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<http://www.oecd.org/future-of-work/>

## Key findings

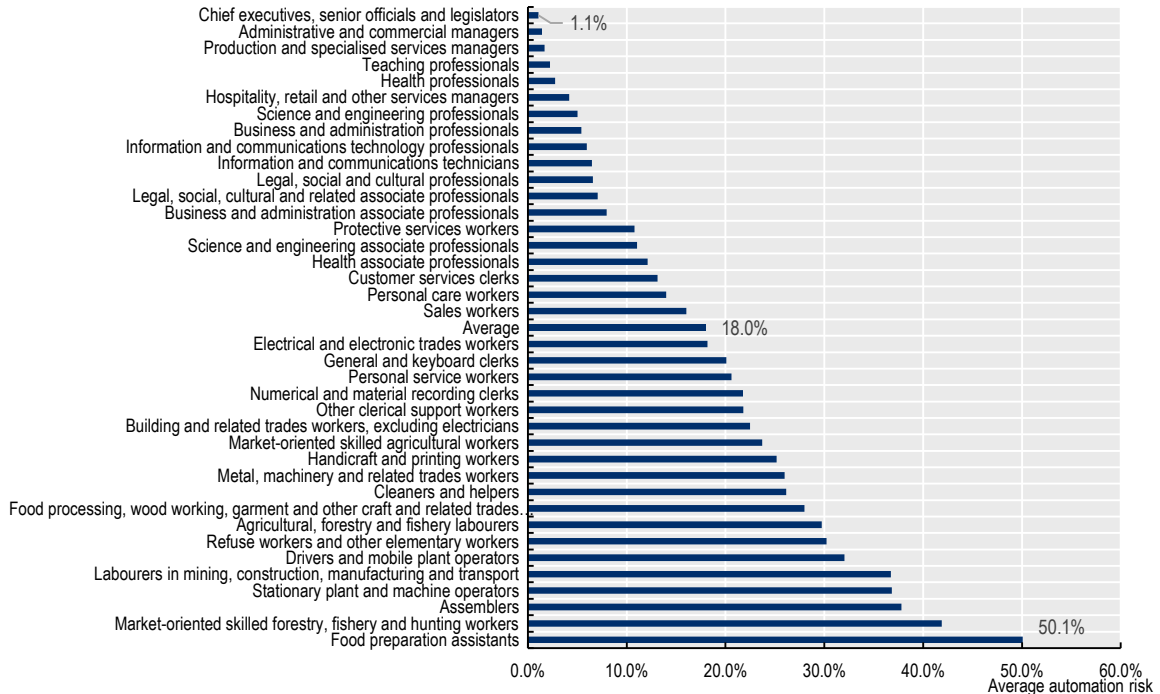
- The OECD has estimated that 14% of jobs are at high risk of automation.
- Despite this, employment grew in all OECD countries over the period 2012-2019.
- At the country level, a higher risk of automation was not associated with lower employment growth over the period. This might be because automation promotes employment growth by increasing productivity, although other factors are also at play.
- At the occupational level, however, employment growth was much lower in occupations at high risk of automation (6%) than in occupations at low risk (18%).
- Low-educated workers were more concentrated in high-risk occupations in 2012 and have become even more concentrated in these occupations since then.
- The low growth in jobs in high risk occupations has not led to a drop in the employment rate of low-educated workers. This is largely because the number of workers with a low education has fallen in line with the demand for these workers.
- Going forward, however, the risk of automation is increasingly falling on low-educated workers and the COVID-19 crisis is likely to accelerate automation, as companies reduce reliance on human labour and contact between workers, or re-shore some production.

## Some countries and occupations were at higher risk of automation than others

The OECD had estimated that 14% of jobs were at high risk of automation (Nedelkoska and Quintini, 2018<sup>[1]</sup>). These estimates varied significantly across countries (from 6.5% in Norway to 34.6% in the Slovak Republic) as well as across occupations (ranging from 1.1% for chief executives and senior officials and legislators to 50.1% for food preparation assistants (Figure 1)). By sector, the risk of automation was typically higher for occupations in manufacturing and in agriculture, although jobs in a number of service sectors, such as postal and courier services, land transport and food services, also faced a high risk.

## Figure 1. The risk of automation varied significantly by occupation

Share of jobs at high risk of automation by occupation (averaged across countries)



Note: Risk of automation is averaged across countries

Source: (Nedelkoska and Quintini, 2018<sup>[1]</sup>)

## Employment has grown in nearly all countries and occupations since 2012

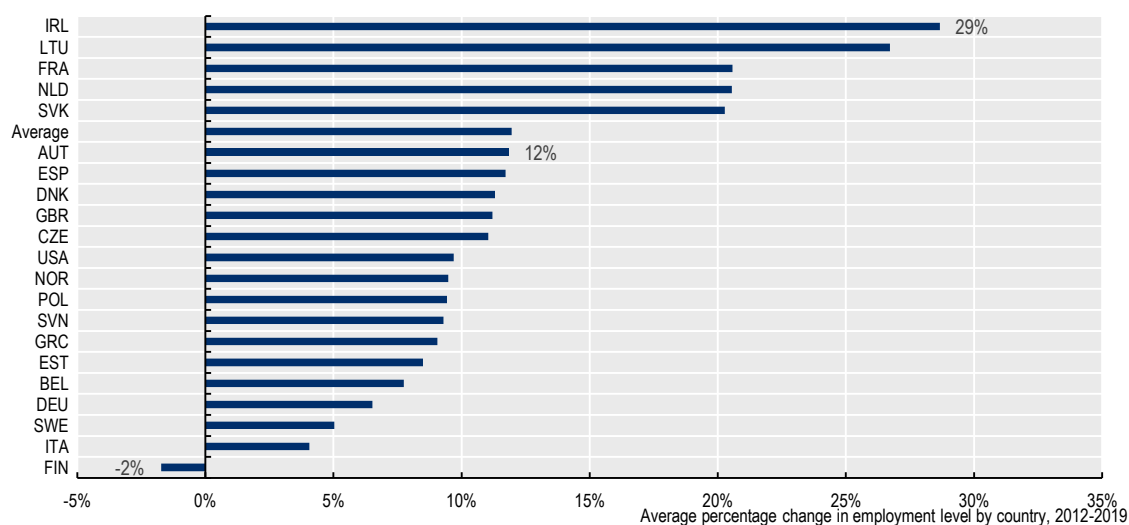
The OECD's estimates of automation were based on data from the Survey of Adult Skills (PIAAC), which was carried out in 2012. Have they been consistent with developments since then?

While a significant share of jobs in all countries were estimated to be at risk of automation, this has not resulted in mass unemployment. In fact, employment has increased in nearly all countries over the period 2012-2019, despite ongoing automation (Figure 2), at an average rate of 12%.<sup>1</sup> Some of this employment growth can be attributed to the recovery from the Global Financial Crisis (GFC). Indeed, the countries that suffered the greatest employment losses during the crisis were also those that experienced the greatest employment growth between 2012 and 2019. However, as discussed below, the recovery does not tell the whole story.

<sup>1</sup> These growth rates represent unweighted averages of the employment rates in each of the 38 occupations analysed in Figure 1. This is done for consistency with the rest of the analysis in this note and the underlying research paper. When weighting for the employment share of each occupation, total employment grew in all countries, ranging from 3.3% in Finland to 23.5% in Ireland, with an average of 8.4% across the 21 countries analysed.

## Figure 2. Employment has grown in nearly all countries since 2012

Average percentage change in the employment level of occupations, by country, 2012 to 2019



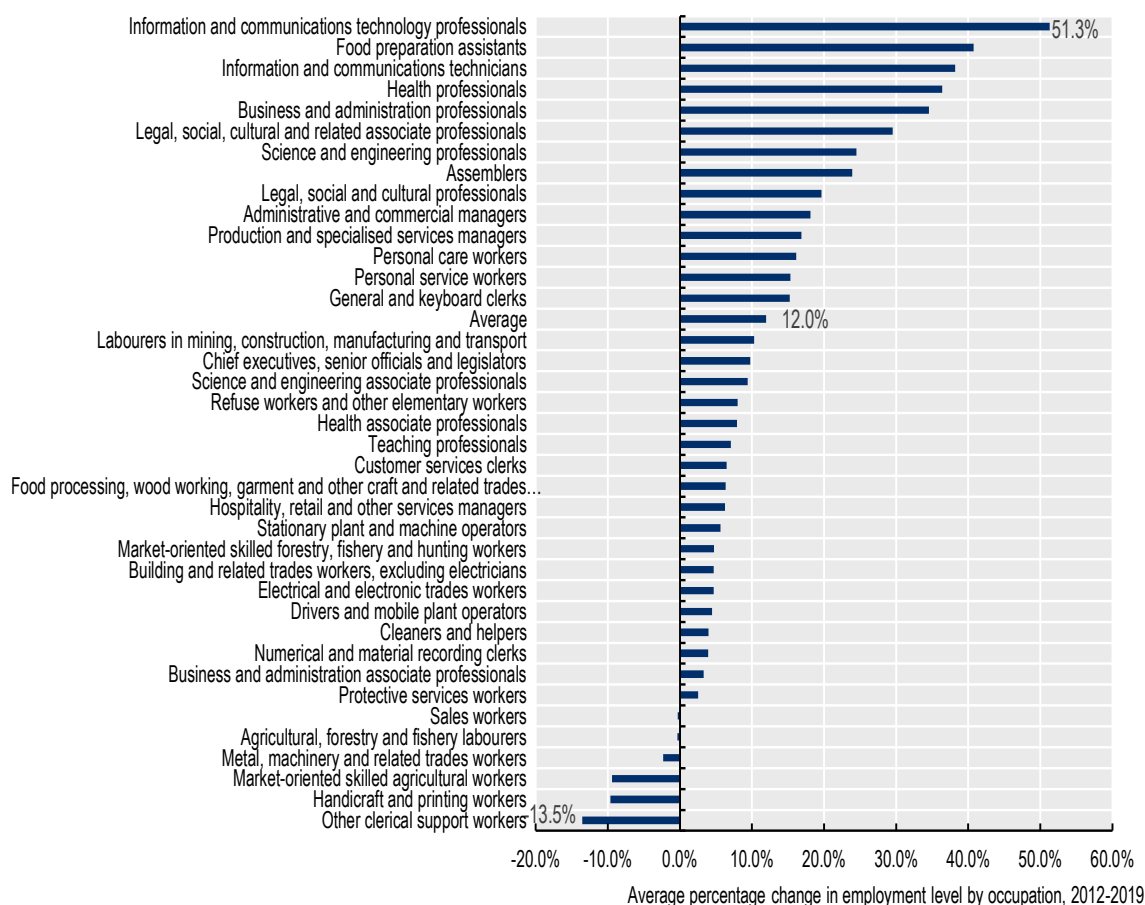
Note: Countries are ranked by percentage change in employment level. The average percentage change is calculated as the average change across occupations within a country. All averages are unweighted.

Source: Georgieff and Milanez (2020).

It is also the case that employment has grown in nearly all occupations since 2012, even in some with a higher risk of automation (Figure 3). On average, across occupations, employment grew by 12%. The highest growth was observed for information and communications technology professionals (51.3%). A few occupations experienced reductions in employment over the period 2012-2019: other clerical support workers; handicraft and printing workers; skilled agricultural workers; metal and machinery workers; skilled forestry, fishing and hunting workers; and sales workers. These were all occupations at high risk of automation at the beginning of the period. The declines in employment in these occupations are all the more striking given that they occurred against a backdrop of rising employment across countries.

### Figure 3. Employment has grown in nearly all occupations since 2012

Average percentage change in employment level by occupation (averaged across countries), 2012-2019



Note: Occupations are ranked by percentage change in employment level. Non-weighted average across countries.

Source: Georgieff and Milanez (2020).

### At the country level, there is no indication that higher automation risk was associated with lower employment growth

At the country level, countries that faced higher overall automation risk back in 2012 did not experience lower employment growth over the subsequent period (2012 to 2019).

This result is not driven by the recovery from the crisis. While it is true that countries that suffered greater employment losses during the crisis also experienced the greatest subsequent rebound in employment, it is not the case that countries that were most heavily affected by the crisis were also the countries facing the highest risk of automation.

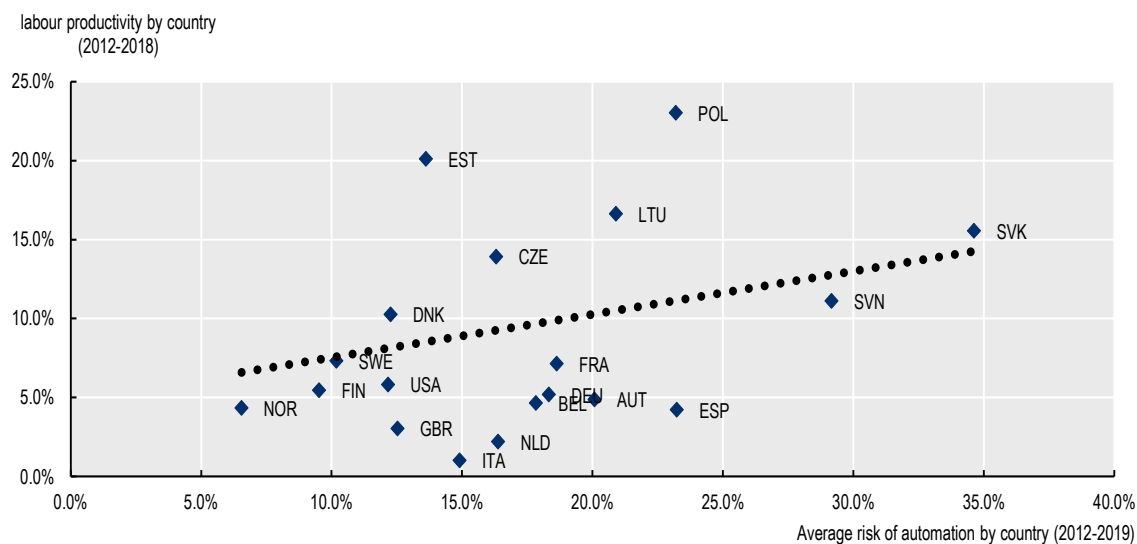
This result also continues to hold even when a range of other factors are controlled for, including differences across countries in wealth, taxes, product market regulations, as well as a range of labour market institutions and policies.

While further research is needed, these findings are consistent with a story in which automation may destroy jobs on the one hand, but also contributes to employment growth through increases in productivity. Increases in labour productivity lead to lower prices on goods and services; and lower prices boost

demand, which in turn increases employment levels (even if the amount of labour per unit has declined). Productivity growth may take place within a given sector or across sectors. There is indeed suggestive evidence that countries that faced a higher average risk of automation in 2012 also experienced higher productivity growth over the subsequent period (Figure 4).

#### Figure 4. Labour productivity growth was greater in countries that were at higher risk of automation

Percentage change in labour productivity (2012-2019) and risk of automation (2012)

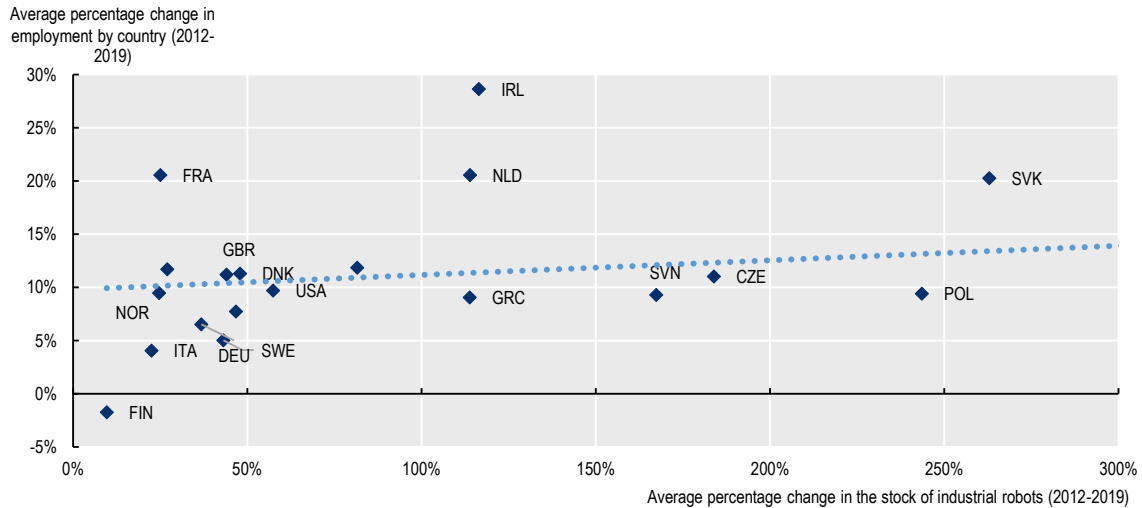


Note: The averages presented are unweighted. Labour productivity is measured by GDP (in USD, constant prices) per hour workers.  
Source: OECD Productivity Database and (Nedelkoska and Quintini, 2018<sub>[11]</sub>)

There is also suggestive evidence that the absence of a negative link between automation risk and subsequent employment growth at the country level holds when examining actual investment in automating technologies. Countries that added more to their stock of robots over the period 2012-2019 did not experience lower employment growth over that period (Figure 5).

### Figure 5. Countries that invested more heavily in robots experienced greater employment growth

Average percentage change in employment level by country and percentage change in the stock of industrial robots (2012-2019)



Note: The International Federation of Robots calculates the operational stock of robots by accumulating annual deployments and assuming that robots operate 12 years and are immediately withdrawn after 12 years. The variable here reflects the average change in the stock of industrial robots between 2012 and 2019 per country. Lithuania and Estonia have been excluded for readability reasons, but the results are qualitatively the same when these countries are included.

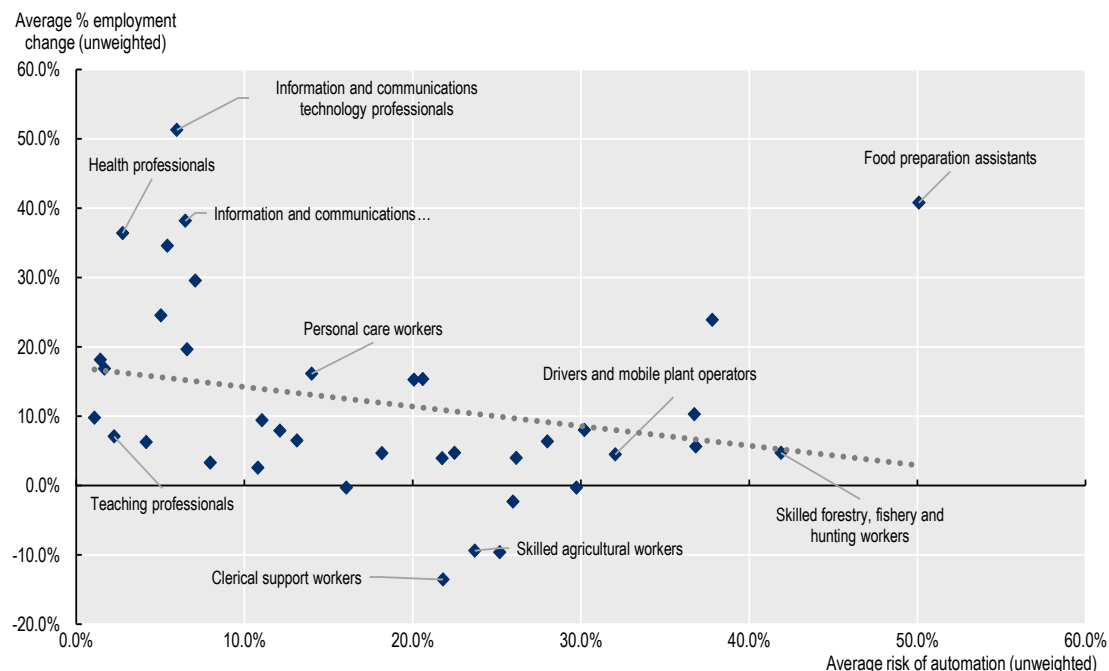
Source: (Nedelkoska and Quintini, 2018<sup>[1]</sup>) and the International Federation of Robots.

### Employment grew less in occupations at high risk of automation

Despite strong aggregate employment growth of the period 2012-2019, employment grew more slowly in occupations that were at high risk of automation (Figure 6). On average across countries, employment among the top half of occupations by risk of automation grew by 6% compared with 18% among the bottom half. At the occupational level, these findings indicate that the OECD's estimates of the risk of automation were good predictors of subsequent employment growth. The findings also indicate that, despite automation, employment still grew overall.

## Figure 6. Employment growth was lower in occupations at higher risk of automation

Average percentage change in employment level by occupation (2012 to 2019) and average risk of automation by occupation (2012)



Note: Not all occupations are labelled due to space constraints. Averages are unweighted across countries.

Source: Georgieff and Milanez (2020) and (Nedelkoska and Quintini, 2018<sup>[1]</sup>).

## Job stability fell more in occupations at higher risk of automation

Occupations that were at a higher risk of automation did not just experience lower employment growth, but also a greater fall in job stability compared to occupations at lower risk of automation. For every 10 percentage point increase in risk of automation in a particular occupation, age-adjusted tenure<sup>2</sup> was found to fall by 0.80 percentage points over the period (the equivalent of around one month reduction over seven years' time). This negative effect was particularly pronounced for older workers.

## The employment rates of low-educated individuals kept pace with those of more educated groups

The low-educated tended to be more concentrated in high-risk occupations. In 2012, 74% of low-educated workers were in the riskiest half of occupations, compared to 53% of middle-educated and only 13% of high-educated workers.

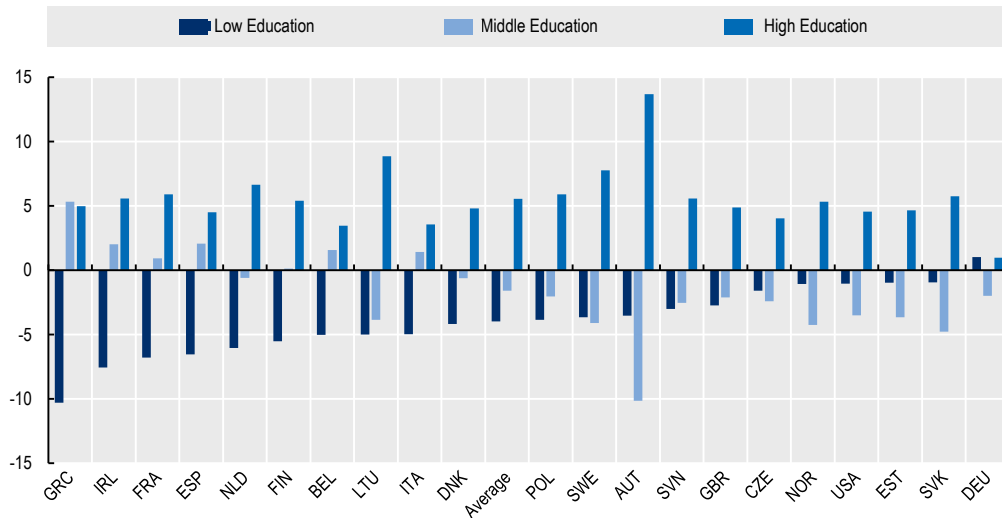
Despite this, lower employment growth in jobs at high risk of automation has not affected the employment rate of the low-educated more than that of other education groups. This is because, even though the number of job opportunities for this group may have declined, the number of low-educated in the general

<sup>2</sup> Tenure is adjusted for age to control for the effect of population ageing.

population has also declined. Across the countries studied, the share of low-educated individuals in the working age population has declined by 4 percentage points on average (Figure 7).

### Figure 7. The share of low-educated individuals has declined in almost all countries

Percentage point change in each education group as share of the working age population, 2012-2019



Note: Averages are unweighted.

Source: Georgieff and Milanez (2020).

### Low-educated workers have become increasingly concentrated in occupations at high risk of automation

Even though lower employment growth in high-risk occupations has not negatively affected the employment rate of the low-educated relative to other groups, those low-educated workers who are left in the labour market have found themselves increasingly concentrated in high-risk occupations. Between 2012 and 2019, the cross-country average share of low-educated workers in the six riskiest occupations increased by 5.9%.

### Policy makers should focus on managing job transitions and ensure that young workers have the new skills demanded in the labour market

The results indicate that, rather than bringing about a “jobless future”, technological change has the prospect of a future with different jobs.

At the same time, however, automation results in uncertain employment prospects for specific demographic groups, such as the low-educated. The COVID-19 crisis may have added to this uncertainty by accelerating automation, as companies tried to reduce reliance on human labour and contact between workers, or to re-shore some production. Policymakers should therefore aim to help affected workers manage transitions to new jobs, especially the low-skilled who may need training to reskill.

With declining opportunities for young people to enter the labour market through low-skilled jobs, it is even more important for policymakers to ensure that skills investments for younger workers match the needs of the labour market, including by forecasting skills needs in light of automation trends.



## References

- Nedelkoska, L. and G. Quintini (2018), “Automation, skills use and training”, *OECD Social, Employment and Migration Working Papers*, No. 202, OECD Publishing, Paris, <https://dx.doi.org/10.1787/2e2f4eea-en>. [1]
- OECD (forthcoming), “Job retention schemes during the COVID-19 lockdown and beyond”, *OECD Policy Responses to Coronavirus (COVID-19)*, OECD Publishing, Paris, <https://www.oecd.org/coronavirus/en/policy-responses>. [2]

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