Research for new economic policies

NERI Working Paper Series

The Future of Work: The impact of automation technologies for job quality in Northern Ireland

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February 2019

NERI WP 2019/No 60

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THE FUTURE OF WORK:
THE IMPACT OF AUTOMATION TECHNOLOGIES FOR JOB QUALITY IN NORTHERN IRELAND

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Keywords: Automation, Robotics, Employment, Technological Change, Technological unemployment; job quality; Future of work.

JEL Codes: D0; J0; J2; O33.

Rapid advancements in artificial intelligence, robotics and other forms of automation technologies have led to a re-emergence of 'automation anxiety' and concerns about the future of work. While automation may destroy some jobs, an equal or greater number of jobs will likely be created in the aftermath. In order to assess the impact of this for workers it is necessary to evaluate not just the jobs lost, but also those that are subsequently created. To-date, technological advancements and other megatrends such as globalisation have reduced employment across advanced economies in sectors such as manufacturing and occupations, predominantly characterised by routine tasks. While the economy has since created enough new jobs to avoid net losses, it has not necessarily been replacing like with like.

We seek to evaluate previous employment adjustments in terms of job quality to understand how impending automation technologies may affect the quality of jobs in the future. We find that the trend of occupational polarisation is likely to continue as routine-biased technological change spreads throughout the economy. We also find that some of the industries and occupations with the lowest risk of automation are more susceptible to lower levels of job quality in Northern Ireland. The commodification of labour in some of these poor-quality jobs prevents an upward revaluation of this work and thus, making it is unlikely that job quality will improve without some direct policy intervention. In policy terms, an increasing role for trade unions and collective bargaining should be combined with social security support for transitioning workers. A broader focus on skills policy is needed at all levels.

This version: 22.2.19

* This NERI Working Paper forms part of an NERI project on the related areas of growth, enterprise, industrial, and innovation policy in Northern Ireland and in the Republic of Ireland. ** The authors gratefully acknowledge helpful feedback from a number of reviewers. The usual disclaimer applies. All correspondence to paul.macflynn@nerinstitute.net or lisa.wilson@nerinstitute.net.

THE FUTURE OF WORK:

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1. INTRODUCTION

Rapid advancements in artificial intelligence, robotics and other forms of automation technologies have unsurprisingly led to a re-emergence of 'automation anxiety' and suggestions by some that we are near the 'end of work'. Foster and Wilson (2019) look at the extent to which automation technologies may have a labour substituting effect. Whilst that paper gives estimates of the risk of job loss for particular groups and cohorts, it also emphasises that there are many constraints that will limit the implementation of automation technologies. Furthermore, much of the literature argues that while some jobs will be lost, technological advancements will generate new jobs and so there will not be a net technological unemployment effect.

The fact that the job creation effect of technological advances is predicted to outweigh the job loss effect, has led some commentators to suggest that we do not need to be concerned with the impact of automation technologies for the labour force. However, just because a worker who has lost their job due to automation technologies finds another job to replace the one lost, does not mean that advances in technology are not having an impact. What is the job lost? What is the replacement job? What is the newly created job? and How do each compare to the other in terms of quality? These are all important factors to take into account when considering the effects of technological advancements for the labour market.

While much of the attention in the media has focused on job losses from advances in automation technologies, there has been little focus on the quality of jobs lost and the quality of jobs that have been 'replacing' them. We argue the fundamental importance of giving consideration to job quality when thinking about the impacts of automation technologies on the labour market.

In this paper we show that new jobs created are often not comparable to those that have been lost, and to think of them as replacement jobs can be quite misleading. New jobs are likely to be in different occupations to the jobs that are lost, and more importantly they also differ in quality.

There has been a polarisation in terms of the occupational structure, with employment growth predominately concentrated in non-routine abstract/cognitive occupations, such as professional occupations and non-routine service occupations, such as caring and leisure

occupations. In terms of quality, the evidence suggests that the growth in non-routine abstract occupations has led to an increase in jobs which are of relatively 'good' quality, whilst the growth in non-routine service jobs has meant that there has also been an increase in relatively 'poor' quality jobs. From this one can conclude that, to-date, technological advancements have led to a polarised labour market comprised of winners and losers.

This has significant implications for what we understand to be the implications of automation. In policy terms, the response to automation technologies has focused on issues such as training and upskilling. Policy has paid less attention paid to workers who will not 'move up' but will move into another job of lower quality.

We argue that while certain industries will decline and occupations become redundant, there is nothing inevitable about the trajectory of job quality. The social, political and economic environment in which automation occurs will determine the quality of replacement jobs and policy can intervene here to provide better outcomes. Therefore, it should be possible to embrace technological innovation and create good jobs at the same time.

In the rest of this paper we set out the context of how policy can respond to an impending significant shift in the labour market. Section 2 outlines how mega-trends such as automation can impact the labour market alongside possible outcomes. Section 3 outlines how previous events have shifted the labour market in terms of its composition, and section 4 looks at how that new composition compares in terms of job quality. Section 4 also looks at how recent developments in employment arrangements may have contributed to the quality of newly created jobs. In light of these findings, section 5 discusses the policy options available to protect job quality.

2. TECHNOLOGY, EMPLOYMENT AND THE DISPLACEMENT OF WORKERS

2.1 THE DISPLACEMENT OF WORKERS: JOB LOSS AND TECHNOLOGICAL UNEMPLOYMENT

Recent studies concerned with the impact of technology and automation for employment have tended to focus primarily on the ability of technology to substitute for human labour. Much of the focus of this stream of literature has been to estimate the destruction effect of technology and thus the risk of job loss. The seminal paper was published by Frey and Osborne (2013) which set out the likelihood of using what has been termed the 'occupation based' methodological approach. Notably, based on this methodology Frey and Osborne (2013) estimate that about 47 per cent of total employment in the USA is at high-risk of automation, 19 per cent is at medium-risk, and 33 per cent is at low-risk, over the next two decades. Other researchers have extrapolated their methodological approach for other countries and regions. For example, applying the same methodology to the UK labour market Frey and Osborne (2015) estimate that 35 per cent of jobs are at high risk, 22 per cent are at medium risk, and 43 per cent are at low risk of automation over the next ten to twenty years.

Other studies question the methodological approach taken by Frey and Osborne (2013; 2015) and in particular query their focus on occupations in estimating the risk to jobs from automation technologies. Arntz *et al* (2016) point to the fact that since automation usually aims at automating certain *tasks*, rather than whole occupations, the potential for automating entire occupations is likely to be much lower than that suggested by the occupation-based approach. Building on Frey and Osborne's (2013) study Arntz *et al* (2016) follow the same methodological approach, but relax one of the major assumptions. Specifically, Arntz *et al* (2016) use individual survey data which captures a comprehensive list of the tasks that workers actually perform at their workplace. This allows for the fact that individuals within the same occupational group often perform quite different tasks, with implications for an estimation of the risk of jobs to automation. This allows for a more convincing estimate of the risk to jobs from automation. This methodological approach is termed the 'task-based approach'.

Arntz *et al* (2016) estimate the risk of automation for jobs across 21 OECD countries and find that 7 per cent of jobs are at high risk of automation. The estimated 'high risk' share is highest in Germany and Austria at 12 per cent, and lowest in Korea and Estonia at 6 per cent. They estimate that in the UK just over 10 per cent of jobs are at high risk of automation, whilst the estimate is lower in the Republic of Ireland at 7 per cent. Using the same approach Foster and Wilson (2019) find that 7 per cent of jobs in Northern Ireland are at high risk of automation (probability of automation higher than

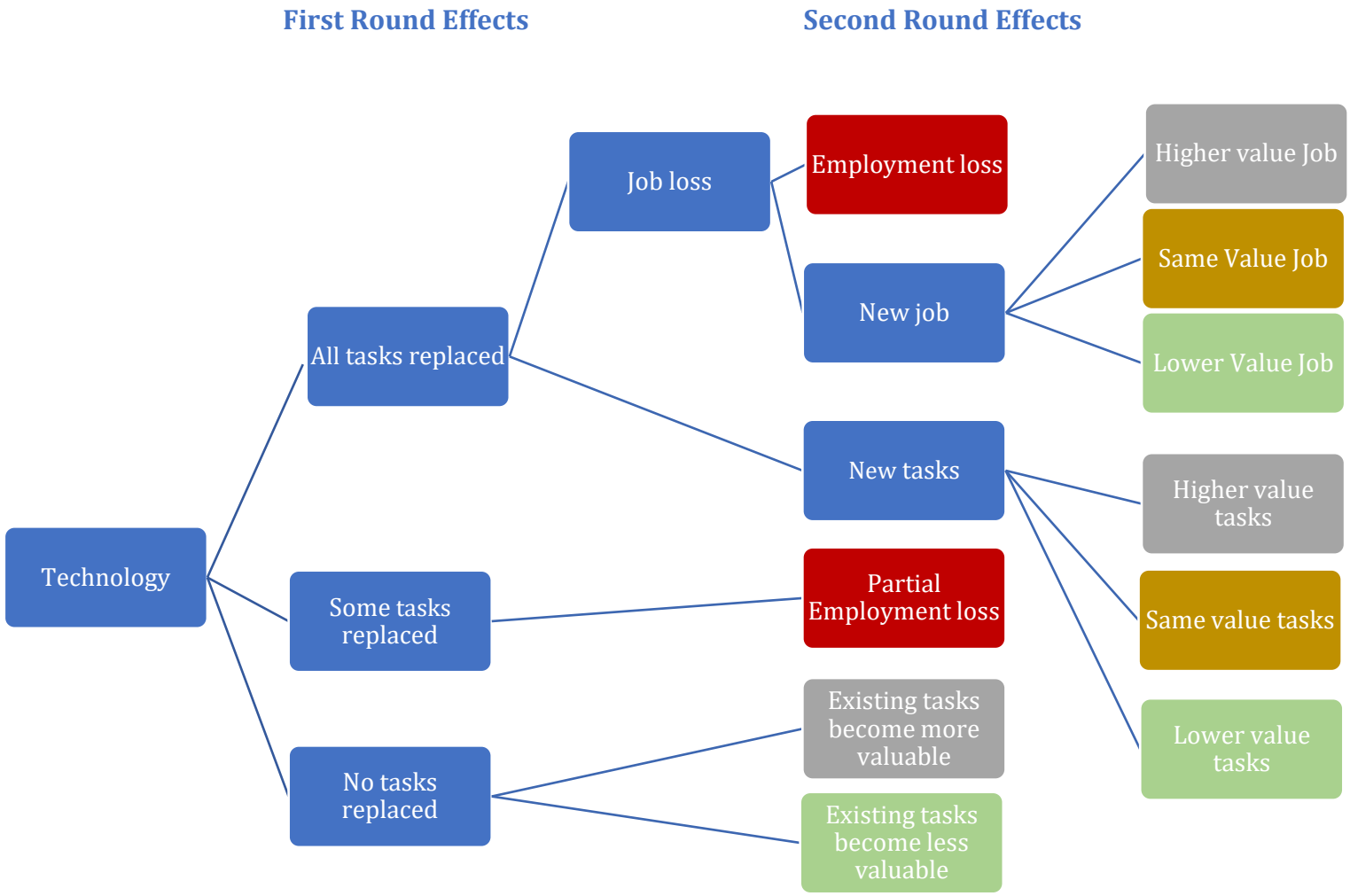
70 per cent) and a further 58 per cent (defined as a probability of automation between 50 per cent and 70 per cent) of jobs are at risk of substantial change in their task structure.

Nevertheless, despite differences in the methodology used and differences in the estimated number of jobs at risk from automation technologies, it is notable that much of the recent focus has been on the risk of job loss (Frey and Osborne, 2013; 2015; Arntz *et al*, 2016). In this sense, when seeking to assess the impact of automation technologies for the future of work researchers have tended to conduct ex-ante evaluations of the expected job losses. This is understandable and one would expect that a body of work focused on the employment implications of automation technologies would begin with a focus on the first-round effects, which we would expect to be labour substitution.

Still, while previous periods of technological advancement did cause some job losses, they have also tended to produce a job creation effect. Employment numbers have continued to grow alongside technological advances, so, over the long-term, technological innovations have had a net employment creation effect (Autor, 2014). This 'job quantity effect' has led to the widespread acceptance that technological advancements have contributed to improved labour market outcomes has arisen.

However, just because overall employment numbers have continued to grow does not necessarily mean that we can conclude that the net labour market effects have been wholly positive. This is an impetuous conclusion which ignores the fact that technology can displace workers in ways other than via unemployment or job loss. Moreover, this conclusion gives priority to the importance of job quantity over job quality, thus disregarding the fact that not all replacement jobs or new jobs are created equal to the ones that are lost. For instance, technological advances can lead to job loss, but not necessarily unemployment, if one finds another job. However, what the job lost is, what the replacement job is, what the newly created job is, and how each compare to the other in terms of quality are all important factors to take into account when determining the effects of technological advancements for the labour market. To understand the labour market impacts of technological advancements there is a need to think, at once, about the different types of displacement, and the quality of both the jobs lost and the jobs created which result from the disruption.

Figure 1: Theoretical Framework outlining the potential impacts of automation technologies for employment



2.2 FORMS OF DISPLACEMENT ARISING FROM TECHNOLOGICAL ADVANCES

Figure 1 above sets out a framework outlining the various ways in which automation technologies may effect different workers:

(a) at high risk of job loss;

(b) likely to experience substantial change in terms of the task structure involved in their job;

(c) facing little risk of job loss or job change, but whom are still likely to face indirect impacts.

We begin with the potential impacts for those who are at high risk of job loss because technology replaces all of the tasks involved in your job. In this case a further two possibilities arise; you could either have your labour redirected toward other tasks within your existing job or you could lose your job. If you lose your job, in some circumstances you may become structurally unemployed. For those who do find a new job, that new job can be either better, worse or the same in value terms as the job you previously held. The same applies to those offered new work in their existing job. That new work is either better, worse or of the same value as what went before.

Previous studies examining the long-term impact of job loss retrospectively identify scarring effects in terms of wages and employment opportunities (Flaim and Sehgal, 1985; Ruhm, 1991; Podgursky and Swaim, 1987). Quintini and Venn (2013) find that a large proportion of those whose jobs are lost, do not become re-employed within two years. Re-employment rates vary significantly across countries, ranging from around 30 per cent in France and Portugal to more than 80 per cent in Finland and Sweden. Research has shown that the working conditions of those who are re-employed are not necessarily equivalent, with those affected tending to end up in jobs of poorer quality when compared to the job lost. Moreover, these earnings and employment scarring impacts from subsequent reemployment are not distributed evenly among the workforce. Older workers and workers with social or geographical constraints are more likely to experience wage disruption or even employment loss. Specifically, Fallick (1996) estimate that local area and local economic conditions have sizeable influences on the wage and employment possibilities of displaced workers. Deelin *et al* (2018) focus on the differing long-term impacts of job loss for prime age and older workers, and find that the latter are more prone to adverse outcomes on both fronts. Importantly, however, Keltzer and Fairlie (2003) find that while younger workers are less likely to experience earnings loss, they are more likely to experience loss of rapid earnings growth, which reduces their lifetime earnings potential.

The second potential impact of automation technologies is where technology replaces some, but not all of your labour input. Here, there are three possible subsequent outcomes. If some of your tasks are replaced by automation technologies there is a possibility of partial employment loss, if there are no additional tasks given to replace the tasks lost. Another option in this circumstance is that if technology replaces some of your tasks, a firm may choose to downsize its workforce to adjust to the lower labour requirement which would lead to job loss for some workers and a change in the task structure involved in the remaining workers jobs. The subsequent outcomes here are the same as they are in the first major impact. The third potential impact is that the portion of the labour input that was previously assigned to the tasks replaced by technology is now redirected toward new tasks. These new tasks can be of higher, lower or equivalent value to those replaced.

The third and final potential impact of automation technologies for employment is an indirect impact, and applies to those whose labour input is not directly affected by automation technologies. Thus, while the scope for substitution of labour is bounded by the fact that there are many tasks that cannot be substituted for by machines, the value of this labour has the potential to be impacted indirectly by the technology. This is because the value of labour input into production is a relative concept and therefore changes in technology can make some tasks more or less valuable then they were before without any material change to the labour input (Morrison and Siegel, 2000). In this case, the impact is either positive or negative in terms of value.

If the labour input can be displaced by automation directly or indirectly, the value of the remaining or new tasks is determined by three main factors. First, determination of value depends on whether the labour input supplies tasks which are either substituted for or complemented by machines. If technology is an imperfect substitute for labour input, it cannot replace labour directly but provides an alternative process or method of production, which can challenge the value of the labour input. Technology that is an imperfect substitute is likely to negatively impact on the value of that workers labour. A commonly used example is the one of the construction worker, who may be an expert with a shovel, but cannot drive an excavator. As automation technology advances, it is likely that the value of the labour of the construction worker will fall (Autor, 2015). However, if the labour input supplies tasks that are complemented by automation technologies, but which are still nonetheless necessary, it is likely that the value of the remaining tasks increase. The work involved in an economist's job provides an example of this. Whilst computer and software technologies aid the tasks involved in an economist's job in terms of making data collation and data analysis much more efficient, it remains

that the labour input of the economist is still required in terms of using creative and social intelligence to both ask the appropriate questions of the data and to interpret the results found.

Secondly, the available labour supply will be an important determinant of whether the value of jobs wholly or partially resistant to technology substitution will increase or decrease. If the skills required to complete the tasks involved in these jobs are abundantly available elsewhere in the economy or if there is a growth in the demand for jobs in occupations and sectors which face the lowest risks from automation technologies then it is highly plausible that the availability of labour supply will temper any wage gains. Autor (2015) goes on to state that the available labour supply will be confounded by the skills-level of non-substitutable tasks. Thus, if the tasks involve high-level skills which are in limited supply or require a period of education or training, the labour supply is likely to be tempered, at least in the short to medium term, and so for this set of workers we might expect an increase in the value of the remaining tasks. If on the other hand, the tasks involved do not require specific skills sets or if there is a lack of recognition of the skill, it is likely that available labour supply will place downward pressure on value, including from workers displaced from other sectors.

Thirdly, Autor and Dorn (2013) point out that the recent focus on job loss succumbs to the 'lump of labour' fallacy, and ignores the broader macroeconomic capacity for labour adjustment away from occupations and sectors at highest risk from automation technologies, towards new occupations and sectors which are less susceptible to automation. The reasoning here is that because demand for products which cannot be produced by technology tend to be strongly income-elastic, the rising productivity from sectors which have implemented technological innovations should, in the end, boost employment and value in jobs which are unable to be substituted for by machines. By this logic advances in productivity in non-labour-intensive areas should increase real purchasing power, which can subsequently support more spending (and jobs) in labour intensive industries such as healthcare etc (Baumol, 2012).

Figure 1 describes how an individual worker might be affected by displacement arising from technology. Looking beyond individual impacts to the labour market as a whole, it is also possible to detect patterns in how workers are likely to be impacted by displacement and what that tells us about the jobs that will be created. The displacement which a given worker is likely to face is dependent upon their occupation. Two key alternative hypotheses have been put forward in the literature to explain why different occupations are likely to be impacted upon differently by technology.

2.2.1 Skill-biased technological change

One hypothesis used to explain differences in the occupational risk is commonly referred to as the 'skill-biased technological change' model (Katz and Murphy, 1992). The theoretical reasoning is that because skilled workers are more capable of adapting to technological change and having technology complement the work that they do, they are less likely to have their job replaced by machines. By the same logic, low-skilled workers are less capable of adapting to technology, are more likely to perform simple tasks, and thus are more susceptible to the risks posed by automation technologies (Acemoglu and Autor, 2011; Maeda and Yugami, 2016).

There is abundant empirical support for this thesis. Various studies demonstrate an increase in demand for high skill workers, an increase in the skills premium for higher skilled jobs, a stagnation of wages at other points on the distribution; and a widening polarisation of wages between high skilled and other workers (Crivellaro, 2014; Hanushek *et al,* 2015; Machin and van Reenan, 1998). This evidence underpins the emphasis on upskilling as a way of mitigating the risks posed by automation technologies (Nedelkoska and Quintini, 2018).

While the skill-biased technological change model provides an explanation for increases in the demand for high-skill workers; it fails to adequately account for more recent increases in the demand for workers at other points of the skills-distribution. Autor, Katz and Kearney (2006; 2008), Acemoglu and Autor (2011), Goos and Manning (2007), as well as others argue that the impact of technology for workers does not depend on whether or not the worker is in a high-, middle-, or low-skilled jobs, but rather depends on the tasks involved in different occupations. An alternative model has been put forward which emphasises the potential for technological change to replace occupations heavily reliant on routine, noncomplex tasks that can be easily codifiable by robotic or algorithmic processes (Autor *et al*, 2006; Autor and Dorn, 2013; Goos *et al*, 2009; Acemoglu and Autor, 2011; Handel, 2012). This theoretical model is what is called 'routine-biased technological change'.

2.2.2 Routine-biased technological change

The basic premise behind the routine-biased technological change model is that the likelihood that your job will be substituted (wholly or partly) for by machines is related to the specific tasks involved in your job (Autor *et al*, 2003; Sebastian and Biagi, 2018). Jobs involving predominantly routine tasks tend to be at higher risk from automation technologies. On the other hand, jobs with a higher incidence of non-routine tasks tend to be at lower risk, principally because machines tend to be much less capable of undertaking these tasks. According to the routine-biased technological change hypothesis, the production process is defined in terms of job tasks. Job tasks are allocated to either workers or to capital (automation technologies) depending on: 1) the degree to which they are automatable (repetitive and replaceable by code and machines); 2) their separability from other tasks; and 3) the relative costs of using machines versus humans. The routine-biased technological change model predicts that advances in automation technologies result in a decline in jobs with primarily routine tasks and an increase in the number of jobs whose tasks are predominantly non-routine in nature.

This theoretical model is supported by an increasing number of authors, including Goos *et al* (2015) Autor and Dorn (2013). Their reasoning is that whilst the skills-biased technological change model provides a useful framework for understanding changes at the higher end of the skills distribution, the routine-biased technological change model provides a more accurate framework of how and the reasons why automation technologies impact workers with particular tasks differently.

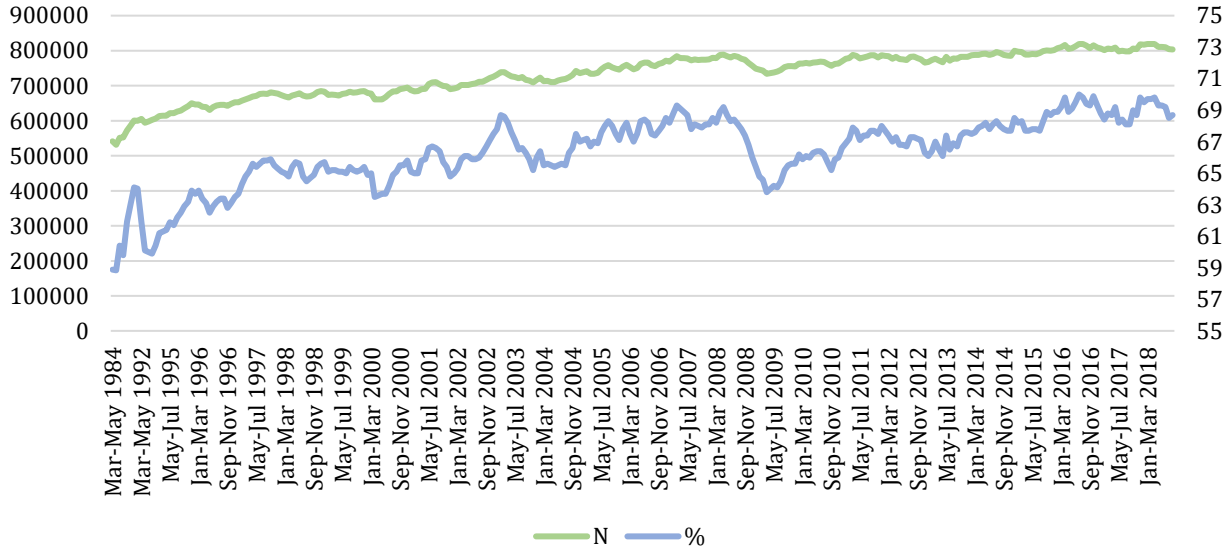
3. AN OVERVIEW OF LABOUR MARKET TRENDS: THE CHANGING STRUCTURE OF THE LABOUR FORCE IN NORTHERN IRELAND

3.1 Automation technology and employment: Is there evidence of technological unemployment?

Given that advancements in automation technologies are ongoing and have been occurring for some time, it is intuitive to begin by assessing if there is any merit to the claim that advancements in technology are destroying jobs, or if there is any indication that the 'end of work' is on the horizon.

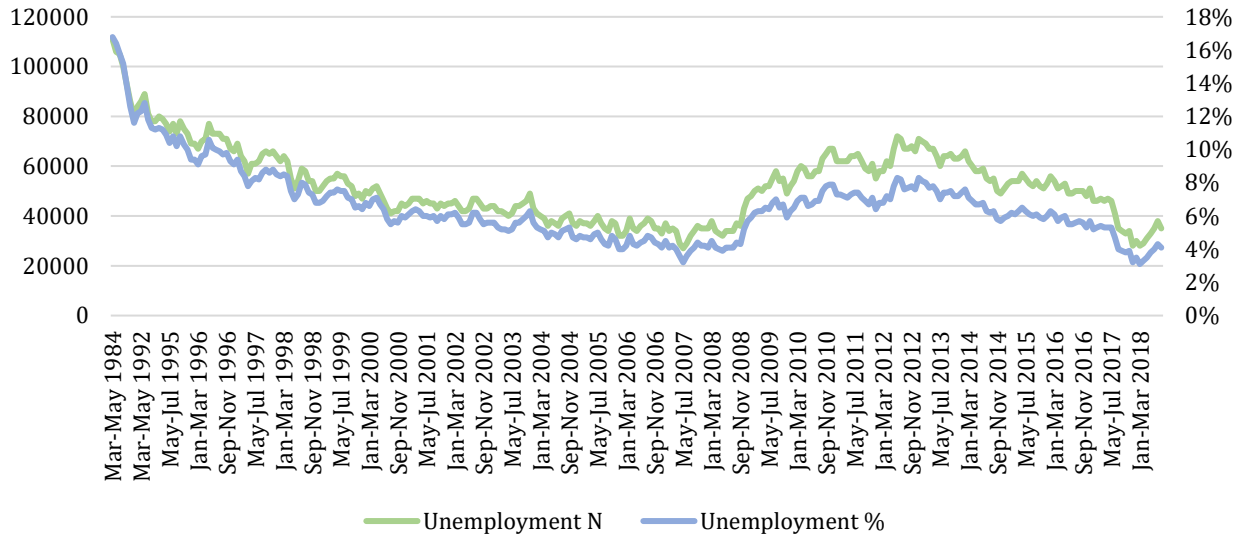
Despite a re-emergence of 'automation anxiety', advancements in technology, on the whole, are not having an overall labour substituting effect. Indeed, what is most clear from an examination of trends in employment overtime, presented in Figure 2 below, is the long-run increase in both the number of workers in employment and an increase in the rate of employment. Figure 3 shows a corresponding long-run decline in the rate of unemployment.

Figure 2: Employment trends in Northern Ireland overtime, number of workers (aged 16-64) and employment rate



Source: Labour Force Survey

Figure 3: Unemployment trends in Northern Ireland overtime, number of individuals (aged 16+) and unemployment rate



Source: Labour Force Survey

Importantly, one should not conclude from the above that particular groups of workers have not been faced with job loss. Moreover, one should not conclude that technological advancements to-date have not had a displacement effect for large swathes of the labour force. Similarly, one cannot assume that technological change has only had a labour creation effect or more worryingly will not have a labour destruction effect in the future. Without assessing trends in employment in terms of where people work and the types of jobs that workers do, it is difficult to determine if or how technological advancements or other megatrends, such as globalisation have been displacing workers to-date.

3.2 Deindustrialisation: The displacement of production jobs and the rise of service jobs

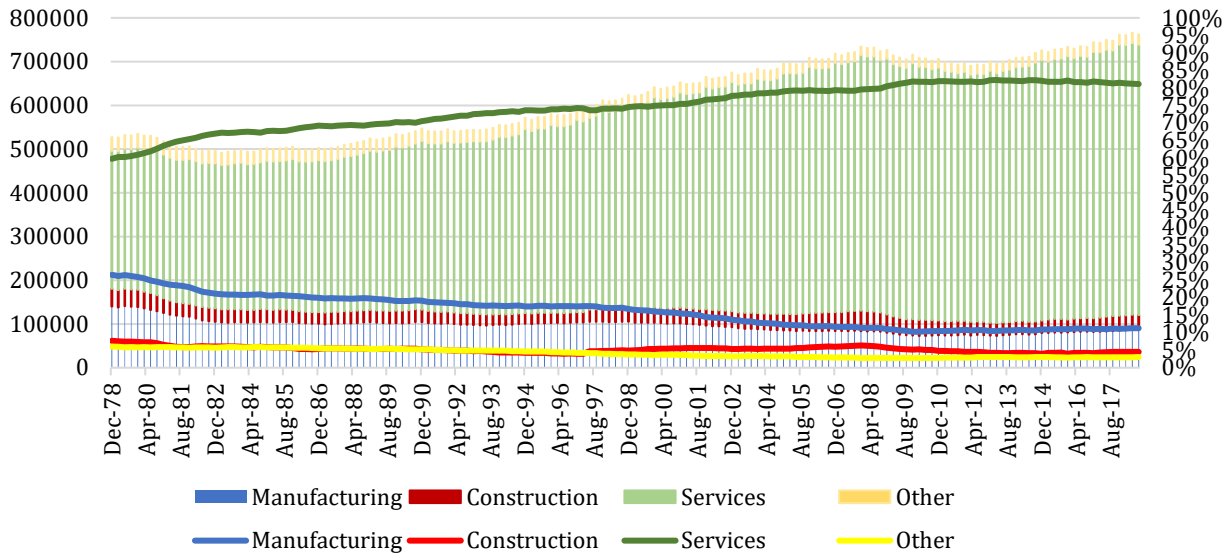
Commentators regularly attribute the loss of employment from the manufacturing sector to automation technologies and globalisation. This may well be the case. However, the same period of job losses in manufacturing also saw a significant increase in service sector jobs. Looking at changes in the composition of the labour force over time by broad industrial sector in (see in Figure 4 below), the proportional decline in manufacturing employment and the increase in the employment share of services are most notable. Of course, this is not a unique occurrence, given the secular decline in the share of workers employed in the manufacturing sector in most advanced economies (Berger and Frey, 2016). Over the forty years from 1978 to 2018, the manufacturing sector has declined from

comprising 26 per cent of total employment to 11 per cent of total employment - a 15 percentage-point decline in its share of employment (employees only). In 1978, just less than 140,000 workers were employed in this sector. By 2018, this had declined by around a half to just over 86,500 workers. The construction and other sectors also experienced declines in their shares of total employment. In 2018, both sectors comprise only about half the employment share they did in 1978 (construction in 1978 was 8 per cent vs. 5 per cent in 2018, 'other' was 6 per cent in 1978 vs. 3 per cent in 2018). In contrast, the services sector has grown its share of employment by over 20 percentage-points over the same period, with the services sector comprising 80 per cent of employment in 2018.

Advancements in technology play a significant role in explaining deindustrialisation, the decline in the manufacturing sector, and the subsequent rise in the services sector (Berger and Frey, 2016). The widespread use of technological innovations such as the standardisation of the production process, computer technologies and industrial robots in the technologically progressive manufacturing sector has clearly had a significant labour substituting effect, resulting in a sharp decline in employment in this sector (Berger and Frey, 2016; Graetz and Michaels, 2015). Certain advances in technology also contributed to the outsourcing of many functions away from the manufacturing sector into the services sector. The simultaneous large increase in employment in the services sector however has meant that the utilisation of labour-saving technologies in the manufacturing sector has not had an overall economy wide job loss effect as workers have found new employment in the services sector. It nonetheless remains the case that over the forty years from 1978 to 2018 a significant share of workers has been displaced from the manufacturing sector.

In terms of where jobs have been created, we can look to a more detailed breakdown by sector. The *human health and social work* sector experienced a three-fold increase in the number of workers increasing from 41,240 in 1971 to 125,850 in 2018, and representing a 205 per cent increase. The *wholesale and retail trade* sector more than doubled its number of workers over the same period from 61,200 in 1971 to 130,460 by 2018 - a 113 per cent increase. The *wholesale and retail* sector now comprises the largest share of employment, with 1 in 6 employed in this sector in 2018.

Figure 4: Broad sectoral employment trends overtime, number of individuals and share of workers



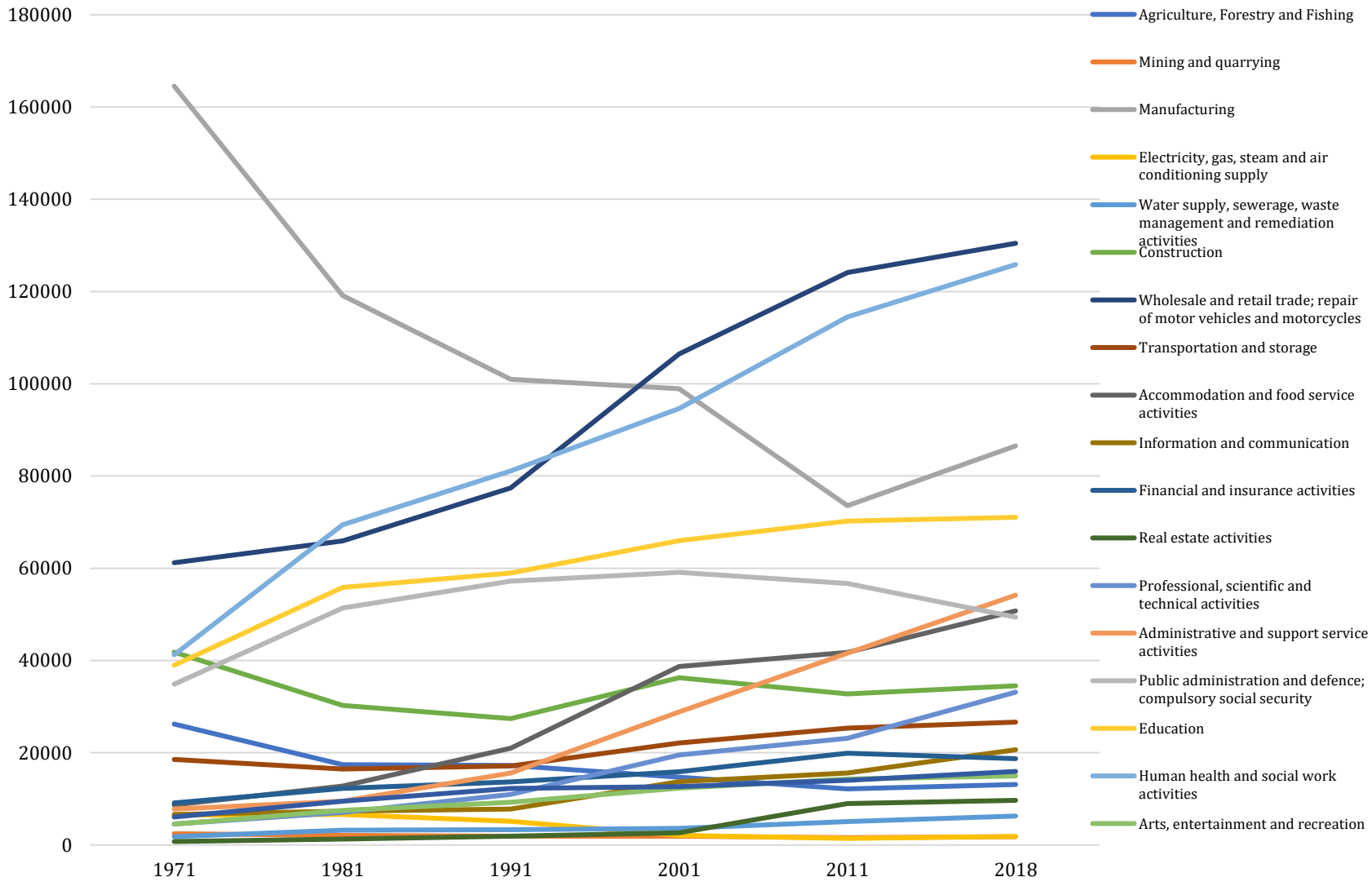
Source: Quarterly Employment Survey
Note: Trend lines are equal to the percentage share of workers in each sector. The shaded bars are equal to the number of workers employed in each sector.

A number of other sectors have also experienced considerable increases in the number of workers employed, demonstrating the extent of job creation across a multitude of service sectors. For example, the *education* sector almost doubled its number of workers over the period 1971 to 2018 from 38,970 to 71,050. In 2018, 9.3 per cent of employees were working in the *education* sector. Similarly, the *administrative and support service* activities sector had more than 46,000 more workers in 2018 than it did in 1971, increasing from having 7,790 workers to 54,170 in 2018 - a seven-fold increase. The *professional, scientific and technical activities* sector also experienced a seven-fold increase in the number of workers, increasing from having 4,560 workers in 1971 to having 33,140 workers in 2018. The *accommodation and food service* activities sector also seen a sharp increase in the number of workers, with over 50,700 workers employed in this sector in 2018 compared to 8,690 in 1971. The *accommodation and food services* activities has increased from comprising close to 2 per cent of all employees in 1971, to comprising almost 7 per cent of all employees in 2018.

The decline of manufacturing jobs over the last number of years to have negatively affected workers. However, as has been shown, the number of service sector jobs created over the same period was greater than the number of manufacturing jobs lost. The question that naturally arises then is -why

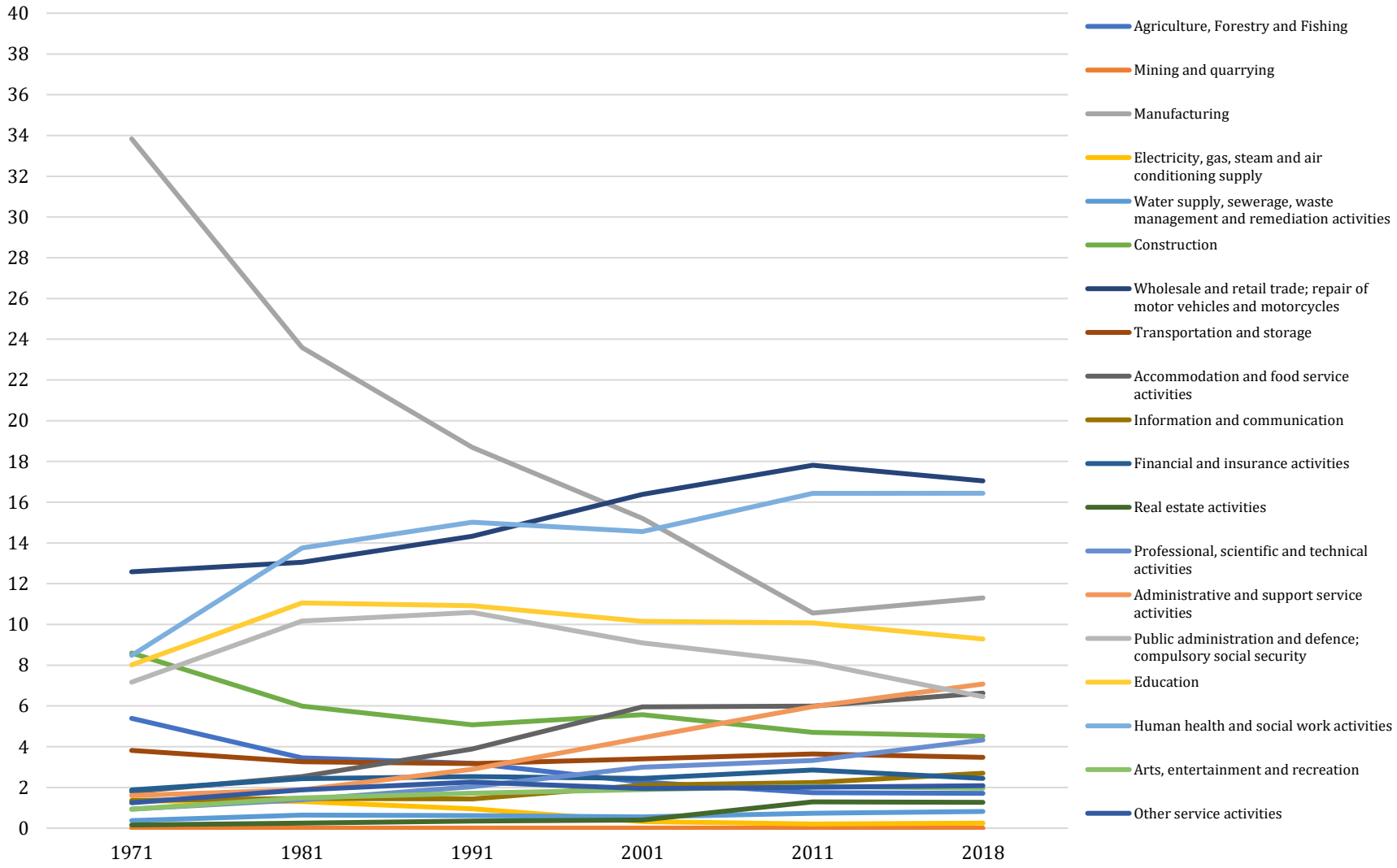
is this shift to service jobs is considered a bad outcome for workers? To understand this question, it is necessary to examine the shift in occupational structure that occurred over this same period.

Figure 5: Industrial sector (SIC2007) employment trends overtime, number of individuals



Source: Quarterly Employment Survey

Figure 6: Industrial sector (SIC2007) employment trends overtime, percentage share of employees



Source: Quarterly Employment Survey

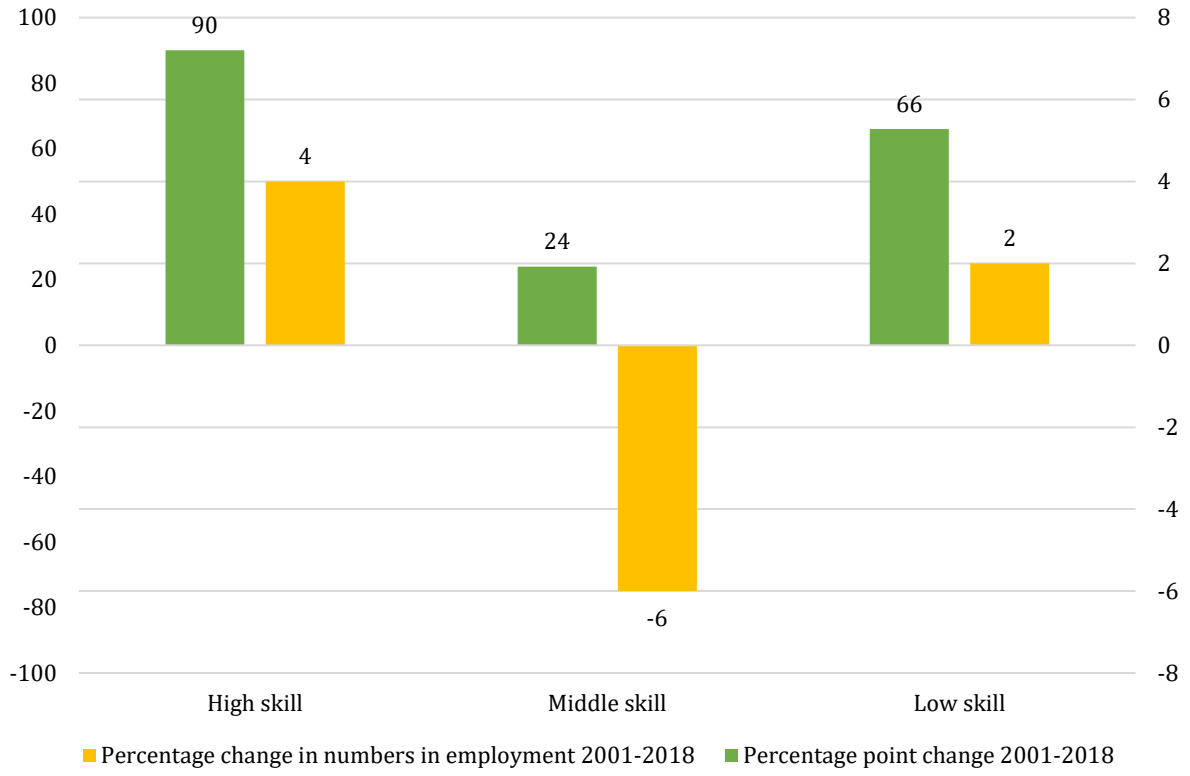
3.3 Job displacement and the polarisation of the labour market

Examining evidence of the displacement of workers across occupations, we look at changes overtime in the broad occupational structure of the labour market. The first point to make is that there is no evidence of technological unemployment across each of the skill levels over the period 2001 to 2018. As shown in Figure 7, over the period 2001 to 2018 there has been a 90 per cent increase in the number of high-skilled workers, a 66 per cent increase in low skilled workers, and a 24 per cent increase in the number of middle-skilled workers.

However, what becomes clear from an examination of changes in the percentage share of employment over time is the general trend towards a polarisation of the labour market. Specifically, looking at the percentage-point change in the share of employment comprised of different broad occupational skills groups the most notable shift occurs in middle-skilled occupations, which experience substantial decline. However, the decline in the percentage-share of employment comprised of by middle-skill occupations has not been driven by an overall decline in the number of workers employed in middle-skill occupations, but by fact that the relative number of workers in high-skilled and low-skilled occupations has increased to a greater extent than middle-skilled occupations. While traditionally most new jobs were middle-skill jobs, this is no longer the case. New jobs are predominantly in high- and low-skilled occupations and middle-skilled occupations are being crowded out. This means that workers are more likely to find new employment in either of the opposite sides of an increasingly polarised labour market.

Thinking about this data one might lean toward the conclusion that the impact of recent technological advances has been skill-biased, in that it favours skilled labour over lower/un-skilled labour. However, as discussed in Section 2, while this theoretical framework is useful to some extent, it cannot explain the growth in employment amongst low-skilled occupations evidenced in Figure 7. Rather, the routine-biased technological change model introduced by Autor *et al* (2003) which argues that computers tend to substitute for workers in routine tasks that follow well-defined rule-based procedures offers a more accurate account of the data. Thus, because non-routine tasks tend to be dominant in higher-skill and lower-skill occupations and routine tasks tend to be dominant in middle-skill occupations, it appears that the theoretical proposition of the routine-biased technological change model can more accurately describe the impact which advances in technology are having in terms of the skills distribution of the labour force.

Figure 7: Percentage change in numbers in employment 2001-2018 & percentage-point change as a share of employment 2001-2018, by broad occupational skills group



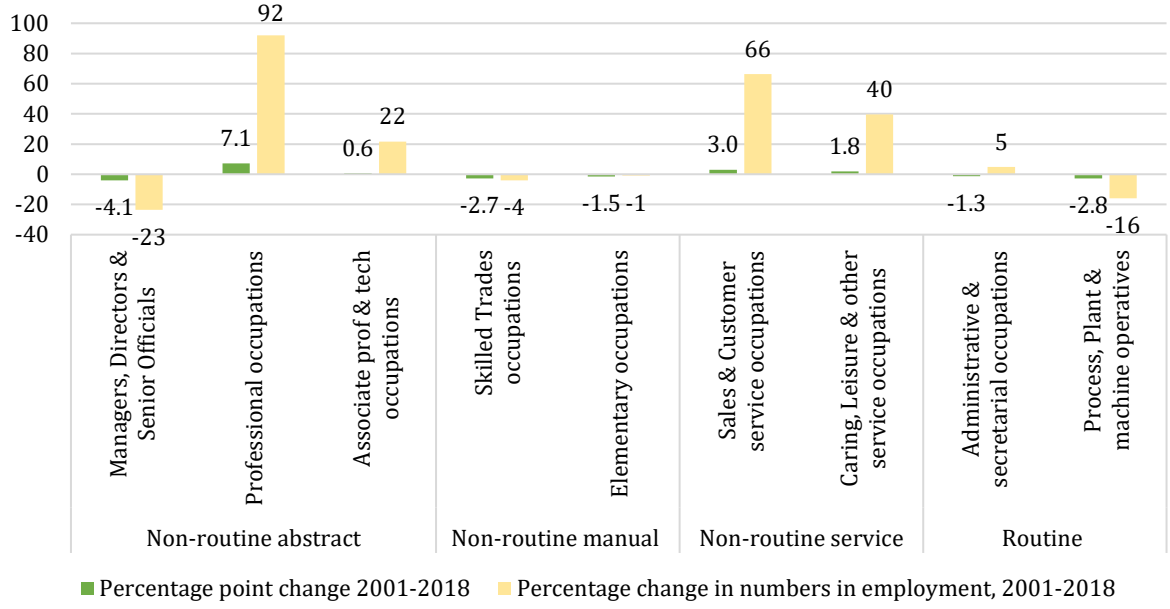
Source: Labour Force Survey

Foster and Wilson (2019) outlined how the potential first-round effect of automation technologies is confounded by occupation - with some jobs being at higher risk of job loss and job change than others. However, as mentioned in Section 2, the likely second-round effect of automation technologies is not simply determined by whether the tasks involved in one's job are predominantly routine or non-routine. The second-round effect of automation technologies for the future of work is also confounded by the skills-level and skills-requirements of new or remaining tasks. Autor, Levy and Murnane (2003) distinguish between occupations which involve primarily: routine abstract/cognitive tasks, routine manual tasks; non-routine cognitive tasks; non-routine interactive tasks; and non-routine manual tasks.

Using the 2-digit SOC 2010 classification of occupations, occupations were broadly classified as being either routine or non-routine, and involving principally abstract/cognitive tasks or manual or non-routine service tasks. Those in *Managerial, Director and Senior Official* occupations; *Professional* occupations; *and Associate Professional and Technical* occupations are classified as involving principally non-routine abstract tasks. Those in *Administrative and Secretarial* occupations and those in *Process, Plant and Machine operative* occupations are classified as

involving principally routine tasks (both abstract and manual). Those in *skilled trades* occupations and elementary occupations are classified as involving principally non-routine manual tasks; and *personal service* occupations; and *sales and customer service* occupations are classified as involving principally non-routine service tasks. Clearly, within these broad occupational groupings there will be exceptions as to whether or not particular jobs involve routine or non-routine and abstract, manual or service tasks and so this methodological approach is by no means perfect. However, given that the approach matches broadly to the description of tasks given for broad occupational categories, it has some merit. Figure 8 charts the percentage-point change in the share of employment and the percentage change in the numbers in employment across over the period 2001 to 2018 in each of these groupings.

Figure 8: Occupational employment, Percentage-point change as a share of employment 2001-2018, Percentage change in numbers in employment 2001-2018



Source: Labour Force Survey

What is most notable from Figure 8 is the relative surge in the number of workers employed in what can broadly be classified as non-routine abstract and non-routine service occupations, albeit with the exception of a substantial decline in the numbers working in *Managerial, Director or Senior Official* occupations. In turn, this has reduced the share of employment accounted for in broadly routine and non-routine manual occupations. There has been a 92 per cent increase in the number of workers employed in *Professional* occupations, a 22 per cent increase in the numbers working in associate professional and technical occupations, a 66 per cent increase in

the numbers working in *Sales and Customer Service* occupations, and a 40 per cent increase in the numbers working in *Caring, Leisure and Other Service* occupations.

The above data support the hypothesis of the routine-biased technological change model. Technological advances appear to be having a labour-saving effect in occupations whose tasks are predominantly routine and non-routine manual in nature. In contrast, there has been sharp increases in the number of jobs whose tasks are predominantly either non-routine abstract or non-routine service-orientated in nature. Thus, we ostensibly need not yet be concerned with the general decline in the numbers of jobs. Moreover, given that these jobs are estimated by Foster and Wilson (2019) to face a low risk of job loss going forward we might be tempted to conclude that the longer-term risks from automation technologies for the labour market are marginal.

However, given the occupational polarisation of the labour market one should be drawn to question the quality of the jobs being created. There is a need to question whether the overall quality of jobs is staying the same, increasing or decreasing overtime as some occupations are hollowed out and jobs are replaced in other occupations. There is also a need to give consideration to the likelihood that as the occupational structure becomes increasingly polarised, that the quality of jobs also becomes polarised into 'good' and 'bad' jobs.

4. AUTOMATION TECHNOLOGY AND JOB QUALITY

4.1 How has the quality of jobs been changing as technology has been advancing?

In order to assess changes in the quality of jobs overtime and to give consideration to the idea that jobs are increasingly polarised into 'good' and 'bad' jobs we examine data on key indicators of job quality across occupations in order to provide some insight as to how the shift in the occupational structure has shifted job quality. It should be noted that the indicators used to assess changes in the quality of jobs are not exhaustive. The data presented is determined by availability. Notwithstanding this, they allow for a sufficient assessment of job quality across three key dimensions of job quality (Irvine and Douglas, 2018). These include employment arrangements and working hours; earnings; and quality of the working environment.

4.2 Employment arrangements and working hours

The work hours provided by a job are a key element of compensation and hours are generally set by the employer rather than by the worker. The data shows that jobs obviously differ in terms of the number of paid hours offered per week or year, and in the variability of hours per week. What is clear from the data is that the increasingly polarised nature of the occupational structure has implications in terms of the overall quality of employment arrangements and working hours available.

Those in routine and non-routine abstract jobs such as *Professional* and *Associate Professional and Technical* occupations are the most likely to be in be in 'standard' i.e. full-time permanent employment. Those in non-routine service jobs are the most likely to be in 'non-standard' forms of employment (all other forms of employment). Close to half of all of those employed in both *Sales and Customer Service* occupations (53 per cent) and *Caring, Leisure and Other service* (47 per cent) occupations are in non-standard employment arrangements. This compares to those in routine occupations whereby 24 per cent of those in *Elementary* occupations and 36 per cent of those in *Process, Plant and Machine operative* occupations are employed in non-standard arrangements.

Given the increased likelihood of non-standard employment arrangements in non-routine abstract and non-routine manual occupations it appears that changes in the occupational structure of the labour force are leading to an overall decline in the traditional 'standard' full-time permanent job. This, in and of itself, is not necessarily bad. However, given that non-standard forms of employment tend to be less secure in nature, have offer less opportunities for progression; fewer opportunities for training; possess higher occupational health and safety risks

and lead to lower job satisfaction there is reason for concern (Wilson, 2016). In this respect, given that non-standard forms of employment are more likely in some occupations than in others, the overall security of employment is lower than what if would have been if the occupational structure had not polarised in the way that it has. This is likely to have had a particularly negative impact for workers who have been displaced from routine or non-routine manual occupations and who have subsequently been re-employed in non-routine service occupations. Furthermore, as shown in Table 1 workers in these occupations are more likely to work very short or short working hours when compared to those employed in other occupations and are among the most likely to say that they would like to work more hours.

Table 1: Working arrangements across occupations, 2017-2018

		Employment arrangements		Working hours					
		Standard	Non-standard	0-10	11-20	21-40	41+	Would like to work more hours	Variable working hours
	Occupation	%	%	%	%	%	%	%	%
Non-routine abstract	Managers, Directors & Senior Officials	66.3	33.7	1.1	1.7	67.8	29.4	1.2	6.9
Non-routine abstract	Professional	69.1	30.9	3.8	8	78.3	10.4	4.1	21.5
Non-routine abstract	Associate Professional & Technical	74.3	25.7	3	5	74.3	14.8	4.6	8.9
Routine	Administrative & Secretarial	63.9	36.1	2.2	8	77.9	3.4	3.7	6.4
Non-routine manual	Skilled Trades	59.4	40.6	x	4.8	57.1	3.1	2.6	13.9
Non-routine service	Caring, Leisure & Other Service	52.9	47.1	3.9	22.4	63.3	10.3	5.4	7.7
Non-routine service	Sales & Customer Service	47	53	11.4	29.7	51.6	7.3	8.7	12.3
Routine	Process, Plant & Machine Operatives	76.2	23.8	x	6	65	29	3.7	10.2
Non-routine manual	Elementary	52.6	47.4	12.1	23.4	52.4	12.1	10.6	12.2

Source: Quarterly Labour Force survey 2017-2018

4.3 Earnings quality

As the occupational structure has become increasingly polarised the result in terms of the quality of earnings is that larger shares of workers have either relatively 'good' or 'poor' earnings quality. Whether we assess the quality of earnings in terms of hourly gross weekly or gross annual pay excluding overtime as a percentage of the median, it is clear that those in non-routine abstract occupations tend to have relatively good earnings quality, whilst those in non-routine service occupations tend to have relatively poor earnings quality.

Those in non-routine service occupations including *Caring, Leisure and Other Service* occupations and *Sales and Customer Service* occupations have among the lowest relative pay, when compared across all of the occupations. The hourly pay excluding overtime in *Sales and Customer service* occupations is only 70.2 per cent of the median. In *Caring, Leisure and Other Service* occupations, it is 79.2 per cent. This compares to the hourly pay excluding overtime of those in *Administrative and Secretarial* occupations which is 91 per cent of the median, and 92 per cent in *Skilled Trades* Occupations. On the other hand, pay levels in non-routine abstract occupations is higher than other occupations. For example, the hourly pay excluding overtime of those in *Professiona*l occupations is 172 per cent of the median. These results stay constant whether we examine the quality of earnings via hourly pay, gross weekly pay or annual pay, with those in non-routine abstract occupations tending to be relatively much better paid, and those in non-routine service occupations tending to be relatively much worse paid. However, the gap in the gross weekly and gross annual earnings of those in non-routine service occupations compared to those in other occupations is much larger than what is seen when we just examine hourly earnings. The reason for the gap is that not only are those in non-routine service occupations likely to earn the least, but they are likely to also work the least hours. As the occupational structure of the labour force changes, it is likely to have particularly negative effects for those who are displaced from routine and non-routine manual occupations, and who have subsequently found employment in a non-routine service job.

Table 2: Earnings quality across occupations, 2018

		Hourly pay excluding overtime as a % of the median	Gross weekly pay as a % of the median	Annual gross pay as a % of median
Non-routine abstract	Managers, Directors & Senior Officials	179.7	177.1	177.4
Non-routine abstract	Professional	171.6	159.5	156.7
Non-routine abstract	Associate Professional & Technical	130.9	131.8	135.5
Routine	Administrative & Secretarial	90.9	85.2	82.9
Non-routine manual	Skilled Trades	92.2	107.7	104.6
Non-routine service	Caring, Leisure & Other service	79.2	65.6	63.7
Non-routine service	Sales & Customer service	70.2	55.2	53.1
Routine	Process, Plant & machine operatives	83.3	94.5	96.7
Non-routine manual	Elementary	70.8	52.5	54.6

Source: Quarterly Labour Force survey 2017-2018

4.4 Quality of the working environment

Another important aspect of job quality relates to issues such as autonomy and flexibility at work and the degree to which employees feel valued, satisfied and secure in their job. Table 3 outlines how occupations fare under several of these measures. The measures capture whether employees feel they have control over their work in terms of tasks, speed, pace, order, manner and method. They also capture the extent to which workers are satisfied with their job across occupations. While there are subtle differences across each measure, there is a consistency in that certain occupations score persistently low in terms of job autonomy and flexibility.

Those in non-routine service occupations including *caring, leisure and other service* occupations and *sales and customer service* occupations are among the least likely to report that they have autonomy, flexibility and satisfaction with their work, when compared to those in other occupations. They do however have more autonomy, flexibility and satisfaction, on average, than those in manual occupations such as *elementary* or *process, plant and machine operative* occupations. In contrast, those in non-routine abstract jobs including *Managerial, Director and Senior Official* or *Professional* jobs report very high levels of autonomy, flexibility and satisfaction with their job. Consequently, as jobs trend increasingly towards non-routine abstract occupations and non-routine service occupations, we are seeing an overall upgrading in terms of the quality of the working environment. Nonetheless, it remains that large shares of those in non-routine service occupations are dissatisfied with their job and have little autonomy or flexibility over their work.

Table 3: Quality of the working environment

		Autonomy over speed of work	Flexibility over work tasks	Flexibility over work pace	Flexibility over manner of work	Flexibility over order of tasks	Flexibility over hours of work	Job Satisfaction	Job Satisfaction
Non-routine abstract	Managers, Director & SO	82	96	92	95	98	72	82	97
Non-routine abstract	Professional	78	87	79	92	95	44	84	92
Non-routine abstract	Associate Professional & Technical	80	82	80	90	90	55	88	95
Routine	Administrative & Secretarial	76	59	67	67	70	52	78	92
Non-routine manual	Skilled Trades	63	78	75	82	85	63	85	99
Non-routine service	Caring, Leisure & other service	79	70	69	81	65	30	93	97
Non-routine service	Sales & Customer service	74	60	63	70	66	21	81	77
Routine	Process, Plant & Machine	45	43	57	61	48	31	77	92
Non-routine manual	Elementary	57	59	71	70	69	23	80	92

Source: PIACC (2012)

5. POLICY CHALLENGES AND RESPONSES

As outlined in Section 3, previous technological and other related shocks have not resulted in overall technological unemployment. They have led to a more polarised occupational structure. There has been growth in non-routine service occupations, which face a low risk from automation. However, despite this shift in occupational structure, there has been no concurrent shift in job quality. The dilemma for policy is that, despite a lower threat of automation, these jobs remain at the lower levels of job quality.

5.1 The policy challenge

In many cases, just the threat of automation has been seen as undermining wages and conditions in the jobs and tasks that it has affected. This is most likely in the early stages of the technological advancement where it is not yet economical to actually replace the human labour involved in that task, but the threat of technological replacement is imminent. However, as the price of the technology begins to fall and as the price of the human labour involved (in the form of wages and conditions) rises, the threat becomes more real. In that case, some workers may feel constrained in making wage demands that hasten the introduction of the technology. In this case therefore, the threat of automation can lower wages and conditions of employment.

As set out in Section 3, while routine and non-routine manual jobs face the greatest threat from automation, non-routine service jobs, that are considered low-skilled, are very unlikely to become automated in the foreseeable future. It also is likely that these jobs will actually be a growth area in the next number of years. If automation is seen to undermine wages in the jobs that it threatens, then it surely follows that automation could boost wages and conditions in jobs that it cannot replace. This is the theoretical question posed in Section 2. If new technology cannot replace the labour input, then surely it gives greater leverage to a worker in negotiations about pay. In theory, this logic holds, but in reality, there is very little evidence for this type of positive result for low-skilled work.

As mentioned in Section 2, Autor (2015) describes the factors that influence whether the outcomes for workers are good, bad or neutral. The second factor has to do with the supply of available labour. It could be argued that wages in non-routine service jobs are held down because there is a glut of labour problem. In this scenario, as machines replace workers in routine and non-routine manual tasks, they compete with other workers for non-routine service

jobs, which typically have low-skill requirements for entry. This contest for jobs contains any wage pressure over the medium term. While this is undoubtedly the case in some situations, aggregate statistics would suggest that such cases are exceptions. Low-paid occupations and industries where low-paid jobs dominate, consistently report the highest number of vacancies in Northern Ireland (Department for Communities, 2018).

If supply of labour is not distorting the expected increase in job quality in the non-routine service sector, it is possible that there is another force which limits the expected impact of automation. At its heart, the issue is that a group of workers are prevented from achieving an increase in reward that market theory judges they should be entitled to. Part of the answer to the puzzle may lie in the occupational polarisation itself. As workers become more concentrated in fewer occupations it becomes harder to classify skills and reward ability. The job quality lost in routine and non-routine manual jobs cannot be as easily replaced in the non-routine services sector. This is because the labour input in these occupations is viewed differently and the commodification of labour has been a distinctly different process in these occupations.

Labour commodification in the purest sense describes how historically, workers moved from labour as a form of self-sufficiency toward providing labour in return for wages. It is often understood as a binary event but even today, arguments persist over the commodification of labour particularly as it pertains to gender issues (Lewis *et al*, 2008). Work that was predominantly performed by women in the home was, for many years, considered to be inferior to that carried out in waged industry. However, as female participation in the labour market increased, many of their previous functions in the home have entered the waged labour sector. This example illustrates the problems that non-routine service workers face in attaining levels of job quality more appropriate to the new valuation of their work.

Many of the tasks and work involved in non-routine service work did not go through the commodification process that applied to routine jobs particularly those in manufacturing. These jobs tended to have "breadwinner" wages and permanent, full-time contracts. The quality that was present in these jobs will not naturally be bequeathed to those in non-routine service jobs because they were not created in the same way to begin with.

We have come to understand wage commodification as an on-going process with some identifiable and codifiable stages. Reich (1989) identified three phases of labour commodification from 1820 to 1975. The first phase up to 1890 describes the period when waged labour became the most common form of labour. The second phase up to 1945 saw technology create similar working conditions and a degree of homogenisation of labour (Madison, 2008). The third phase up to 1975 is characterised by segmentation and the growth of the secondary labour market.

Many of the new jobs that will be created represent a further stage of commodification. There has been a deepening of the secondary labour market but also a fundamental change in the nature of secondary labour. This can be seen in the rise in issues such as zero-hours contracts but also a recommodification of existing jobs through practices such as outsourcing. Outsourcing has become the most common way in which non-routine service work has been changed over the last number of years. Cleaning services, security guards, and laundry services are just few examples of work which would normally have been performed in-house. Over the last number of decades, more and more of this work has been outsourced to services companies, starting with larger firms but spreading throughout the economy (Grimshaw *et al*, 2015). Workers in these areas are no longer employed to do a job but are contracted from a supplier to provide a service.

To the extent that one accepts the existence of stages of labour market commodification, they appear to follow mega-trends of disruption within the labour market. In this sense the labour market experiences a shock, such as technological advancement or trade liberalisation. There then follows a response whereby some facet of the employment of labour adjusts to this new environment. This is often presented as an impartial or neutral process, where the change in labour market condition is simply a product of the original disruption. However, there is nothing inevitable about the commodification processes that take place. They are a function of the industrial, social, economic and political environment in which they take place. Labour market commodification has not been uniform and there are marked differences in outcomes based on the institutional structures (Deakin, 2016; Papadopoulos, 2005).

The challenge for policymakers in responding to automation is how to acknowledge the quality of the jobs that are lost to automation and to provide a mechanism for this to be regained in the jobs that will replace them.

5.2 The policy response

The preceding analysis highlights where the policy response to automation technologies should be focused. While it is understandable that much of the focus at present is on potential job losses, there is no evidence that policy would be effective in attempting to either prevent or delay these losses. Technological change is necessary for productivity growth and it is a key determinant of improved living standards (McDonnell, 2018). Automation also has the capacity to dramatically improve the working environment and conditions of many workers. These developments are welcome in many instances. This does not detract from the fact that for a sizeable number of workers, automation may result in job loss or negative job change. Policy should focus on this issue.

While technological unemployment is unlikely on any significant scale, we must accept that a large number of workers will change employment either by sector, occupation or both. The scale of this movement requires a policy platform to directly intervene and ameliorate the transition between different forms of employment. Firstly, we need to reform labour market policy in order to smooth transitions to new employment and to make allowances for the small number of workers who will not transition. This encompasses skills, social security, regional development, unionisation and collective bargaining capacity. Secondly, we need to introduce a new occupational infrastructure in what are currently considered low-skilled/low paid sectors of the economy in order to rebuild good quality jobs and provide opportunities for career progression.

Policy intervention needs to begin with the social security system. At present, in Northern Ireland, both in-work and out-of-work benefits have faced several years of real terms cuts in addition to the curtailment of many entitlements (Edmiston, 2017). Such an environment is not conducive to large transfers of workers between different forms of employment. Furthermore, if workers are not to suffer significant material loss from automation technologies, we must address the issue of welfare-wage replacement rates.

Over the last three decades welfare state reforms have moved unemployment benefit away from acting as a preserver of living standards to one that simply aims to provide subsistence income. In tandem with other active labour market policies, the intent was designed to prevent welfare from hindering full-employment and creating other perverse incentives. The Hartz reforms in Germany are a key example of such reforms. However, as Bruttel and Kemmerling (2005) noted at the time, such policies can also lead to the creation of low wage jobs, as welfare no longer provides a higher income floor.

Though there are disagreements about the comparability of data, most research on replacement rates for unemployment benefits put the UK in the bottom half of both EU and OECD countries (Wang and Van Vliet, 2016). This varies between family types and wage brackets, but the UK scores consistently below Nordic countries and also the Netherland and France (Drejer *et al* 2010). The system of unemployment social transfers needs to be reformed to allow for a greater link between the support level provided and existing income levels. Moving toward replacement rates of the Northern European average is necessary to guard against the impact of automation technologies. Concerns over the effects of higher replacement rates on unemployment have been used to block such policies in the past, but most recent research finds no discernible or significant effect between the two (Eugster, 2015).

An issue, which often sees less attention in the automation technology debate, is that of regional development. As with Foster and Wilson (2019), and many other studies much of the analysis of automation technology impacts are carried out on a national or in this case regional level. While there is unlikely to be aggregate employment losses from automation technologies, we cannot say the same with any degree of certainty for local areas. Whilst new employment will be created, there is no guarantee that new employment opportunities will match job losses on geographic terms. This poses problems for workers in areas exposed to automation risk with little chance of replacement jobs. While the state could provide support for workers in these areas to move to areas with greater employment prospects, such policies can become costly, particularly as employment moves toward cities and urban areas with a higher cost of living. Berger and Frey (2015) argue that bringing down the cost of living in productive cities can aid worker mobility and provide benefit to existing city workers. However, providing incentives for workers to move out of areas where automation has taken place can compound the issue by decreasing economic activity further, and endangering support and ancillary jobs.

In order to tackle these impacts, governments need to target industrial development in tandem with a strategy for balanced regional development. The UK has some of the largest regional variation in economic output per head of population of any comparable European economy, (Mac Flynn, 2016) and the island of Ireland is even more polarized (Goldrick-Kelly and Mac Flynn, 2018). Policy should not seek to directly subsidise job creation in particular areas through tax breaks or other deductions as these polices can create perverse incentives. Policy should involve identifying localised risks and putting in place strategies to boost infrastructure and human capital.

As with any significant realignment of employment, the issue of skills is clearly very important. There is a great deal of emphasis on the need to upgrade skills in order to respond to the challenges posed by automation technologies (Dolphin, 2015; Berger and Frey, 2016). Clearly, for example, more intensive use of technology will require a greater proportion of engineers, computer scientists and technicians. Furthermore, because higher-skilled workers are more likely to be shielded from the risk of job loss, this policy proposal has some merit. However, as we demonstrate in Section 4 there is an increasing requirement for workers in jobs which are that are not necessarily high-skilled, such as *sales and customer service* jobs and *caring, leisure and other service* jobs. Consequently, policy cannot solely focus on upskilling workers and needs also to concentrate on reskilling workers for these jobs.

Recognition and reward for skills acquisition and use is key to building a new occupational structure within the low-skilled/low-wage sector of the economy. Studies of the returns to skills acquisition in the UK indicate that while there is a significant wage premium for high and intermediate level skills, the return on low-level skills is zero or negative in some cases (Dickerson and Vignoles, 2006). There have been many proposals to address this, including the boosting of skills councils and the role of employer led initiatives (IPPR, 2017). Skills councils do provide a model for bringing regulation and standardisation of skills to new sectors of the economy, but once again most of the policy emphasis in this area has been on upgrading rather than re-skilling (Payne, 2007). Skills councils can theoretically provide a mechanism for lower skilled work but, in reality, successful implementation of occupational infrastructure requires pressure from worker representation.

The weight of international evidence argues the importance of strong labour market institutions, and in particular the importance of unionisation and collective bargaining capacity as a way to hedge

against the risks of negative displacement or degrading owing to automation technologies. Increasing union density in occupations with poor conditions will also be key to increasing the quality of these jobs. Unionisation and collective bargaining or a system of sectoral agreements provide a mechanism to introduce a skills and wage infrastructure that could improve job quality. Madison (2008) highlights the role that unions have historically played in introducing specificity in occupations and fostering skills recognition. Furthermore, research has shown that devolved bargaining structures such as works councils in Germany that implement sectoral agreements at firm level, give the greatest premium to workers at the lower end of the wage distribution (Addison, Teixeir and Thomas, 2006). Moves toward outsourcing and contracting in employment relations complicates the capacity for unionisation among workers in new areas of employment. It will be necessary for the legal definition of an employee to evolve to reflect these new employment practices. However, legal definitions can only go so far. It will also be necessary for trade unions to develop new way of providing these workers with the representational capacity they will require to achieve greater job quality.

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