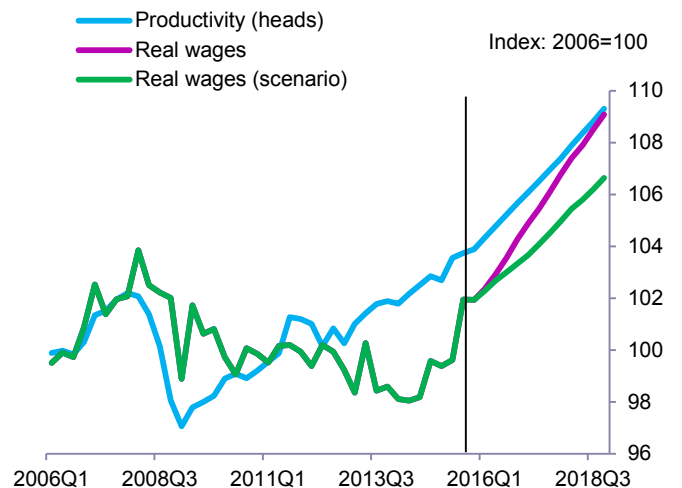
Notes: This chart shows the estimated average probability of automation across occupations using the probabilities in Frey and Osborne (2013) weighted by UK employment

Chart 30: Inflation Report projections of nominal wages



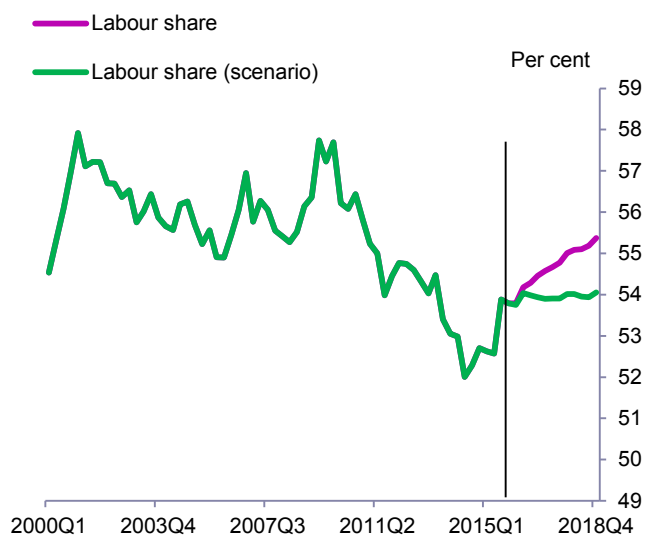
Source: Bank of England *Inflation Report* projections

Chart 31: November 2015 Inflation Report productivity and real wages projections and alternative scenario forecast



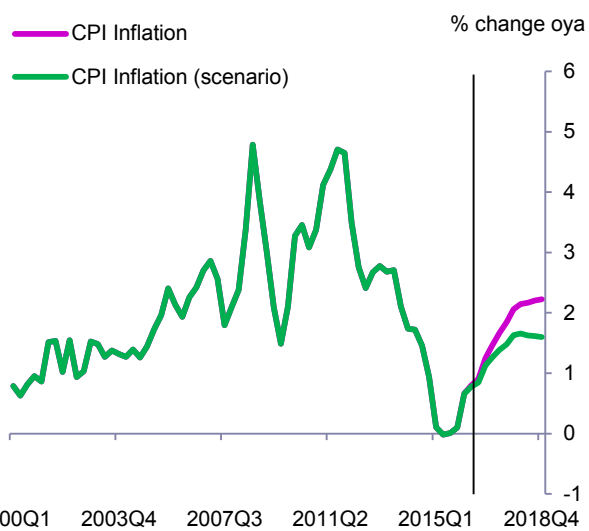
Source: ONS; Bank calculations

Chart 32: November 2015 *Inflation Report* labour share projection and alternative scenario



Source: ONS; Bank calculations

Chart 33: November 2015 *Inflation Report* inflation projection and alternative scenario



Source: ONS; Bank calculations