

# Economic Commentaries

## Technological change and the labour market

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Technological change has increased global competition because more jobs can now be performed digitally. It has also raised fears that vast amount of jobs may disappear as automation and digitalisation increase. This Economic Commentary highlights how technological change may have affected the functioning of the Swedish labour market.

Empirical research shows that automation has led to the disappearance of some jobs, although new jobs have simultaneously been created. Empirical research finds no support for the claim that total employment has so far decreased as a result of technological change. However, technological change has polarised labour demand and certain groups are being hit harder by the development as their knowledge and abilities are no longer in demanded on the labour market. Technological change therefore risks leading to increased inequality on the labour market. Consequently, rapid technological change places demands on the labour market's ability to adapt, especially in the event of an economic downturn.

Rapid technological change raises both fears and hopes for the future. On the one hand, there is a risk of certain types of labour being knocked out of the labour market and of unemployment and income inequality increasing as a result. On the other hand, technological change can also lead to increased productivity and hence greater prosperity. Some claim that the ongoing technological change will have different effects to those caused by previous technological shifts.<sup>2</sup> This, they say, is because artificial intelligence and more advanced robotics are reducing the demand for labour more rapidly than previously and because not as many new jobs are being created. Assessments as to what proportion of jobs are expected to disappear as a result of technological change within the next 10–15 years vary considerably, between 10 and 50 per cent.<sup>3</sup> It is difficult to assess developments in the future, but an important starting point is to understand how the labour market has developed so far and whether the same patterns can be seen in Sweden as in other countries. The effects of technological change may differ among different countries depending on the initial conditions and the labour market institutions. How the labour market develops is important for monetary policy. It is therefore important to study how different structural changes affect wage formation and developments on the labour market. The aim of this Economic Commentary is to highlight how technological change may have affected the functioning of the Swedish labour market.

### So far, total employment has not decreased as a result of technological change

Historically, employment in Sweden and in other countries has developed in step with the labour force. There are obviously some variations over the economic cycle, but the size of the labour force has historically determined the long-term level of employment. This means that the number of jobs depends on how many people want to work, and there is no fixed number of jobs to be distributed among those who want to work. Labour force participation has increased in Sweden and employment has risen more than the working-age population (15–74 years) over the last ten years. This can be seen in a higher employment rate.<sup>4</sup> The employment rate increased by 1.7 percentage points in Sweden between 2008 and 2018 and is on a high level historically and compared with other European countries, represented here by EU15, Norway and Switzerland (see diagram 1 and diagram 2). Over the last decade, the employment rate has increased in all age groups, but especially among older people (55–74 years) (see diagram 3). The employment rate has also risen among foreign-born persons, despite a large

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<sup>2</sup> Brynjolfsson and McAfee (2016), Ford (2015) and Acemoglu and Restrepo (2019).

<sup>3</sup> See Arntz et al. (2017), Frey and Osborne (2017) and OECD (2019).

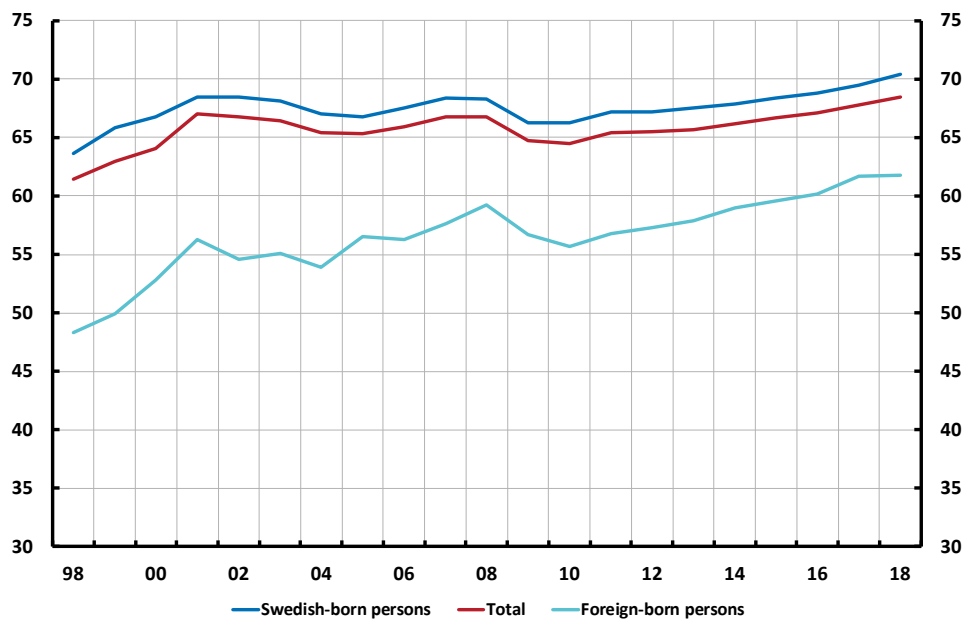
<sup>4</sup> The employment rate is defined as the share of employed persons in the population in the same age group.

increase of foreign-born persons in the population (see diagram 1). The higher employment rate means that new jobs have been created, despite the rapid technological change.

Empirical research does not provide any support for the claim that total employment has decreased as a result of technological changes.<sup>5</sup> Technological progress is of considerable importance for productivity growth and higher productivity can lead to fewer employed persons in certain industries and regions.<sup>6</sup> However, since productivity growth also increases prosperity in society and the demand for services and goods in other parts of the economy, technological change need not necessarily reduce total employment.

**Diagram 1. Employment rate broken down by Swedish-born and foreign-born persons, 15–74 years**

Per cent of the population in each group respectively



Note. Break in time series in 2001 and 2005.

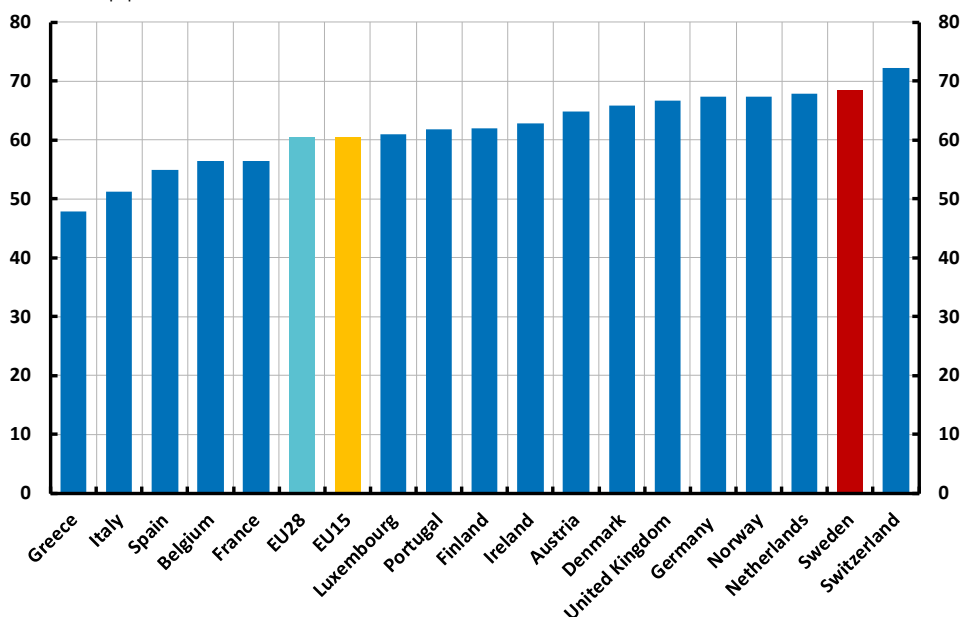
Source: Eurostat.

<sup>5</sup> See, for instance, Bessen (2016), Gregory et al. (2016), Dauth et al. (2017), Autor and Salomons (2018) and Graetz and Michaels (2018).

<sup>6</sup> Since 2007, actual productivity growth has been relatively weak in Sweden and a similar trend can also be seen in other countries. Research is not unanimous regarding the degree to which the slowdown in productivity growth is due to technological innovation being less important for productivity and the degree to which it is due to other contributory factors, such as lower investments. See, for instance, National Institute of Economic Research (2017).

**Diagram 2. Employment rate in European countries, 2018, 15–74 years**

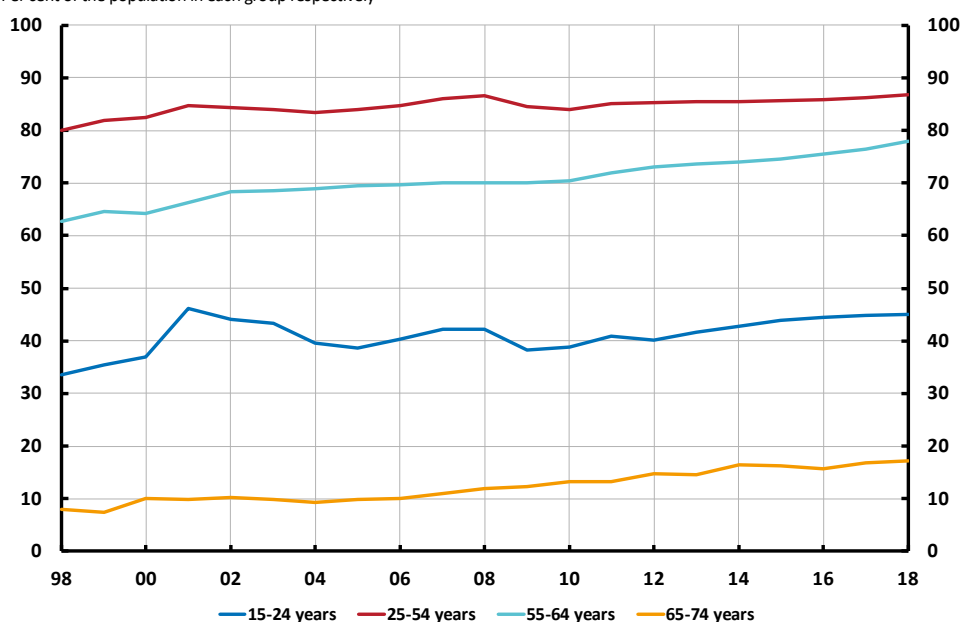
Per cent of the population



Source: Eurostat.

**Diagram 3. Employment rate broken down by age, 15–74 years**

Per cent of the population in each group respectively



Note. Break in time series in 2001 and 2005.

Source: Eurostat.

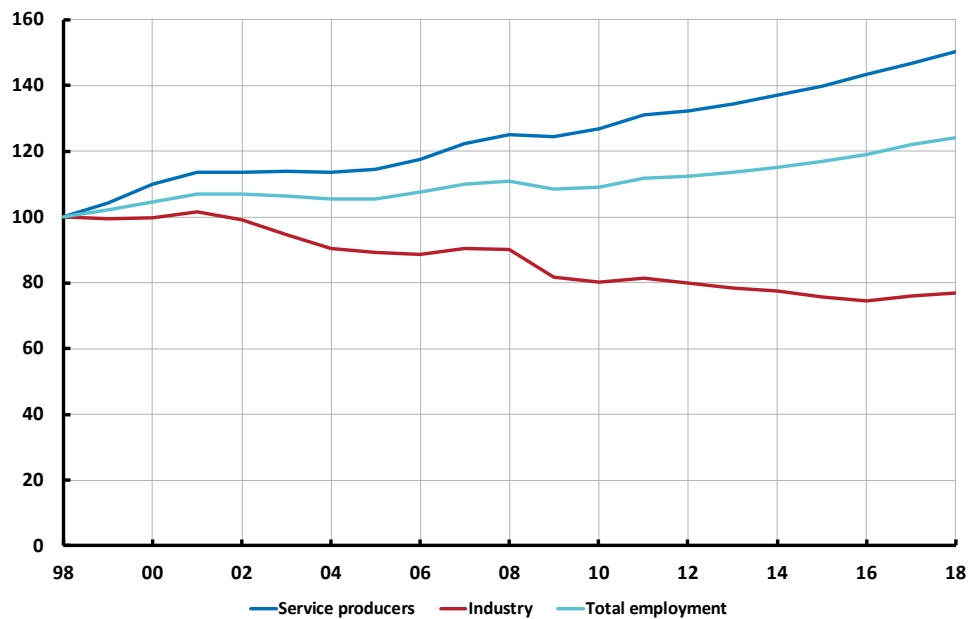
## Employment has increased in the service sector and decreased in industry

In a longer-term perspective, employment in Sweden has decreased in industry and increased in the service sector (see diagram 4). Some of this development may be due Swedish industry having automated its production to a high degree. In 2017, the Swedish

manufacturing industry had 240 robots per 10,000 employees, which is fewer than in certain Asian countries and in Germany, but significantly more than in the United States and in Europe on average (see diagram 5). In countries that use robots to a lesser degree, automation may continue to have relatively substantial effects on employment. Swedish empirical studies show that the number of jobs that are highly likely to be automated has fallen, especially in the manufacturing industry.<sup>7</sup> Studies have also found similar employment effects of industrial robots in other countries.<sup>8</sup> In Germany, research shows that for every industrial robot, employment in industry has decreased by two employees.<sup>9</sup> However, one effect of automation is that industry is now hiring much more highly educated labour in Sweden. This also applies to industry-related services.<sup>10</sup> One explanation for this may be that digital technology is now a complement to large groups of employees in industry.

**Diagram 4. Trend in the number of employed persons in industry, service producers and in total**

Index 1998=100



Note. Service producers refer to SNI2007 codes G45-T98 and industry refers to codes B05-C33.

Sources: Statistics Sweden

<sup>7</sup> See, for instance, Heyman (2016).

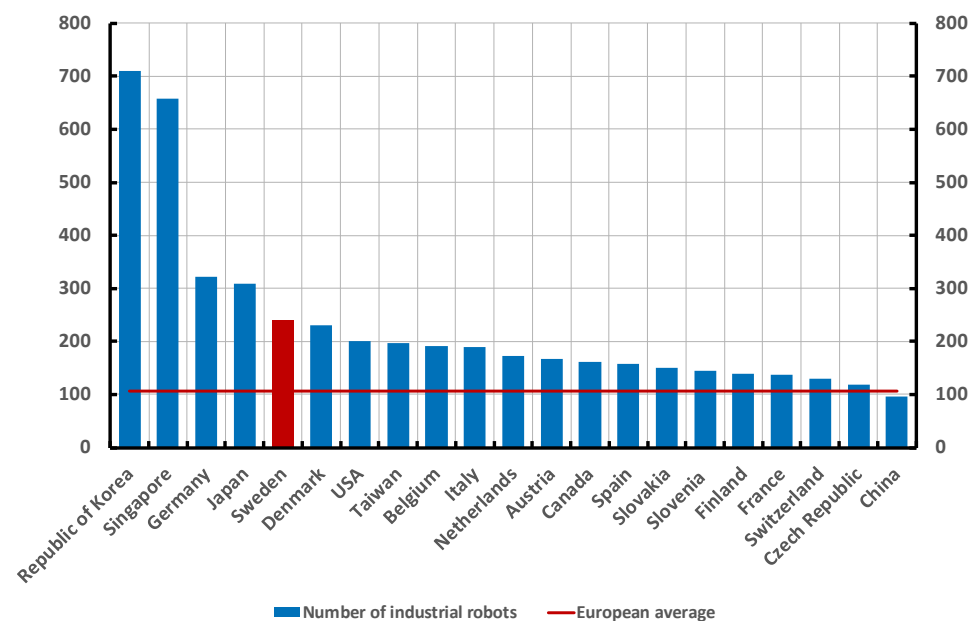
<sup>8</sup> Graetz and Michaels (2018) and Dauth et al. (2017).

<sup>9</sup> Dauth et al. (2017).

<sup>10</sup> Economic Council of Swedish Industry (2017).

**Diagram 5. Number of robots in the manufacturing industry in different countries in 2017**

Number of robots per 10,000 employees



Source: International Federation of Robotics (2018).

The reduced employment in industry is due not only to automation but also to greater specialisation.<sup>11</sup> Specialisation means that industrial companies buy more corporate services, for example computer consultant, legal, PR, security and cleaning services, instead of producing these themselves. These are reported in service sector employment when industry buys services but in industrial employment if industrial companies produce the services themselves. Therefore, specialisation leads to fewer reported employees in industrial sector.

The reduction in industrial sector employment has been more than fully compensated for by an increase in employment in the service sector. Total employment has therefore increased (see diagram 4). Technological change with more digitalisation and automation is also expected to affect the service sector. However, the process has not reached as far in the service sector as in industry. The scope for digitalisation and automation varies within the service sector, depending on the nature of the jobs and tasks involved. Certain service professions, such as hairdresser or chef, may be difficult to automate. In the Riksbank's business survey, companies in consumer-related service sub-sectors believe that technological change will lead to fewer employees within a few years' time.<sup>12</sup> In the trade sector, for example, there are large groups of cashiers, warehouse workers and shop assistants who can be replaced by automated solutions. The subsequent effect on total employment will depend on what other job opportunities arise in the economy and how adaptable the labour force is. In the longer term, all historical experience suggests that new jobs will be created in some part of the economy.

## Demand for different groups on the labour market has shifted

Even though technological change so far has not reduced total employment, the demand for different types of labour has clearly shifted. New technology can either replace or be a complement to labour. The effects of technological change therefore vary among

<sup>11</sup> Economic Council of Swedish Industry (2017).

<sup>12</sup> Sveriges riksbank (2018).

occupations and affect different groups in the labour force differently. A long-term trend on labour markets in many countries is the polarisation of jobs, that is, that employment has risen in occupations that were at the bottom and the top of the wage distribution 20–30 years ago and has reduced relatively speaking in occupations that were in the middle of the wage distribution 20–30 years ago.<sup>13</sup> There are many possible explanations for the observed job polarisation, but some that are often considered as the most important are the automation of routine tasks, more global value chains and the offshoring of jobs. The medium wage occupations that have decreased are more routine jobs that are easy to automate. In the lower part of the wage distribution, there are many service occupations that are difficult to automate but neither do they derive any major benefit from technology. In the upper part of the wage distribution, there are jobs that are more ‘abstract’ in nature and therefore difficult to automate. In addition, these abstract jobs derive benefit from technology, that is, technology is a complement to these jobs. Adermon and Gustavsson (2015) find that differences in the amount of routine tasks in various occupations could explain 44 per cent of the observed job polarisation in Sweden. Job polarisation is taking place both within and between firms.<sup>14</sup>

Many studies have used wages as a measure of competence and skills on the labour market. However, empirical studies show that the return on various skills has changed on the labour market over time and that wages are therefore not a good measure of specific skills. The significance of physical attributes, such as strength, has decreased on the labour market and the return on cognitive skills has fallen.<sup>15</sup> At the same time, the return on social and non-cognitive skills<sup>16</sup> has increased over time.<sup>17</sup> These changes in return on various skills has a strong connection to changes in the nature of tasks.<sup>18</sup> The demand for employees with technical and verbal abilities and social maturity has increased during the 2000s in Sweden. Research also shows that employment has grown among those with high intellectual competence and even those low-wage jobs that have increased in Sweden require relatively high intellectual skills.<sup>19</sup> Forecasts of the demand for various occupations suggest that this increased demand for non-cognitive skills will probably continue.<sup>20</sup> This implies that investment in education and enhancing the skills of the labour force are important for how employment and unemployment will develop going forward.

## Wage dispersion has increased slightly in Sweden

There is quite convincing empirical evidence of job polarisation which shows that employment in medium wage jobs has decreased in many countries, while it has increased in both low and high wage jobs. Decreasing employment in medium wage jobs can put pressure on wage development in low wage jobs as competition for jobs increases. In the United States, it is clear that wage development has also become more polarised.<sup>21</sup> Wages have increased faster for highly educated workers and wage dispersion has increased between those with low levels of education and the highly educated. However, job polarisation as such does not need to lead to wage polarisation. In Sweden, wage increases have been relatively

<sup>13</sup> See, for instance, Goos et al. (2009) for results for European countries and Adermon and Gustavsson (2015) and Hensvik and Skans (2019) for results for Sweden.

<sup>14</sup> See Goos et al. (2014) and Heyman et al. (2016).

<sup>15</sup> Cognitive skills include, for example, literacy and numeracy.

<sup>16</sup> Non-cognitive skills concern individual attitudes, behaviour and social and emotional aspects. They can include things like self-perception, motivation, cooperative ability, self-discipline, social maturity and emotional stability. These are measured using combinations of various psychological tests.

<sup>17</sup> See, for instance, Deming (2017) for the United States and Edin et al. (2018) and Hensvik and Skans (2019) for Sweden.

<sup>18</sup> Cortes (2016) and Böhm (2017).

<sup>19</sup> Hensvik and Skans (2019).

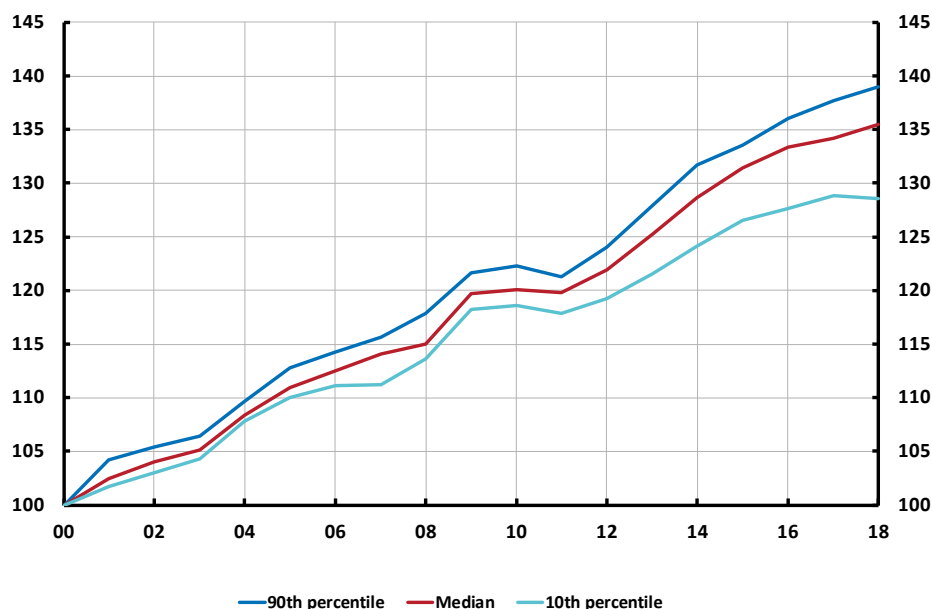
<sup>20</sup> Based on 10-year forecasts of occupations made by the US Bureau of Labor Statistics, which historically have also been relatively accurate for Sweden, see Edin et al. (2019).

<sup>21</sup> Autor and Dorn (2013).

equal across the wage distribution and the variation that can be seen has not been systematically linked either to level of education or nature of tasks.<sup>22</sup> Wage dispersion has increased slightly in the lower part of the wage distribution over the last decade. This can be seen in diagram 6 as slightly lower increases in real wages for those with the lowest wages (10th percentile) compared with the median wage and with the development of real wages for those with the highest wages (90th percentile). The slightly lower increases in wages in the lower part of the wage distribution may be associated with the increased supply of relatively low-qualified labour due to refugee immigration. However, real wages have increased in all parts of the wage distribution. Wage dispersion in the upper part of the wage distribution has not changed substantially since the start of the 21st century.<sup>23</sup> One reason that wage differences have not increased so much may be that wage setting in Sweden is highly coordinated.

**Diagram 6. The development of real wages for various wage percentiles**

Index 2000=100



Note. Wage distribution is based on the full-time equivalent monthly wage. For 2000–2013, the wage data include employees aged 18–64 years. For 2014–2018, the wage data include employees aged 18–66 years. The nominal wages are deflated using the consumer price index. The lines are for the 10th, median and 90th percentile in the wage distribution each year.

Source: Statistics Sweden

Empirical research shows that Swedish workers in occupations that have decreased in number due to technological change have received an average of 2–5 per cent lower incomes over a 30-year period, compared with similar workers in stable occupations.<sup>24</sup> The incomes are lower because workers in declining occupations have been without work more often, for example they have been unemployed or have retired earlier. While the average income losses seem to have been relatively limited, the costs of having a declining occupation are significantly larger for workers in the lower part of the earnings distribution, 8–11 per cent measured over a 30-year period. Even employees with long tenure and older workers can suffer large earnings losses if they lose their job due to technological change.<sup>25</sup> This is because their knowledge may be firm specific or obsolete, and because older unemployed

<sup>22</sup> See Adermon and Gustavsson (2015).

<sup>23</sup> Median wages have thus increased at approximately the same rate as the 90th percentile's wages.

<sup>24</sup> Edin et al. (2019).

<sup>25</sup> Jacobson et al. (1993) and Gathmann et al. (2018).

people run a higher risk of becoming long-term unemployed. The economic conditions at the time of job loss matter for the individual losses in earnings.<sup>26</sup> In an economic upswing, it is easier to find a new job than it is in a downturn and the costs of losing a job due to technological change are therefore larger in downturns.

## Technological change has contributed to new forms of employment

In addition to the polarisation of demand for labour, technological change has also contributed to the emergence of new, more flexible forms of employment, for example so-called gig jobs on various local and global platforms for exchanging services.<sup>27</sup> These platforms enable clients and contractors to be matched with each other instantaneously, and even to interact globally if the task can be performed at a distance. This has increased employers' ability to use labour more flexibly. The job platforms have also made employment possible for groups that would otherwise have found it difficult to enter the labour market.

However, these new, assignment-based jobs mean that workers have less job security and are more vulnerable to fluctuations in demand. Technological change can therefore lead to increased inequality on the labour market, where certain groups of employees have secure and well-paid jobs, while other groups have little job security and low-paying jobs. This, in turn, increases income inequality in the economy. In many countries, income inequality has also increased heavily. Income inequality has also increased in Sweden, but this is not due primarily to increased wage dispersion but rather because compensation from social insurance for those who are not working has increased much less than wages have and because the risk of becoming unemployed or leaving the labour force is not evenly distributed across the labour force.<sup>28</sup> A further negative effect of short-term and insecure jobs is that innovations and productivity growth can be affected negatively in the long term if more flexible forms of employment mean that employers invest less in their employees' training and skills.

Performing gig jobs via local and global digital platforms is relatively unusual in Sweden. According to a survey, 10 per cent of all persons in the ages 16–64 years in Sweden had performed work via a digital platform in 2016–2017.<sup>29</sup> However, few have these gig jobs as main employment, as just under 3 per cent of respondents earned at least 50 per cent of their income from work via a platform and just under 5 per cent had performed such work at least once a week. The survey showed similar results for other European countries.<sup>30</sup> Another investigation in Sweden, from 2016, showed that a significantly lower proportion, 2.5 per cent, had performed any work via digital platforms over a year and that only 14 per cent of these earned at least 50 per cent of their income from work via digital platforms.<sup>31</sup> There is insufficient data on how many people work via various digital platforms in Sweden and other countries. However, the number of assignments mediated by various global digital platforms does not seem to have increased since the middle of 2017 (see diagram 7). Nevertheless, it is difficult to say whether this means that the platforms have achieved saturation.

<sup>26</sup> Davis and von Wachter (2011) and Edin et al. (2019).

<sup>27</sup> Examples of global digital platforms for exchanging services include Amazon Mechanical Turk, Baidu and Upwork. Examples of local digital platforms, where the actual work is not performed digitally, include Foodora, Uber and Taskrunner.

<sup>28</sup> See, for example, the Swedish Fiscal Policy Council's report (2018).

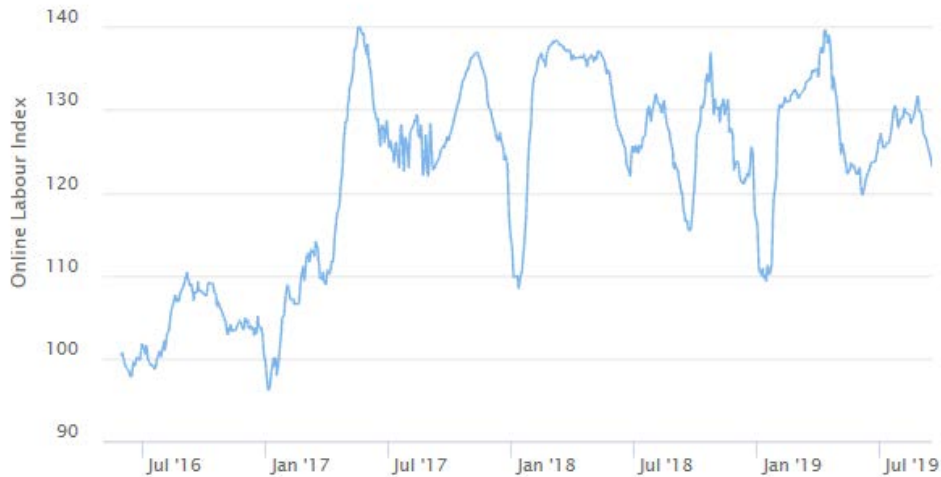
<sup>29</sup> Huws et al. (2017). It is unclear how representative the study is for the entire population. Surveys of this kind can provide higher estimates of contractors than are found on the platforms. The result should therefore be interpreted with great caution.

<sup>30</sup> Huws et al. (2017). In seven European countries investigated, between 1.6 and 5.1 per cent of the population is estimated to earn at least half its income from platform jobs and between 4.7 and 12.4 per cent work with an assignment each week.

<sup>31</sup> SOU (2017).



**Diagram 7. Amount of assignments on digital job platforms measured using the Online Labour Index**  
Index, July 2016=100, 28-day moving average



Note. The Online Labour Index measures the amount of assignments present on the five largest English-language digital job platforms. The index covers at least 70 per cent of the volume of assignments on the market.

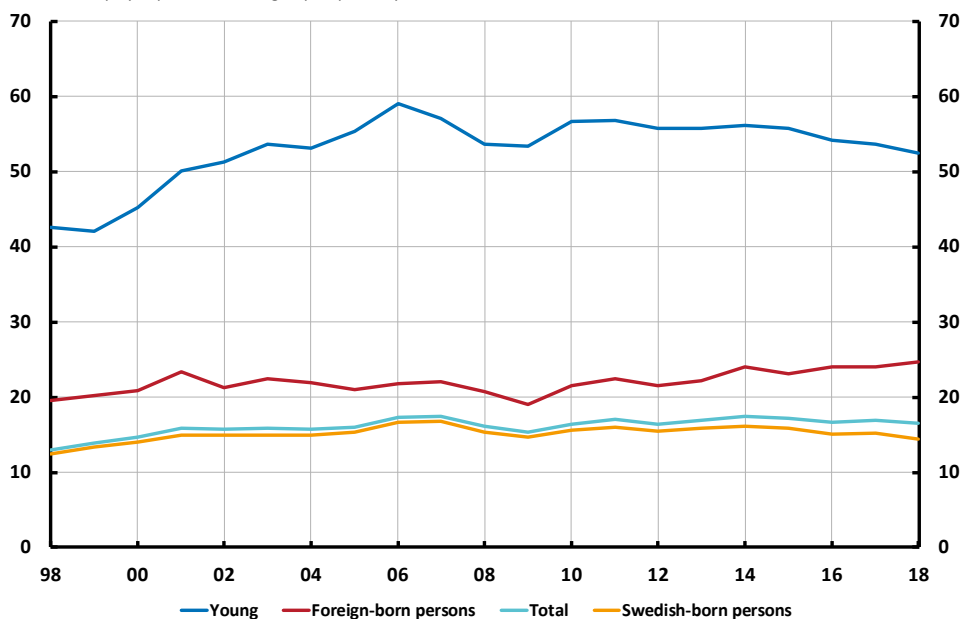
Source: Oxford Internet Institute.

## Fixed-term employment contracts and self-employment have not generally increased in Sweden

The development of the Swedish labour market is most usually described using Statistics Sweden's labour force surveys (LFS) and these new types of job should also be captured there, in principle. However, it is unclear how well the LFS measure jobs with very short duration. Fixed-term employment contracts have increased over time among young people and foreign-born persons (see diagram 8). However, the total proportion of those in employment who have fixed-term contracts has been more or less unchanged over the last decade. The number of self-employed people, which many gig workers can be classified as, has fallen as a proportion of total employment. All in all, there are no strong indications in the statistics that new, more flexible forms of employment have pushed aside permanent contracts in Sweden to any great extent.

**Diagram 8. Proportion of employees with fixed-term contracts among young people (15–24 years), Swedish-born and foreign-born persons, and total 15–74 years**

Per cent of employed persons in each group respectively



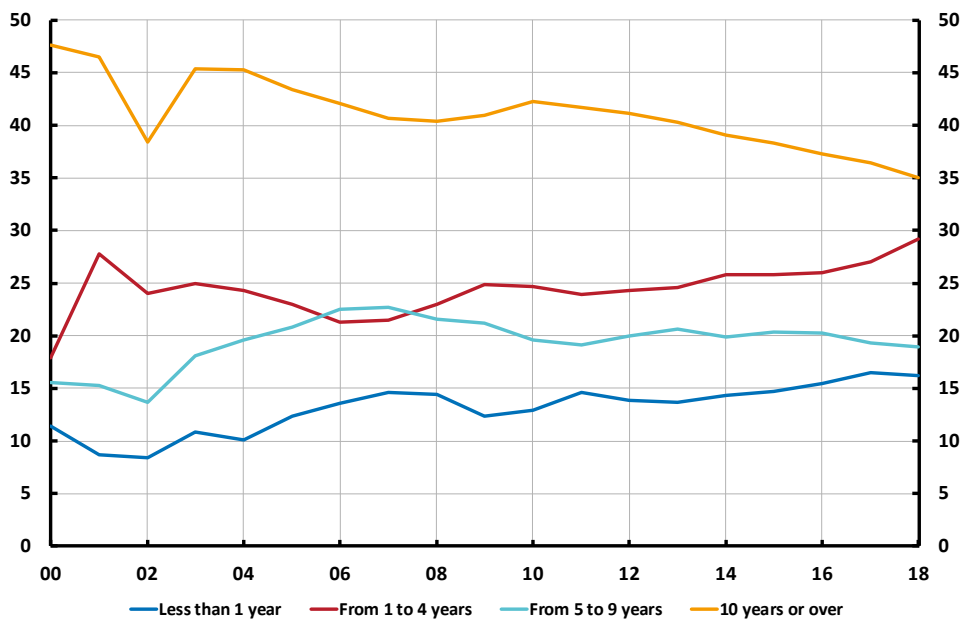
Note. Break in time series in 2001 and 2005.

Source: Eurostat.

However, there are some signs that the labour force in Sweden has become somewhat more mobile over time. The proportion of employees with the same job for at least ten years has fallen and the proportion with shorter job tenure (up to four years) has increased (see diagram 9). This could partly be an effect of the more rapid growth of employment and the labour force in recent years.

**Diagram 9. People in employment (25–74 years) by job tenure**

Per cent of employed persons



Note. Break in time series in 2001 and 2005.

Source: Eurostat

## Wage formation could be affected if insecure employment contracts increase

The rapid rate of technological change and automation in the manufacturing sector may have restrained wage increases there. Since the manufacturing sector sets the benchmark for the economy-wide wage increases in the Swedish pattern-bargaining model, it may also have contributed to slower wage increases in the entire economy. Over time, wage setting has become somewhat less centrally determined since wage agreements where wages are set entirely in local wage negotiations have been introduced for some groups of employees. However, it is unclear how much this has changed wage setting in practice, as the local wage agreements also seem to follow the industrial agreement's benchmark.<sup>32</sup> Increased global competition between firms has probably also contributed towards restraining wage growth. If more people start working under various atypical forms of employment with short-term and insecure employment contracts, the relevance of collective agreements will probably decline in Sweden. This means that minimum levels for employment conditions and wages would lose significance. An increasing number of workers with less secure jobs reduces wage pressure in the economy.

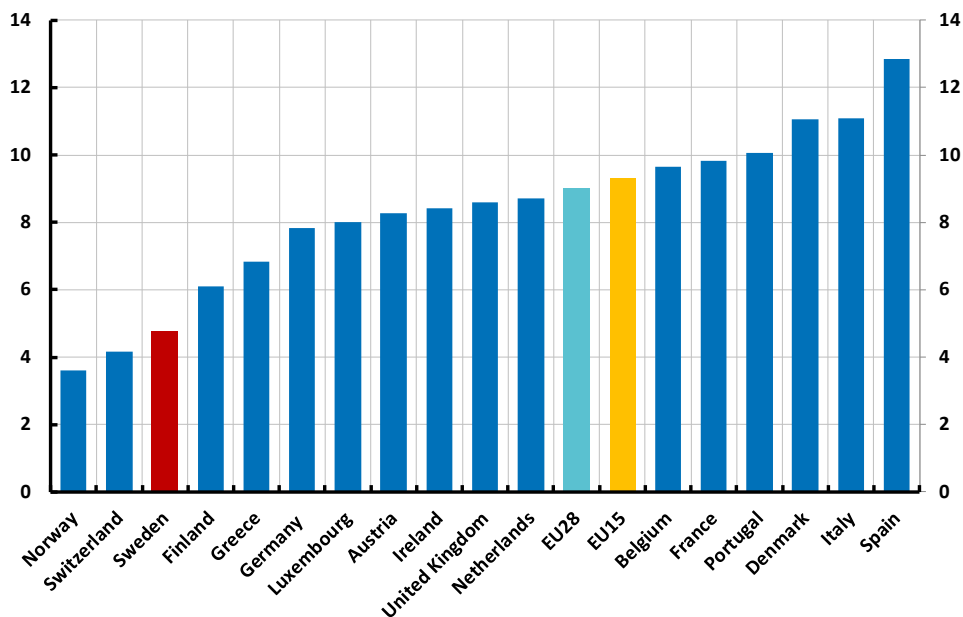
There is a large variation in how qualified the jobs available on the digital job platforms are. Some jobs are highly qualified, while others are low-paid jobs that do not require much education or experience. An interesting question is which other job opportunities a worker has if he or she works with various types of unqualified gig jobs in Sweden, and whether these jobs can act as stepping stones to better paid jobs. The share of elementary jobs, which is to say jobs with no particular requirement for education or experience, is less than 5 per cent of employment in Sweden. This is a small share from an international perspective (see diagram 10). The share of elementary jobs has also been unchanged in Sweden over the last 30 years, even though the number of people in the labour force with low qualifications has increased strongly due to refugee immigration. The new types of job that have emerged through various digital job platforms could be important for entry into the labour market and they could be the only alternative for some groups. However, there is also a risk that income inequality will increase if the new jobs do not offer a stable or sufficiently high income. The risk is greatest for those with low level of education. More research is needed on what these platform jobs mean for people with a very low probability of finding work.

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<sup>32</sup> See National Institute of Economic Research (2018).

**Diagram 10. Share of elementary jobs 2018**

Percentage of employed persons aged 15–74 years



Note. Elementary jobs are jobs with no particular requirement for education or experience.

Source: Eurostat.

## A strong focus on education and skills development are needed to help the adjustment of the labour market

Typically, technological change replace some occupations and tasks but form a complement to others. It is therefore difficult to know how new technologies will affect the labour market in the long term. The labour market is constantly changing and has always done so. Nevertheless, of course, the historic fact that the labour market has managed to adapt to new conditions is no guarantee that it will continue to do so in the future.

The rapid technological changes are placing demands on the labour market's ability to adjust. Mitigating the effects of a rapid structural change and increasing inequality on the labour market will require a major focus on education and skills development. Some regulation of new, less secure forms of employment may be needed, alongside adjustments of social insurance and the tax system to these.<sup>33</sup> Effects of structural change tend to be noticed more on the labour market during downturns, when more businesses shut down at the same time as it becomes more difficult for those who have lost their jobs to find new ones. Consequently, there may be a particular need for resources to help the adjustment of the labour market in the next recession.

<sup>33</sup> See, for example Dølvik and Jesnes (2018).

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