Rethinking country effects: Robotics, AI and work futures in Norway and the UK

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Abstract

Current debates around robotics and artificial intelligence (AI) are dominated by concerns over the threat to employment, amid widely varying estimates of potential job losses. Countries are expected to fare differently, but there is little comparative research that goes beyond analysing industry and occupational structures. This article rethinks 'country effects' by exploring the role of institutions and social actors in shaping technological change in Norway and the UK. Drawing upon interviews with technology experts, employer associations and trade unions, it examines their perspectives on public policy support for the development and diffusion of robotics and AI, along with potential consequences for employment, work and skills. The research indicates significant country differences and the continued relevance of institutions, interests and power in analysing country effects.

Keywords

Robotics, AI, institutions, trade unions, employment, skills, Norway, UK

Introduction

There is currently much discussion around the implications of robotics and artificial intelligence (AI) for employment and wider society. Whether it is self-driving cars, 3-D printing, machine learning or big data, we are said to be facing a 'Second Machine Age' (Brynjolfsson and McAfee 2014) or 'Fourth Industrial Revolution' (Schwab 2016), with devastating implications for jobs (Ford 2015). These narratives recall earlier pessimistic predictions of a 'jobless future' and the 'end of work' that never arrived (Rifkin 1996), only for today's technological Cassandras to warn 'this time it is different' (Wajcman 2017:120).

Many such accounts are heavy on speculation and anecdote. Even those attempting to quantify the number of jobs at risk arrive at widely varying predictions; simply compare Frey and Osborne's (2017) figure of 47 percent for the US to Arntz et al's (2016) nine percent. The few empirical studies that look cross-nationally indicate that countries will fare differently, but no consistent pattern emerges. Where there is greater consensus is on the types of jobs and workers most susceptible, notably 'routine' manual and cognitive tasks and the 'low qualified'. Although jobs requiring 'creativity' and 'social intelligence' are deemed relatively safe, some argue that AI will hollow-out 'middle-class' professional occupations on an unprecedented scale (Ford 2015, Susskind and Susskind 2015). The creation of 'new jobs', while acknowledged, has quickly become subsumed by headlines of mass unemployment, spiralling inequality and societal collapse.

There are voices that warn against treating technology as a determining force, insisting the impact on the quantity, quality and distribution of work depends on 'the priorities of the holders of social and economic power' (Howcroft and Taylor 2014:1, Spencer 2018, Fleming 2019). This article draws on approaches that emphasise the role of institutions, power and interests in shaping *whether* and *how* technology is inserted into an economy and workplace. A technology may exist but employers will not necessarily adopt it. Even where technology is taken up, the impact on the organisation of work, skills and job quality will be partly influenced by employer objectives, and contestation or negotiation by workers and any representatives (Beirne and Ramsay 1992, Edwards and Ramirez 2016). Given national differences in institutional and regulatory frameworks and power relationships, we might expect the pace and shape of technological change to vary between countries.

International comparisons that address the challenges in different countries are 'surprisingly lacking in the vast volumes of research on the fourth industrial revolution' (Neufeind et al 2018a:540). There is a critical gap in analysing how these technologies may play out and the scope for social actors to shape different outcomes. Institutionalists approaches, such as 'varieties of capitalism' (Hall and Soskice 2001) and 'national innovation systems' (Edquist 1997) have attempted to theorise country differences in innovation, although they have yet to be applied to robotics and AI. These theories may provide some insights but, as with the models of predicted job loss (e.g. Frey and Osborne 2017), they lack significant engagement with issues of power and interest.

This article seeks to contribute to an analysis of 'country effects' and the role of institutions and actors in shaping technological change through a comparison of developments in robotics and AI in the UK and Norway. These countries were purposefully selected for their starkly contrasting economic and industrial relations institutions, and role and power of the social partners. If institutions and social actors are important in shaping the development and use of technology, we would expect to find some differences emerging between the UK and Norway, even at this early stage. The article draws on the views of 'key experts' involved in research, development and implementation of robotics/AI, and 'key stakeholders' in employer organisations and trade unions. The aims are, first, to compare their reflections on the emerging public policy and institutional supports for the development and diffusion of robotics/AI and, second, to explore perceptions of the pace and shape of technological change and the implications for work.

The article begins by critically examining studies that have sought to estimate country differences in jobs at risk, before considering potential contributions of the VOC and NIS approaches to a discussion of 'country effects'. Key contextual features of Norway and the UK are then presented, including existing data on the use of robotics and AI. Next, the research methods are outlined. The sections that follow bring together the interviews with key experts and stakeholders to compare views on national policy and institutional supports for robotics/AI, and their impact on employment, work and skills. The article concludes with a discussion of country differences and suggests avenues for future research.

Predicting country differences

Attempts to measure the impact of robots and AI on employment have been dominated by a few studies seeking to predict 'risk of job loss' (Frey and Osborne 2017, McKinsey 2017, Arntz et al 2016). The most widely cited is Frey and Osborne's work, which draws on a group of 'experts' assessing whether individual occupations could be replaced by a robot or AI. They conclude that nearly half of jobs in the US are at risk of automation over the next two decades or so. An important counterpoint is Arntz et al's (2016) OECD report which argues that a job comprises multiple tasks, only some of which may be replaceable. More jobs are therefore expected to change task composition rather than disappear. Using data from the PIAAC survey, where individual workers identify tasks and skills required in their own jobs, they predict that only nine percent of jobs are at risk across 21 OECD countries.

These types of studies anticipate substantial national differences; for example, Arntz et al (2016:33) report six percent of jobs at high risk in Korea compared to 12 percent in Germany, with the UK and Norway estimated at 10 percent. PWC (2017) cite 21 percent at risk in Japan, 30 percent in the UK, and 38 percent in the US (Norway is not included). These figures are mainly derived from differences in industrial and occupational structures. Countries, for example, that have more jobs in manufacturing (considered at higher risk of replacement) and fewer in the creative industries (lower risk) face the prospect of greater job losses, as do those countries with a lower proportion of managers (less risk) and higher share of semi-skilled workers (high risk) (McKinsey 2017). Arntz et al (2016) also take account of the qualifications of jobholders (assuming those with higher education are likely to be doing jobs that are less replaceable) and task composition within the same occupation. In the US, for example, more workers are undertaking routine tasks in like-for-like occupations than in Germany, resulting in a higher risk of job loss (Arntz et al 2016:16-17).

The positive aspect of these studies is the recognition that sectors will be affected differently and that the distribution of sectors (and occupations) varies across countries. However, although there is an acknowledgement that employment effects are mediated by broader country-level factors, such as wage levels, public acceptance and regulation (also McKinsey 2017), these are not integrated into the empirical predictions. We are, therefore, encouraged to think of robotics and AI as an exogenous force driving changes in the labour market. This view of technology has long been critiqued from within the innovation field (Freeman 1995), industrial relations (Sorge and Streeck 1988) and labour process tradition (Thompson 1983) for marginalising social and economic forces.

Substantial country differences have been found in the use of earlier technologies (e.g. Daly et al 1985, Freeman 2004) indicating the potential importance of national institutions and public policy. To date, there has been no systematic attempt to integrate institutions and policy into an analysis of how and why robotics and AI may develop and diffuse differently across countries. The role of institutions in shaping country approaches to innovation has been central to the 'varieties of capitalism' (VOC) and 'national innovation systems' (NIS) literatures, which could offer some useful insights into the latest wave of technological change.

The VOC literature distinguishes between two ideal types of economy that are claimed to be better at supporting different types of innovation (Hall and Soskice 2001). 'Liberal market economies' (LMEs), such as the US and UK, are considered more successful in 'radical innovation' involving 'substantial shifts in product lines, the development of entirely new goods, or major changes to the production process' (2001:38-39). The availability of short-term venture capital, light-touch regulation, and a plentiful supply of workers with advanced general skills is said to enable organisations to compete successfully in fast-moving, high-technology sectors, such as software and pharmaceuticals.

'Coordinated market economies' (CMEs), the example is typically Germany but it has also been applied to Norway, are regarded as better at 'incremental innovation', that is 'continuous but small-scale improvements to existing product lines and production processes' (Hall and Soskice 2001:39). Cooperative relations between companies, long-term finance, high-quality vocational training systems, and regulations that support trust-based relations within the firm help sustain comparative advantage through quality-oriented production approaches in slower moving industries. The VOC approach could be interpreted as suggesting that LMEs will be 'ahead in path-breaking technological innovation' (Dølvik and Steen 2018:41), such as the initial development and adoption of AI and robotics, with CMEs using these technologies once established.

Surprisingly, there have been few attempts to test whether countries categorised as LMEs and CMEs are systematically different in relation to innovation. There has, however, been criticism over the definition and measurement of the two forms of innovation (Allen et al 2011, Taylor 2004), along with research suggesting CMEs can also be successful in areas of 'radical innovation' (Casper and Whitley 2004). A further concern is the lack of attention afforded to the state as a driver of innovation, given that the US's comparative advantage in biotechnology, ICT and aerospace is widely attributed to large-scale public funding (Mazzucato 2015).

The NIS literature offers a more empirically driven approach to how countries evolve *national* systems that 'constrain or incentivise innovation' (Edquist 1997:2). Institutional structures are seen as important in shaping country differences (Freeman 1995), with the state figuring more prominently. The literature covers a range of perspectives (see Lundvall 2016), but of importance here is the distinction often made between narrow and broad forms of innovation. The former focuses on scientific and technological innovation and the links between publicly funded R&D institutions and firms (Edquist 1997). The latter emphasises the role of employees' learning by doing and interacting inside organisations to support or drive incremental innovation, including harnessing the productive potential of technology (Lundvall 2016).

Much of the focus is on the Nordic countries, which are found to have a greater proportion of workers in high-discretion, learning-rich forms of work organisation linked to inclusive education systems, strong vocational training, and collective regulation of the labour market (Arundel et al 2007). Employee learning in the workplace is seen as central to 'in-house' innovation, while in countries, such as the UK, where worker discretion is more limited, organisations are considered to be more dependent on 'innovations developed elsewhere' (Arundel et al 2007:1202). While there are differences within the NIS field, one implication is that workers in the Nordic countries are more likely to be actively engaged in improving the effectiveness of robotics/AI once introduced in the workplace.

Looking across the three sets of literature, several points emerge about how robotics and AI may have different impacts on countries. There is a convincing argument that sector and occupational mix play a role (Arntz et al 2016, Frey and Osborne 2017). VOC and NIS accounts also indicate that wider economic and labour market institutions may influence the way in which different countries are able to develop and absorb technological innovations. Nevertheless, these approaches offer little insight into the role of power and interests in shaping state intervention (through public policy for example), the development and diffusion of robotics and AI, and their impact on work. A few studies have begun to address the potential of trade unions to shape public policy, highlighting how unions in some North European countries are participating in tripartite structures concerned with the development of policies on robotics and AI (Ilsøe 2017, Neufeind et al 2018b). However, these studies are limited in scope, tending to focus on the union perspective, with little on the question of diffusion.

This article addresses a critical gap in research by bringing together the perspectives of social actors with those of technology experts in two starkly contrasting countries. In exploring country effects, it focuses on the policy and institutional supports for robotics/AI, as well as the power of social actors to shape these arrangements and influence diffusion. The next section outlines key contextual features of the Norwegian and UK economies and labour market institutions, along with available data on the use of robotics and AI.

Comparing the UK and Norway

The UK is one of the largest economies in Europe. It is heavily reliant on the financial sector, has a small manufacturing base, highly internationalised patterns of ownership, and a corporate governance regime centred on shareholder value. Norway is a small country built on natural resources, shipping and hydropower (Dølvik and Steen 2018). Dominated by the oil and gas industry, the economy comprises a small domestic-oriented manufacturing sector, few large international firms, and a high concentration of small and medium-sized enterprises (SMEs). As with other Nordic countries, there is a large public sector and well-resourced universal welfare state.

The role and influence of employer associations and trade unions stand in stark relief. In the UK, union density is 23 percent and only 26 percent of the workforce have their pay covered by collective bargaining (DBEIS 2018). Employers are highly fragmented and their associations play a limited role in industrial relations (Gooberman et al 2018). The labour market is lightly regulated, wage inequality is high, and there is little social partnership within institutions or policymaking (Lloyd and Payne 2016). Although union density in Norway (at 50 percent) is lower than its Nordic neighbours, unions are powerful actors. With 65 percent employer density (EuroFound 2015), there is strong tripartite concertation, multi-level collective bargaining (covering 70% of the workforce), a high and relatively flat wage structure, and extensive co-determination and collective voice mechanisms at the workplace (Løken et al 2013).

Investment in R&D[1] and capital (ONS 2017a) is relatively low in the UK at 1.7 percent and 16.5 percent of GDP respectively in 2017. Although Norway's R&D investment is higher at 2.1 percent, it is only at the European Union (EU) average and some way behind other Nordic countries. Norway scores better on capital investment at 22 percent of GDP, which is slightly higher than Germany and France. Productivity is over 25 percent higher in Norway compared to the UK, even discounting the substantial oil and gas sector (ONS 2017b[2]) High labour costs may encourage economic activity to transfer into more productive sectors and workplaces in Norway (Dølvik and Steen 2018), whereas the UK has a 'long tail' of low productivity companies (Lewis and Bell 2019).

Both countries have undergone a major expansion in higher education. While the UK has a number of long-established, 'world-leading' universities, no Norwegian university consistently figures in the top 100[3]. Norway has been praised for its high quality vocational education and training (VET) system, developed through a social partnership approach (Payne 2016). By contrast, the UK suffers from longstanding weaknesses in VET and has experienced a dramatic decline in the volume of employer training over the last 25 years (Green et al 2015).

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[1] Gross domestic expenditure on R&D (percent of GDP)
https://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=t2020_20&plugin=1

[2] For manufacturing only, see Eurostat sbs_na_ind_r2.

[3] Times Higher Education World University Ranking, QS World Rankings

The UK and Norway are low users of industrial robots, at 71 and 57 per 10,000 employees respectively in manufacturing, compared to 301 in Germany (IFR 2016). The picture with regard to the broader use of robots and AI is more opaque. A recent survey reports only 14 percent of employers in the UK had invested in, or were about to invest in, AI or robotics (Dellot and Wallace-Stephens 2017). Unions and employer organisations have also raised concerns that the pace of technological diffusion is too slow and that competitiveness will be undermined (TUC 2017:44, CBI 2017, STUC 2018). A survey of affiliates conducted by the main Norwegian employers' confederation found that a third of respondents had implemented some form of robotics or digitalisation (Dølvik and Steen 2018:62). Unfortunately, these surveys are not comparable and do not identify the magnitude of change, for example whether a technology affects one job or hundreds. More robust evidence shows Norway ranking among the highest in Europe for business digitalisation, ecommerce and digital public services, with the UK only at the EU average (EC 2019).

Research Method

The research draws on interviews with 'experts' and 'stakeholders' in Norway and the UK. 'Experts' are defined as those closely involved with the funding and development of robotics and AI, and/or their application to the workplace. Experienced research scientists in universities and those involved in technology transfer, such as UK Catapult Centres and research institutes in Norway, are uniquely placed to comment on robotic/AI capabilities, the pace at which these technologies are changing, and constraints on their development and implementation. 'Stakeholders' include employer associations and unions, along with representatives of robotic networks, and public policy 'Think-Tanks'. They offer insights into their engagement with the policy agenda and provide a broader perspective on the economic and labour market context, as well as 'take-up' across a range of organisations beyond first-level 'adopters'.

Twenty-five meetings with interviewees were undertaken in 2017, as shown in Table 1. The main set of interviewees were selected to provide a broad overview of contextual and policy differences affecting the development and diffusion of robotics and AI. However, the authors expected to find substantial sector variation. To provide a more grounded discussion around *specific examples* that could be compared across countries, further interviews were undertaken in the food and drink processing industry and healthcare. These are contrasting sectors, of similar importance in both countries, and technology websites and sector reports already indicated some use of robotics and digitalisation.

Interviewees were identified using web searches, key informant sampling and snowballing techniques. For example, in Norway, the authors initially contacted a national officer in the main union confederation, LO (*Landsorganisasjonen*), with responsibility for developing policy on the digital economy who provided key contacts. Interviewees in UK Catapult Centres frequently recommended other prominent individuals in their field. Separate and overlapping interview schedules were constructed for each group. The initial phase of the interview probed understandings of terms such as 'robot' and 'AI', along with views of their current use and expectations about the likely pace of change and impact on jobs. Further questions focused on supports for development, 'key enablers and constraints' affecting diffusion, and 'implications for education and training'. Technology experts were specifically asked about technological capabilities (e.g. 'what is possible' and 'over what timescale?'). Interviews with employer associations and trade unions also explored their strategies around robotics/AI and role within government policy formation.

Face-to-face interviews were held with one or both of the authors, recorded and transcribed. As shown in Table 1, most involved a single interviewee, although some were group interviews. Interviews typically lasted between 60 and 90 minutes and were semi-structured, with the researchers responding to issues raised, and each interview building on previous ones. Interviews were coded using Nvivo software, with key themes derived initially from the literature-informed interview schedules and a sample of interviews. To ensure accuracy and consistency, the researchers discussed the emerging themes and subsequent reading of the data. Where clarification was necessary, points were followed-up via email with interviewees. The researchers also had the opportunity to sense-check findings from Norway through a presentation to relevant 'social partners'.

Robotics Policy and Support Structure

This section examines interviewees' perceptions of the supports available for the development and diffusion of robotics and AI. In Norway, it was not until 2017, when the first industrial policy white paper for over 35 years appeared, that the centre-right government indicated its support for a broad-based strategy to deal with the challenges presented by robotics/AI. The dramatic slump in oil prices in 2015 was also an important impetus towards developing an 'active industrial policy', with the aim of making Norway 'a world leader in industry and technology' (*Nærings-og fiskeridepartementet* 2017:1). The interviews revealed that the main union confederation, LO, and employer confederation, NHO (*Naeringslivets*

Hovedorganisasjon), were instrumental in pushing for a new form of industrial policy through a 'bi-partisan initiative' (official, LO).

Even without such a policy, robotics and AI were already a key element of the funding strategy of the Research Council of Norway and Innovation Norway[4], while the digitalisation of public services, such as health records and tax returns, had been initiated over a decade earlier. Research institutes and universities, often in collaboration, undertake R&D in robotics and AI, with the former working more closely with organisations in the workplace (Nerdrum and Gulbrandsen 2009). A wide range of government-funded initiatives are available, with many directed at the public sector. Several interviewees claimed that government's prioritisation of the oil and gas industry had led to a neglect of more traditional land-based sectors, although there were signs of change. A representative from an employers' association described a 'slightly lopsided policy', where other industries remained 'in the shadow of the oil industry' (F&D-Norway).

Improving the position of land-based industries and enhancing the efficiency of the public sector are now widely emphasised in policy. RI-Norway referred to a process of technological transfer: 'some of the more solidly-based companies, technology-wise, have been able to move from the oil industry to other industries.' Robotic prototypes in land-based industries, including agricultural sprayers and pickers, are also being developed with support from the Research Council and Innovate Norway. Reflecting the white paper (*Nærings-og fiskeridepartementet* 2017:3), the majority of interviewees stressed the importance of the diffusion of automation technologies to the sustainability of Norway's high-wage, high-welfare model. Automation, as a means of reducing labour costs, was viewed as particularly important in manufacturing and agriculture.

> We have such a high cost of labour it's more profitable to replace workers with robots, automation, so we modernise all kinds of processes… you will see in southern, eastern Europe, perhaps more manpower intensive, most Norwegian plants are very slimmed down. (F&D-Norway)

Features of the institutional environment in Norway appear to encourage deliberative policymaking and the stability that can aid longer-term investment. Government funding for technology development was said to be provided on a relatively sustainable, long-term basis,

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[4] The Research Council of Norway is the chief advisory body to government on research policy, distributing state funding for research and innovation. Innovation Norway is a state-owned company and national development bank providing products and services aimed at boosting innovation and regional development.

attracting cross-party consensus (RC-Norway, T/T Norway). A number of interviewees stressed that changes in government have not led to a substantive shift in direction, attributing stability to the embeddedness of the social partners and civil society in the development and implementation of policy. An official from LO explained:

> If you make a law or… a huge research programme with hundreds of millions of krone, we will expect you, the government or a directorate or whatever to bring on-board the partners, and I mean even the sports clubs, their organisations, or the church.

More recently, government funding has targeted start-ups and small firm innovation, including the establishment in 2017 of Catapult Centres (copied from the UK) which provide support for organisations to develop innovative products and processes. The extent to which these initiatives will move beyond a small number of leading-edge organisations and support a broader process of diffusion is unclear. A research director argued that some areas were still behind:

> If you look at the laggards in Norway it's some of the public sector and also parts of industry… they don't understand this new technology… how they can utilise it, they don't have the mechanisms for encouraging people to use it, they don't have the culture to employ it. (TI-Norway)

Senior officers at a local council recounted the numerous digitalisation and innovation projects taking place in the public sector. The problem, they argued, is that this could lead to 'pilot sickness' (Council-Norway), with projects often initiated with time-limited funding and a lack of resources to support wider diffusion.

In the UK, centre-right governments after 2010 have brought forward 'new' industrial strategies aimed at 'rebalancing the economy' in the wake of the financial crisis (HM Government 2017). Against the background of worsening productivity performance, a central element has been investment in robotics and AI in universities and the setting up of Catapult Centres from 2011 (currently 10) to assist with the commercialisation of prototypes. The technology 'expert' interviewees saw the UK as 'leading' on autonomous cars, robotics related to nuclear decommissioning and AI, where RobotAssoc-UK claimed 'we are not far behind the rest of the world'. While the UK was described as strong on research and a 'great place to do tech' (Researcher2-UK), some interviewees raised concerns about the ability to retain ownership of digital/AI start-ups such as Deepmind (acquired by Google) and True Knowledge (bought by Amazon).

Those working in universities and Catapult Centres welcomed the injection of funding from government and the EU in supporting new robotic centres and expanding doctoral research. However, the level of investment was still widely felt to be inadequate:

> £40 million went into universities around field robotics… you could easily have put ten times that in… opportunities I think are going to be missed. (Researcher1-UK)

The prospect of the UK's exit from the EU was also causing uncertainty around the future availability of funding through Horizon 2020, and the ability to recruit and retain high quality scientists and doctoral students.

Much of the funding and policy agenda related to diffusion has been aimed at high value manufacturing (HM Government 2017). Interviewees from the funding bodies and Catapult Centres acknowledged that there was little support aimed at encouraging take-up across a broader range of organisations. In contrast to Norway, many interviewees commented on the low level of automation among manufacturers in the UK, even in some large organisations. As a representative of the robotics association remarked, when reflecting on industry's readiness for 'Industry 4.0': 'there is an awful lot of manufacturers that haven't done industry three yet' and a 'very long tail of SMEs' (RobotAssoc-UK). The researchers in the university robotics centres and funding bodies noted that substantial resources were being invested in developing technologies for health and social care, such as robotic surgical tools and interactive assistive robots to support independent living. However, they could give few examples of widespread diffusion, reflecting broader evidence about slow progress in the public sector (House of Lords 2017, EC 2019).

A further challenge identified by the 'expert' interviewees was the lack of a long-term perspective in relation to government policy and funding. Although funding has improved, Research3-UK saw this as 'precarious', a view shared by those in Catapult Centres. As one manager explained: 'stability of policy has probably been one of our biggest failings… There are good indicators but it occurs in a green paper and… the government changes' (Catapult2-UK). Another referred to 'short-term political cycles' where 'carrying on doing something you've been doing for ten years isn't a great thing to say as a politician' (Catapult1-UK). One explanation for such volatility is that, unlike Norway, the UK lacks strong social partnership institutions that can provide stability. Trade unions have no guaranteed role on committees and working groups established by the UK government in relation to industrial policy or the digital economy[5]. As a TUC official stated, government might listen 'if we produce good research they think is worth hearing…we don't have that seat at the table as a right'. Such marginalisation seriously restricts unions' ability to engage:

[5] This situation contrasts, to some extent, with the more inclusive approach favoured by the devolved governments of Scotland and Wales. However, the principal levers for industrial and economic policy, and labour market regulation, remain with the UK government.

> Since 1979 onwards, unions place… has been ideologically and systematically undermined. There's a limitation to what we can do. (UNITE)

In addition to the lack of a long-term policy perspective, several interviewees raised concerns about the damaging effects of company short-termism on employer investment in new technologies. Many companies were described as 'risk averse' (RobotAssoc-UK), 'interested only in now and want a two-year payback' (F&D-UK), with a widespread 'lack of investment and foresight' (Innovate-UK). These interviewees also identified the availability of cheap, flexible workers, often from overseas, as a further constraint on investment, particularly in sectors such as food processing and agriculture:

> it's been a much easier step to… just hire a few more people than maybe think about giving the workforce the tools, robots being one of them, to be more productive. (RobotAssoc-UK)

Others remarked how in the public sector, austerity was limiting opportunities offered by technology, 'with local councils under great stress with their budgets' (Innovate-UK) and questions over 'whether there's that money to invest in the NHS at the moment' (Catapult1-UK).

In Norway and the UK, there are some similarities with both governments focusing on the development of robotics/AI technologies and bringing new products to market. The UK is seen to have greater strength in research and development capacity, while Norway has more policy emphasis on diffusion, including to SMEs and the public sector. High-wage costs in Norway provide stronger incentives for organisations to invest, compared to the UK where institutional and regulatory structures encourage short-termism and enable the use of flexible, low waged labour. We might, therefore, expect the pace of change to be faster in Norway, and there to be a more significant role for the social partners, in particular trade unions, in shaping the future direction. How then do interviewees view the potential impact of robotics/AI on employment? Which sectors do they see as most likely to be affected, and what challenges are there in managing labour market adjustment?

Implications for Employment and Skills

Nearly all interviewees in both countries were sceptical of predictions of mass technological unemployment:

> It's tosh… they said that that 30 or 40 years ago that we'd all be doing a two-day week. (Innovate-UK)

> I think they're exaggerating the effects [but] …many of the jobs you have today will have to be at least redefined, they will have to change. (RI-Norway)

Trade unions were relatively positive towards technology, arguing that it was necessary to improve productivity and had potential job quality benefits. In Norway, the LO official insisted that automation was fundamental to the maintenance of the country's high-wage, high-welfare model. Employer organisations also saw unions as pro-technology:

> They will of course want that everybody should have a job in the future but I think they recognise that if we are to protect the high level of cost a lot of productivity measures will be needed. But they want to be part of that journey not to resist it. (F&D-Norway)

In the UK, the TUC interviewees considered that the overall impact on employment would be shaped by how government responded and planned for the future. Echoing recent policy statements (TUC 2017), they voiced concerns around weak diffusion and the need for a broad-based industrial strategy:

> I think the amount of jobs we lose and the amount of jobs we create will be dependent on how we plan this, on how active government is in setting out an industrial strategy… It could be really damaging but I don't think it has to be.

Widespread concerns were expressed in both countries around the short-term, disruptive effects of technology on the labour market, yet only one interviewee expressed long-term fears, questioning whether there would be 'jobs for everyone' (Researcher1-Norway). Interviewees found it difficult to predict where 'new jobs' would come from, although it was often noted, particularly in Norway, that there would be substantial growth in labour demand in health and social care, owing to an ageing population.

The picture that emerges from the interviews is one of constraints on rapid technological change, with those involved with the implementation in the workplace being the most cautious. Catapult1-UK described the current period as one of 'evolution… [not] revolution where suddenly everything changes', while Catapult2-UK argued that robots 'can't think as well as people, they are not as dextrous, they are not as flexible. They are progressing…[but] I don't see it as a complete big bang'. Similarly, a Norwegian research director commented that AI was a misnomer, with 'a lot of artificial and very little intelligence' (RI-Norway).

Several interviewees highlighted the potential benefits of robotics/AI in substituting for, as one put it, 'the dirty, the demanding and arduous jobs that people really shouldn't be doing' (RobotAssoc-UK). In Norway, some went further, referring to the importance of 'meaningful' work, and suggested that meaning would be lost if a job could be automated. T/T-

Norway commentated, ‘who wants to do work that is useless? …that’s not a good feeling, that’s not fulfilling’, and Researcher1-Norway asked, ‘do you want to do a job that a machine can do a lot better and cheaper than you? I don’t think so.’ Although this raises the question of who can say what is meaningful for whom, such comments may reflect an expectation or aspiration surrounding the quality of working life in a country where the institutional and policy environment affords this issue greater public prominence (Gallie 2003).

Current and future expected impact

The article now turns to explore in more detail how the interviewees viewed the current use of robotics/AI and future developments, with some specific examples from food processing and the healthcare sectors. In manufacturing more generally, robots were viewed as the next step in a process of automation that had already seen dramatic reductions in employment over the last 50 years. Many interviewees felt that the current phase of automation would lead to a more skill-intensive production process involving fewer workers with enhanced skillsets, comprising monitoring robots, basic maintenance and data analysis. However, country differences emerge in their perspectives about the diffusion of robotics.

In Norway, interviewees noted that much of manufacturing was already highly automated due to high labour costs, with robots expected to displace some of the remaining routine tasks, such as packing. There are signs that some activities previously off-shored to lower wage countries are returning to Norway through ‘reshoring’. As robotics further reduces the number of production workers, labour costs are less relevant and closeness to market becomes more important.

> in Norway there is a large opportunity... to take back a lot of production [which] actually is happening right now. The industrial production is actually starting to rise again after some period when it has been lower and lower each year. (RI-Norway)

In the UK, those working with manufacturers raised concerns about the low levels of take-up of pre-robotic automation. Automotives and aerospace were seen as sectors with substantial investment in robotics but elsewhere change was felt to be very slow.

Even in Norway, sector differences were apparent. In food processing, it was reported that ‘a lot of companies are backwards’ (F&D-Norway). This was attributed partly to tasks requiring the manipulation of soft materials, such as sandwiches, where robotic technologies remain undeveloped or are too slow and inflexible. Even where technology is available, the costs can prove prohibitive. Notwithstanding high wage pressures in Norway, the food workers’ union (NNN) argued that there were cases ‘when we listen to companies and management, they will say "oh no, this is too expensive".' In the UK, the availability of cheap, flexible workers, many of whom are migrants, in food manufacturing and agriculture, was seen as a further limitation on investment. A number of interviewees from the food industry and Catapult Centres identified potential restrictions on migrant labour, in a post-Brexit scenario, as presenting some employers with a stark choice between investing in robotics, moving overseas or business closure.

In the service sector, the current use of physical robots was felt to be limited, with expectations that future changes would be far slower than in manufacturing. The interviews highlight some interesting examples of the challenges surrounding the use of robots. Automated guided vehicles have been adapted for use in hospitals to transport items, such as waste, linen and food. However, they require specially designed hospital layouts which restricts their application largely to new builds. Web searches indicate only seven hospitals across the two countries are currently using them. Major constraints were identified in designing mobile robots to work in non-structured environments. Technology experts explained that robotic cleaners could be used in hospitals in large uncluttered areas, such as atriums, but not in wards or single-occupancy rooms. Even these technologies were not considered particularly advanced, as one researcher commented:

> We're designing technologies that allow us to do things better in a very narrow way…[it costs] millions and millions to design the [robot] vacuum cleaner…and that's not even a robot that can manipulate its world. It's just a robot that can vacuum. (Researcher2-UK)

Robots are being used in some hospital pharmacies, in similar ways to manufacturing processes, to pick, sort and pack. Assistive robotic surgery technologies are also available, which enhance the precision of operations but without replacing the surgeon. These systems are slowly diffusing in both countries but are limited by their high costs and the minimal labour savings offered (Cole et al 2018).

Many interviewees felt that the biggest impact on employment in the service sector would be through application of AI and digitalisation rather than by replacement with physical robots. Financial and legal services were considered most at risk. As one interviewee claimed, digitalisation was 'massively disrupting a lot of clerical jobs, accounting, potentially legal jobs' where routine tasks, such as working with spreadsheets or basic accounting functions, could be better performed by an algorithm (Researcher3-UK). These sectors, it was claimed, were 'already feeling the pressure' given the availability of data in digital form that makes it 'quite easy to replace people' (TI-Norway). Evidence from Labour Force surveys, however, indicates no significant employment reductions to date in the finance and legal sectors in either country

(Norway STAT, ONS[6]), suggesting an over-estimation by these interviewees in the extent of current changes taking place.

In healthcare, digitalisation is relatively advanced in Norway (NMLGM 2016), with patient records digitalised and the ordering of tests and prescriptions 'almost finished' (Researcher3-Norway). As demand for healthcare increases, it was felt that any displaced workers could be absorbed within the sector. In the UK, evidence indicates slow progress in digitalisation, particularly patient records (Honeyman et al 2016). In both countries, those involved in technology research in the health sector argued that advances in AI and big data promise major breakthroughs in the provision of diagnostic information for health professionals and in self-diagnosis tools for individuals through their mobile phone or tablet. Digital testing, they argued, would have major implications for areas like pathology and radiology. While some jobs would be lost, big data and self-testing would stimulate demand for other work, such as follow-up tests and procedures and interpreting complex data. Technology was also seen as reducing some manual and routine tasks, such as lifting patients and dispensing medicines, potentially freeing up more time for human interaction, something which interviewees regarded as essential to the giving of 'care'.

> [we] need people anyway to do things the robots can't, like really caring for you and look into your eyes and say 'hi, how are you today?' (NSF-Norway)
>
> humans value human interaction… when I'm old for Chrissake never send a robot to look after me (Catapult1-UK).

Country differences emerge in perceptions of the pace of diffusion, particularly in manufacturing and the public sector, where Norway appears more advanced. The 'expert' interviews underline the limitations of robots and AI, and lend support to recent academic commentaries which suggest they 'are not close to displaying the flexibility, adaptability and range of skills of human beings' (Lewis and Bell 2019:303, Upchurch 2018). Interviewees involved with implementing robotics/AI in the workplace emphasised the bespoke and complex nature of the process which increases costs and slows down diffusion. The biggest threat to jobs was seen to be in sectors such as finance and law, although interviewees did not support the more cataclysmic projections suggested by some commentators (Susskind and Susskind 2015). Even so, it is unclear to what extent they are currently affecting these areas, amid little evidence of shrinking employment levels to date.

[6] EMP04 Employment by occupation ONS; 09792 Employed Persons by sex and occupations, Statistics Norway

Dealing with labour market disruption: social support and skills

There has been much discussion of the role of social protections and the education and training system in dealing with labour market changes wrought by new technology (Neufeind et al 2018b). These aspects were also raised in the interviews, as most pointed to a period of labour market adjustment, with many workers required to change jobs or take on new tasks. Unions in both countries were particularly concerned about the consequences of automation for the low skilled. In Norway, the LO interviewee insisted that workplaces had to focus on reskilling workers, while the broader challenge of dealing with those who lost their jobs could be dealt with if there was a continued commitment to full employment.

> The most important vehicle… is full employment. If you can offer people a different job then you will be able to do this without much social friction. (LO)

In addition, the unions emphasised the importance of the existing 'social pact' in Norway which supported active labour market policies and strong social security provisions. In the UK, the unions interviewed were also supportive of the positive potential of technology. However, they point to a more a challenging institutional environment, with a lack of employment security, weak provision for retraining, and minimum welfare supports, where the risks associated with job loss fall more heavily upon individuals.

Interviewees raised concerns that some occupational groups deemed at high risk of job loss would not necessarily have the skills for new tasks or might struggle to adapt to workplaces with new technology. Examples cited were drivers and agricultural labourers. In Norway, the proportion who might be 'left behind' was felt to be relatively small. LO insisted that they needed to be 'taken care of by the welfare state… and have the possibility to lead a dignified life… [in which case] we will say yes to your robots'. In the UK, policy discussions have been framed in terms of a 'digital skills crisis' (HCSTC 2016), with the assumption that significant numbers of people are at risk of exclusion from the labour market due to lack of 'digital skills'. There was little support for this 'crisis' perspective among the interviewees. As in Norway, there was recognition that some would find it 'difficult to adapt' (Researcher1-UK) and were at risk of being 'left behind' (UNITE, UK). Several noted that most jobs were only likely to require digital skills at a basic level that most people could acquire through exposure to technology in everyday life.

There were notable differences in perceptions of the ability of the education and training systems to meet changing skill requirements. Only two interviewees in Norway cited weaknesses. A representative from an IT employers' association remarked:

> When you look at whose being educated today and if they have the skills that are needed for a robotics or AI industry, no, we're not educating the right types of people. (IT-Norway).

The suggestion was to improve ICT education, beginning in schools, addressing problems of outdated equipment and an ageing teaching workforce, often unfamiliar with the latest technologies. Another interviewee (F&D-Norway) thought there were 'perhaps' too few students opting to study physics, mathematics and engineering. There was, nevertheless, a general confidence in the system being able to adapt to reskill and upskill workers. In Norway, there is longstanding public support for adult learning and a wide range of vocational schools and adult learning associations, but questions remain over the funding of any major increases in provision for lifelong learning. As IT-Norway noted, 'I would say we have barely started that discussion of who's going to pay.'

In the UK, interviewees referred to shortages of skills in relation to a small group of specialists, such as engineers at the interface with IT, programmers and those involved in development and implementation. Some in Catapult Centres also highlighted the lack of engineering degrees that related specifically to robotics and computer systems, which required a 'different breed of engineers' (Catapult2-UK), and the limited availability of apprenticeships in robotics. The bespoke process required to introduce these technologies into the workplace was said to depend on individualised solutions developed between technology suppliers and the purchasing organisation. In the UK, it was felt that workplace managers and engineers often lacked the appropriate skillset for this work.

A number of interviewees also questioned whether employers in the UK would provide the training to reskill workers, echoing concerns around employers' poor record on training. A National Retraining Partnership was established in 2018 by the government, with representatives from the TUC and CBI (Confederation of British Industry), to focus on adult learning in response to changes in the economy, 'including as a result of automation' (HM Government 2017). Details are sketchy but it will be operating in the context of lack of union voice in training at government or organisational level, substantial reductions in state funding since 2010, and two decades of declining employer training (Green et al 2015).

Discussion and Conclusions

The article highlights similarities and differences in how key experts and stakeholders in the UK and Norway view the policy and institutional supports for the development and diffusion of robotics and AI. In both countries, government is providing more funding for R&D,

including increased resources for universities and research institutes. The UK has some advantages, reflected in a critical mass of researchers in universities that builds upon an already strong science base and the earlier development of Catapult Centres. These findings have some affinity with the VOC literature (Hall and Soskice 2001), which suggests the UK would be more likely to lead on first-stage technological development. However, there is little evidence that this leads to early adoption in the workplace. Norway has a greater focus on diffusion, supported by a more stable and longer-term approach to policy-making and the influence of other stakeholders, particularly employer organisations and trade unions. Government and state institutions are also more prominent as drivers in the public sector.

The findings provide a distinctive contribution to the research on technological change and 'country effects', by indicating that institutions and social actors are likely to be more influential than industrial policy in the diffusion of robotics and AI. Organisations in Norway have greater incentives to invest due to the high cost of labour, aided by a supportive environment for long-term investment. The provision of strong social rights in cushioning labour market risks for workers further helps to bind employer organisations and unions in common cause around the need for automation in the context of a high-wage, high-welfare model. In the UK, business short-termism and the availability of relatively cheap and flexible labour have long been identified as significant contributors to the 'long tail' of low productivity organisations and low levels of adoption of technology (Kitson et al 2000). These problems have not gone away (Lewis and Bell 2019) and are reflected in a slower rate of diffusion of robotics/AI. Government initiatives around R&D and technology-transfer are likely to struggle without substantial changes to an environment that militates against employer investment.

These findings support the argument that wider labour market and welfare institutions matter for innovation (Lundvall 2016). Nevertheless, these institutions are strongly interlinked with the relative power of different actors and remain key to whether benefits are shared with workers. The future pace and shape of change in Norway is likely to depend on the ability of unions to remain powerful enough to defend (or improve upon) the Nordic model (Dølvik and Steen 2018:12). In the UK, stronger employment regulation, high minimum wages and support for collective bargaining would provide greater incentives for organisations to invest in robotics/AI, policy changes which are more likely where strong unions can apply pressure on the state or government is willing to move beyond a neoliberal agenda (Lloyd and Payne 2002).

The research also contributes to debates about the pace of technological change. We argue that those best placed to identify the challenges of diffusion are those engaged in technological transfer and those with knowledge of the sector and workplace context. These perspectives indicate that although the 'innovation diffusion mechanism' may be less problematic in Norway than in the UK, the current and projected use of robotics/AI across *both* countries is rather slower than suggested by many contemporary accounts (Brynjolfsson and McAfee 2014, Frey and Osborne 2017). Indeed, few of those interviewed believed a future of mass technological unemployment beckons (Ford 2015). While other commentators have also questioned such predictions, the importance of our study is its grounding in evidence from technology developers and implementers.

This research, therefore, highlights the inadequacies of existing approaches to predicting job losses and addressing country differences, whereby technological change is a given, and variation in employment effects are primarily derived from industry and occupational structures (Frey and Osborne 2017, Arntz et al 2016). The constraints and barriers, in the form of institutions and social actors, should be central to an analysis of the diffusion of technology and comparisons across countries. Rather than presented as an after-thought, such an approach allows a more open debate about alternative possibilities and the ability of actors to shape technological change.

There, nevertheless, remain many gaps in research, particularly at the level of the workplace, in terms of whether technologies are being used and why, the way their introduction is being negotiated (or not) and how different interest groups shape employment and job quality outcomes. Trade unions are likely to play an influential role in Norway, given higher union density, institutionalised voice mechanisms, and a more cooperative tradition between management and unions. In the UK, unions are much weaker and the institutional environment less supportive, although they have a stronger presence in the public sector and parts of manufacturing which might provide opportunities for proactive unions. Research that compares sectors, across and within countries, drawing on rich workplace case studies, would be particularly useful in uncovering the conditions under which unions can make a difference, the impact these technologies have on work, and the ways in which this is contested by workers. Such studies would add considerably to our knowledge of 'country effects' and provide a substantial advance on existing research in the field.

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Table 1: Research Interviews*

	Norway	UK
Experts	**RC-Norway** Research Council 3 senior advisors from the Innovation Division **RI-Norway** research director, large research and innovation centre **Council-Norway** group meeting, project workers/innovation leads municipality	**RC-UK** head of robotics, Research Council **Innovate-UK** lead on robotics, Innovate UK **RobotAssoc-UK** head of Robotics Association, 35 years in industry **Catapult1-UK** director of Catapult Centre **Catapult2-UK** professor, Catapult Centre, 25 years in automation design & implementation **Researcher3-UK** professor, director of robotics centre,
Stakeholders	**T/T-Norway** director & project director at technology 'think tank' established by Government **IT-Norway** director, employer association technology sector **F&D Norway** ex-NHO senior executive **LO** digital technologies lead	**TUC** robotics lead & policy/economics officer **Researcher2-UK** Lead, UK robotics network **Researcher1-UK** contributor to public debates
Food and Drink	**F&D-Norway** senior employer association representative **Researcher1-Norway** university professor, developer agricultural robotics **Food Norway** operations director, large food processing plants **NNN** group interview, officials & local representatives in food & drink union	**F&D-UK** senior employers' association representative **Unite**, research officer, food and drink, general union
Healthcare	**Researcher2-Norway** university professor, developing and testing clinical technologies **Researcher3-Norway** medical clinician: expert in Big Data analysis in clinical healthcare **NSF** two senior advisors on innovation/ehealth, nurses union	**Researcher1-UK,** robotic researcher healthcare **Researcher2-UK** senior researcher developing medical robotics, **Unison** senior national officer healthcare, public sector union

- Three interviewees appear in two places due to their different roles.