Over the last 30 years, inequality has risen as new technologies have massively increased the demand for highly skilled workers. But as research by **Guy Michaels** and colleagues shows, it is not simply a case of the more educated benefiting at the expense of the less educated; rather, it is the middle-skilled who are losing out most.

# The shrinking middle: how new technologies are polarising the labour market

In the UK today, the richest tenth of male earners receive almost four times as much as the poorest tenth; 30 years ago they only earned twice as much. A good chunk of this increase in wage inequality is due to higher returns to education (see Figure 1). Because this has been accompanied by a massive increase in the proportion of the university educated, the inescapable conclusion is that the demand for more highly skilled workers has risen.

This holds true across the developed world. The academic consensus is that this increase in skill demand is linked to technological progress, driving up the demand for workers who are able to deal with a more complex and challenging workplace.

New facts on inequality have recently emerged. In the United States, 'upper half' inequality – the difference between the richest tenth of the population and the middle – has risen continuously over the last three decades. But after increasing during the 1980s, 'lower half' inequality – the difference between the middle and the poorest tenth – has actually fallen since then (see Figure 2).

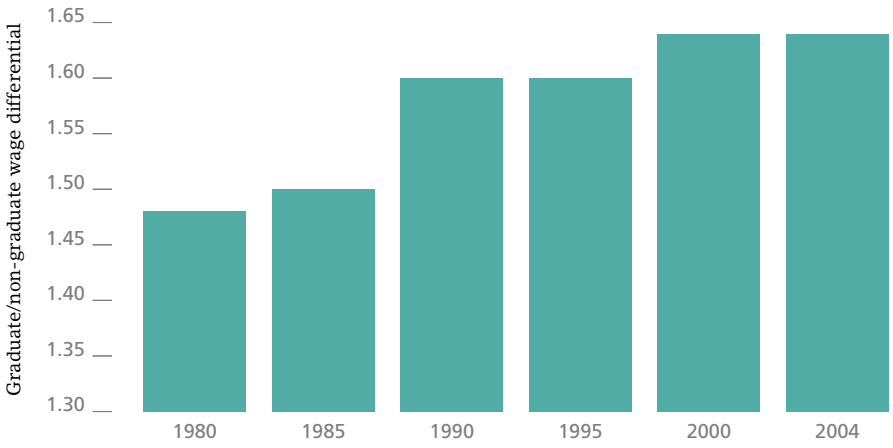
And while college graduates' wages have continued to increase relative to those of non-graduates, high school graduates' wages (the wages of those who leave school at age 18) have ceased to increase relative to those of high-school dropouts (those who leave at age 16) since the 1990s. It also seems that jobs in middle-skilled occupations have decreased relative to both high-skilled and low-skilled occupations across Europe and North America (see Figure 3).

## Information technologies replace mid-level jobs: look at the cleaning robots

What could account for this 'polarisation', in which the prospects of the middle-skilled have been declining? One clue is to be found by looking at robot competitions in Japan. Every year in Tokyo, the 'Robo-One' competition rewards the robot that is best at doing tasks such as cleaning, playing football, dancing and punching other robots (really hard). What is

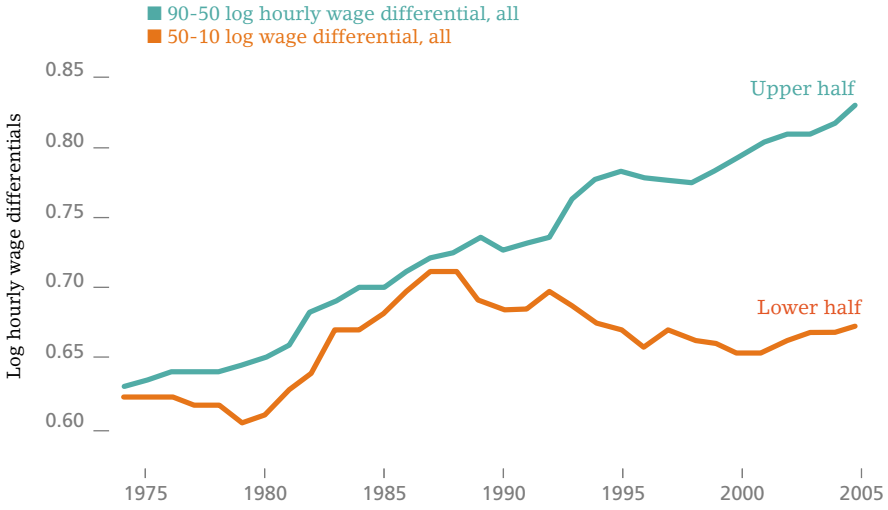
## Technology has raised the demand for college-educated workers and reduced the relative demand for middle-skilled workers

Figure 1:
Increasing returns to higher education: the wage ratio between all UK workers with a college degree and all UK workers without a college degree, 1980-2004




**Source:** Machin and Van Reenen (2010), General Household Survey and Labour Force Survey.

Figure 2:
The divergence of upper half and lower half inequality in the United States, 1975-2005



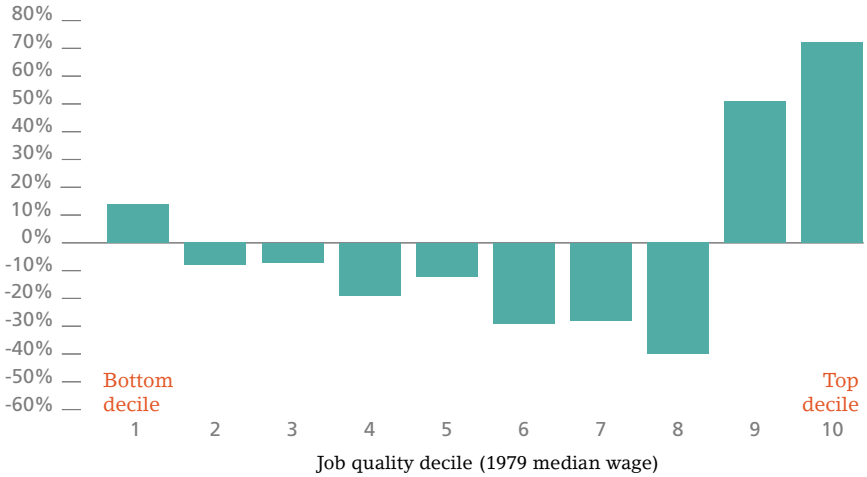

**Source:** Goldin and Katz (2008).

remarkable about this competition is not so much the sophistication of Japanese technology, but how bad these robots are at doing things that humans find very easy.

This suggests that what new technologies – such as information and communication technologies (ICT) – are very good at doing is replacing repetitive, boring, 'routine' tasks (Autor et al, 2003; Goos and Manning, 2007). Tasks that require responding rapidly to unfamiliar situations (such as driving or cleaning) are not easy for robots to reproduce. Repetitive activities that were traditionally performed by less educated workers, such as assembly workers in a car factory, have been good candidates for job destruction by new technology.

But it isn't only this group that has been affected. ICT has also reduced the need for middle-educated workers carrying out routine tasks. Bank clerks, for example, have found demand for their services plummeting as a result of computerisation – ATMs, online banking and the like.

Figure 3:
## Lovely and lousy jobs: employment share growth 1979-2008 by job quality (occupational wage), UK




**Source:** Mieske (2009), updates Goos and Manning (2007), percentage changes for entire period.

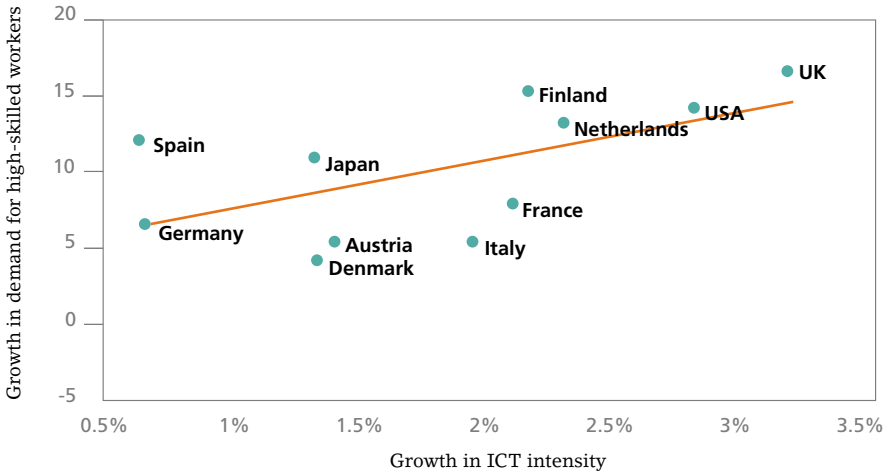
More educated workers making analytical, non-routine use of ICT – such as management consultants, advertising executives and physicians – have found their jobs made easier by ICT rather than threatened by it. Nor has ICT reduced the demand for less educated workers carrying out non-routine manual tasks – such as janitors and cab drivers – contrary to claims that low-skilled jobs are disappearing (see Figure 4).

Since the number of routine jobs in the traditional manufacturing sectors (such as car assembly) declined substantially in the 1970s, the subsequent growth of computerisation may have primarily increased demand for highly educated workers at the expense of those in the middle of the educational distribution, leaving the least educated (mainly working in non-routine manual jobs) largely unaffected.

Figure 4:
## A taxonomy of tasks

| Task type | | Task description | Example of occupations | Education levels | Effect of ICT | Change in demand |
|---|---|---|---|---|---|---|
| **Routine** | **Manual** | Rules based repetitive procedural | Assembly line workers | Low | Direct substitution | Down ▽ |
| | **Non-manual** | | Clerical, Book-keepers | Middle | Direct substitution | Down ▽ |
| **Non-routine** | **Non-manual** | Abstract problem solving (analytic) mental flexibility | Managers, doctors lawyers, scientists | High | Strongly complementary | Up △ |
| | **Manual** | Environmental adaptability Interpersonal adaptability | Maids, janitors security guards waiters, drivers | Low | Broadly neutral | Zero |

Figure 5:
## In countries where technology grew fastest, so did the share of the most highly skilled




**Note:** The figure plots the growth of ICT/VA (the ratio of information and communication technology to value added) against the growth of the highest skill group (the share of the wage bill going to those with college education). This is done across the entire economy of 11 OECD countries between 1980-2004.

## In industries where technical change was fastest, the middle-skilled lost out to the most skilled and the least skilled: growth of skills shares and ICT, 1980-2004

Figure 6:
ICT growth causes big increase in highest skill share

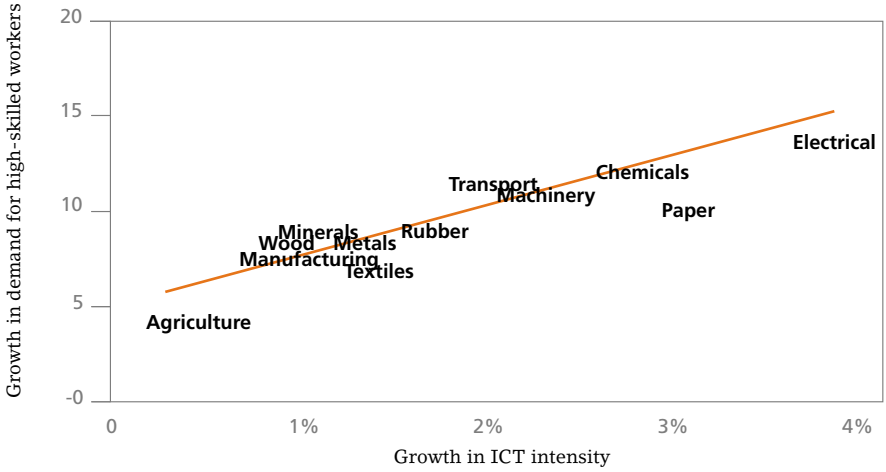



Figure 7:
ICT growth causes big decrease in middle skill share

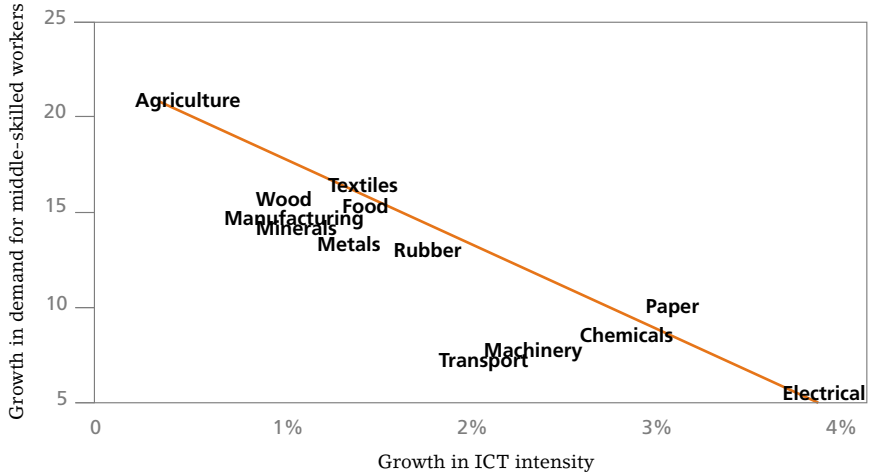
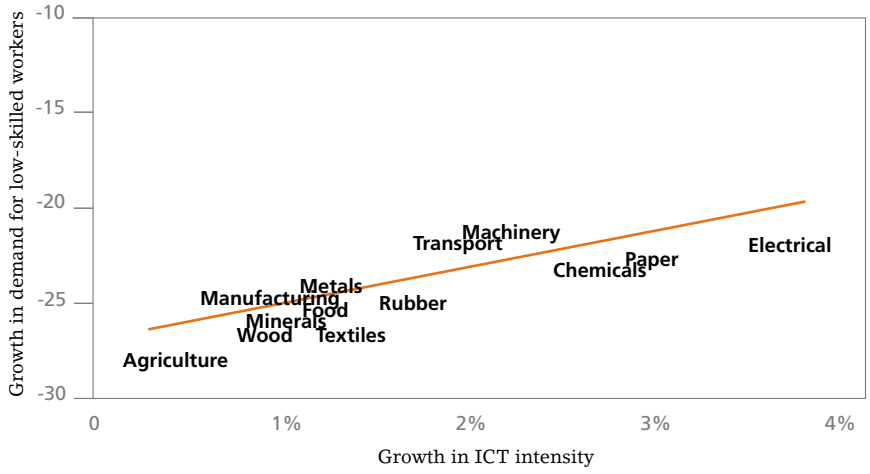



Figure 8:
ICT growth causes small increase/no change in least skill share




**Note:** All three figures plot the growth of ICT/VA (ratio of the information and communication technology to value added) against the growth of a skill group (the share of the wage bill going to the education group). This is done across all the traded sectors of 11 OECD countries between 1980-2004. Michaels et al (2010) show this pattern also holds for non-traded sectors.

## Substitution of middle-skilled workers by high-skilled workers is most prevalent in industries with higher R&D and higher use of ICT

Images: Peter Reid www.flickr.com/photos/38509565@N00/

## Technology is replacing the middle-skilled

To look at whether technology is reducing demand for those in the middle, we have conducted a simple test using 25 years of data across 11 countries and all sectors of the economy. If our story is right, we would expect industries that had a faster growth of computerisation to have also had an increase in demand for college-educated workers relative to workers with middle levels of education, leaving the least skilled unaffected. Our analysis of the data reveals that this is basically what has been going on.

After 1980, countries with faster upgrading of ICT (Finland, the Netherlands, the UK and the United States) also saw the most rapid increase in high-skilled workers (see Figure 5). Across different countries, similar industries – for example, financial services, telecommunications and electrical equipment manufacturers – replaced middle-skilled workers with high-skilled workers at the fastest rate.

This finding is consistent with a technology-based explanation for polarisation, but not with alternative explanations that emphasise institutional changes, such as the decline of trade unions or the introduction of minimum wages.

Changes in skill demand across industries are strongly correlated with ICT upgrading. Industries that experienced more rapid ICT upgrading also increased the relative demand for high-skilled workers (see Figure 6) at the expense of middle-skilled workers (see Figure 7), with little impact on low-skilled workers (see Figure 8).

The change in demand reflected an increase in both the wages and the hours worked by high-skilled workers relative to middle-skilled workers. We document this finding not only for the full sample of countries together, but also separately for the United States and for continental Europe.

There is also evidence of technology polarising the demand for skills not only through increased intensity of ICT. Industries that engage in more research and development (R&D) also show the same pattern of substitution of middle-skilled workers by high-skilled workers. Taken together, ICT upgrading and R&D account for about a quarter of skill upgrading since 1980.

## The middle classes should beware – the robots are coming for you next

## What about trade?

An alternative explanation for the falling demand for non-college workers is globalisation. The idea is that increased trade with low-wage countries like China has depressed the wages and taken the jobs of the less skilled.

We find that the positive correlation between trade openness and the increased demand for high-skilled relative to middle-skilled disappears once we control for technological change. This could either mean no role for trade or a more subtle effect whereby trade has an indirect effect by inducing faster technical change (an effect discussed elsewhere in this *CentrePiece* – see page 2).

In either case, unless one believes in a Luddite view of smashing machines, there is no reason to erect trade barriers to protect less skilled workers from the effects of China, India or other emerging economies.

## Conclusions

Polarisation is not bad news for the least skilled – there will be jobs for them even in a high-tech world. But for the middle classes, technology may be endangering their future labour market prospects.

This article summarises 'Has ICT Polarized Skill Demand? Evidence from Eleven Countries over 25 Years' by Guy Michaels, Ashwini Natraj and John Van Reenen, CEP Discussion Paper No. 987 (http://cep.lse.ac.uk/pubs/download/dp0987.pdf).

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## Further reading

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Stephen Machin and John Van Reenen (2010) 'Inequality', CEP Election Analysis (http://cep.lse.ac.uk/pubs/download/ea015.pdf).

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