Department for Education

Labour market and skills demand horizon scanning and future scenarios

Research report

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Preface and acknowledgements

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The opinions expressed in this report are those of the authors and do not necessarily reflect the views of the Department. The scenarios should be regarded as indicative of possible developments for the economy and the labour market, rather than forecasts of what is likely to happen in the next 15-20 years. The results should be regarded as contributing to a debate and used in combination with other sources of Labour Market Information, including quantitative assessments and projections.

Summary

Purpose and methods of the study

To ensure effective provision of skills in the future, it is important to assess what the future labour market in the UK might look like. While quantitative projections are available, the future of the labour market is shaped by many factors, which are often characterised by great uncertainty. This can make planning effective policy intervention aimed at supporting skill development, for example through the right investments in education and training, challenging.

The objective of this study was to scan the horizon of the labour market over the next 15-20 years to identify the drivers and emerging trends, and to create 5 different scenarios of what the labour market could possibly look like in the future. The purpose of these scenarios is not to predict. Rather, it is to help decisionmakers envisage different possible futures and support them in assessing which policy levers might be useful under which circumstance. Accordingly, scenario building can be a useful policy planning tool.

In addition, this research critically assesses the role of quantitative techniques in labour market analysis such as ‘Working Futures 2017-2027’ by Wilson and others (2020a).

The methodology comprised: an evidence-review of 130 sources, focussed on 6 specific sectors (construction, wholesale and retail, higher education, transport and logistics, health and social care, energy); 23 expert interviewees; qualitative scenario development and a scenario workshop.

Key drivers and trends affecting labour market and skills demand

Domestic and political environment
Global political settings
Economic growth
State of public finances
Ageing population
Migration
Pace of technological change
Technology-facilitated changes to the location & organisation of work
Climate change
Circular economy
Bioeconomy
Quality of work
Skills mismatches
Inequality
Changes in delivery of education and training

Overview of the scenarios and their implications for skills in the sectors of interest

Five qualitative scenarios have been developed for the labour market using a structured approach to reflect uncertainties in the economy, the environment, technology and the wider societal, political and legal landscape, 15-20 years in the future.

The scenario narratives do not focus on specific sectors but provide a high-level view of the labour market, given the key political, economic, societal, technological and environmental drivers. The implications, however, of each scenario are outlined for each of the 6 identified sectors – construction, wholesale and retail, higher education, transport and logistics, health and social care and energy.

Digital greening

Strong economic recovery and international co-operation, coupled with a high level of public spending to facilitate re-skilling, has led to a digital, green, and more inclusive society.

Construction: growth of non-traditional career prospects, demand for data analytical skills; *Wholesale and retail*: demand for programming skills, green skills and knowledge of e-commerce; *Digital Greening*: demand for skills in management, engineering, testing, communications, information security, computer science; *Transport and logistics*: demand for data analytical skills, skills to operate and repair vehicles remotely; *Health and social care*: demand for ICT skills and to operate remotely; *Energy*: demand for data analytical skills, knowledge of nuclear and renewable energy, energy efficiency measures and green skills.

Living Locally

Building on public sentiment, the UK has invested in greening its economy, leading to the reshoring of some activities and a more local sustainable approach to living and working.

Construction: shift towards skills related to electronic equipment, computer hardware, software, and programming; *Wholesale and retail*: demand for technical skills in operating and maintaining ICT equipment and for knowledge of e-commerce; *Higher education*: demand for skills in management, engineering, ICT, computer science; *Transport and logistics*: demand for skills to maintain infrastructure for zero emissions vehicles, to convert fuel systems, to model traffic flows and for low-skilled delivery workers; *Health and social care*: demand for human-machine interface skills, skills in assisting and caring for others; *Energy*: demand for engineering skills.

Protectionist Slowdown

A stagnant economy and a lack of investment has led to an increase in inequalities in many parts of the UK, including a digital divide and unequal access to education.

Construction: demand for technical skills (for example, to operate equipment; know-how of 'green' materials); *Wholesale and retail*: limited change in the skills required; *Higher education*: demand for short, tailored courses; *Transport and logistics*: limited change in the skills required; *Health and social care*: demand for skills in providing personal care to others; *Energy*: limited change in the skills required.

Continued Disparity

The economy continues focus on the Southeast of England. A skills mismatch persists, and high-skilled workers benefit from lifelong learning and greater flexibility, while the low-skilled experience increasing precarity.

Construction: unmet demand for technical skills; *Wholesale and retail*: limited change in the skills required; *Higher education*: limited change in the skills required; *Transport and logistics*: limited change in the skills required; *Health and social care*: limited change in the skills required; *Energy*: demand for knowledge of renewable energy.

Generating Generalists

While the direct economic impact of the pandemic was relatively short-lived, there has been an increased emphasis on transferable vocational skills to ensure resilience in a rapidly evolving world.

Construction: specialised skills needed from the agile workforce; *Wholesale and retail*: demand for technology, problem-solving and inter-personal skills; *Higher education*: demand for essential skills (problem-solving, inter-personal skills); *Transport and logistics*: gaps in specialised, technical skills (for example, repairing electric vehicles); *Health and social care*: demand for high-skilled roles (diagnosis, treatment alternatives, drug properties); *Energy*: demand for knowledge of and skills using energy efficient technologies.

Key policy implications

Qualitative scenario planning acknowledges that the future cannot be predicted and may evolve in different ways. From this research, the following implications can be drawn:

ICT/digital skills are critical to the future of most jobs with the emergence of specialist skill areas. Introducing STEM subjects for longer, incorporating these skills alongside regular studies and investing earlier in digital skills in the education system would support this skills need.

Any future vocational education and training system needs to provide clear and more flexible pathways so that workers are well aware of training options and can make informed decisions about what to do and how to do it.

More flexible, portable training with corresponding micro-credentials could be accompanied by accreditation and licensing of providers to mitigate the risk in quality of qualifications obtained in this way.

A broad range of stakeholders should be involved in developing courses and training to meet local labour market demand.

Education and training system also need to teach broad concepts and foundation skills (for example communication, networking, problem-solving, literacy and numeracy skills).

Employer investment in training will be increasingly important, but employer unwillingness to train their workers will continue to be a barrier. Incentives for life-long learning, both for the employer and employee, will be increasingly important, as will information on the benefits and options outlined.

1. Introduction

Motivation for this study

Ensuring that the labour market is provided with the right skills mix to function effectively requires advanced planning. There are, however, no perfect methodologies to accurately anticipate future needs. Quantitative assessments, even if robust, have limitations and are not sufficient alone. Alternative methods, such as qualitative scenarios, can complement these assessments.

The motivation for this study is to complement findings of the 'Working Futures 2017-2027' report by developing qualitative, future scenarios to stimulate reflection and debate for UK policymakers, social partners, and researchers and ultimately inform decision making. The aim of this study is also to critically assess the role of quantitative techniques in labour market analysis.

Qualitative scenarios are a useful tool for addressing future uncertainties as they can draw on a wider range of factors than can easily be considered in a quantitative framework. They are also designed to be representative of the range of futures that could plausibly occur. Scenarios, however, are not forecasts and their development is reliant on the existing evidence base, expert opinion and current thinking on what is plausible.

The approach to developing the scenarios used in this study builds on a targeted evidence review and expert interviews. It involves a structured process of examining the most important variables that influence the labour market and skills demand and generating coherent future scenarios validated though workshop discussions. While the structured approach is designed to mitigate some of the limitations of qualitative scenario development and builds on diversity of expert opinion, the results are based on the specific evidence and experts consulted. Finally, there is an inherent level of uncertainly in using the futures method. Even the most robust scenarios do not aim to predict the future: they merely serve to outline plausible future states.

1.1. Background and rationale for the study

Education and training should provide skills that are of value to the economy, employers and individuals anticipating their needs in the future. Yet, the abilities to anticipate the future of the labour market with any degree of certainty are limited. Technological advances, globalisation, an ageing population, migration and environmental change, combined with transformational events such as the UK departure from the European

Union (EU) and the COVID-19[1] pandemic are affecting the future of the economy, labour market and our society at large.

The UK Government needs to better understand the significant changes in the tasks, skills, and knowledge required for the jobs of the future to help determine what new skills provision might be needed and what changes need to be made to existing provision. Wilson and others (2020) in their 'Working Futures 2017-2027' report provide projections of the future labour market through a quantitative assessment of the demand for skills and employment prospects in the UK labour market over the next 10 years. These projections are based on a detailed multi-sectoral, multi-regional econometric model that relies on past labour market patterns and trends to illustrate possible future demand.

Similar quantitative forecasts such as this provide an important input into horizon scanning and foresight, but they are also subject to a number of assumptions, risks and uncertainties, given the methodological inability to anticipate disruptive developments. For these reasons, other methodologies are needed to construct detailed and plausible alternative futures. The work of Störmer and others (2014a, 2014b) draws on such methods, namely on qualitative future scenarios, to anticipate how the UK's work landscape might look like in 2030, and what skills might be required. This is further expanded on in Section 1.3 and in Section 3.

This qualitative evidence, however, about the future of the UK labour market has limited relevance today (given that it was carried out before COVID-19 and the UK departure from the EU). Therefore, new research is needed to assess systematically and robustly what the future labour market might look like and what the challenges, opportunities and implications are, to help make better informed decisions about the skills strategy. By using futures methodology and scenario building, policymakers can envision different kinds of possible futures and consider different policy levers to address these possible futures. This way, the findings in this study can serve as a useful planning tool. The next section will provide a more detailed overview of this study's objectives.

[1] COVID-19 is a coronavirus disease cause by the virus named as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). It was first identified in December 2019 and has since spread around the world. See WHO (2021).

1.2. Objectives and research questions

This research scans the horizon of the labour market over the next 15-20 years and identifies key drivers and emerging trends, to create possible labour market scenarios and to assess the broad implications of these scenarios for the jobs, skills, and qualifications.

This report answers the following research questions:

1. **Key trends and drivers -** What are the global drivers and key trends of the labour market? How might these evolve over the next 15-20 years? Which of these are likely to be most important in defining the future of UK jobs and skills?
2. **Evidence from specific sectors -** How do global and local trends interact in the UK labour market?
3. **Qualitative scenarios -** Given the key global and local trends, what are the different possible scenarios about how the labour market might develop over the next 15-20 years? What would have happened anyway? What is the impact on different sectors likely to be?
4. **Implications of the scenarios -** What are the implications of these scenarios for jobs, skills, and qualifications? How might the jobs, skills, and qualifications needed now change over the short term (0-5 years), medium term (5-15 years) and long term (15-20 years)?

In addition, this research critically assesses the role of quantitative techniques in labour market analysis such as 'Working Futures 2017-2027' by Wilson and others (2020a).

To support the research, 6 specific sectors, for which substantial labour market changes could be expected over the next 15-20 years, have been identified in conjunction with DfE and considered in more detail in the study. These sectors are: construction; wholesale and retail; higher education; health and social care; transport and logistics; and energy. The sectors are both of particular policy interest to the DfE and/or are where substantial changes in the labour market are expected to occur over the next 15-20 years.

1.3. Methodology

RAND Europe's Centre for Futures and Foresight Studies (CFFS) in collaboration with Institute for Employment Research (IER) were commissioned by the Department for Education (DfE) to conduct this study.

The methodology used comprises:

- **Evidence review**: to identify the types of global and local drivers of change which might be expected in the next 15 to 20 years, and how these drivers are likely to be important on the UK's labour market and the demand for skills over the foresight period, a review of existing evidence was undertaken. The review was carried out in April-May 2021 and used a systematic search and template for data extraction, based around the PESTLE framework.[2] The review included 130 sources and focussed on 6 specific sectors (construction, wholesale and retail, higher education, transport and logistics, health and social care, energy). The results were synthesised thematically and generated a long list of factors most likely to impact upon the types of jobs and skills needed in future which informed the scenario building (see below). More information about the review is provided in Annex A. Evidence review.
- **Expert interviews**: to validate, explore and refine findings from the evidence review semi-structured expert interviews were conducted in May-June 2021. A total of 23 interviewees could be grouped into: experts in labour market, skills and sectoral (9 interviews), academics and researchers (5 interviews), and representatives of international organisations and bodies (4 interviews). Further details on the interviews, including the list of interviewees, are outlined in Annex B. Expert interviews.
- **Qualitative scenario development**: a structured methodology was used to examine the interaction of the key drivers in the labour market with the wider social, economic and technological factors – and the uncertainty in the future development of these factors – to develop a range of labour market scenarios that represent a wide spectrum of possible futures in 2040. Detailed information about the scenario method is presented in Annex C. Scenario method.
- **Scenario workshop**: the purpose of the workshop was two-fold: (1) to elicit feedback on the scenarios (examine if these are plausible, identify inconsistencies and gaps); and (2) to consider implications of each scenario (on skills, productivity and growth, quality of work, policies and interventions). The online workshop was held in June 2021. It involved 19 participants, including: 10 experts representing academia and research institutes, international organisations, national committees and industry bodies; 9 representatives of Government departments; and the research team. Detailed information about the workshop is presented in Annex C. Scenario method.

The study is constrained by a number of limitations. These include a targeted (rather than comprehensive) character of the evidence review, a limited number of interviews and views and opinions gathered during the workshop. While wider consultations were beyond the scope of this study, the diversity of experts involved in the interviews and the

[2] PESTLE analysis considers Political, Economic, Sociological, Technological, Legal and Environmental factors. See CIPD (2020a).

workshop ensures that a broad range of perspectives are captured. It was, however, not possible to target literature on the 6 sectors of interest or interview experts representing views from across all these sectors within the scope of the study.

Similarly, the scenario development is not free from, and indeed heavily relies on, expert knowledge and judgements made by the researchers. As such, the team combined researchers with labour market and skills expertise and scenario specialists. The implications of the scenarios for the labour market also draw heavily on input from experts and policymakers at the scenario workshop. Importantly, using future scenarios method involves a degree of uncertainty: they are not forecasts or likely predictions but they do outline plausible futures.

Finally, a strength of this research that helps to mitigate some of the limitations above is its approach to scenario development. This involves a structured 6-step process and the 'systematic framework' (Gausemeier and others, 1998), which identifies critical factors and combines cross-impact analysis, consistency analysis and cluster analysis to identify scenarios. The scenarios are thus developed on the basis of a multi-factor, multi-sector interrelated system and do not rely on only 1 or 2 main drivers.

1.4. Critical assessment of quantitative skills projections

Alongside this qualitative research, a separate critical assessment was undertaken of the role of quantitative skills projections given their limitations in the current economic environment and the degree of emphasis that should be placed on quantitative versus qualitative evidence. This is summarised below, and the full analysis is provided in Annex D. Critical assessment of quantitative measures.

While IER leads the *Working Futures* study, there was no overlap in IER staff who was involved in the horizon scanning and scenario building. Recognising that this does not fully remove a perceived conflict of interest, this critical assessment: (1) is informed by expert interviews; and (2) was reviewed by 2 independent reviewers (RAND Europe's researchers).

Having a strategic and systematic process to anticipate future skill needs, including forecasting or projections, is crucial to help understand the future of the labour market, including what type of jobs will be needed, and what education and training levels might be required.

The DfE's current quantitative approach, the 'Working Futures' study, adopts a multi-sectoral, multi-regional econometric model based on past labour market patterns and trends to illustrate possible future demand for skills and employment prospects in the UK labour market in the short- to medium-term. The quantitative projections are theoretically grounded, comprehensive in coverage of the whole UK economy and provide detailed sectoral and regional information. While the approach is well regarded worldwide (see, for example, Cedefop, 2010; OECD, 2016), it is not well suited to accounting for

unforeseen disruptions. Another limitation of the 'Working Futures' study is that the model relies upon occupation and qualification as proxy measures of skill. This is due to lack of suitable data, which is an area where the DfE might consider funding additional work to complement and extend the evidence.

A range of other approaches exist, both qualitative and quantitative, which the DfE could combine with the 'Working Futures' study to develop a more comprehensive picture of future labour market and skills needs. The ideal mix of exercises would generate data on the supply and demand for skills as well as on the current and future situation and would also be repeated regularly. Ideally, such exercises would not only generate aggregate national-level data, but also detailed data per sector and/or region. The skills anticipation system would, again ideally, also provide detailed skills information at both the occupational and educational-level.

Crucially, it is not a case of simply substituting qualitative methodologies for quantitative methodologies. Each methodology has its own set of strengths and weaknesses. Some methods are better at describing the current skill supply and demand situation, whereas others are better at producing long-term projections. Importantly, there is widespread consensus that while alternative approaches such as ad hoc and/or tailored exercises can provide useful insights, they are generally regarded as *complements* to the model-based projections, rather than *substitutes* for them (Dickerson and Wilson, 2017; Van Bruegel, 2017; Wilson, 2008).

Subject to policy priorities and resource availability, the DfE might want to consider funding a large-scale, regular survey of employers about current skill requirements (or integrating additional questions in the existing surveys, such as the Employer Skills Survey (Winterbotham and others, 2018) or the Labour Force Survey (ONS, 2021c)). Funding extension-work that applies the US O*NET to UK data to improve labour market intelligence on skill requirements within occupations might also be considered (see O*NET, 2021).

Other complementary sources of evidence worth considering include real-time web scraping of online vacancy data to improve intelligence about emerging skill requirements (similar to Cedefop's Skills-OVATE tool (Cedefop, 2021a)), Further options also include case studies about skill use within and between firms and/or within and between sectors, along with targeted foresight or scenario exercises. In short, qualitative approaches tend to be more flexible (compared to quantitative methods) and can thus be conducted as and when they are needed and on a more targeted basis in response to emerging issues, but they are also more speculative.

In conclusion, the 'Working Futures' projections play a fundamental role in providing benchmark or baseline data to inform relevant stakeholders. Complementing the projections with other quantitative and qualitative evidence will provide a more comprehensive picture to the DfE of the future of the labour market and skills needs. Getting the right mix and complementarity of different evidence will be dependent on

factors including the objectives of the skills anticipation exercises and resource availability.

The critical assessment is set out in full in Annex D. Critical assessment of quantitative measures.

1.5. Structure of the report

The remainder of this report is structured as follows:

Section 2 presents key trends and drivers affecting labour market and skills demand drawing on the evidence review and expert interviews.

Section 3 offers 5 qualitative scenarios for labour market and skills demand that build on the evidence review and expert interviews.

Section 4 outlines implications from the evidence review and the scenarios for future skills, qualifications and jobs in the 6 identified sectors.

Section 5 concludes with policy implications.

2. Key trends/drivers affecting labour market and skills demand

Key messages

Key drivers and trends affecting labour market and skills demand

Domestic and political environment
Global political settings
Economic growth
State of public finances
Ageing population
Migration
Pace of technological change
Technology-facilitated changes to the location & organisation of work
Climate change
Circular economy
Bioeconomy
Quality of work
Skills mismatches
Inequality
Changes in delivery of education and training

Note: Factors likely to be most important in defining the future of UK jobs and skills are highlighted.

These key drivers and trends do not evolve in isolation from one another. Rather, the future of the labour market depends on how different drivers interact. For example, global and local trends interplay in a number of ways:

- The relationships between the 4 nations of the UK (also in relation to the UK's departure from the EU) continue to evolve.
- The interactions between population ageing and migration trends, in combination with regulation of future UK migration arrangements, pension's age and platform work, are likely to determine the extent to which the demand for labour in the UK meets supply and UK ability to attract global talent.

- Climate change affects all aspects of life at global and local level.

Key messages (cont.)

Sector specific implications for skills

Construction: demographic factors including the sector's heavy reliance on migrant workers and that a large proportion of workers are shortly due to retire, are key drivers likely to contribute to existing skills shortages.

Wholesale and retail trade: the dramatic increase in online sales allowed the sector to remain resilient during the Covid-19 pandemic. Just over half of jobs in this sector are at risk of automation.

H**igher education:** skills shortages in the sector exist but the proportion of jobs in the education sector at risk of automation is one of the lowest amongst sectors.

Transport and logistics: shortages affect drivers, managerial and administrative occupations. Yet, over half of jobs in the sector are considered at risk of automation.

Health and social care: the ageing population is the main driver of growing demand for health and social care. Skills shortages are increasing.

Energy (renewables): skills shortages are in engineering and technicians' occupations with STEM qualifications as well as in other occupations and nearly half of jobs are at risk of automation.

2.1. Factors influencing the labour market

This section outlines the key factors for the future evolution of the labour market and their likely implications for jobs, skills and qualifications over the next 15 to 20 years. These factors include both global and local drivers of change.

2.1.1. Political and regulatory factors

Looking towards the future there are 2 main groups of political and regulatory factors which might influence the labour market. These relate to domestic political environment and global geopolitical settings.

Domestic political environment

The relationship between the 4 nations, including the English regions and central government is shifting towards greater devolution of powers. Elections to the Scottish Parliament in 2021 saw a pro-independence majority (Paun and others, 2021), and the position of Northern Ireland (NI) within the UK economy has been complicated by the UK's departure from the EU (McGuiness and Birgin, 2020). This trajectory carries potential for economic divergence. Ongoing devolution settlements are also taking place with regions and metropolitan areas within England.

Implications for jobs, skills and qualifications

Education, training and skills power are already devolved in NI, Scotland and Wales. Employment law is also devolved in NI, Scotland has powers over raising and lowering income tax (Civil Service, n.d.) and city and regional devolving deals in England have included devolving parts of the skills system. Further devolution may provide opportunities to restructure the complicated environment and make the provision of further education and training more responsive to local needs. It may, however, also lead to divergences in how funding operates and complicate such questions as the degree of emphasis that should be placed on boosting economic growth and productivity versus social inclusion and create a patchwork of employment and skills strategies and outcomes. In the unlikely case of severance of any of the home nations, the resulting political disruption would alter revenue raising arrangements and impact on the functioning of the respective economies and their constituent labour markets, including intra-UK labour force mobility of workers.

Global geopolitical settings

It is difficult to foresee what will happen in the global political environment, particularly post-Covid-19, but the rising presence of China and India is likely to continue.[3] Problems, however, with global supply chains during the Covid-19 pandemic may lead to a

[3] INT-1, INT-2, INT-3, INT-5, INT-6, INT-7, INT-16.

reinvigoration of UK production capabilities in sectors such as manufacturing, food production, agriculture, renewables, pharmaceuticals, health diagnostics and construction.[4] Such a shift towards national economic resilience has the potential to stay, if not reverse, the long-term shift towards increased globalisation. Yet, the level of digitalisation (see Section 2.1.4) is likely to play a key role in determining the extent to which firms re-shore/in-shore jobs previously off-shored to the Global South, and in-source work that was previously outsourced.[5] The site(s) of this relocation may have large-scale impacts on the structure of the economy and the demand for certain kinds of labour.

A final consideration linked to the above is how the UK positions itself globally and what alliances it develops with other countries in the wake of departure from the EU and whether the latter results in any shift in its regulatory regime. While the EU is likely to remain the UK's largest trading partner,[6] the UK may look to further its trade links with the Asia-Pacific Rim, for example, in the effort to pursue a 'Global Britain'. This may, in turn, impact their links with the EU.

Implications for jobs, skills and qualifications

It is likely the global equilibrium will be maintained over the medium-to-long term, with the UK continuing along current lines with potentially intermittent periods of crisis, particularly should the Covid-19 situation become endemic. Certain potential risks, however, could lead to more significant medium-to-longer term political and economic shifts that would in turn bear implications for the labour market:

- Political instability in certain parts of the world could increase the cost of world trade as supply chains are less resilient. This would see a dampening of global demand with attendant risks to the open UK economy.
- Deglobalisation would have adverse impacts on certain sectors which are integrated into world-wide production chains.
- Increased public expenditure on defence and security would likely reduce the capacity of the state to invest in other areas, such as education and training, though it is recognised that there will be spill overs.
- Political instability may affect migration trends such that the UK might be unable to attract workers with key skills.

[4] INT-2, INT-3, INT-7, INT-8, INT-12, INT-13, INT-16.
[5] INT-3, INT-7, INT-8, INT-11, INT-12, INT-13, INT-14, INT-15, INT-16.
[6] INT-1, INT-2, INT-3, INT-5, INT-7, INT-8, INT-11, INT-12, INT-13, INT-14, INT-15, INT-16, INT-18, INT-19, INT-18.

2.1.2. Economic factors

Economic growth, measured in terms of changes in Gross Domestic Product (GDP) and the state of public finances are 2 main determinants of the future labour market.

Economic growth

While evidence from previous recessions indicates that the recovery period can be drawn out (Hogarth and others, 2011), immediate economic outcomes seem to suggest a relatively rapid bounce-back from the recent severe economic downturn resulting from the Covid-19 pandemic. For instance, while headline GDP declined by 9.9% in 2020 (ONS, 2021a), it is estimated to have increased by 4.8% in Quarter 2 (April to June) 2021, following easing of Covid-19 restrictions, with increases in services, production and construction over the quarter (ONS, 2021b). The largest contributors to this increase were from wholesale and retail trade (12.8%) accommodation and food service activities (87.8%), and education (19.4%) (ONS, 2021b). GDP, however, remains 4.4% below the level it was before the pandemic (Quarter 4, October to December, 2019) (ONS, 2021a). The scale and speed of recovery is likely to depend largely on household spending (Nabarro, 2020), which, in turn, relies on the confidence of households in the post-Covid period when the various support schemes come to an end. Savings built up over the course of the pandemic may also result in a pick-up in consumer spending (OBR, 2021).

While considerable uncertainties around the future of the pandemic remain, the roll-out of vaccines, the capacity to develop new ones to deal with variants, and the emergence of various therapies do point to a relatively fast recovery. Some economists and commentators, however, are concerned that the recovery will be shaped differently than experienced in the past. For instance, there is talk of a K-shaped rather than U-shaped recovery (see Ballard, 2020; Hutton, W., 2021). This is characterised as being where, on the one hand, those living in more prosperous regions, high technology companies, healthy citizens, and those who have been fortunate able to be able continue working during the pandemic are likely to recover relatively fast. One the other hand, the rate of recovery for others, such as the disadvantaged, small-to-medium sized companies, the digitally challenged, those employed in sectors such as hospitality, and the young, is likely to take much longer to recover (Hutton, W., 2021).

As an open economy, the UK is also strongly influenced by global economic activity. Global GDP is estimated to have contracted by 7% in 2020 with the potential recovery period[7] likely to be protracted, and some of the UK's main trading partners have experienced a relatively steep decline in their GDP. The UK's departure from the EU is also likely to have a negative impact on trade, which may translate into a lower level of GDP compared with the UK staying in the EU (HM Government, 2018b). It is not yet clear to what extent the UK will be able to forge deals with non-EU countries which might offset any lost trade with the EU (HM Treasury, 2016; Reis and others, 2017) or the

[7] That is, the time it takes to return to the pre-COVID estimated level of GDP.

extent to which increased barriers will accelerate reshoring (firms having to relocate to remain competitive). Moreover, some firms may no longer consider the UK as a base from which to trade with the EU, and this may reduce future FDI. Consequently, the impact of leaving the EU and the extent to which the UK is able to gain comparative advantage in global markets through changes in regulation around the economy and labour market will be important factors (Harari, 2020).

Implications for jobs, skills and qualifications

The implications of the Covid-19 pandemic and the UK's departure from the EU for jobs, skills and qualifications depends on the extent to which: (1) these events represent one-off shocks that the economy recovers from and resumes its long-term growth path (even if this takes a number of years); or (2) whether they will lead to long-term scarring and/or structural shift in the economy due to its likely long-term differential impact on particular sectors of activity.

Should a K-shaped recovery occur as a result, certain sectors and individuals will recover relatively quickly while others may continue to decline. For example, it is likely that sectors that were hit harder by the pandemic, such as hospitality and the creative industries, will take longer to adjust to new economic realities (Sentance, 2020). It is too early to tell whether other industries will be able to compensate if scarring does lead to long-term loss of output and employment from these sectors. Reskilling workers will also be crucial to building post-pandemic resilience (Agrawal and others, 2020a), and ensuring skills matches.

State of public finances

The Covid-19 pandemic has had a significant negative impact on the state of the UK's public finances, with the Government's budget deficit reaching a peacetime record in 2020/21 (House of Commons, 2021). The current forecast is that this deficit will fall over the coming years, although the extent of this depends on both how long the pandemic continues to impact daily life and the extent of long-term economic damage (House of Commons, 2021). There may also be more directing of public finances towards the government's levelling up agenda (Powell and others, 2021). For the time being, there is relatively little known about the fiscal stimulus packages put in place to assist the economy adjust to the new normal which requires facilitating structural changes in the economy while compensating vulnerable regions and populations that suffer most from the long-term consequences (Schultz, 2020). Given that government debt levels have reached historical highs (of 106% of GDP in Q1 2021) (ONS, 2021d), there is always the possibility that there may well be pressures to pay down the debt unless a new economic consensus arises.

Implications for jobs, skills and qualifications

Current pressures on public finances may constrain future public investment in essential sectors such as health and social care, public transportation, energy/utilities, and education and training.[8] While the pandemic seemed to have increased the appetite for higher levels of public investment in essential services, the ageing workforce and long-term inactivity would most likely lead to a continuation of pressure being placed on public finances.

Pressures will likewise be placed on state investment in education and training, although the levelling up agenda may result in some directed investment in specific areas.

2.1.3. Socio-cultural factors

The key socio-cultural factors affecting the labour market include the ageing of the population and migration.

Ageing population

While in 2018, approximately 1 in 5 people in the UK were aged over 65 years of age, this is expected to increase to 1 in 4 by 2050, with a particular growth in those aged 75 and over (ONS 2019d). With the declining fertility rate, increasing average life expectancy, and an expectation that large cohorts of workers are approaching retirement age, the percentage of the working age population is projected to decrease from 62.5% in 2018-19 to 61.2% by 2050-51 (ONS, 2019b). At the same time, with the rising state pension age (HM Government, 2021b), there is likely to be an ageing workforce (Government Office for Science, 2016).

Implications for jobs, skills and qualifications

Many experts thought that the current trajectory for population ageing was likely to have broad implications for the labour market as a whole. But it may be felt most acutely in health and social care, training and education, other parts of the public sector, as well as in fields related to life/biomedical/health sciences.[9] Increased average life expectancy also means a probable extension of the working lives of many people. This will create a need for more training for older workers to make sure they maintain and/or update their skills. Some sectoral experts identified several industries where it was already known that a large proportion of their workers were shortly due to retire. These included: agriculture, the public sector, energy and utilities, manufacturing, transport, construction and traditional crafts.[10] An increase in

[8] INT-2, INT-3, INT-4, INT-5, INT-6, INT-7, INT-8, INT-10, INT-11, INT-13, INT-16, INT-17, INT-23.
[9] INT-1, INT-2, INT-3, INT-4, INT-5, INT-6, INT-7, INT-8, INT-9, INT-10, INT-13, INT-12, INT-14, INT-15, INT-16, INT-17, INT-18, INT-19, INT-20, INT-22, INT-23.
[10] Such as, for example, blacksmithing, ceramics, leatherworking and jewellery making.

employment in the care sector will be needed to look after the ageing population (ILO and OECD, 2019).

Migration

An important element of demographic change is the role of migration. There is much uncertainty about future changes in migration depending upon geopolitical flows and the operation of the points-based immigration system, among other factors (Home Office, 2020). Consequently, future immigration policy is key for achieving the right mix of (skilled) workers. The UK's departure from the EU provides both potential challenges and opportunities in this respect.[11] Any reduction in what is predominantly a young migration population could further exacerbate the concerns around the reduced and ageing workforce noted above.

Implications for jobs, skills and qualifications

Labour supply may become constrained by limited migration with implications for those sectors which have been historically reliant upon migrant labour; these are often ones which are not amenable to automation. In particular, there may be challenges meeting the demand for workers in the care sector given the ageing population and sector's reliance in recent years upon migrants from eastern Europe.

The effects of the ageing population may be alleviated to some extent by the capacity of the UK to attract skilled workers from the global labour market (Hogarth, 2021).

Reducing reliance on foreign labour would also increase the importance of and raise incentives for better education, skills and vocational training opportunities for lifelong learning for UK workers.[12] It could also incentivise improvements in the attractiveness of some jobs to domestic workers, as is already being seen in the hospitality sector through increased pay and better working hours (Strauss, 2021). Moreover, the risk of a 'brain drain' in STEM could be offset by compensating policies to stimulate supply of highly skilled people in the UK (HM Government, 2020b).

2.1.4. Technological factors

Recently there have been a number of technological advances, including: artificial intelligence (AI), automation and robotics, combined with the emergence of big data, the Internet of Things (IoT) and ever-increasing computing power. These are expected to have wide-ranging impacts on the quantity, quality and organisation of work, as well as on the content of jobs, the skill requirements and any underpinning education and training that may be necessary to perform future work (Arregui Pabollet and others, 2019; CIPD, 2019b). In this section, the focus is on the rate of adoption and diffusion of

[11] INT-3, INT-4, INT-5, INT-9, INT-12, INT-15, INT-16, INT-17, INT-21.
[12] INT-4.

technology in general as well as digital skills of the workforce. Specific technologies are not considered in detail.

Pace of technological change

There is evidence to suggest that these recent technological innovations are taking place at an unprecedented rate (see Eurofound, 2018; Rani and Grimshaw, 2019). The significance of this, however, is unclear. Some experts consider digitalisation to be a set of peripheral innovations that will have very little effects on growth in the long-run,[13] while others talk of a fourth (for example Schwab, 2016) industrial revolution (Rifkin, 2001, cited by Eurofound, 2018). Regardless of these debates, we are currently in a period where the IoT is being harnessed in a variety of activities such that the degree of interconnectedness allows the realisation of many things previously considered impossible.

The pace, however, of technological change also depends on the uptake of technology by businesses and the broader population, and this often takes place at a much slower (incremental) pace than some commentators suggest. This is because businesses are risk-averse or face no market demand for change when it comes to making significant investments in technology. On the other hand evidence is emerging to indicate that the pandemic has accelerated the pace at which certain technologies are being introduced by firms in an effort to improve their resilience (Agrawal and others, 2020a; EY, 2020; MGI, 2021).

Demand for technological change within businesses is also driven by the digital skills of consumers. Prior to the pandemic, a slowing in the rate of progress in people moving online and gaining basic digital skills had been observed. Over the course of the pandemic, however, e-commerce and internet usage accelerated dramatically, with indications that these new habits are likely to continue in future (Lloyds Bank, 2021). Going forward, in order to participate in society, citizens will need at least basic digital skills for life and work.[14]

Demand is also increasing from consumers, seen in the growth of e-commerce accelerating significantly due to an increase in demand for online ordering of goods and services the Covid-19 pandemic, with indications that these new habits are likely to continue in future (Lloyds Bank, 2021). The ageing population may also provide incentive to firms to adopt new technologies to replace a depleting workforce (Manyika and others, 2017, p. 15), although the UK is not currently investing highly in automation and robotisation, and these technologies are still more prevalent in manufacturing than in

[13] Such as the American economic historian Robert J. Gordon (2016, cited by Eurofound, 2018).
[14] Different terminology is used including basic, foundation and essential digital skills. See for example, the UK Government's 'Essential digital skills framework' (HM Government, 2018a), which sets out 5 categories of essential digital skills for life and work: communicating, handling information and content, transacting, problem solving, and being safe and legal online; whereas the DfE's (2019) 'National standards for essential digital skills' sets out the digital skills needed for work and life across 2 levels: entry and level 1 (with a set of prerequisite foundation skills).

services (Eurofound, 2018). Where investment in new technologies does appear to be increasing is with respect to the green transition (see Section 2.1.5).

Finally, the rate of technological change is driven by the availability of improved infrastructure, such as universal access to ultra-fast broadband and ICT hardware, to enable take-up both within the workplace and among consumers. Rates of digital inclusion continue to vary considerably across region, age and gender (ONS, 2019b), and given the difference in lockdown working arrangements and requirements, some parts of the UK workforce have shifted online more rapidly than others.

Implications for jobs, skills and qualifications

Rather than replacing work, it is likely that technology will cause work to change and shift – in terms of the supply chain, types of occupations, types of tasks performed by workers and employment statuses (Valenduc and Vendramin, 2019).

While it is anticipated certain activities or tasks within occupations will become automated (Arregui Pabollet and others, 2019), few jobs are likely to become completely automated in the near-to-medium term. Firms will need to transform their business processes and redefine the tasks and jobs their workers perform (Chui and others, 2015; Manyika and others, 2017), particularly as new labour-intensive tasks are anticipated to emerge even as others are replaced (Acemoglu and Autor, 2011). Indeed, some experts believe that the current trajectory of incremental uptake of new technologies is likely to result in more (net) new jobs being created than lost.[15]

Increases in inequality may consequently be seen as it is likely the new jobs will favour highly skilled workers, while those jobs involving lower skilled routine tasks (concentrated in the elementary, and operator and assemblers occupational groups) are the ones to be replaced (Acemoglu and Repestro, 2018; Pouliakas, 2018). Those sectors identified as being most at risk include the utilities and energy sectors, construction, mining, agriculture, manufacturing, wholesale and retail trade, financial services, transportation and storage, and professional, scientific and technical services. Several experts, however, have provided examples of how machine learning is already extending automation and AI into areas previously considered out of scope, including 'rule-based' intermediate level (white collar administrative) and higher-skilled jobs, such as legal and estate agency work, and health diagnostics.[16] The impact of the accelerated trend towards e-commerce is also likely to be felt acutely in the retail sector, as many high street retail shops have already been forced to close or shift to online-only channels.[17] If technological change gathers pace, there is the risk that people are forced to exit these sectors and occupations without there being compensatory employment growth in others.

[15] INT-1, INT-2, INT-3, INT-5, INT-9, INT-13, INT-14, INT-15, INT-21.
[16] INT-1, INT-2, INT-5, INT-7, INT-10, INT-12, INT-16.
[17] INT-1, INT-2, INT-5, INT-7, INT-8, INT-8, INT-11, INT-13, INT-14, INT-16, INT-17, INT-18, INT-20.

Moreover, it is anticipated that as more discrete, repetitive and routine tasks become automated, more workers in the future will need higher level or advanced digital skills, including digital skills and human skills, such as autonomy and teamwork (Arregui Pabollet, 2019; Cedefop, 2018a, 2018b; WEF, 2018). A failure to embrace digital skills could leave UK companies struggling to compete globally (Microsoft, 2020).

This trend towards more highly skilled jobs may lead to higher demand for better education, skills and vocational training opportunities for lifelong learning. Automation might mitigate the impact of a declining working age population (see for example Abeliansky and Prettner, 2017; Acemoglu and Restrepo, 2017). Effective regulation might be needed to prevent firms from using technology to further fragment tasks and de-skill workers (Arregiui Pabollet and others, 2019). There is also the risk that employers continue to favour recruitment of new digitally-skilled graduates rather than developing the digital skills of their existing staff, as is currently the case in the area of ICT specifically (Deming and Noray, 2020).

Another risk is the capacity of the supply-side to support companies engaged in technological change, which could potentially feed into skill shortages. Alternatively, if sufficient technological change fails to take place, there is a risk that the equilibrium skill level will fall. There is also a risk that employment restructuring will run ahead of changes to education and training, which would result in further skills mismatches.

Technology-facilitated changes to the location and organisation of work

New digital technologies offers opportunities such as the alleviation of skill shortages, increased productivity, making jobs more interesting or rewarding, new earnings opportunities and enhanced opportunities for workers to choose when, where and for whom they work (CIPD, 2019b, p. 5). Two key trends in particular are significant for the future of jobs, skills and qualifications: remote and platform working.[18]

The pandemic has accelerated existing trends in remote work, with around one-third (35%) of employees working solely from home at the peak of counter-pandemic restrictions in the UK (MGI, 2021). While this trend is highly concentrated in professional and managerial positions, the pandemic also saw remote working extended to administrative and sales occupations. A trend of ‘hybrid working’ is now emerging in the recovery phase of the pandemic, with employees’ time being split between remote and non-remote work (Microsoft, 2021).

The introduction of new technologies is also opening up new ways of organising work (Rani and Grimshaw, 2019). One of the major transformations in work over the past decade has been the emergence of online digital platforms and platform working. Platform working offers flexibility and freedom around when and where an individual

[18] Remote working is the practice of an employee working at their home, or in some other place that is not an organisation's usual place of business.

works (HM Government, 2018d). There is, however, often a trade-off involved in terms of security and employment rights, with fluctuations in hours and income levels creating heightened risks of precarity, particularly for individuals who rely on platform work as their main source of income (HM Government, 2018d).

Implications for jobs, skills and qualifications

While it is too soon to tell whether the trends of increased remote and shifts to hybrid working will be short lived or longer lasting,[19] these work arrangements have the potential to disrupt the way that work is organised, the skills needed by employees and their managers.

Platform working tends to limit opportunities for career progression, and low pay and unstable work has potential to limit employment and training opportunities, in addition to compounding existing low incomes (HM Government, 2018d).

Extending beyond platform work itself, concerns have also been raised around the potential for technology to impact working conditions through, for example, intrusive employee monitoring and surveillance. This has the potential to limit work autonomy, diminish employees' wellbeing and reduce their trust in management (Riso, 2020).

2.1.5. Environmental factors

The key environmental factors influencing labour market and skills demand are climate change, the shift to a more circular economy and developments in the bioeconomy.

Climate change

In recent years, the urgency of the necessity of tackling climate change has become increasingly apparent (BEIS, 2021). The UK government has identified decarbonising the UK economy and building resilience to the impacts of climate change as the 'greatest challenge facing the UK and the world' (UK Government, 2020b). To address this challenge, the UK has engaged with initiatives at the global and EU-level, and has introduced additional national ones. The UK is a signatory to the Paris Agreement, designed to limit global warming to well below 2, and preferably to 1.5 degrees Celsius. The Paris Agreement will be updated in COP 26 to be held in Glasgow this year (2021). The UK government has set itself ambitious future targets through its *Ten Point Plan* that lays the foundations for a Green Industrial Revolution, and already low carbon businesses and their supply chains have a turnover estimated at £42.6 billion in 2019, and a value of exported goods and services exceeding £7 billion (BEIS, 2021). The UK government also expects significant economic growth opportunities resulting from their environmental ambitions (BEIS, 2021). A successful green transition would also allow the

[19] INT-4, INT-6, INT-7, INT-8, INT-9, INT-10, INT-11, INT-13, INT-14, INT-18, INT-19, INT-20, INT-23.

UK to capture a substantial share of the high value-added segment of global trade in new green technologies.

However, risks relating to the UK's capacity to reach these targets do remain, including:

- Ongoing weaknesses in the economy may limit the capacity of firms to invest in green transition.
- Technological innovation may not be able to achieve all of the UK's environmental goals.
- Skill shortages may emerge that constrain the introduction of green new technologies, which may be sector-specific depending upon sensitivity to the green transition.

These risk factors could all contribute to varying degrees to environmental targets being missed and constrain green employment. This may in turn affect the UK's capacity to trade with some countries, which would further constrain the economy's capability to accelerate progress towards these goals.

Implications for jobs, skills and qualifications

Econometric modelling suggests that, as a whole, green policies tend to have limited impacts on net employment levels and occupational demand (Cedefop, 2013). This suggests that total employment demand will be largely unaffected by the greening of the economy. Different sectors will nonetheless be impacted in different ways, with those sectors that are carbon-intensive, difficult to decarbonise and/or are dependent on society's reliance on fossil fuels being particularly at risk (BEIS, 2021). Well-established 'green' sectors, however, such as renewable energy, smart systems technologies and the buildings retrofit sector will continue to expand (BEIS, 2021). It is also possible that costs imposed on industry by the green transition affects competitiveness and, potentially, employment.

As with the impact of technological advances, shifts may occur regarding the nature of the skills that will be in demand (BEIS, 2021). While 'green jobs' use more intensively high-level cognitive and interpersonal skills compared to non-green jobs, and tend to involve higher levels of human capital (Consoli and others, 2016). The definition of 'green jobs' used by the UK's Green Jobs Taskforce [20] does not detail skills required for such jobs. Yet, the report does examine the importance of education and skills for creating the net zero workforce and flags a possible bias towards higher skills needed for 'green' jobs. New economic activity, however, will generate new occupations, while existing occupations will require 'greening' changes (BEIS, 2021). Both will require new or updated skills, qualifications and training frameworks (BEIS, 2021). While an

[20] The UK's independent Green Job Taskforce defines 'green jobs' as 'employment in an activity that directly contributes to, or indirectly supports, the achievement of the UK's net zero emissions target and other environmental goals, such as nature restoration and mitigation against climate risks' (BEIS, 2021).

estimated 10% of UK jobs may be in high demand as a result of the transition to net zero, another 10% of jobs in the UK will require skills that will also experience reduced demand, resulting in the need for reskilling, upskilling or new applications for their existing skills (BEIS, 2021). Most jobs, however, will require some modification of existing tasks as part of 'greening'. Yet, these tasks tend not to be at the core of the role (Hogarth, 2011). There may also be a relatively small destruction of some existing jobs (Hogarth, 2011). The overall scale of additional demand on the education and training system is expected to be modest and the transition gradual. There may be a potential mismatch between the location of some green industries and the location of workers risks undermining the development of some green industries, resulting in a loss of potential employment.

Circular economy

The circular economy is concerned with reducing, rethinking, repairing, recycling and re-using goods and emphasises that the inputs to the production process should be recyclable and reusable (Aldersgate Group, 2012). It is expected to result in industry using less expensive recycled materials (Ellen McArthur Foundation and others, 2015). This shift has been associated with a mindset of greater social responsibility, which could lead to more innovation around alternative ownership models such as social enterprises and employee-share ownership schemes in an effort to reduce inequality.[21]

Implications for jobs, skills and qualifications

The rising circular economy is expected to generate employment opportunities in reuse and recycling industries. Macroeconomic modelling suggests that the circular economy, if fully implemented, has the potential to increase overall employment, estimated at 0.5% by 2030, with recycling and repair sectors will experience additional growth. There is also estimated to be a link to a growth in entrepreneurship linked to recycling activities, some of which is concentrated in SMEs (Ellen McArthur Foundation and others, 2015). Sectors that produce and process raw materials are expected to decline in size, however, and sectors that produce durable goods, such as electronics, machinery, and automotive manufacture, may also be at risk (Cambridge Econometrics and others, 2018).

Bioeconomy

The bioeconomy is concerned with the production of renewable biological resources and their use in products as replacements for fossil/carbon-intensive materials, and is another key concern for the UK's environmental objectives (IACGB, 2020). It is critically important

[21] INT-2, INT-12, INT-16, INT-17.

for creating a carbon-neutral economy, and overlaps with the circular economy given its emphasis on reusable materials.

Implications for jobs, skills and qualifications

Policy development and behavioural changes linked to the bioeconomy have implications for various sectors, including agriculture, forestry, fisheries, energy, and food, pulp and paper production (Berndes and others, 2016). This is seen, for example, in agriculture and its links to the food industry with reference to local sourcing and reducing food miles, food security, and the use of pesticides.

2.1.6. Additional factors

Certain additional factors beyond the PESTLE framework that are likely to impact on the future of jobs, skills and qualifications over the horizon scanning period have been identified. These include work quality, housing affordability, skills mismatches, inequality, and delivery of education and training.

Quality of work

The 'Taylor Review of Modern Working Practices' emphasises the importance of good work in employment (including atypical forms of work: part time and temporary work, self-employment, agency work, zero-hour contracts, multi-jobs and gig economy) (Taylor and others, 2017). It calls for a national strategy on good work for all (regardless of the form of employment). The aspects of work quality consider wages, employment quality, education and training, working conditions, work life balance, consultative participation & collective representation.

While quality of work relates to all forms of employment, platform work – even if its incidence in the UK is low (Pesole and others, 2018) – raised concerns around some aspects such as irregular hours and low income, work intensification, and lack of voice and representation.[22] On the other hand, platform work also offers flexibility and opportunities for those who may not be able to work in more conventional ways (Taylor and others, 2017).

Concerns have also been expressed about the growing insecurity of work (for example Felstead and others, 2017; Taylor and others, 2017; TUC, 2018), although there are indications to suggest that this has stabilised in recent years (CIPD, 2019a). As with platform working, flexible and/or temporary working arrangements (including contracting and freelancing) can bring a number of benefits and drawbacks for both workers and employers, such lower productivity and higher absenteeism in the latter case (see for example Green, 2015). At the same time, several experts expressed the view that changing attitudes and values of workers, particularly among younger workers, is

[22] For example, see the collection of essays in Irvine (2020).

contributing to a renewed or increased emphasis on quality of work, including facets such as work-life balance and flexibility around the location of work.[23] The UK government has similarly expressed its commitment to ensuring all work should be 'fair and decent', and to placing equal importance on the quality and quantity of work (HM Government, 2018c).

Housing affordability

The UK continues to experience a lack of housing that is affordable, with nearly half of working-age adults in the poorest fifth of the population spend more than one-third of their income on housing (Brook, 2018). Affordability of housing is a problem even for higher earners in expensive areas, especially London and the Southeast.

Lack of affordable housing may restrict the mobility of labour to certain areas (Brook, 2018). Lack of public investment in affordable housing was cited by multiple experts as impacting not only the location of where people work, but also whether workers can afford to invest in their own education and training.[24]

Broad-based benefits from public and private sector investment in housing construction was identified as one possible way to help with 'levelling up' or re-balancing of the UK economy.[25] While the pandemic has seen some people move away from large cities to smaller cities, some experts were not sure whether this trend would continue post-pandemic.[26]

Existing skills mismatches between the supply and the demand for skills

While the UK has seen a gradual increase in the proportion of workers who have a level of educational attainment that matches the average of their occupation, there remains a higher proportion of over-educated workers than under-educated ones, with over one-third (37%) of workers being over-skilled and more than 1-in-10 (13%) under-skilled (CIPD, 2018; ONS, 2016). This is partly attributable to younger workers having higher average levels of education compared to older workers, as well as higher rates among self-employed and part-time workers, who tend to be more undereducated than the UK workforce as a whole. It is estimated that by 2030, 7 million additional workers could be under-skilled for their job requirements, along with close to one million additional workers (0.9 million) workers over-skilled. It is believed that the most acute under-skilling in 2030 will be in basic digital skills, core management skills, STEM workplace skills and teaching and training skills (Industrial Strategy Council, 2019). This points to the concern that UK businesses are not making use of the skills that their current workforces already possess. In addition, some industries and occupations are also experiencing skills shortages in hard-to-fill vacancies (ONS, 2021e). At the same time, while the UK has a strong foundation of advanced skills, it lags behind international competitors on technical and

[23] INT-6, INT-8, INT-9, INT-11, INT-13, INT-14, INT-18, INT-19, INT-20.
[24] INT-1, INT-3, INT-8, INT-8, INT-13, INT-15, INT-16, INT-17.
[25] INT-9, INT-15, INT-17.
[26] INT-9, INT-13, INT-15.

basic adult skills.[27] Skill mismatches of all kinds hamper productivity and international competitiveness.[28]

In general, the evidence from the Employers Skills Survey demonstrates that the number of skill shortages in the economy has been steadily rising over time and the number of internal skills gaps has been increasing (Winterbotham and others, 2018). There is, of course, a regional dimension to the supply and demand for skills which is linked, to some extent, to differences in regional productivity resulting from differential levels of employments and skills matching.

Considerable strides have been made in recent years to establish a skills system responsive to the demand for skills through, for example, greater employer input to the design of vocational programmes and the development of a funding system that ensures training providers are more dependent on satisfying market demand. This has been a particular focus for regional and local areas, as seen in the devolving of skills strategies to ensure they respond to local demand. A number of risks remain, however, with the potential to exacerbate current skills mismatches:

- The supply-side may be unable to produce the skills the country requires in either sufficient volume or quality.
- A failure to invest in new skills or attract skills from people abroad would result in future growth opportunities being lost.
- If employment and skill demand become increasingly skewed towards high level skills, the opportunities for those with relatively low skills will become increasingly limited, with implications for social inclusion.
- Opportunities to upskill may be further limited by precarious employment and a lack of individual capacity to invest in education and training.

Growing inequality, including inequality in access to lifelong learning

Issues surrounding income inequality, unemployment (including long-term inactivity), growing in-work poverty and related wage stagnation mean that certain groups of workers will be more likely to experience labour market disadvantage. These include women, young adults, older workers, people with disabilities and those from Black and other ethnic minorities (BAME). Participation in formal learning also tends to decline with age and is more likely to be undertaken by wealthier, more highly skilled individuals (Government Office for Science, 2017). Moreover, there is a risk that these inequalities will be further exacerbated by any further shift in responsibility for skills development and training away from firms onto their workers (Rani and Grimshaw, 2019).

[27] INT-3, INT-4, INT-5, INT-22.
[28] INT-3, INT-4, INT-5, INT-7, INT-9, INT-22.

Changes in the delivery of education and training

Even before the pandemic, there was already a high adoption of technology in education, such as virtual tutoring, video conferencing tools, and online learning software, although there has been a significant increase in uptake since Covid-19 forced schools, colleges and universities to deliver their education and training remotely and on digital platforms (Li and Lalani, 2020). Despite the opportunities offered by technology in delivering education and training remotely, there are also challenges around upskilling educators and the effectiveness of technology, as well as concerns that the use of technology can exacerbate existing inequalities. In particular, learners in the Vocational Education and Training (VET) sector have been hit with 'a double disadvantage' as social distancing requirements and the closure of enterprises during the pandemic made practical and work-based learning either difficult or impossible. While at the same time, economic pressures on companies may mean fewer apprenticeships are available (Schleicher, 2020).

2.2. Evidence from specific sectors with implications for skills

This section presents a brief summary of key sectoral features and available forecast data that help in understanding the likely implications of the key drivers identified above on 6 specific sectors: construction, wholesale and retail, higher education, transport and logistics, health and social care and energy.

2.2.1. Construction

Construction is one of the biggest industry sectors and encompasses the construction of new buildings and repairs or alterations to existing properties, heavy and civil engineering construction and specialty trade contractors (CTP, 2021).

In 2020, there were more than 340,000 businesses in the sector (Ibisworld, 2021a). These grew, on average, by 4.7% per year in the 5-year period from 2015 to 2020 (Ibisworld, 2021a). Employment has grown by 2.6% on average per year during the same 5-year period, where total employment in 2020 was around 1.52 million (Ibisworld, 2021a). Forecasts suggests that construction employment will increase to almost 2.8 million by 2023.[29]

Construction is one of the fastest growing sectors in the UK (De Best, 2021a), with its Gross Value Added (GVA) projected to increase from around £112 million in 2017 to just over £120 million by 2027 (£2016m) (Wilson and others, 2020a). While the sector's share of GVA is projected to fall from 6.3% to 6.0% during the same period, productivity growth is expected to improve (increasing from 0.6% in 2017 to 0.9% by 2027) (Wilson and

[29] For the forecasted number of people employed in the construction industry in the United Kingdom (UK) in 2023, by occupation, see De Best (2021b).

others, 2020a). A relatively small increase in employment is projected (from around 2.3 million jobs in 2017 to just over 2.34 million jobs by 2027), with the share of total employment remaining unchanged (at 6.5%) (Wilson and others, 2020a). Non-construction professionals, technical, IT and other office-based staff are expected to remain the largest group of employees in the sector (De Best, 2021a).

The sector continues to be faced with skill shortages (the number of skill-shortage vacancies was 10,700 in 2019) (Winterbotham and others, 2020). The sector relies heavily on a foreign migrant labour force. So any potential future restrictions on migration impacting on future flows of EU workers may dampen the sector's growth prospects, reduce firms' capacity to deliver new housing stock (Wilson and others, 2020a), and the sector's green transition.

The ONS estimates the proportion of jobs in the construction industry at risk of automation at just under half (47%) (ONS, 2019c).

2.2.2. Wholesale and retail trade

Wholesale commonly refers to selling goods either to retailers, or to industrial, commercial, institutional and professional users, while retail constitutes the sale of goods for consumption (Mosley and others, 2012). This includes occupations in shops, department stores, supermarkets, market stalls, and door-to-door sales (Smith, 2021a). It spans numerous areas of industry, including but not limited to entertainment, fashion, food, general merchandise, health, beauty, home, sport and leisure, and technology (Smith, 2021a).

Retail generates about one-twentieth (5%) of the UK's total GDP, growing on average 1% per year between 2015 and 2020 (Retail Economics, 2021). In 2020, the sector included more than 406 thousand businesses with just under 5.1 million employees (Ibisworld, 2021a). Economic performance of wholesale and retail trade hinges on factors such as household disposable income and business activities, as well as tension between the demand for cheap (often disposable) goods, and the potential for more goods to be produced or sourced locally (Wilson and others, 2020a). A dramatic increase in online sales allowed the sector to remain resilient during the Covid-19 pandemic (Deloitte, 2021). The shift, however, away from the traditional 'high-street' environment towards increased online sales has implications on the types of jobs and skills demanded by the sector (Hutton, G., 2021). The noticeable decline of the high street in the last few years was accelerated by the COVID-19 pandemic. In 2020, the UK has experienced the

highest number of store closures reported since the 2008 financial crisis. This led to the sector experiencing a relatively high number of job losses (Hutton, G., 2021). In the future, jobs may shift increasingly from in-person services inside shops, towards logistics, call centres, and transport underpinning online sales.

The sector continues to be faced with major skill shortages (36% of vacancies in 2019 were hard to fill due to difficulties in finding applicants with appropriate skills, qualifications or experience) (Winterbotham and others, 2020).

The ONS estimates the proportion of jobs in the sector at risk of automation at just over one half (53%) (ONS, 2019c).

2.2.3. Higher education

The higher education (HE) sector breaks down into 3 broad types of providers: Higher Education Institutions (such as universities receiving direct grant funding), further education (FE) colleges offering HE courses, and a mixture of other publicly and privately funded HE providers (House of Commons, 2017).

In 2019/20, the total reported income of the UK higher education sector was roughly £41.9billion (HESA, 2021). For universities, tuition fees represent an important source of revenue, particular as government funding has reduced (Ibisworld, 2021b). Accordingly, the export of UK higher education to international students who commonly pay much higher tuition fees than domestic students has become of central importance (Ibisworld, 2021a). In 2019/20, the total UK value of non-EU fees was around £6.9 billion (HESA, 2021). Despite the pandemic, entry numbers for students remained at a record high (Universities UK, 2021), although providers did rely heavily relied on distance learning and via Massive Online Courses (MOOCs) (Ibisworld, 2021b).

In 2019/20, there were 223,525 staff (excluding atypical staff) employed at UK higher education institutions (HESA, 2021). Staff employed on academic contracts made up almost half of all staff (49%). About 17% of academic staff had an EU nationality, a further 14% had a non-EU nationality (HESA, 2021). The

entire education sector (including HE) faces skill shortages (Winterbotham and others, 2020). In 2019,23% of vacancies were hard to fill (Winterbotham and others, 2020).

The ONS estimates that proportion of jobs in the education sector at risk of automation to be just over one-third (36%, 2nd lowest rate by sector) (ONS, 2019c).

2.2.4. Transport and logistics

Transport includes road, rail, air and water networks, vehicle manufacturing, transport planning and traffic management (Smith, 2021b). Logistics/supply chain covers aspects such as freight transportation, maritime and port operations, postal and courier activities, warehousing, storage and handling (Smith, 2021b). In 2019, there were over 192 thousand logistics enterprises in the UK, almost all (99.7%) SMEs (FTA, 2019). In the same year (2019), the wider logistics industry employed 2.6 million people and added about £124 billion Gross Value Add (GVA) to the UK economy (FTA, 2019). Even before the pandemic, changing consumer demand, such as continued switching to purchasing goods online, was expected to increase demand in transportation and distributional services (Wilson and others, 2020a).

Data compiled in May 2020 by the Federation for Industry Sector Skills & Standards (FISSS) indicates that employment in the sector is male-dominated (where the Female to Male ratio is 4.1). Just over one-third (35%) of the workforce is aged over 50 and around 13% of the workforce is from the EU. Staff turnover in the UK transport and storage sector is just over one-fifth (21%), which is similar to the all industry average (22%). Notably, average pay growth from 2018 to 2019 was 4.5 per cent (4.5%), which is 2.5 times higher than the whole sector average (2%). Unsurprisingly, given the nature of work in this sector, before the pandemic just over 1-in-10 of workers (11%) had ever worked from home. This is the second lowest proportion of workers to have done so, with only those employed in accommodation and food services to have worked from home less (at 10%) (Boys, 2020).

The ONS estimates the proportion of jobs in the transport and storage sector at risk of automation is just over one-half (55%), which is second highest only to accommodation and food services. Along similar lines, an estimate by the MGI put the technical potential for automation in the US transportation and warehousing sector at three-fifths (60%) of all the sector's work activities, again second only to accommodation and food services (73%) (Manyika and others, 2017).

The transport (and storage) experience skill shortages (26% of vacancies in 2019 were hard to fill) (Winterbotham and others, 2020). The driver shortage figure was 51,000 in 2017 and in logistic shortages affected in particular managerial and administrative occupations (FTA, 2018).

The ONS estimates the proportion of jobs in the transport and storage sector at risk of automation is just over one-half (55%), which is second highest only to accommodation and food services (ONS, 2019c).

2.2.5. Health and social care

The UK health and social care sector comprises about 16 industries, including but not limited to telehealth services, general medical practices, and residential nursing (Ibisworld, 2021a). In 2020, this sector consisted of over 70 thousand businesses and around 1.85 million employees (Ibisworld, 2021a).

The latest 'Working Futures' report identifies wider demographic trends, such as the ageing population, as the expected main driver of increased demand in the long-run in health, residential care and social work. Activity in health and social care are dependent on political decisions, as government is a major component of this sector's demand. Demand for public spending and health services is anticipated to increase, driving increases in both output and employment (Wilson and others, 2020a).

In terms of skill challenges, data compiled in May 2020 by the Federation for Industry Sector Skills & Standards (FISSS) indicate employment in the sector is female-dominated (where the Female to Male ratio is 0.3). Around one-third (33%) of workers in this sector are aged over 50, while around 1-in-20 (5%) workers are from the EU. Staff turnover in the UK health and social work sector is 16%, which is slightly lower than the all sector average (22%). Pay growth from 2018 to 2019 was 3.3%, which was higher than the all industry average (2%). Before the pandemic, 1-in-5 (20%) workers in health and social work had ever worked from home (Boys, 2020).

ONS estimates the proportion of jobs in the health and social work sector at risk of automation is two-fifths (40%). This is similar to the estimate by the MGI that put the technical potential for automation in the US health care and social assistances sector at just over one-third (36%) of the sector's work activities (Manyika and others, 2017).

The health and social work sector faces skill shortages (25% of vacancies in 2019 were hard to fill – a main increase from 2017 where the figure stood at 21%) (Winterbotham and others, 2020).

The ONS estimates the proportion of jobs in the health and social work sector at risk of automation is 40% (ONS, 2019c).

2.2.6. Energy (renewables)

Renewable technologies use natural fuel sources, such as wind, wave, marine, hydro, biomass and solar, to generate energy (Energy UK, 2021).

In 2019, renewables produced more than one-fifth (20%) of the UK's electricity (Energy UK, 2021). In the same year, turnover in the UK low carbon and renewable energy economy (LCREE) was estimated to be £42.6 billion (ONS, 2019a). Full-time equivalent direct employment was estimated at just over 202,000workers (ONS, 2019a). Energy supply and construction industries accounted for 82% of all UK low carbon and renewable energy economy turnover in 2019, and 74% of all employment (ONS, 2019a).

Skills shortages are causing recruitment problems in the energy sector and technical skills are in demand (ERP, 2014). Skills shortages are in engineering and technicians' occupations with STEM qualifications as well as quantity surveyors, data scientists, cyber security and project management experts (Energy and Utilities Skills, 2020).

The ONS estimates the proportion of jobs in the electricity, gas and air conditioning sector at risk of automation is 43% (ONS, 2019c).

In terms of future employment and skill challenges, achieving the set targets will require a labour force with sufficient 'green skills' to fill the 'green jobs' needed to develop and use green energy (BEIS, 2021). 'Green jobs' can include both existing occupations that are changing in response to demands for environmental sustainability, and new occupations

that are emerging as a response to specific needs of the green economy (Mullock, 2016). In terms of skills needed, it has been argued that green jobs tend to be less standardized and require stronger cognitive and interpersonal jobs (Mullock, 2016). While many of these jobs can be found in high-skilled sectors, such as management, architecture, and engineering, many are also in areas such as construction, installation, maintenance and repair (Mullock, 2016). It has also been suggested that the move towards a greener economy could further elevate STEM skill shortages (Mullock, 2016).

3. Qualitative scenarios for labour market and skills demand

Overview of the scenarios

Five qualitative scenarios have been developed for the labour market using a structured approach to reflect uncertainties in the economy, the environment, technology and the wider societal, political and legal landscape, 15-20 years in the future.

Digital greening: Strong economic recovery and international co-operation, coupled with a high level of public spending to facilitate re-skilling, has led to a digital, green, and more inclusive society.

Living Locally: Building on public sentiment, the UK has invested in greening its economy, leading to the reshoring of some activities and a more local sustainable approach to living and working.

Protectionist Slowdown: A stagnant economy and a lack of investment has led to an increase in inequalities in many parts of the UK, including a digital divide and unequal access to education.

Continued Disparity: The economy continues focus on the Southeast of England. A skills mismatch persists, and high-skilled workers benefit from lifelong learning and greater flexibility, while the low-skilled experience increasing precarity.

Generating Generalists: While the direct economic impact of the pandemic was relatively short-lived, there has been an increased emphasis on transferable vocational skills to ensure resilience in a rapidly evolving world.

Of the these, the Continued Disparity scenario is the closest to the status quo and offers an approximation of how the labour market could develop in the long term if current trends continue. In this scenario, economic growth and productivity are projected to continue over the next 15-20 years in a similar fashion as was the case during the period 2010-2020. Under this scenario, some tasks and jobs would be replaced by automation. There would be increased social exclusion, social disparity, and polarisation of jobs. In this scenario, highly skilled workers are likely to do well. Low-skilled workers are likely to experience increasing precarity.

3.1. Introductions to scenarios

Exploring possible futures involves some level of uncertainty. Scenarios are long-standing tools that are used to address this (Pillkahn, 2008). Yet, they are not forecasts. They do not outline a most likely future based on current trends and drivers but represent a wide spectrum of possible future states (Figure 1). Scenarios, however, should be plausible, which means that the combination of factors and their projections specific to each scenario is not contradictory and could occur together. Scenarios stop short of indicating whether they are probable (likely to occur).

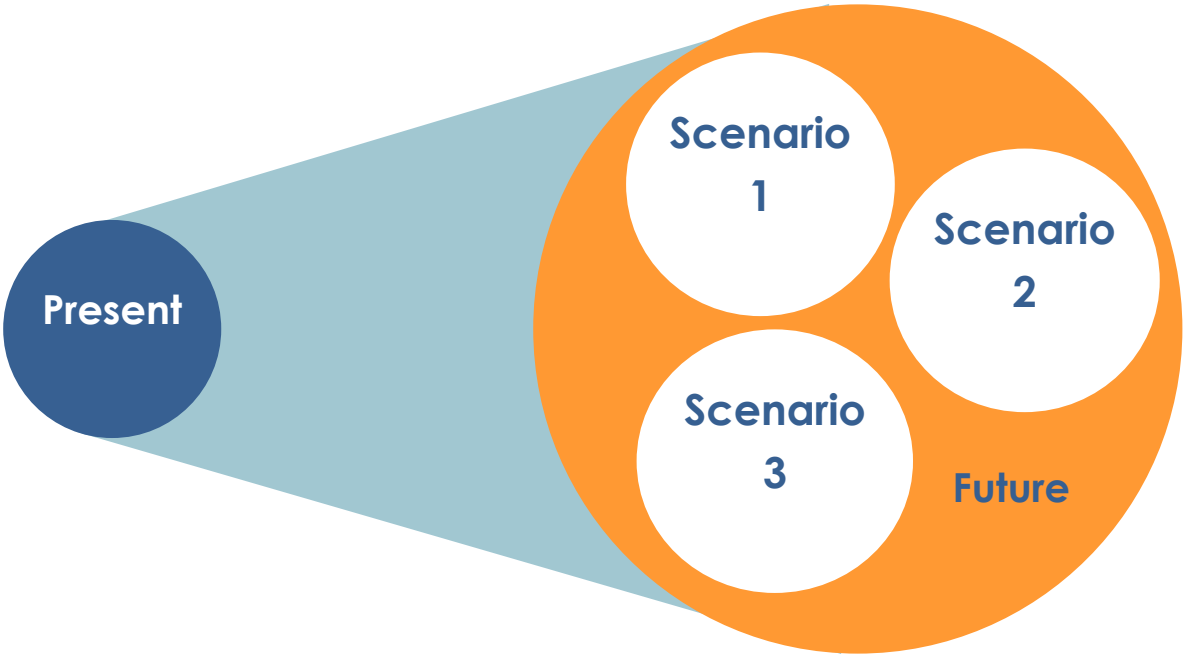


Figure 1: Plausible future scenarios reflect a wide range of possible future states

In this study a structured-scenario development methodology is used. A key feature of this approach is that the scenarios are developed based on a multi-factor, multi-sector, interrelated system and do not rely on 1 or 2 main drivers. As a result, the scenarios provide an internally consistent (or plausible) picture of what may happen both in the labour market and for wider society. The method is described in detail in Annex C. Scenario method.

3.2. Scenario narratives

Five scenarios (digital greening, living locally, protectionist slowdown, continued disparity, generating generalists) have been developed using this approach to be representative of a wide spectrum of possible futures and that are sufficiently differentiated from each other, in terms of employment and skills, and wider societal development, to be informative from a policy-making perspective. The scenarios are set 15-20 years in the future.

The scenarios are built around a set of factors that cover the labour market and its interactions with the economy, the environment, technology and the wider societal, political and legal landscape. Each scenario is characterised by a combination of future values (projections) for these factors that reflect different ways in which the future could evolve. It is these projections that differentiate the scenarios (Figure 3). The effects of these future factor projections on different aspects of life (economy and environment, working and living, education and training) are developed across the scenario narratives in an internally consistent way. The scenario approach is not designed to directly generate a 'business as usual' (BAU) scenario as it is inherently difficult to forecast what this would be in 15 to 20 years' time. Based, however, on the evidence of current trends, the Continued Disparity scenario is considered most likely to reflect the BAU.

Figure 2: Five future scenarios

Digital Greening
Living Locally
Protectionist Slowdown
Continued Disparity
Generating Generalists

The evidence review and expert interviews (Section 2) were used, in conjunction with consultations with experts on the team on wider factors, to identify a long list of potential factors from which to develop the scenarios. Following the structured steps of the

scenario process, a final set of factors, shown in Figure 3, was identified. These factors are considered to be both important for the labour market and uncertain in terms of their future development, as reflected in the factor projections. Other factors, such as the ageing population, which are important but not uncertain, are not included in the scenario development directly but their impact on each of the scenarios can be inferred. More information on the development of the final factor list and the definitions of the factors are presented in Annex C. Scenario method.

These factors and their projected development in the future provide only the outlines for the scenarios. The scenario narratives bring these to life: they are written from the perspective of the future and are not intended to present a detailed roadmap from the present. Each scenario explores the details behind the factors: the key societal, economic and employment developments. Together, they also provide a glimpse of how people might live in this particular future. Not every factor is covered in each scenario narrative. Only key trends and how they might lead to a future that differs from the present are identified.

The 5 scenarios are presented in turn below, each is followed by the key implications for growth and productivity, skills and qualifications and quality of work. These implications are discussed further for the 6 sectors of interest for this study in Section 4.

Figure 3: Factor projections for scenarios

	Digital Greening	Living Locally	Protectionist Slowdown	Continued Disparity	Generating Generalists
Trade	International	Protectionist	Protectionist	International	International
Economic growth	Widespread	Widespread	Low	With disparity	Widespread
Trends in economy structure	Towards service sector	Towards manufacturing	Towards manufacturing	Towards service sector	Towards service sector
Dominant firm size	Large	SMEs and start-ups	SMEs and start-ups	Large	Large
Location of employment	Even distribution	Even distribution	Focused in London and SE	Focused in London and SE	Even distribution
Public spending	Increasing	Increasing	Decreasing	Targeted	Increasing
Uptake of new technology	Gradual	Gradual	Differential	Differential	Gradual
Digitalisation	Widespread	Widespread	Stalled	Differential	Widespread
Internal mobility/immigration of skilled labour	Increasing/increasing	Increasing/decreasing	Decreasing/decreasing	Decreasing/decreasing	Increasing/decreasing
Devolution of powers	Increasing	Moderate	Centralised	Centralised	Increasing
Quality of work	Improved for majority	Improved for majority	Increased polarisation	Increased polarisation	Improved for majority
Inequalities	Decreasing	Decreasing	Increasing	Increasing	Decreasing
Skills mismatch	Narrows	Narrows	Widens	Widens	As now
Lifelong learning	Good for majority	Good for majority	Poor for majority	Unequal access	Good for majority
Pre-employment learning	Academic breadth for longer	Academic breadth for longer	Narrow and academic	Narrow and academic	Broader non-academic skills
Sustainability of consumption patterns	Increasing	Increasing	Decreasing	Increasing	Increasing
Impacts of climate change	Better than expected	Better than expected	Worse than expected	As expected	As expected
Progress towards net-zero targets	Rapid	Rapid	Slow	As expected	As expected

3.2.1. Scenario 1: Digital Greening

Strong economic recovery and international co-operation, coupled with a high level of public spending to facilitate re-skilling, has led to a digital, green, and more inclusive society.

Economy and environment

During the 2020s there was further realisation across governments, industry leaders and populations that the relationship with the planet is key and resources are finite. Technological development was seen as an essential tool in combatting climate change. The UK has since transformed into a digitally enabled, outward looking, productive and well-performing economy. While expanded international trade is a crucial component of this, the EU also remains the UK's main trading partner, with trade flows well-balanced amongst regions, which also enjoy increased devolution of powers.

The economy and employment in the UK have further benefited from increased digitalisation. Industry 5.0 has facilitated the creation of new jobs with more human-centric industrialisation; in this case through advances in robotics, AI/machine learning, augmented reality and advanced data analytics. Digitalisation and automation have spread from manufacturing into services. As well as increasing efficiency and reducing costs, data processing, analytic and prediction capabilities have transformed decision-making in relation to climate targets for firms, authorities and individuals. This has come with a trade-off in terms of access to personal data, which is viewed with concern by some politicians and consumer groups.

The UK has exceeded expectations in most areas of its Ten Point Plan Green Industrial Revolution (HM Government, 2020a), co-operating with the EU on green hydrogen, and making progress towards international climate change targets slightly ahead of schedule.

Working and living

While many jobs resemble those of previous decades quite closely, some low-skilled jobs/tasks have been replaced by automation, new jobs have been created and others transformed in a way that digital competency is a must-have for most workers. Although larger tech companies are perceived to dominate, the digital-green transition also offers opportunities for smaller firms that provide a range of solutions from novel bio-materials to virtual entertainment. Data has also been key to consumption patterns becoming more

sustainable. The UK continues to be an attractive destination for high-skilled migrants and is a strong partner in R&D with European and international partners.

There has been some improvement in the quality of work for the majority. Devolution of power has led to a better matching of skills and employment at the regional level and opportunities for remote working mean that high-skilled labour, at least, is quite mobile, and employment has become more evenly distributed across the UK. Working in a virtual office has meant a better work-life balance and increased productivity for some, while others struggle to disconnect. Moreover, the increased digitalisation also means that there are an increasing number of workers who face precarious situations and some vulnerable groups still experience digital exclusion.

Education and training

As a higher level of public debt became more normalised after the pandemic in the 2020s, the UK was able to invest heavily in lifelong learning and upskilling, particularly digital skills. This was combined with a broadening of the curriculum in schools and universities to include more STEM, keeping a wider variety of educational options open for longer. While schools are moving to a blended offering, online training provision is widespread and courses from a wide range of international providers are accessible. As a result, people are able to re-skill to keep up with innovation and the booming economy. This is seen as a way to offset the imbalance between employees of large companies, which have started to dominate within and across a range of sectors, and other workers, in terms of access to vocational education and training. There has, however, been some criticism that this provision, delivered by both public institutions and the private sector, is not flexible or portable enough to keep pace with future needs.

Growth and productivity

Technological developments lead to increased efficiency and to the creation of new jobs. This helps facilitate growth and productivity.

Skills and qualifications

The creation of new types of jobs might lead to greater skills mismatch. The changes and investments in the public school system (for example, broader curriculum in schools, more STEM fields at university) are steps in the right direction.
The increased digitalisation may require individuals to be able to adapt and acquire new skills at a faster and faster pace. It would be important to balance public and private investments in training and upskilling. Interventions need to cover a broad spectrum of skills (not just digital skills) to support people to adapt to, and evolve with, the changing

labour market environment. A national system of certification of skills could enable mobility of workers.

Quality of work

The majority of people experience an improvement in their quality of work. This scenario could result in working, on average, fewer hours, more flexibly – at least for some (high-skilled) workers.
The expansion of some jobs, such as platform work, may lead to more insecure employment. To ensure proper working conditions in precarious areas, government will need to issue some regulations around working conditions to help preserve a minimum standard for everyone.

3.2.2. Scenario 2: Living Locally

Following the crisis period of the early 20s and building on public sentiment, the UK invested in greening its economy, leading to the reshoring of some activities and a more local sustainable approach to living and working.

Economy and environment

Following the upheaval of the early 2020s, the UK government decided to strengthen its commitments on climate change and levelling-up agenda. Positioning itself as a green leader, the UK has been able to develop close ties with like-minded nations and attract investors and firms also looking to promote strong environmental credentials. Increasing resilience to climate change impacts and in supply chains are a key part of their approach. While productivity remains an important economic objective, a shift in emphasis towards more sustainable growth now prevails.

The greening of transport has been at the forefront of this process, together with investment in renewable energy, with a strong focus on offshore sources. There has been considerable public investment in infrastructure and public spending remains high. Yet, the financial sector also continues to play an important role in the UK economy by offering a range of innovative green investment products. While most employment is still in the service sector, reshoring of some activities has rebalanced the structure of the economy to a degree.

The circular economy has expanded significantly. Many initiatives started at the community level, fuelled by pro-environmental public sentiment around the need to change consumption

patterns, and facilitated by continued widespread digitalisation of society. There are, however, also regional schemes, as decision-making powers continue to devolve that affect construction, energy and more.

Technology continues to be important, with data analytics and automation and precision robotics all playing a role as advances are made across sectors, including large-scale engineering applications, logistics, medical and health technologies and food production. Widespread digitalisation has also enabled small companies to proliferate in the circular economy.

Working and living

Although London remains a financial hub, the creation of more local employment and the possibility of flexible working for an increasing number of employees has led to a growing number of people moving to live and work in smaller towns and cities. New employment in the offshore energy sector, for example, has created high-skilled jobs regionally. While the dispersion of employment did make housing more affordable and improve work-life balance for some people, house prices are steadily increasing in some areas, particularly those seen as accessible and potentially more liveable as the effects of climate change are felt.

The fear of rapid replacement of jobs by artificial intelligence has not materialised but machine learning has become widespread in the financial sector and is making inroads in the legal profession and other white-collar jobs, among others. While this has replaced some roles, new ones, both technical and general, have been created for companies and workers alike to derive the benefit from this capability.

There has also been a shift in the type of employment in some sectors, with many more SMEs, and more novel forms of earning a living through online activities. Consumers are both more digitally aware and more environmentally conscious, looking to purchase locally and with an ‘experience not have’ mentality.[30]

Education and training

The flagship ‘Learning for life’ package is now reaching its 10-year anniversary. This scheme is heavily subsidised by the government and available anywhere, anytime. This provision is managed at a regional level to ensure that upskilling and re-skilling are matching the skills demands in the area, with employers, education and training providers and local authorities working closely together. The education and training system has also been revised to both keep young people’s options open for longer and to create workers with a wider range of skills and expertise that can be adapted to different areas. For example, it is

[30] Such attitudes value sharing resources over purchasing and owning them.

now compulsory to study one STEM stream and one arts stream as part of every undergraduate degree.

Growth and productivity

The widespread economic growth in this scenario, with a protectionist approach taken in international trade, demands that productivity is the main engine of growth and that the UK improves its ranking when comparing against some of the best performing economies in the world. This productivity growth may come for example, from more investment in research and development, or from using skills more effectively in the workplace by better matching skills with job requirements.
With new job opportunities, digitalisation of society and work flexibility, there are greater opportunities for groups previously facing barriers to employment (for example, people with disabilities, health conditions or caring responsibilities) to contribute to the labour market.

Skills and qualifications

Given the turn to more local life, there is a need to learn a broader set of skills and turn away from narrow specialisation. This is because living in local communities requires a breadth of competences and entrepreneurial attitudes.

Yet, broadening and thus making the curricula longer, poses a risk that younger cohorts may initially struggle when entering a job market in certain sectors and jobs requiring some specialisation. Therefore, the role of adult education in addressing these challenges is key.

Quality of work

Work-life balance forms the key link in this scenario with the quality of work. Living more locally means that people are more likely to be living where they want to live rather than just closer to work. Flexible working means there may be differences in people's perceptions of quality of work. While the skill use and discretion may be improved in this scenario improving workers' overall job satisfaction, there are health and wellbeing concerns related to social and physical environment, when working from home more permanently.

3.2.3. Scenario 3: Protectionist Slowdown

A stagnant economy and a lack of investment has led to an increase in inequalities in many parts of the UK, including a digital divide and unequal access to education.

Economy and environment

Shifts in geopolitical power and trade conflicts led to increased global instability by the end of the 2020s. With difficulties in supply chains, particularly during and after the COVID-19 pandemic, many countries, including the UK, adopted a more protectionist approach. Signs of discontent can be seen online, and small numbers of protestors have taken to the streets.

Some sectors have benefited from reshoring – notably defence, advanced manufacturing and pharmaceuticals – generating economic benefits and employment opportunities in regions outside of London. These efforts have been supported by central government as part of their continued levelling-up agenda and technological innovation has also focussed on these sectors. Other areas, however, such as education and health and social care, have lost out.

A period of economic slowdown has meant that there has been little public money for major investments to tackle climate change. Beyond the roll-out of zero emissions vehicles, efforts have been directed to green construction and agriculture. While consumers are also spending less, they are not greatly influenced by climate concerns so progress towards net-zero targets has slowed.

Working and living

Reshoring in some sectors has led to improved opportunities regionally and increased demand for STEM and engineering skills for defence and manufacturing. Government and employment, however, remain focussed in London and the Southeast. With a return to regular office-based working in the previous decade, customer-facing jobs in hospitality and retail have rebounded to some extent and there has also been growth in online, technology-based firms. Most companies have become more digitalised and demand for ICT skills continues to grow.

Despite widespread anxiety about potential job losses from technological change, these have not materialised. Automation has continued to replace low-skilled jobs but there has been increased demand in other areas due to much reduced immigration and to replace older workers. A need to innovate has led to more R&D demand. More widespread use of

machine learning has created new data analyst roles but has not led to mass net job destruction. Despite some innovation, an ageing population means that the health and care sector remains largely labour-intensive.

Education and training

The online delivery of education and training increased following the COVID-19 pandemic. Massive open online courses disrupted traditional education and training providers by offering more affordable and flexible forms of education and vocational training.

A lack of investment in ICT and infrastructure means there is still a digital divide – and some of those who would most benefit from online learning are unable to due to lack of meaningful access. Some young adults in the UK, who already had relatively poor literacy and numeracy compared to international competitors, are falling further behind. Whilst those with online access experience a freedom from the 'one-size-fits-all' model of delivery.

A desire for faster, less expensive and more effective pathways to employment has also led to an increase in demand for shorter, fast-track qualifications. The accelerated pathway has become popular, offering learners the opportunity to save on tuition fees and living costs while earning the same qualification. Yet, there are inequalities in access and opportunities for people with disabilities and mental health issues, and people with caring responsibilities.

Growth and productivity

The economic slowdown leads to a lack of growth, which can lead to a reduction in wages, hampering productivity. With public spending constraint, there might be increased taxation, which reduces both consumer spending as well as job creation and therefore fails to stimulate the economy.

Skills and qualifications

Challenges related to skills mismatch, training and education as they existed in 2021 would be amplified. The educational offer of tertiary education would be narrow and demand specific. Constraints placed on public spending mean that the private sector acts at the primary training provider. The availability, however, of this private sector provision depends on high demand within its sector, or on public sector incentives.
People might be less interested in pursuing further education and training, or to re-skill. This is because the economic slowdown, which has also affected wages, means that people can expect less pay-off from additional training activities than they might in times of economic growth. It could be helpful to offer short-term training courses that do not place high demands on participants.

Quality of work

Employment remains concentrated in London and the Southeast of England. There is greater polarisation in the quality of work, with high-skilled workers experiencing more flexibility and low-skilled workers experiencing more precarity.

3.2.4. Scenario 4: Continued Disparity

The UK economy continues to be concentrated in the south and Southeast of England. A skills mismatch persists, and uptake of technology is disparate. High-skilled workers benefit from lifelong learning and greater flexibility, while low-skilled workers experience increasing precarity.

Economy and environment

The mid- to late-2020s saw a return to business as usual for most of the world, including the UK, with a slow, but steady drift of economic power and influence away from Western nations. The UK has focussed on building strategic and trade relationships internationally with efforts generally being led by central government. Although relations with Europe have normalised, co-operation and trade with the EU across most sectors has declined in the post-Brexit era. Within the UK, 'levelling-up' has not led to an improvement in national productivity performance nor widespread devolution of powers, as some foresaw, with many initiatives remaining centralised.

There has been continued progress towards climate change targets with some co-operation at the international level, but this has not led to transformational change. The UK continues to make steady progress towards reaching its 'net-zero' targets, sticking to its schedule for zero emission vehicles. The expansion of green financial products has also enabled a growth in renewables, although green hydrogen has not yet taken off.

Working and living

The trend towards increased digitalisation of society as a whole has continued, although digital skills are often developed on-the-job or through self-directed learning at home. Many companies have also invested in their digital infrastructure; there has been an expansion of platform-based firms and new technology companies, alongside the larger, more established firms. Employment is still focussed in London and the Southeast, where house prices remain relatively high. Some tasks and jobs have already been replaced by automation, including

those on assembly lines or machine operation. Further deployment of machine learning, led by the financial sector and big tech companies, is expected to increase efficiencies, eliminating some roles but fuelling the demand for the highly skilled.

The rapid expansion of flexible working seen at the start of the 2020s was followed by a gradual return to office working. This was driven mainly by employers but both younger and older workers now find some degree of office-based working desirable, in terms of quality of work and social interaction. While some, mainly high-skilled, workers do have an increased degree of mobility, low-skilled workers have limited opportunities to progress their career.

Education and training

There has been little change in the provision of formal education over the past 15 to 20 years. The curriculum remains narrow and STEM subjects remain unattractive to many, with firms competing to snap up STEM graduates. Although there has been some increase in the use of online tools in schools, this has not translated into increased digital literacy across the board. Lifelong learning continues to be available to people in secure employment whose employers provide training opportunities. Larger firms have more awareness of future skills gaps and can upskill employees better than small ones. A broader offering of online training has made it possible for workers who willing to invest to retrain in sought-after STEM skills, but smaller firms may lose out as they cannot compete with larger, high salary-paying London-based firms for highly-skilled workers.

Growth and productivity

Economic growth and productivity continue in a similar fashion as it did during 2010-2020, continuing to be concentrated in London and Southeast of England.

Skills and qualifications

Employers continue to experience skill shortages. This is largely because learning and development is primarily facilitated by on-the-job training or by self-directed learning at home. This means that access to training and development depends on individuals' employment or personal circumstances.
In this scenario, some tasks and jobs would have already been replaced by automation. It would be important for the government to work with training providers and provide funding to enable people to re-train into new opportunities, to avoid increased social exclusion and social disparity. Effective targeting of public spending would be key. In line with other scenarios, it would be important to target older workers for re-skilling and additional training, particularly as skills gaps are less likely to be met through migration.

Quality of work

High skilled workers are likely to do well. Yet, because of the skill shortage, polarisation of jobs is likely to continue and low skilled workers experience increasing precarity. This could even lead to an emergence of a 'black market' as people are looking for more work. To counter-act some of these trends, an expansion of the governments' levelling up policy and related investments would be key.

3.2.5. Scenario 5: Generating Generalists

While the direct impact of the pandemic on the national economy was relatively short-lived, there has been an increased emphasis on transferable vocational skills to ensure resilience in a rapidly evolving world.

Economy and environment

The COVID-19 pandemic had a significant but temporary impact on the UK economy. With the rapid vaccine roll-out and domestic action to support the economy, this quickly returned to normal. Concerns of a K-shaped recovery, where firms either survive or go to the wall, proved to be overstated and inequalities did not increase substantially. Although the 2020s saw a reduction in trade with the EU, the UK worked hard to establish new trade relations, so that international trade remains strong and, in recent years, there has been moderate productivity improvements resulting in modest economic growth across the UK.

The pandemic did, however, lead to a sense of anxiety about the extent to which the UK economy was integrated into the global economy, and concerns about its resilience and ability to manage future shocks and crises. As a result, public funding focussed on 'essential' sectors and there has been some limited increase in regional decision-making powers. One further consequence of this was a shift to a more generalist education with the aim of providing adaptable workers, reducing reliance on immigration to fulfil key roles.

Following a period of international activity in the early 2020s in which the UK government was strongly engaged, the prevailing view has been that climate goals can be achieved through market-led solutions. While there has been some success in the area, technology is also seen as part of the problem in terms of resource and energy use. 'Regional greening' is, however, taking place in transport, housing, and planning.

Working and living

The emphasis on essential workers during the pandemic led to the introduction of provisions to improve the quality of work in these sectors. These comprised improved protections (including for platform workers), improved health and safety regulations, increased pay and more investment in vocational training for these sectors. While most employees find themselves back in the workplace on a fairly regular basis, family-focussed and wellbeing provision by employers have also become normal. Those in more precarious employment have also benefited from some of these measures.

Technological development continues to impact the workplace, which is rapidly evolving in terms of the roles available, with existing service sector roles being increasingly replaced. Workers find themselves needing to regularly develop new skills or seek out new opportunities.

Education and training

In order to create a resilient, agile workforce, able to respond to rapid changes in the workplace resulting from technological developments or other societal change, the education and training system has shifted to a focus on socio-emotional learning.[31] Generalist, transferable and vocational skills are also now favoured over purely academic skills or skills that are likely to be replaced by technology. This is supplemented by continued access to training, designed to match skills to constantly evolving workplace needs. Much of this is provided in a higher education setting, providing a domestic source of highly flexible labour that can return to retrain and upskill. Training opportunities are also available to older workers or those whose jobs are replaced. Some of this training is offered by private providers.

While this approach aims to provide a long-term solution for a highly technological society, current criticism suggests that it has contributed to a shortage of specialist labour to meet existing needs.

Growth and productivity

This scenario may have a negative impact on productivity. This is due to lack of specialisation and expertise: if people are not establishing themselves in a single career and building up knowledge, skills and experience in one area, this could have negative implications for productivity.

[31] Socio-emotional learning refers to teaching ‘soft skills’ that allow people to adapt their skills and knowledge to perform to future roles, without specifically knowing what they might entail. It includes being resilient, having strong communication skills, and being able to work well with others. See, for example, Devaux and others (2019).

Given the high internal mobility in this scenario, people with adaptable skills can move easily between jobs and enjoy some degree of employment protection. This may further contribute to decreasing productivity if these workers are not highly motivated.

Skills and qualifications

This scenario allows the benefits to be reaped from improving key basic skills (literacy and maths) and some of the existing skills gaps in management to be tackled. Yet, in order to deliver a more mobile workforce with careers across multiple sectors, the skills system needs to adapt both its communication and ways it operates.
Employers may be disincentivised from investing in employees' skills, knowing the high mobility of labour and risks associated with trained workers moving to their competition. This means that either employers need to more appreciate appropriate skills management (from skills assessment to utilisation) that attracts and retains talent, or that the burden of adaptability of workforce will rely more heavily on public investment.

Quality of work

This scenario also draws on digitalisation of the society that allows flexible working with corresponding opportunities (better work-life balance) and risks (health and wellbeing concerns when working from home). There is, however, less certainty around the improvements of the skill use and discretion and with the persistent skills mismatches workers' overall job satisfaction may not improve.

4. Implications of the scenarios for sectors of interest

Key implications for skills

Digital Greening:

- *Construction*: growth of non-traditional career prospects, demand for data analytical skills.
- *Wholesale and retail*: demand for programming skills, green skills and knowledge of e-commerce.
- *Higher education*: demand for skills in management, engineering, testing, communications, information security, computer science.
- *Transport and logistics*: demand for data analytical skills, skills to operate and repair vehicles remotely.
- *Health and social care*: demand for ICT skills and to operate remotely.
- *Energy*: demand for data analytical skills, knowledge of renewable energy, energy efficiency measures and green skills.

Living Locally:

- *Construction:* shift towards skills related to electronic equipment, computer hardware, software, and programming.
- *Wholesale and retail*: demand for technical skills in operating and maintaining ICT equipment and for knowledge of e-commerce.
- *Higher education*: demand for skills in management, engineering, ICT and computer science.
- *Transport and logistics*: demand for skills to maintain infrastructure for zero emissions vehicles, to convert fuel systems, to model traffic flows and for low-skilled delivery workers.
- *Health and social care*: demand for human-machine interface skills, skills in assisting and caring for others.

- *Energy*: demand for engineering skills.

Protectionist Slowdown:

- *Construction:* demand for technical skills (for example, to operate equipment; know-how of 'green' materials).
- *Wholesale and retail*: limited change in the skills required.
- *Higher education*: demand for short, tailored courses.
- *Transport and logistics*: limited change in the skills required.
- *Health and social care*: demand for skills in providing personal care to others.
- *Energy*: limited change in the skills required.

Continued Disparity:

- *Construction*: unmet demand for technical skills.
- *Wholesale and retail*: limited change in the skills required.
- *Higher education*: limited change in the skills required.
- *Transport and logistics*: limited change in the skills required.
- *Health and social care*: limited change in the skills required.
- *Energy*: demand for knowledge of renewable energy.

Generating Generalists

- *Construction*: specialised skills needed from the agile workforce.
- *Wholesale and retail*: demand for technology, problem-solving and inter-personal skills.

- *Higher education*: demand for essential skills (problem-solving, inter-personal skills).
- *Transport and logistics*: gaps in specialised, technical skills (for example, repairing electric vehicles).
- *Health and social care*: demand for high-skilled roles (diagnosis, treatment alternatives, drug properties).
- *Energy*: demand for knowledge of and skills using energy efficient technologies

The scenario narratives do not focus on specific sectors but provide a high-level view of the labour market, given the key political, economic, societal, technological and environmental drivers. The implications of the scenarios for the 6 identified sectors (construction, wholesale and retail, higher education, transport and logistics, health and social care and energy) were discussed at the workshop with supporting evidence from expert interviews. In this section, the key points raised for the different scenarios are presented for each sector. Further exploration of these issues would require wider sectoral consultation and is beyond the scope of this analysis.

4.1. Construction

Key findings

- *Digital Greening*: growth of non-traditional career prospects, demand for data analytical skills
- *Living Locally*: shift towards skills related to electronic equipment, computer hardware, software, and programming
- *Protectionist Slowdown*: demand for technical skills (for example, to operate equipment; know-how of ‘green’ materials)
- *Continued Disparity*: unmet demand for technical skills
- *Generating Generalists*: specialised skills needed from the agile workforce

Technological change, the transition to a green economy and the ability to match skills to labour needs are key factors affecting the construction sector across the scenarios.

In the **Digital Greening** scenario, the more rapid rollout of technology and extensive use of data are likely to have implications for the construction sector with an increased need for

data analytical skills. Technologies such as virtual reality could increasingly be used, reducing the need for onsite staff. Machine learning and AI capabilities could use data from previous and existing projects to suggest solutions at all stages of process. Widespread data sharing could also facilitate the matching of workers with employment opportunities, with construction workers more able to directly engage with employers, although labour could still be sourced from outside the UK.

The UK exceeds its targets under the 10 Point Green Plan in this scenario. This, coupled with the impact of technology and a growing economy, indicates that there will be continued growth in the construction sector with greater increases seen in non-construction roles. The growth and non-traditional career prospects in the sector may further attract talent from groups currently underrepresented in the construction workforce, such as women or people with disabilities.

In **Living Locally**, the construction sector would benefit from the reshoring of some manufacturing and investment in public infrastructure. The focus on levelling up and local communities would also mean changes in the infrastructure needed so that a smaller share of the construction workforce is pulled into London and the Southeast. Digitalisation and the prominence of the environmental agenda in this scenario would also have implications for the skills needed in the construction sector. For example, a wide use of IoT and 3D printing in construction could shift emphasis from technical skills and knowledge of materials, methods and the tools involved in construction or repairs to those related to electronic equipment, computer hardware and software. With more limited access to immigrant workers significant changes are likely to occur in this sector, with a growth of digital and off-site (modular-based) construction jobs.

Construction also stands to benefit to some extent in **Protectionist Slowdown** as there is some investment in this sector but limited technological progress. There is, however, likely to be a mismatch in terms of the skills needed to achieve net zero ambitions, exacerbated by low labour mobility in this scenario. In practice this could mean an unmet demand for low-skilled workers with technical skills (for example, to operate and maintain equipment), as well as highly skilled construction professionals (for example, with resource management skills on the appropriate use of ‘green’ equipment, facilities, and materials).

A similar picture is also seen in **Continued Disparity**, while in **Generating Generalists**, the skills needed for this sector may not align with the agile workforce concept as many skills in construction are quite specialised. On the other hand, training for transferable skills and upskilling may be positive to meet changing nature of construction sector in response to net-zero ambitions.

4.2. Wholesale and retail trade

Key findings

- *Digital Greening*: demand for programming skills, green skills, knowledge of e-commerce
- *Living Locally*: demand for technical skills in operating and maintaining ICT equipment and for knowledge of e-commerce
- *Protectionist Slowdown*: limited change in the skills required
- *Continued Disparity*: limited change in the skills required
- *Generating Generalists*: demand for technology, problem-solving and inter-personal skills

Across all the scenarios, the current trend away from retail trade to wholesale trade is likely to continue and changes to the retail sector from its pre-pandemic form are also likely. These changes may be less pronounced for scenarios, such as **Continued Disparity** and **Protectionist Slowdown**, where there is some form of 'office-based' working and employment remains focussed in London and the Southeast. In both **Digital Greening** and **Living Locally**, the shift towards widespread digitalisation would suggest long-term trends towards online shopping which would impact both the skills needed in this sector and the share of employment. Higher demand on workers with sales and marketing skills, knowledge of e-commerce and internet banking, including relevant cyber-security policies, procedures and strategies, as well as those skilled in web design and programming would illustrate this well. Both of these scenarios entail relatively strong economies. Yet, despite this, consumers spending patterns are becoming more sustainable, resulting in a change in the nature and volume of consumption.

In **Digital Greening**, the more widespread adoption of technologies and focus on data analytics would have implications for employment in the retail sector and its supply chains and online retail would appear to dominate. This could mean for example higher demand for workers with programming skills to better serve customer needs and those with resource management and green skills to reduce waste and make supply chains and operations more environmentally friendly. Smarter, automated back-end solutions and collaboration between businesses may mean fewer miles travelled for goods.

In **Living Locally**, the rise of SMEs and movement into regional areas suggests that small local shops may still thrive, while big tech companies dominate online with the middle-level, 'high street' shops potentially squeezed out as a result. There may be more scope in this scenario for manufacturers and retailers who provide consumers with the means and blueprints to print or manufacture goods 'hyper-locally' or that offer products and services as part of the circular economy. Hence, technical skills in operating and maintaining ICT equipment and machinery could be sought after.

Reshoring of activities in both **Living Locally** and **Protectionist Slowdown** are also likely to affect the retail sector, particularly for goods where the UK is reliant on imports, such as clothing and consumer goods. Potential resulting impacts on prices may have knock-on effects for the sector and how it's structured. Some employment in this sector is likely to be precarious across all the scenarios, although in **Generating Generalists**, employees would benefit from measures to improve quality and security of work, although there may be market impetus to replace jobs with technology. Generalist skills, including the ability to use technology, problem-solving and inter-personal skills, may be more applicable and mobile for wholesale and retail.

4.3. Higher education

Key findings

- *All scenarios:* demand for ICT skills and (personal) training and teaching skills
- *Digital Greening*: demand for skills in management, engineering and ICT
- *Living Locally*: demand for skills in management, engineering, testing, communications, information security, computer science
- *Protectionist Slowdown*: demand for short, tailored courses
- *Continued Disparity*: limited change in the skills required
- *Generating Generalists*: demand for essential skills (problem-solving, inter-personal skills)

The higher education (HE) sector is in charge of generating graduates with: certificates (Level 4 qualifications); diplomas of higher education (Level 5 qualifications); bachelor's degrees (Level 6 qualifications); and advanced academic degrees (Level 7 and 8 qualifications). These qualifications degrees are formal entry requirements for a number of

occupations (from skilled traders to science, research, engineering and technology professionals). As such, the sectors play a critical role in meeting demand for skills and qualifications across all sectors of interest and in each of the developed scenarios. Different scenarios, however, bear some implications for the HE sector itself.

Most of the scenarios foresee an increase in online delivery of education (raising demand for ICT skills among academic tutors), but there appears to be low risk of job automation. While online learning can increase access to students, the current pandemic has shown that learners still want face-to-face learning (indicating a continuous demand for training and teaching skills). It is also harder to deliver practical subjects (like STEM) remotely. Better collaboration between HE and employers/platforms will be required to deliver the type of education and training that is cutting edge/relevant. Meaningful access is also an issue when not coupled with access to digital infrastructure. Attracting not only students but also researchers to HE institutions with different levels of physical and virtual access will also be a key issue. The future of the HE sector would be closely linked to the differential focus and pace of greening the economy across the 5 scenarios (for example, by recruiting academics and adapting curricula that meet new demands for specific occupations in construction, transport or energy – such as engineers, scientists and ICT specialists).

Increased academic breadth in pre-employment learning in **Digital Greening** and **Living Locally** suggests growth and expansion of HE and a decline of occupation-specific education. A greater prominence for STEM would need to translate into appropriate skills to avoid a continuation of skills shortages (in management, engineering, testing, communications, information security, or computer science) (EMSI, 2019) in this sector and a significant minority of STEM graduates transitioning into routine employment.

HE currently facilitates internal migration, with young people from disadvantaged areas moving away for HE and then seeking employment in large cities. More local employment opportunities in **Living Locally** may mean young people do not see as much of a need for HE and/or may complete HE locally or move back to the local area afterwards.

Protectionist Slowdown has mixed implications for HE. There is a possibility of moving to a low skills based economy in this scenario, in which HE is not seen as useful but this could be offset by shorter, more tailored courses in the tertiary sector. Moreover, research and development may benefit in the scenario as innovation is seen as a solution to economic problems.

In **Continuing Disparity**, HE largely continues along existing lines and the sector has not diversified its education and training offering significantly, with STEM subjects remaining unattractive.

The HE sector could also either be underutilised (if it remains focussed on specialisms, as no one would see the benefit of this) in **Generating Generalists** or would undergo a fundamental change, becoming the main mechanism for training people in these essential skills (such as problem-solving and inter-personal skills.

4.4. Transport and logistics

Key findings

- *Digital Greening*: demand for data analytical skills and skills to operate and repair vehicles remotely
- *Living Locally*: demand for skills to maintain infrastructure for zero emissions vehicles to convert fuel systems, to model traffic flows and for low-skilled delivery workers
- *Protectionist Slowdown*: limited change in the skills required
- *Continued Disparity*: limited change in the skills required
- *Generating Generalists*: gaps in specialised, technical skills (for example, repairing electric vehicles)

Greening of the transport sector is expected to occur across all the scenarios to some extent, with implications for the types of skills required to support this transition in the energy as well as the transport sector. Employment in the sector will depend on the extent to which there is commuting to the workplace and where employment is located. Scenarios with extensive online retail could also see implications for skilled and unskilled workers if delivery to consumers is provided through platform working as this could mean higher demand for low-skilled workers to deliver goods to clients cheaply.

In **Continued Disparity** and **Protectionist Slowdown**, current trends in the transport sector (for example, green transition, blurring boundaries between transport and logistics) are likely to continue. **Living Locally** could also have implications for the transport sector with less commuting and travel in general, and a greater focus on shifting people away from private transport onto alternatives such as local buses. The transport workforce may require training to ensure the maintenance of the underlying infrastructure (for example, technical diagnostic skills to service and repair electric vehicles, recycling electric car batteries). Transport flow managers, modellers and engineers will be expected to have skills to minimize the impact of transport (for example, skills in conversion of fuel systems) and encouraging the transitions,

while drivers and public transport managers will need to be able to use new technologies (for example, satellite navigation).

Automation of transport is potentially most likely in the **Digital Greening** scenario, where there is still high mobility and automation could support a green agenda. This could lead to considerable disruption with further blurring of boundaries across sectors for dominant, large firms. Driverless vehicles could reduce employment needs, offsetting labour shortages in some areas, but new skills requirements would be generated. These could include skills to operate and repair vehicles remotely, as well as analyse data to improve the efficiency of service operations. Without automation, there may be labour shortages if the transport sector remains less attractive to workers.

Generating Generalists could also support market-led, rapid technological innovation in the transport sector, potentially providing employment opportunities in both generalist roles and more specialist ones. Compared to other scenarios, there could be more collaboration needed between sector employers and providers of lifelong learning to fill gaps in highly specialised, technical skills (for example, repairing electric and driverless vehicles) that may result from broadening and extending education curricula and focusing on generalist skills, such as problem solving.

Freight transport and logistics will impact the retail sector, but also by reshoring of activities and the extent to which goods and services are sourced locally in the **Protectionist Slowdown** and **Living Locally** scenarios.

4.5. Health and social care

Key findings

- *Digital Greening*: demand for ICT skills and to operate remotely
- *Living Locally*: demand for human-machine interface skills, skills in assisting and caring for others
- *Protectionist Slowdown*: demand for skills in providing personal care to others.
- *Continued Disparity*: limited change in the skills required
- *Generating Generalists*: demand for high-skilled roles (diagnosis, treatment alternatives, drug properties)

Demand from an ageing population will be an issue across all the scenarios with differences generated by labour mobility within and into the UK and the general health of the elderly cohort. For scenarios with greater technological development and digitalisation, there may be scope to offer services digitally, use data to streamline services and expand the use of robotics and AI in the sector. Dirty, dangerous and repetitive tasks could be automated creating demand for tasks requiring human-machine interface skills. The extent to which these occur and the implications for the size of the workforce and skills needed will be influenced by public funding and the organisation of health care delivery. In **Digital Greening**, there is scope for a significant expansion of technology in the health sector, depending on how this is funded with implications for both high and low-skilled roles. The ability to undertake more activities virtually could alleviate potential skills shortages.

Many jobs (or parts of jobs) requiring 'human contact' that cannot be automated, or that are not desirable to automate, will remain.

For **Protectionist Slowdown** and **Living Locally**, limited immigration will have an impact on labour supply, given the reliance on immigrant workers in this sector pointing to demand for skills to provide personal assistance, medical attention, emotional support, or other personal care to others. In the **Living Locally** scenario, this may be offset by the use of technology and local management of training. Informal caring arrangements may become easier if everyone is living more locally and consequently closer to their extended families. In the **Protectionist Slowdown** scenario, skills shortages (for example for providing personal assistance, emotional support, or other personal care to others) may be more acute and demand greater. Although lower public spending could, in fact, provide the impetus for innovation.

Improved employment protections in **Generating Generalists** would benefit the health and social care sector but in a highly regulated sector, the speed of change might be slowed by the safety requirements. Moreover, a broad education system may have implications for training provision (for skills requiring long and specialist education and practice, such as recognising symptoms, diagnosing and treating injuries or diseases, knowledge of treatment alternatives and drug properties) and demand for high-skilled roles in the sector.

4.6. Energy (renewables)

Key findings

- *Digital Greening*: demand for data analytical skills, knowledge of nuclear and renewable energy, energy efficiency measures and green skills
- *Living Locally*: demand for engineering skills
- *Protectionist Slowdown*: limited change in the skills required
- *Continued Disparity*: demand for knowledge of renewable energy
- *Generating Generalists*: demand for knowledge of and skills using energy efficient technologies

A transition in the energy sector is seen across all the scenarios, driven by the UK's green ambitions and leading to a potential expansion of skills requirements ranging from green hydrogen to offshore energy. This has consequences for the workforce currently working in high-carbon industries, some of whom will need to reskill either into new or adapted green jobs in their own or other industries. Greening of other sectors, such as transport through zero-emissions vehicles, green construction or the need for green financial instruments will also impact the types of jobs in this sector to different extents across the scenarios.

In **Digital Greening**, data analytics is key to managing energy needs sustainably across sectors and consumer demand. Skills mobility and an education system with a broader STEM focus enables the development of green hydrogen for transport, domestic and commercial heating and industrial use. Scientists and engineers with training or transferable knowledge for nuclear and renewable energy (including wind and marine) will be in demand, as well as technicians able to install energy efficiency measures and retrofit at a household and business premises level.

Public investment in offshore wind energy as part of its reshoring agenda in the **Living Locally** scenario has led to a regional expansion of engineering skills matched by mobility of labour within the UK and regionally managed training. The localism agenda and focus on the circular economy also means that other energy schemes such as district heating using biomass.

Renewable energy has not been a focus in the **Protectionist Slowdown** scenario and with consumers price conscious, efforts in the sector have focussed on increasing efficiencies with limited change in the skills required. Although public funding for renewables is limited in the **Continued Disparity** scenario, private sector involvement has been encouraged, potentially resulting in an increasingly green and more diverse energy sector. Smaller firms may still find it difficult to retain staff with requisite skills.

Complacency on climate change and reliance on market-based technology led solutions suggest that there has not been a significant shift in the energy sector in the **Generating Generalists** scenario. The skills focus may be on developing energy efficient technology or using technologies, such as machine learning to improve demand and supply management.

5. Policy implications

Key policy implications

From this research, the following implications can be drawn:

ICT/digital skills are critical to the future of most jobs with the emergence of specialist skill areas. Introducing STEM subjects for longer, incorporating these skills alongside regular studies and investing earlier in digital skills in the education system could support this skills need.

Any future vocational education and training system needs to provide clear and more flexible pathways so that workers are well aware of training options and can make informed decisions about what to do and how to do it.

More flexible, portable training with corresponding micro-credentials could be accompanied by accreditation and licensing of providers to mitigate the risk in quality of qualifications obtained in this way.

A broad range of stakeholders should be involved in developing courses and training to meet local labour market demand. This could include education training providers, local employers, local governments and local enterprise partnerships (LEPs).

Education and training system also need to teach broad concepts and foundation skills (for example, communication, networking, problem-solving, literacy and numeracy skills).

Employer investment in training will be increasingly important, but employer unwillingness to train their workers will continue to be a barrier. Incentives for life-long learning, both for the employer and employee, will need to increase and information on the benefits and options outlined.

The Government needs to make long-term policy choices that are robust enough to succeed across the spectrum of possible futures. This section draws on the implications of the scenarios for jobs, skills and qualifications and synthesises the policy implications that were discussed revealed during the expert interviews. These implications provide important considerations across all scenarios. Yet, where they speak to any scenario in particular, it is noted below.

ICT/digital skills are critical to the future of most jobs with the emergence of specialist skill areas, such as cyber skills, AI skills, geospatial data skills, IT analytics and data analysis skills. Including STEM subjects for longer, incorporating these skills alongside regular studies, and investing earlier in digital skills in the education system could support this skills need and reduce the unattractiveness of STEM courses to many. This will be especially important in the 'Digital Greening' and the 'Living Locally' scenarios to mitigate the increased skills mismatch that might result from the creation of new jobs and technological developments.

While technical and ICT/digital skills are important for future jobs, there was also broad agreement that **the education and training system also needed to teach broad concepts and more general or foundation skills** (such as communication, negotiation and networking skills, leadership and management skills, mathematics, problem-solving, literacy, numeracy, understanding processes, team working and collaboration).[32] This will be especially important in the 'Living Locally' scenario as the turn to local life will require a

[32] INT-2, INT-4, INT-5, INT-7, INT-10, INT-11, INT-18, INT-19, INT-21, INT-23.

breadth of competences and entrepreneurial attitudes. It will be equally important in the 'generating generalists' scenario where strong foundation skills can helps support a resilient, agile workforce, able to respond to rapid changes in the workplace.

Any future vocational education and training system needs to provide clear and more flexible pathways so that workers are well aware of training options and can make informed decisions about what to do and how to do it in terms of changing jobs and/or updating their skills. This could be done by continually improving policy and practice on career education, information, advice and guidance. The flexibility of the pathways should also involve the ability to adapt to new circumstances and their specific challenges and opportunities. While professional bodies have an important role, narrow qualifications should be avoided.

As education and training moves to an increasingly blended or 'anywhere/anytime' approach, this may lead to more flexible, portable training with corresponding micro-credentials.[33] This could be accompanied by accreditation and licensing of providers to mitigate the risk in quality of qualifications obtained in this way. These qualifications need not be aligned with specific occupations or sectors to provide flexibility as occupations change or become obsolete. Portability of skills and qualifications was identified as crucial to facilitate intra- and inter-sectoral mobility as workers change jobs and re-skill.[34] This portability of skills and qualifications would be especially important in the 'Generating Generalists' scenario, which is characterised by high internal mobility.

A broad range of stakeholders should be involved in developing courses and training to meet local labour market demand as the boundaries between sectors become more blurred and to respond to regional differences. This could include education and training providers, local employers, local governments and local enterprise partnerships (LEPs). There will be a need for cross-firm and cross-sectoral collaboration to facilitate the transition of workers in jobs at risk of automation/redundancy to move into new jobs/sectors. This would be especially important in the 'Living Locally' scenario.

Strengthening governance and institution-building for FE and post-16 qualifications was seen as vital. A single national awarding authority or central authority to monitor quality assurance (as is the case in Scotland) is considered a way of avoiding training providers 'marking their own homework' and ensuring portability of qualifications if training provision becomes more devolved.[35]

[33] Micro-credentials demonstrating qualifications gained through a short, online, in-person or blended courses delivered by universities, vocational education and training (VET) institutions, or private organisations. For more information, please see Kato and others (2020).
[34] INT-2, INT-4, INT-5, INT-7, INT-11, INT-12, INT-14, INT-16, INT-19, INT-22.
[35] INT-4, INT-5, INT-12, INT-19.

Incentives should be considered to encourage firms to invest in training for their own employees to help smaller firms retain employees and access specific skills needs. Different incentives may be appropriate for different firms to reflect the blurring of boundaries across sectors and the types and sizes of firms operating in them. Tax credits, for example, may not be most effective for smaller firms, when there is an immediate need for labour.

Targeted investment in re-skilling and upskilling support for firms and their workers, with cross-firm and cross-sectoral cooperation, were seen as important in helping facilitate the transition of workers at risk of automation to move into new jobs and/or sectors.[36] The need for funding of a range of targeted schemes for on-the-job training was mentioned as an important alternative or complementary approach to formal education and training.[37] This could also help avoid workplace training being biased towards those who are already highly skilled. Funded programmes of mentoring/coaching by senior/qualified workers to transfer technical knowledge to new entrants in the workplace were suggested, particularly in firms and/or sectors that have ageing workforces.[38] Targeted investment would be key in the 'Continued Disparity' scenario, where increased automation might lead to more social inequity if people are unable to re-skill. It will also be important in the 'generating generalists' scenario where the increased internal mobility might disincentivise employers from investing in employee's skills.

Employees also need incentives to undertake life-long learning. Linking training budgets to individuals could incentivise them to develop new skills. A portable skills passport could also ensure workers are motivated to engage in lifelong learning to keep their skills current. While professional occupations already have systems of Continuing Professional Development (CPD), a similar system could be used to encourage updating skills required for other jobs/across all sectors. A requirement to regularly authenticate skills is also foreseen as skills sets are changing more rapidly. Incentives to undertake training and life-long learning would be especially important under the 'Protectionist Slowdown' scenario to ensure that people remain incentivised to engage in training during an economic downturn. It will also be important in the 'Continued Disparity' scenarios to try to bridge gap between high-skilled and low-skilled workers.

All interviewees viewed the Lifetime Skills Guarantee (HM Government, 2021a) as a good policy initiative to help make technical and vocational education more attractive.[39] Some experts, however, questioned whether it would be more effective if a universal guarantee of free education and training was offered, rather than a loan scheme.[40]

[36] INT-2, INT-5, INT-8, INT-10, INT-12, INT-14, INT-17, INT-20.
[37] INT-2, INT-5, INT-8, INT-10, INT-12, INT-14, INT-17, INT-20.
[38] INT-2, INT-9, INT-12, INT-13, INT-16, INT-19, INT-20, INT-23.
[39] All interviewees.
[40] INT-4, INT-5, INT-8, INT-15.

Demand for jobs in health and social care, hospitality and retail and cultural work is likely to continue across all futures. Attracting people to this type of work in sufficient numbers will likely require not only investment in education and training, but also developing career prospects and offering salary progression. There is no single, clear solution to this major challenge and it will require multiple and coordinated efforts to address it.

Regardless of the skills needs and delivering of training to meet this demand**, there will be a need for good Labour Market Intelligence** (LMI) for careers guidance and counselling to help workers transition to 'green' and 'digital' jobs/sectors. This should provide information and advice about education and training qualifications, job opportunities, re-training opportunities. Additional policies may need to be developed to support 'dirty' industries/sectors/jobs to help them transition to 'green' economy, including funding for displaced workers via retraining schemes.

Policy interventions in a range of other areas could be needed to support levelling up and economic growth. Government efforts may be needed to make housing more affordable in small towns and cities to support people moving away from London and the Southeast to help support 'levelling up' across the UK. At the same time, firms might need incentives to move to regional hubs and support more local and regional transport investment. More consistent broadband would be needed across the country to have a genuinely local economy and to support widespread digitalisation.

At the sectoral level, there may be a need for additional specific policies within the above broad framework to address skills shortages due to migration in health care and construction, for example, or because of the way in which technology is implemented or net-zero ambitions develop in the transport and energy sectors. This could also have implications for the skills needs and policies in the higher education sector both in terms of research and delivery. A more detailed exploration would be needed to understand the particular needs of these sectors and how they could be made robust across different futures.

References

All web links were last checked on 19 October 2021.

Abeliansky, A. and Prettner, K. (2017) *Automation and demographic change*. Hohenheim Discussion Papers in Business, Economics and Social Sciences, No. 05-2017. Stuttgart: University of Hohenheim.

Acemoglu, D. and Autor, D. (2011) 'Skills, Tasks and Technologies: Implications for Employment and Earnings', in Ashenfelter, O. and Card, D. (eds.) *Handbook of Labor Economics*, *Volume 4*. Amsterdam: Elsevier, pp. 1044-1171.

Acemoglu, D. and Restrepo, P. (2017) 'Secular Stagnation? The Effect of Aging on Economic Growth in the Age of Automation', *American Economic Review: Papers and Proceedings*, 107(5), pp. 174-179.

Acemoglu, D. and Restrepo, P. (2018) 'The race between man and machine: Implications of technology for growth, factor shares, and employment', *American Economic Review*, 108(6), pp. 1488-1542.

Agrawal, S., De Smet, A., Lacroix, S., and Reich, A. (2020a) *To emerge stronger from the Covid-19 crisis, companies should start reskilling their workforces now*. McKinsey & Company.

Aldersgate Group. (2012) *Resilience in the Round: Seizing the growth opportunities of the circular economy.* London: Aldersgate Group.

Arregui Pabollet, E., Bacigalupo, M., Biagi, F., Cabrera Giraldez, M., Caena, F., Castaño Muñoz, J., Centeno Mediavilla, I.C., Edwards, J.H., Fernandez Macias, E., Gomez Gutierrez, E., Gomez Herrera, M.E., Inamorato Dos Santos, A., Kampylis, P., Klenert, D., Lopez Cobo, M., Marschinski, R., Pesole, A., Punie, Y., Tolan, S., Torrejon Perez, S., Urzi Brancati, M.C., and Vuorikari, R. (2019) *The changing nature of work and skills in the digital age*. *Joint Research Centre*. Luxembourg: Publications Office of the European Union.

Ballard, O. (2020) 'What type of recovery can the UK economy expect?', *Business Leader*, 23 October 2020. Available at: https://www.businessleader.co.uk.

BEIS (Department for Business, Energy and Industrial Strategy) (2021) *Green Jobs Taskforce Report*. London: Department for Business, Energy and Industrial Strategy.

Berg, J., Furrer, M., Harmon, E., Rani, U., and Silberman, M.S. (2018) *Digital labour platforms and the future of work: Towards decent work in the online world*. Geneva: International Labour Organization.

Boys, J. (2020) Briefing note: Data on skills challenges by industry sector. London: Federation for Industry Sector Skills and Standards (FISSS).

Brook, P. (2018) *Life on a housing treadmill: struggling to make a home on a low income*. Available at: https://www.jrf.org/, 30 April 2018.

Cambridge Econometrics, Trinomics, and ICF (2018) *Impacts of circular economy policies on the labour market*. Brussels: European Commission.

Cedefop (European Centre for the Development of Vocational Training) (2010) *Skills supply and demand in Europe: medium-term forecast up to 2020*. Luxembourg: Publications Office of the European Union.

Cedefop (European Centre for the Development of Vocational Training) (2013) *Skills for a low-carbon Europe: The role of VET in a sustainable energy scenario - Synthesis report*. Research Paper No. 34. Luxembourg: Publications Office of the European Union.

Cedefop (European Centre for the Development of Vocational Training) (2018a) *Skills forecast trends and challenges to 2030*. Cedefop reference series, 108. Luxembourg: Publications Office of the European Union.

Cedefop (European Centre for the Development of Vocational Training) (2018b) *Less brawn, more brain for tomorrow's workers*. Briefing note, June 2018. Luxembourg: Publications Office of the European Union.

Cedefop (European Centre for the Development of Vocational Training) (2021a) *Skills-OVATE: Skills Online Vacancy Analysis Tool for Europe*. Available at: https://www.cedefop.europa.eu

Chui, M., Manyika, J., and Miremadi, M. (2015) *Four Fundamentals of Workplace Automation*. Available at: https://www.mckinsie.com, 1 November 2015.

CIPD (Chartered Institute of Personnel and Development) (2018) *Over-skilled and under-used: Investigating the untapped potential of UK skills*. London: Chartered Institute of Personnel and Development.

CIPD (Chartered Institute of Personnel and Development) (2019a) *Is work really becoming less secure?* Megatrends, July 2019. London: Chartered Institute of Personnel and Development.

CIPD (Chartered Institute of Personnel and Development) (2019b) *People and Machines: from hype to reality*. London: Chartered Institute of Personnel and Development.

CIPD (Chartered Institute of Personnel and Development) (2020a) *PESTLE Analysis*. Available at: https://www.cipd.co.uk, 10 November 2020.

Civil Service (n.d.) *Introduction to Devolvement*. London: Government Publishing Service.

Consoli, D., Martin, G., Marzucchi, A., and Vona, F. (2016) 'Do green jobs differ from non-green jobs in terms of skills and human capital?', *Research Policy*, 45(5), pp. 1045-60.

CTP (Career Transition Partnership) (2021) *Construction Industry Sector Guide*. London: Career Transition Partnership.

De Best, R. (2021a) *Employment in the construction industry based on occupation in the UK 2016-2019*. Available at: https://www.statista.com, 20 April 2021.

De Best, R. (2021b) *Total employment in the construction industry in the United Kingdom (UK) from 2016 to 2020 with a forecasts for 2025*. Available at: https://www.statista.com, 25 June 2021.

Deloitte (2021) *Retail trends 2020*. Available at: https://www.deloitte.com.

Deming D.J. and Noray, K. (2020) 'Earnings Dynamics, Changing Job Skills, and STEM Careers', *Quarterly Journal of Economics*, 135(4), pp. 1965-2005.

Devaux, A., Dunkerley, F., Koch, N., Bruckmayer, M., Phillips, W., and Jordan, V. (2019) *Research for CULT Committee – Education and Youth in the European Union – Current Challenges and Future Prospects*. Brussels: European Parliament, Policy Department for Structural and Cohesion Policies.

DfE (Department for Education) (2019) *National standards for essential digital skills*. London: Department for Education (DfE).

Dickerson, A. and Wilson, R. (2012) *Developing Occupational Skills Profiles for the UK: A Feasibility Study*. Evidence Report 44. February 2012. London: UK Commission for Employment and Skills.

Dickerson, A. and Wilson, R. (2017) *How should we consider future skills demand?* Skills Demand Workshop 2017, 18 July, Westminster. Available at: https://www.warwick.ac.uk.

Ellen MacArthur Foundation, Sun, and McKinsey Center for Business and Environment. (2015) *Growth within: A Circular Economy vision for a competitive Europe*. Available at: https://www.ellenmacarthurfoundation.org.

EMSI (2019) *Focus on the demand for stem jobs & skills in Britain*. Available at: https://www.economicmodelling.co.uk, 7 January 2019.

Energy and Utilities Skills (2020) *Workforce Renewal & Skills Strategy 2020 – 2025*. Available at: https://www.euskills.co.uk, 2020.

Energy UK (2021) *Renewable generation*. Available at: https://www.energy-uk.org.uk, Energy Industry, Renewable generation.

ERP (Energy Research Partnership) (2014) *Investigation into high-level skills shortages in the energy sector*. London: Energy Research

Eurofound (European Foundation for the Improvement of Living and Working Conditions) (2018) Automation, digitisation and platforms: Implications for work and employment. Luxembourg: Publications Office of the European Union.

EY (2020) *EY Megatrends 2020 and Beyond Report*. EYQ 3rd edition. Available at: https://www.ey.com/megatrends.

Felstead, A., Gallie, D., Green, F., and Henseke G. (2017) *Insecurity at work in Britain: first findings from the Skills and Employment Survey 2017*. London: Centre for Learning and Life Chances in Knowledge Economies and Societies, UCL Institute of Education.

FTA (Freight Transport Association) (2018) *Skills Shortage Report. An independent analysis of employment trends in the UK logistics sector*. Royal Tunbridge Wells: Freight Transport Association.

FTA (Freight Transport Association) (2019) *Logistics Skills Report 2019*. Royal Tunbridge Wells: Freight Transport Association.

Gausemeier, J., Fink, A., and Schlake, O. (1998) 'Scenario management: An approach to develop future potentials', *Technological Forecasting and Social Change*, 59(2), pp.111-130.

Goodwin, P. and Wright, G. (2010) 'The limits of forecasting methods in anticipating rare events', *Technological Forecasting and Social Change*, 77(3), pp. 355-368.

Government Office for Science (2016) *Future of anAgeing Population*. London: Foresight, Government Office for Science.

Government Office for Science (2017) *Future of Skills & Lifelong Learning*. London: Foresight, Government Office for Science.

Graetz, G. and Michaels, G. (2018) 'Robots and work', *Review of Economics and Statistics*, 100(5), pp. 753–768.

Green, F. (2015) 'Health effects of insecurity', IZA World of Labor, 2015(212), pp. 1-10.

Harari, D. (2020) *End of Brexit transition period: Economic impact*. House of Commons Library Briefing Paper 9096, 18 December 2020. London: House of Commons Library.

HESA (Higher Education Statistics Agency) (2021) *What is the income of HE providers?* Available at: https://www.hesa.ac.uk.

HM Government (2018a) *Essential Digital Skills: Framework*. Available at: https://assets.publishing.service.gov.uk.

HM Government (2018b) *EU Exit Long-term economic analysis*. Cm9742, November 2018. London: HM Stationery Office.

HM Government (2018c) *Good Work Plan*. London: HM Stationary Office.

HM Government (2018d) *The experiences of individuals in the gig economy*. London: HM Stationary Office.

HM Government (2020a) *The Ten Point Plan for A Green Industrial Revolution: Building back better, supporting green jobs, and accelerating our path to net zero*. November 2020. London: Stationery Office.

HM Government (2020b) *UK Research and Development Road Map*. July 2020. London: Stationery Office.

HM Government (2021a) *Hundreds of free qualifications on offer to boost skills and jobs*. Available at: https://www.gov.uk, Press release, 1 April 2021.

HM Government (2021b) *State Pension age timetables*. Available at: https://www.gov.uk.

HM Treasury (2016) *HM Treasury analysis: the long-term economic impact of EU membership and the alternatives*. London: HM Treasury.

Hogarth, T. (2011) *Studies on Sustainability Issues – Green Jobs; Trade and Labour*. Coventry: Warwick Institute for Employment Research & Cambridge: Cambridge Econometrics.

Hogarth, T. (2021) *COVID-19 and the Demand for Labour and Skills in Europe: Early Evidence and Implications for Migration Policy*. Brussels: Migration Policy Institute.

Hogarth, T., Owen, D., Gambin, L, Hasluck, C., Lyonette, C., and Casey, B. (2011) *The Equality Impacts of the Current Recession*. Equality and Human Rights Commission Research Report No.47. Manchester: Equality and Human Rights Commission.

Home Office (2020) *New immigration system: what you need to know*. Available at: https://www.gov.uk, 28 January 2020.

House of Commons (2017) *Higher education sector report*. Report of the Exiting the European Union Committee. London: Library of the House of Commons.

House of Commons (2021) *Coronavirus: Economic impact*. Briefing Paper, Number 8866, 1 June 2021. London: Library of the House of Commons.

Hutton, G. (2021) *Retail Sector in the UK*. House of Commons Library, Briefing Paper Number SN06186. London: House of Commons Library.

Hutton, W. (2021) 'Don't let pandemic losers slide further in a K-shaped recovery', *The Guardian*, 28 February 2021. Available at: https://www.theguardian.com.

IACGB (International Advisory Council on Global Bioeconomy) (2020) *Global Bioeconomy Policy Report (IV): A decade of bioeconomy policy development around the world*. Berlin: Secretariat of the Global Bioeconomy Summit 2020.

Ibisworld (2021a) *Sector Trends 2021 - Construction Sector in the UK*. Available at: https://www.ibisworld.com, 2021.

Ibisworld (2021b) *Universities in the UK – Market Research Report*. Available at: https://www.ibisworld, 31 March 2021.

ILO (International Labour Organization) and OECD (Organization for Economic Co-operation and Development) (2019) *New job opportunities in an ageing society*, Tokyo: Organization for Economic Co-operation and Development).

Industrial Strategy Council (2019) *UK Skills Mismatch in 2030*. Research Paper, October 2019. London: Industrial Strategy Council.

Irvine, G. (ed.) (2020) *Can good work solve the productivity puzzle? Collected essays*. Dunfermline: Carnegie Trust UK.

Kato, S., Galán-Muros, V., and Weko, T. (2020) *The Emergence of Alternative Credentials*. OECD Education Working Paper No. 216. Paris: Organisation for Economic Co-operation and Development Publishing.

Li, C. and Lalani, F. (2020) *The Covid-19 pandemic has changed education forever. This is how.* Available at: https://www.weforum.org, 29 April 2020.

Lloyds Bank (2021) *UK Consumer Digital Index 2021*. London: Lloyds Bank.

Manyika, J., Chiu, M., Miremadi, M., Bughin, J., George, K., Willmott, P., and Dewhurst, M. (2017) *Harnessing automation for a future that works*. McKinsey Global Institute Report. London: McKinsey & Company.

McGuiness, S. and Birgin, A. (2020) 'The political economy of a Northern Ireland border poll', *Cambridge Journal of Economics*, 44(4), pp. 781-812.

MGI (McKinsey Global Institute) (2021) *The Future of work after Covid-19*. London: McKinsey & Company.

Microsoft (2020) *Unlocking the UK's Potential with Digital Skills*. Available at: https://www.microsoft.com, November 2020.

Microsoft (2021) The Next Great Disruption Is Hybrid Work – Are We Ready? 2021 Work Trend Index: Annual Report. Redmond, WA: Microsoft.

Mosley, P., Winters, G., and Wood, S. (2012) *Wholesale and Retail Sector Skills Assessment 2012*. Briefing Paper, November 2012. London: UK Commission for Employment and Skills.

Mullock, K. (2016) *Defining 'green skills' using data*. Available at: https://www.oecdskillsandwork.wordpress.com, OECD Skills and Work Blog, 7 October 2016.

Nabarro, B. (2020) 'UK economic outlook: the long road to recovery', in Bourquin, P., Davenport, A., Emmerson, C., Farquharson, C., Johnson, P., Miles, D., Nabarro, B., Schulz, C., Stockton, I., Waters, T., and Zaranko, B. *IFS Green Budget 2020*. London: Institute for Fiscal Studies, pp. 78-131.

O*NET (2021) O*NET OnLine. Available at: https://www.onetonline.org.

OBR (Office of Budget Responsibility) (2021) Economic and Fiscal Outlook: March 2021. London: HM Stationery Office.

OECD (Organisation for Economic Co-operation and Development) (2016) *Getting skills right: Assessing and anticipating changing skill needs*. Paris: Organisation for Economic Co-operation and Development Publishing.

ONS (Office for National Statistics) (2016) *Analysis of the UK labour market – estimates of skills mismatch using measures of over and under education: 2015*. Available at: https://www.ons.gov.uk, 17 March 2016.

ONS (Office for National Statistics) (2019a) *Low Carbon and Renewable Energy Economy*, Available at: https://www.ons.gov.uk, 29 March 2021.

ONS (Office for National Statistics) (2019b) *ONS 2018-based Principal Projections*. Available at: https://www.ons.gov.uk, 21 October 2019.

ONS (Office for National Statistics) (2019c) *Probability of Automation in England 2011 and 2017*. Available at: https://www.ons.gov.uk, 25 March 2019.

ONS (Office for National Statistics 2019d) *Overview of the UK Population: August 2019*. Available at: https://www.ons.gov.uk, 23 August 2019.

ONS (Office for National Statistics) (2021a) *Coronavirus and the impact on output in the UK economic: December 2020*. Available at: https://www.ons.gov.uk, 13 October 2021.

ONS (Office for National Statistics) (2021b) *GDP first quarterly estimate, UK: April to June 2021*. Available at: https://www.ons.gov.uk, 12 August 2021.

ONS (Office for National Statistics) (2021c) *Labour Force Survey*. Available at: https://www.ons.gov.uk, 2021.

ONS (Office for National Statistics) (2021d) *UK government debt and deficit: March 2021. Quarterly estimates of UK government debt and deficit*. Available at: https://www.ons.gov.uk.

ONS (Office for National Statistics) (2021e) Vacancies and jobs in the UK. Available at: https://www.ons.gov.uk, August 2021.

Oxlearn (Oxford Learning Lab) (2020) *PESTLE—Macro Environmental Analysis*. Available at: https://www.oxfordlearninglab.com, December 2020.

Paun, A., Sargeant, J., Kane, J., Thimont Jack, M., and Shuttleworth, K. (2021) *Scottish independence: EU membership and the Anglo–Scottish border*. London: Institute for Government.

Pesole, A., Urzí Brancati, M.C, Fernández-Macías, E., Biagi, F., and González Vázquez, I. (2018) *Platform Workers in Europe: Evidence from the COLLEEM Survey*. Luxembourg: Publications Office of the European Union.

Pillkahn, U. (2008) *Using trends and scenarios as tools for strategy development: shaping the future of your enterprise*. Hoboken, N.J.: John Wiley & Sons.

Pouliakas, K. (2018) 'Risks posed by automation to the European Labour Market', in Hogarth, T. (ed.) *Economy, Employment and Skills: European, Regional, and Global Perspectives in an Age of Uncertainty*. Rome: Fondazione G. Brodolini Quaderni Series, pp. 45-74.

Powell, A., Harari, D., Hutton, G., Sandford, M., Keep, M., and Ward, M. (2021) *The Levelling Up Agenda*. Research Briefing, 11 June 2021. London: Library of the House of Commons.

Rani, U. and Grimshaw, D. (2019) 'Introduction: What does the future promise for work, employment and society?', *International Labour Review*, 158(4), pp. 577-592.

Retail Economics (2021) *UK retail stats and figures*. Available at: https://www.retaileconomics.co.uk.

Riso, S. (2020) *Employee monitoring and surveillance: The challenges of digitalisation*. Luxembourg: Publications Office of the European Union.Schleicher, A. (2020) *The impact of Covid-19 on Education: Insights from Education at a Glance*. Paris: OECD Publishing.

Schwab, K. (2016) 'The Fourth Industrial Revolution: What It Means and How to Respond', *Foreign Affairs,* 12 December 2015.

Schultz, C. (2020) 'Global Economic Outlook: lessons from the pandemic', in Bourquin, P., Davenport, A., Emmerson, C., Farquharson, C., Johnson, P., Miles, D., Nabarro, B., Schulz, C., Stockton, I., Waters, T., and Zaranko, B. *IFS Green Budget 2020*. London: Institute for Fiscal Studies, pp. 40-77.

Sentance, A. (2020) In the Bleak Midwinter – UK output and employment outlook. Available at: https://www.camecon.com, 22 December 2020.

Smith, J. (2021a) Overview of the retail sector in the UK. Available at: https://www.prospects.ac.uk, October 2021.

Smith, J. (2021b) Overview of the UK's transport industry (Jan. 2021), last accessed on 27.05.2021.

Störmer, E., Patscha, C., Prendergast, J., Dahelm, C., Rhisiart, M., Glover, P., and Beck, H. (2014a) *The Future of Work. Jobs and Skills in 2030*. Evidence Report 84. London: UK Commission for Employment and Skills.

Störmer, E., Patscha, C., Prendergast, J., Dahelm, C., Rhisiart, M., Glover, P., and Beck, H. (2014b) Annex F: Trends and disruptions: Full Report. London: UK Commission for Employment and Skills.

Strauss D. (2021) 'Surge in hiring as hospitality reopens adds to pressure on labour market', *Financial Times*, 17 May 2021. Available at: https://www.ft.com.

Taylor, M., Marsh, G., Nicol, D., and Broadbent, P. (2017) *Good Work: The Taylor Review of Modern Working Practices*. London: Department for Business, Energy and Industry Strategy (BEIS).

Tetlow, G. and Stojanovic, A. (2018) *Understanding the Economic Impact of Brexit.* London: Institute for Government.

TUC (Trades Union Congress) (2018) *A future that works for working people*. Future of Work report. London: Trades Union Congress.

Universities UK (2019) *Higher Education Facts and Figures 2019*. London: Universities UK.

Universities UK (2021) *Higher education in numbers*. Available at: https://www.universitiesuk.ac.uk, Insights and analysis, 3 September 2021.

Valenduc, G. and Vendramin, P. (2019) *The Mirage of the end of work*. ETUI Foresight Brief Series No. 6. Brussels: European Trade Union Institute (ETUI).

van Breugel, G. (2017) *Identification and anticipation of skills requirements: Instruments used by international institutions and developed countries*. Project document for Vocational Education and training for equality in Latin America and the Caribbean. Geneva: United Nations.

WEF (World Economic Forum) (2018) *Future of Jobs Report 2018*. Insight Report. Geneva: Centre for the New Economy and Society, World Economic Forum.

WHO (World Health Organization) (2021) *Naming the coronavirus disease (COVID-19) and the virus that causes it*. Available at: https://www.who.int.

Wilson, R.A. (2008) *UK approaches to skills needs analysis and forecasting: Lessons for the Czech Republic*. Coventry: Institute for Employment Research.

Wilson, R.A., Barnes, S.-A., May-Gillings, M., Bui, H. and Patel, S. (2020a) *Working Futures 2017-2027: Long-run labour market and skills projections for the UK. Main report*. London: Department for Education (DfE).

Winterbotham, M., Vivian, D., Kik, G., Huntley Hewitt, J.H., Tweddle, M., Downing, C., Thomson, D., Morrice, N., and Stroud, S. (2018) *Employer skills survey 2017: Research Report*. London: Department for Education (DfE).

Winterbotham, M., Kik, G., Selner, S., Menys, R., Stroud S., and Whittaker, S. (2020). *Employer Skills Survey 2019: Skills Needs. Research report*. London: Department for Education (DfE).

Annex A. Evidence review

The first stage of data collection involved a review of the existing evidence to identify: (1) the types of global and local drivers and trends of change which might be expected in the next 15 to 20 years; and (2) how these drivers and trends are likely to be important on the UK's labour market and the demand for skills over the foresight period. Although most of the drivers and trends affect all sectors, the review gave particular attention to 6 sectors. The sectors were agreed with the DfE, where the rationale for selection of the sectors was based on the likely impact of the type of changes that might be expected, the scale of any likely impacts on employment and/or the demand for skills over the foresight period and government priorities.

While an evidence review typically follows a structured approach, in this case it was deemed suitable to adopt a more pragmatic approach based around the PESTLE framework, starting with existing studies drawing on our respective expertise and taking account of discussions with the DfE.

Political, economic, sociocultural, technological, legal and environmental (PESTLE) analysis is widely used as a tool to identify and evaluate the important external or macro-environmental forces (or factors) that might positively, or negatively, affect the subject under review. It is commonly used in social sciences research to contextualise a specific topic, where everything external to the unit of analysis (in this instance, the future of jobs, skills and qualifications) is considered part of the environment and can therefore have significant impacts on it (Oxlearn, 2020; Walsh, 2019).

In addition to searching the academic literature via the University of Warwick's Library online, grey literature from both the UK and internationally, including policy reports and insight studies, were searched via an extensive range of databases. This included those of Cedefop, the OECD, the European Commission and the ILO, online publication repositories and websites, including UK Government websites, relevant UK (and EU) sectoral and skills councils, research institutes, think tanks and global consultancy firms.

Although the various components of the PESTLE analysis are usually conducted independently (Walsh, 2019), many of the factors relevant to this study transcend the boundaries of a single category. For this reason, a broad range of search terms, sometimes used in combination with one another, were used in order to identify relevant evidence. Terms used included: economic growth, employment growth, structural change, future of work, future skill needs, digitalisation, automation, green jobs, green transition, net zero, megatrends, technological change, routine-biased technological change, population ageing, home working, working from home and hybrid working. Additional search techniques were used, including 'snow-balling' references and following up recommendations from the experts who were interviewed as part of the study.

The search was generally restricted to evidence published from 2014 onwards. A number of articles and reports that were published before 2014 were included, if they provided important historical context.

After searching and screening, 135 pieces of evidence were identified that were later synthesised using the PESTLE categories. The evidence review was enhanced with interviews with 23 UK and international labour market, skills or sectoral experts. A long list of 29 factors most likely to impact upon the types of jobs and skills needed in the immediate and long-term was then generated. It is these factors that, along with insights gathered from the expert interviews, were used to inform the scenario building.

Annex B. Expert interviews

A series of in-depth, semi-structured interviews were conducted with key UK and international labour market, skills and sectoral experts. These were conducted to validate, explore and refine emerging themes and to capture any new themes not yet evident in the literature.

A purposive sampling method[41] was used to identify a long-list of labour market, skills and sectoral experts. The list was developed, and agreed, in consultation with the DfE. In this instance, the deductive sampling strategy involved identifying, and then contacting, a mix of key experts with either specialist or generalist knowledge about the labour market, skills anticipation, the future of work or sectoral-specific knowledge. The aim of doing so was to obtain a mix of informed views.

An introductory email with a supporting letter from the DfE was sent to 32 experts/organisations by the research team, inviting them to participate in the study. After sending a second follow-up email, no response was received from 7 experts. While 2 experts initially agreed to being interviewed, they subsequently had to cancel, and it was not possible to re-schedule their interviews within the required timeframe. As a result, a total of 23 semi-structured interviews were conducted with a mix of experts who have both UK and international expertise, labour market subject matter expertise and sectoral-specific knowledge.

The interviews were conducted during May and early June 2021 via Microsoft Teams at a time convenient to the expert. Participation was voluntary with them being free to withdraw up to 2 weeks after their interview without giving any reason. The interviews lasted approximately 45 minutes. Consent was provided on the basis that information gathered during the interviews would be pseudonymised.

In most cases, consent was given to digitally record the interviews for the purposes of this research only and recordings being kept until the end of the project. If not, the interviewer took notes during the interview. In line with the University of Warwick's Research Data Management Policy, interviewees gave consent to their data being securely stored for 10 years and destroyed when no longer needed. All except 1 of the interviewees was happy to

[41] Purposeful sampling is a non-probability based technique widely used in qualitative research for the identification and selection of information-rich cases for the most effective use of limited resources (Patton, 2002). This involves identifying and selecting individuals or groups of individuals that are especially knowledgeable about or experienced with a phenomenon of interest (Cresswell and Plano Clark, 2011). In contrast, probabilistic or random sampling is used to ensure the generalizability of findings by minimizing the potential for bias in selection and to control for the potential influence of known and unknown confounders (Palinkas and others, 2015, p. 534).

be named as one of the key experts interviewed for this study. The list of experts interviewed is set out in Table 3.

The interview questions were framed around the first 2 overarching research questions for the study, with experts being asked to identify the most important global and local trends of the labour market, and how these might interact and evolve in the UK over the next 15 to 20 years, and their assessments on how might jobs, skills and qualifications need to change over the short, medium and long-term?

Insights arising from the expert interviews were incorporated into the evidence base for identifying global drivers and key trends in the UK labour market over the next 15 to 20 years, and the implications of these trends/drivers for jobs, skills and qualifications (section 2 of the report). Taken together with the findings from the evidence review, insights were used to generate a long list of factors that served as the starting point for development of the qualitative scenarios (Section 3 of the report).

Experts were also asked to provide an assessment of the ideal mix between quantitative and qualitative techniques used in labour market analysis, and to identify any existing gaps in data needed to better foresee future jobs and skills requirements. The data gathered from this component of the interview was incorporated into the critical assessment of quantitative skills projection methods (Annex D).

A copy of the interview topic guide that was used is provided below.

Interview topic guide

Introduction Provide an overview of the project, reporting process and explain the purpose of the interview

- Explain about the interview, participant information leaflet, and consent form
- Ask permission to record the interview
- Check if there are any questions before proceeding

1. **Background – Participant and role**
   1.1. Current role and organisation where currently employed
   1.2. Context in which professional experience gained
   1.3. How labour market and skills forecasting relevant and/or currently used in role

2. **Key global drivers and trends in the labour market**
   2.1. What are the current global drivers and key trends of the labour market (in your sector)? (Probe using critical factors from evidence review) How might these evolve over the next 15-20 years? (Probe)

2.2. How do global and local trends interact in the UK labour market (in your sector?)
2.3. What impact has/will technology (for example, digitalisation, AI, automation and IoT) have on the future of jobs and skills (in your sector)?
2.4. What impact has/will the *Green Agenda/UK move to net zero carbon emissions by 2050* have on the future of jobs and skills (in your sector)?
2.5. What impact do you think the *ageing population* will have on the future of UK jobs and skills (in your sector)?
2.6. What impact has/will the *UK's departure from the EU* have on the future of UK jobs and skills (in your sector)?
2.7. What impact do you think the Covid-19 pandemic have on the future of UK jobs and skills (in your sector)?
2.8. Which of these are likely to be the most important defining the future of jobs and skills (in your sector/UK/globally)?
2.9. What other transformational events might you foresee that will have an impact on the future of UK jobs and skills (in your sector)?

3. Future scenarios

3.1. Given the key global and local trends, what are the different possible scenarios about how the labour market might develop over the next 15-20 years (in your sector)?
3.2. What would have happened anyway?
3.3. What is the impact on different sectors likely to be?
3.4. What are the implications of these scenarios for jobs, skills, and qualifications?
3.5. How might the jobs, skills and qualifications needed now change over the short term (0-5 years), medium term (5-15 years) and long term (15-20 years)?
3.6. What limitations or barriers can you foresee with current skills provision in providing the skills needed for the future labour market?

4. Quantitative versus qualitative techniques for labour market analysis?

5.1 What, if any, gaps exist in data needed to better foresee future jobs and skills requirements?

5.2 What are the relative strengths and weaknesses of current quantitative techniques used in labour market analysis?

5.3 What are the relative strengths and weaknesses of current qualitative techniques used in labour market analysis?

5.4 What would you say would be the ideal mix of quantitative and qualitative techniques for best identifying how the labour market might develop over the next 15-20 years?

5. Ending

- Any final thoughts/comments and/or questions for the research team
- Recap on reporting etc. and thank for participation

List of interviewees

The following table presents the details of experts who agreed to be interviewed as part of this study. All experts whose details are displayed have given their explicit permission to present this information here. While most interviewees were happy to share their details to disclose their overall participation in the study, their views were reported in an anonymised manner so that it is not possible to tell which expert held which point of view. Accordingly, we have created used a simple coding system (for example, INT-1, INT-2) to cite interviews throughout the report.

Table 1: List of interviewees

Name (listed alphabetically by surname)	Position	Affiliation
Mr Tom Bewick	CEO	Federation of Awarding Bodies
Mr Nye Comminetti	Senior Economist	The Resolution Foundation
Dr Steven Dhondt	Project Leader (European Commission Horizon 2020 BE-YOND 4.0 project on the impact of Industry 4.0 and Digital Disruption on the future of jobs, business models and welfare)	TNO
Emeritus Professor Richard Ennals		European Workplace Innovation Network (EUWIN)
Emeritus Professor Ewart Keep	Member of DFE Skills and Productivity Board	Oxford SKOPE
Mr Jon Boys	Labour Market Economist	CIPD
Dr Enrique Fernández-Macías	Head of Unit (Employment and Human Capital Unit)	Joint Research Centre, European Commission
Ms Gail Irvine	Senior Policy and Development Officer	Carnegie UK Trust
Dr Ilias Livanos	Labour Market Economist	Cedefop
Professor Steven McIntosh	Professor of Economics	Sheffield University

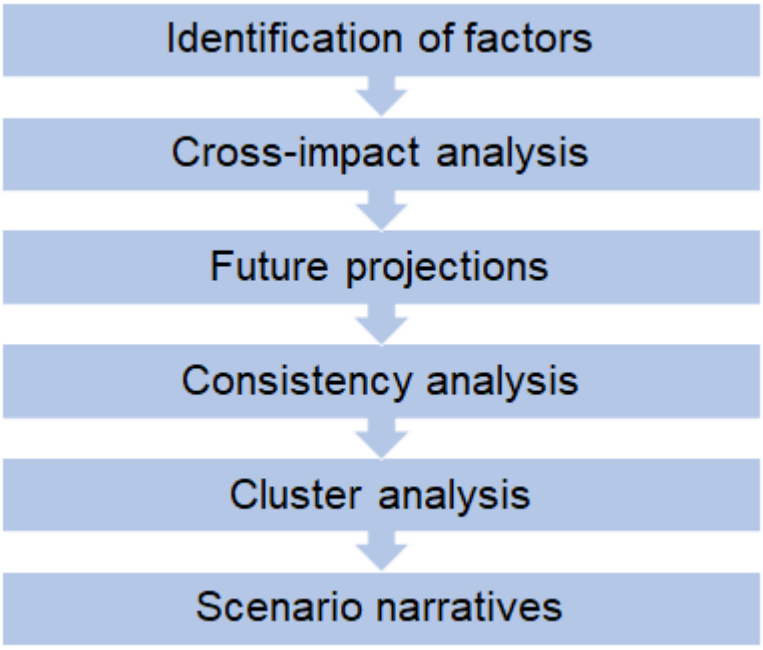
Name (listed alphabetically by surname)	Position	Affiliation
Professor Sandra McNally	Professor of Economics, Director of Centre for Vocational Education Research, Director of Education and Skills Programme, Centre for Economic Performance	London School of Economics (LSE)
Ms Candace Miller	Managing Director	SJF Awards & Workforce Development Trust
Mr Jack Orlik	Economist	NESTA
Mr Jon Parry	Head of Research and Evaluation	Skills for Health
Ms Nimmi Patel	Policy Manager (Skills, Talent and Diversity)	TechUK
Dr Uma Rani	Senior Economist	International Labour Organisation (ILO)
Ms Tina Sawyer	Head of Membership and Strategy	Cogent Skills
Dr Peter Totterdill	Director	Workplace Innovation Europe
Dr Katherine Trebeck	Economist	Wellbeing Economy Alliance
Dr Cesira Urzi Brancatti	Scientific Officer (Human Capital and Employment Unit)	Joint Research Centre, European Commission
Ms Sara Whybrew	Director of Policy and Development	Creative and Cultural Skills (CCS)
Professor Rob Wilson		Institute for Employment Research, University of Warwick
Anonymous	Labour market expert	

Annex C. Scenario method

Overview

To develop the scenarios, we used the framework presented in Gausemeier and others (1998), which identifies factors and combines cross-impact analysis, consistency analysis and cluster analysis to identify scenarios. This approach is operationalised in 6 steps (Figure 4), with each step subsequently described in more detail. The ScMI software suite was used to support the scenario development (ScMI, 2021).

Figure 4: Stages of scenario development



Identification of factors

A number of key areas were identified by members of the project team, who possessed labour market, employment and scenarios expertise. Key areas were defined as those that could both influence developments in labour markets and also be influenced by such developments. They were broadly categorised using the PESTLE framework (political, economic, sociological, technological, legal, and environmental). Each area can be characterised by additional factors. For example, GDP would be classed as an economic factor, and the pace of uptake of new technology, a technological factor. A literature review was used to inform the selection of factors that could be important for the future of the labour market. This was considered in terms of both the specific factors related to labour market and skills demand, as well as factors from other key areas that were linked to these. Additional factors were also developed based on wider expertise in the labour market sector and from previous scenario studies of socio-economic, demographic,

environmental and technological developments. An initial longlist of 29 factors was compiled.

Cross-impact analysis

Critical factors are defined as those factors that are interlinked, important and uncertain. To identify the critical factors for the scenarios, a cross impact-analysis was undertaken on the longlist. This analysis was designed to:

- Help us understand potential links between factors (how interlinked they are), an important part of the scenario development process.
- Identify which were the most important factors. Here we focussed on those that had the most influence on other factors in the system (called ‘active’ factors), and those that are most influenced by other factors (called ‘passive’ factors).

In a cross-impact analysis, subject experts are asked to qualitatively score the relationship between pairs of factors. The scoring scale is:

3 – strong and direct impact

2 – medium impact

1 – weak and delayed impact

0 – No impact

We focus on a direct relationship between factors. Every combination of factors is given a score on the degree to which one factor influences another. In other words, the degree to which factor X (row) influences factor Y (column). In the excerpt below, ‘Global political and economic security’ is deemed to have a ‘medium impact’ (2) on ‘Structure of the UK’.

Figure 5 below shows an excerpt from the cross-impact analysis scoring sheet. The actual spreadsheet included all 29 factors identified in the previous step across both the rows and columns.

Figure 5: Excerpt of cross-impact analysis scoring sheet

			Political		Economic								Technological			
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
			Global political and economic security	Structure of the UK	International trading patterns (from UK perspective)	State of public finance	GDP/economy	Reshoring (of companies, not just manufacturing)	Structure of the economy	Types of firms	Role of private sector	Location of employment	Housing affordability	Uptake of new technology	Ability of technology to meet green targets	Role/structure of digital economy	Cyber security
Political	1	Global political and economic security		2	3	2	3	3	2	1	0	1	0	1	1	2	2
	2	Structure of the UK	1		1	2	3	1	1	1	1	3	2	2	1	0	1
Economic	3	International trading patterns (from UK perspective)	1	1		2	3	3	3	2	0	1	1	2	2	3	1
	4	State of public finance	1	2	1		1	0	1	2	3	1	3	1	1	1	2
	5	GDP/economy	2	2	1	3		1	2	2	1	2	2	3	2	2	1
	6	Reshoring (of companies, not just manufacturing)	1	1	2	0	1		3	2	1	3	2	2	2	1	1
	7	Structure of the economy	0	2	2	1	2	1		3	2	3	2	2	2	2	1
	8	Types of firms	1	1	1	2	2	2	3		3	2	1	3	2	3	2
	9	Role of private sector	0	0	0	2	2	1	3	2		2	2	3	2	2	1
	10	Location of employment	0	2	0	0	2	1	1	1	1		3	1	1	1	0
	11	Housing affordability	0	0	0	1	1	0	1	1	0	3		0	0	0	0
Technological	12	Uptake of new technology	0	0	1	0	2	2	2	3	1	3	2		3	3	2
	13	Ability of technology to meet green targets	1	0	2	0	2	1	2	1	1	1	1	2		1	0
	14	Role/structure of digital economy	1	1	2	1	3	1	3	3	2	3	1	3	2		3

The cross-impact analysis is used to reduce the number of factors to a manageable number, both in terms of functionality of the software and to make sure distinct scenarios can be developed, while maintaining sufficient detail.

The cross-impact analysis scores the different factors, based on which the most active and passive factors to be used in the development of scenarios were identified. The process is iterative, and the cross-impact analysis showed that some factors could be combined into a single factor.[42] In addition to activity and passivity, the uncertainty of the factors is also an important criterion for the scenarios. Hence, a final set of 18 critical factors were selected, based on their influence scores and uncertainty.[43]

The mapping of the longlist of factors to the final shortlist is shown below.

[42] In fact, some factors were combined during the consistency analysis as they were found to be highly correlated. Eighteen critical factors were used in the final scenario development.

[43] The software limits the number of factors to 20. This limit is also sensible because having too many factors makes the consistency analysis and the development of distinct scenario narratives intractable.

Future projections

Future projections were produced for each of the 18 factors. These projections are qualitative and are designed to represent divergent future outcomes so that the resulting scenarios capture the full spectrum of possibilities. Starting from evidence on current trends for the factors, the qualitative projections effectively indicate directions of travel away from the current path. They were developed based on desk research and discussion with experts internal to the team. It is important for the plausibility of the scenarios that the factor projections in any given scenario, while qualitative, are consistent with each other. This internal consistency check is undertaken in the next step (see below). Some projections were removed from the analysis as part of this process. The final set of projections for each factor is presented in Table 2.

Table 2: Definition of factors and their projections

Factor	Definition	Projections
Trade	International trading patterns from the perspective of the UK (influenced by global political and economic security and shifts in power, possible further EU fragmentation)	International trade with EU as main trading partner International trade (share with EU declines) Reduced international trade (protectionism)
Economic growth	Covers economic growth with regional effects across UK (influenced by global political and economic security)	Economic growth across all parts of UK Economic growth with regional disparity Low economic growth/stagnant economy
Trends in economy structure	Relates to relative importance of service and manufacturing in the economy but also includes reshoring in both service and manufacturing sectors (influenced by global political and economic security, circular economy)	Continued trend away from manufacturing to service sector Slowdown in trend away from manufacturing (green, reshoring, other innovation)
Dominant firm size	Covers the size and type of firms operating in different sectors and the blurring of boundaries across sectors, the influence of big tech firms	Large companies start to dominate within and across range of sectors Traditional mix of large and small companies in most sectors Increasing numbers of SMEs and start-ups in some sectors

Factor	Definition	Projections
Location of employment and housing	Covers both employment and housing, focusing on regional location of employment, de-urbanisation and housing affordability (including social housing)	Employment focussed in London and the Southeast (house prices high) Employment more distributed to regions but concentrated in major conurbations (house prices remain high or become more affordable) Employment more evenly distributed across UK
Public spending	Captures effect of pressures on public finances including social security/welfare system	Low level of public spending Medium level of public spending (targeted) High level of public spending (broad based)
Uptake of new technology	This factor does not distinguish specific technologies but focuses on the rate of uptake and how this may differ across sectors Includes associated destruction of some jobs and creation of new ones	Rapid uptake of technology Differential uptake of technology across sectors Continued gradual uptake of technology
Digitalisation	Accessibility in terms of infrastructure and equipment but also digital skills in firms and wider population Should take account of cybersecurity and attitudes to data sharing here	Widespread digitalisation of society Continuation of current differential trends towards digitalisation Digitalisation slows
Internal mobility/immigration of skilled labour	Covers both net inward migration of labour to the UK as well as labour mobility within the UK. Includes virtual mobility Population ageing is assumed to be a given and demographic effects seen through migration and degree to which older people remain in workforce	High mobility of skilled labour (into and within UK) Mobility of skilled labour within UK (but limited inward mobility) Limited migration/mobility
Devolution of powers	Covers devolutions of powers towards regions as well as Scotland, Wales and NI.	Power remains mainly centralised Some devolution of powers to regions Increasing devolution of powers to regions
Quality of work	This factor covers a range of aspects including new forms of work, work flexibility, employment protection, security and safety of employment,	Improved quality of work for the majority Increased polarisation of quality of work

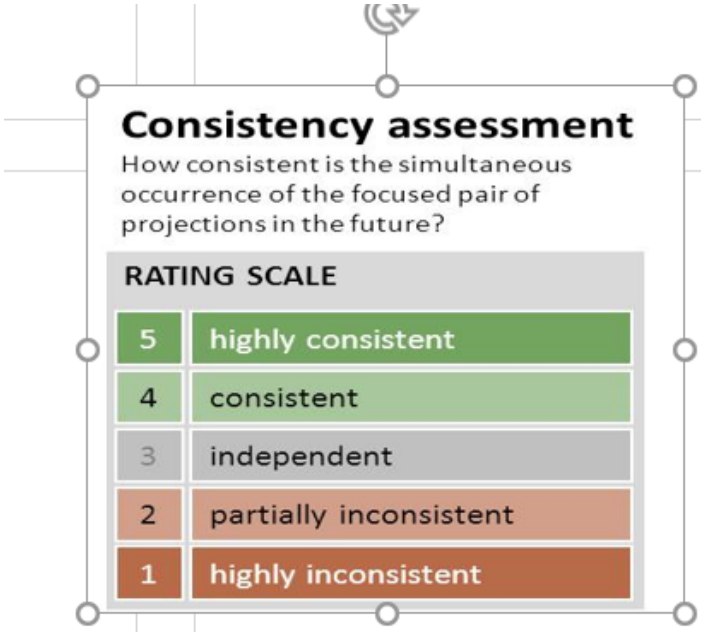
Factor	Definition	Projections
	precarity of employment, attitudes to work/life balance and mental health	Deterioration in quality of work for the majority
Inequality	This captures income inequality, but also unemployment, in-work poverty, wage stagnation, social inclusion, diversity Also takes account of potential regional inequalities and levelling-up agenda	Increased inequality Inequalities as now Reduced inequality
Skills mismatch	Extent to which skills of workforce match labour market demand Covers share of high/medium/low skilled labour and 'hollowing out of middle'	Skills mismatch narrows Level of skills mismatch continues as now Skills mismatch widens
Lifelong learning/upskilling (formal or informal)	This factor covers provision of and access to training/education throughout the working lifetime, after finishing pre-employment education and entering or being ready to enter employment	The majority of individuals benefit from lifelong learning that matches them to appropriate employment across life course Individuals benefit unequally from lifelong learning that matches them to appropriate employment across life-course The majority of individuals do not benefit from lifelong learning that matches them to appropriate employment across life-course
Pre-employment education and training	Formal education and training required before entering employment and higher education/training undertaken voluntarily before entering the labour market	Curriculum as now (narrow academic and early narrowing of pathways) Broadening of academic curriculum (pathways narrow at later stage) More focus on broader non-academic skills
Sustainability of consumption patterns	This captures aspects such as pressure on natural resources, online demand for goods, the circular economy, energy use, shifts to non-ownership (consumption as a service) models, sharing, non-material experience consumption and environmental attitudes	Increasingly sustainable consumption patterns Current trends in consumption continue Increasingly unsustainable consumption patterns
Impacts of climate change	Impacts in UK as envisaged given levels of global temperature rise foreseen	Better than expected (temperature 1.5C by 2050)

Factor	Definition	Projections
		As expected (temperature increase limited to 2C by 2050) Worse than expected (temperature increase greater than 2C by 2050)
Progress towards net-zero targets	Rate at which UK makes progress to net zero targets	Rapid progress Continuation of current progress Slower progress

Consistency analysis

Consistency analysis is undertaken to ensure that pairs of factor projections could plausibly occur together in the future. Each pair is scored once on a scale from 1 (highly inconsistent) to 5 (highly inconsistent). Hence, in this case only half the matrix needs to be scored as there is no directional effect to consider. This information forms the basis for identifying consistent collections of factor projections, which become the key building blocks for development of the future scenarios. At this stage projections can be refined and factors that are found to be highly correlated can be combined.

Box 1: Excerpt of consistency matrix



			International trading patterns (from UK perspective)			GDP/economy			Structure of the economy	
			1A	1C	1D	2A	2C	2D	3C	3D
			Europe main trading partner	Protectionism (less trade as % GDP)	International trade (share with EU declines)	Economic growth across all parts of the UK	Low economic growth/stagnant economy	Economic growth but disaprity across regions	Shift back towards manufacturing (green, reshoring,	Continued trend away from manufacturing to servic
International trading patterns (from UK perspective)	1A	Europe main trading partner								
	1C	Protectionism (less trade as % GDP)								
	1D	International trade (share with EU declines)								
GDP/economy	2A	Economic growth across all parts of the UK	5	2	4					
	2C	Low economic growth/stagnant economy	2	4	2					
	2D	Economic growth but disaprity across regions	3	3	3					
Structure of the economy	3C	Shift back towards manufacturing (green, reshoring, oth	3	5	3	3	3	4		
	3D	Continued trend away from manufacturing to service sec	4	2	4	4	3	4		
Types of firms	4A	Increasing number of SMEs and start-ups in some sector	3	4	3	4	2	3	3	3
	4C	Existing mix of large and small companies in most secto	4	3	4	3	3	4	3	3

Cluster analysis

The ScMI software implements hierarchical cluster analysis to generate a number of clusters using the scoring from the consistency analysis. These clusters form the basis of the scenarios considered in the report.

Scenario narratives

An important part of the scenario process is to build a narrative around the projections for each scenario. The narrative is told from the perspective of the future – building on the factor projections and, in a sense, bringing them to life to provide a description of labour markets situated in the context of broader societal developments. Where necessary, the narrative provides an indicative pathway as to how a particular future has been reached and is designed to provide sufficient information for policy testing without being prescriptive.

Scenario workshop

A virtual workshop was held in June 2021 to obtain feedback on these scenario narratives from experts and validate the scenarios. The workshop was attended by figures from government departments, sectoral / qualifications award bodies, skills productivity boards, and research foundations. Feedback from the workshop was captured using Mural. The feedback gathered from the experts during the workshop were used to either confirm the scenarios, or to make slight adjustments to them following the workshop.

Annex D. Critical assessment of quantitative measures

D1. Introduction

As a standalone exercise, the study includes a critical assessment of the role of quantitative techniques in labour market analysis resulting in a recommendation to the DfE on the balance to place on quantitative versus qualitative forms of evidence. The critical assessment drew on general literature around skills anticipation/projection, labour market forecasting and quantitative forecasting/modelling/projections of jobs/employment/skills, as well as key technical reports and other literature available on the 'Working Futures' website (Warwick Institute for Economic Research, 2020). After screening, a total of 62 pieces of evidence were identified as 'in-scope'. The full list of evidence is found at the end of this Appendix. Relevant insights from the 23 labour market and sectoral experts who were interviewed as part of the study have also been incorporated into the critical assessment.

After this introduction, the assessment is comprised of 6 sections. The second section sets the scene around the importance of collecting data for skills anticipation. The third section outlines the DfE's current approach to skills projections, namely an overview of the 'Working Futures' study. The fourth section briefly reviews several alternative methodologies that might be used by the DfE to complement and extend its current projections. To triangulate evidence from the literature review, the fifth section summarises insights garnered from 23 labour market and sectoral experts on quantitative versus qualitative techniques for labour market analysis. The last section provides a final assessment about the degree of emphasis that the DfE might place on quantitative versus qualitative evidence going forwards.

D2. Importance of skills anticipation

The rationale for regular, coherent and systematic skill forecasts is well established.[44] The ability to systematically assess and anticipate skill needs, including forecasting or projections, is seen as playing a fundamental role providing intelligence on the type of jobs that will be needed, and what education and training levels might be required to deliver the right mix of skills. While skills anticipation exercises can be used to help structure thinking about what might happen in the future (Rihova, 2015), they do not try to predict future skill needs with any certainty (Cedefop, 2017a, p. 1; ILO, 2015, p. 3). Rather, skills anticipation is a forward-looking activity focussed on 'providing guidance, preparedness and flexibility, and supporting more effective operation of labour markets' (ILO, 2015, p. 3). It also provides the foundations for assessing the potential effects of unforeseen disruptions. This

[44] For discussions on the merits of conducting skills anticipation exercises, see, for example, Bonen and Loree (2021); Cedefop (2010, 2017a, 2017b, 2018a); Dickerson and Wilson (2017); OECD (2016); Rihova (2015); Wilson (2013).

intelligence can also be used as the starting point for more speculative, longer horizon scanning (Dickerson and Wilson, 2017, p. 2).

Having established that skills anticipation is important, the next section reviews the DfE's current approach to skills projection.

D3. DfE's current approach to skills projections – the 'Working Futures' study

The 'Working Futures' series of assessments and its predecessors date back over 40 years (Dickerson and Wilson, 2017, p. 4). The latest set of projections, 'Working Futures 2017-2027' (Warwick Institute for Employment Research, 2020), is the seventh in a series of labour market assessments that have been produced every couple of years since 2002, and that have provided detailed employment projections for the UK labour market.

The primary objective of the 'Working Futures' study is to provide useful labour market information that can help to inform policy development and strategy around skills, careers and employment, for both policymakers and a much wider audience. Importantly, the results are intended to provide a sound statistical foundation for reflection and debate among all those with an interest in the demand for and supply of skills.

Having provided a general overview, in order to be able to critically assess 'Working Futures' it is useful to describe the type of approach that is used. On this, Wilson (2008) identifies 4 general approaches to anticipating education and training needs.[45] It is the first of these 4 approaches that is used in the 'Working Futures' study. That is, where a formal, national-level, quantitative model is used to generate projections of the future labour market through a quantitative assessment of the demand for skills and employment prospects of the UK labour market over the next 10 years (Wilson and others, 2020a). More specifically, the detailed multi-sectoral, multi-regional econometric model based on past labour market patterns and trends is used to illustrate possible future demand. The model distinguishes employment by industry, occupation, qualification level, gender and employment status. While the demand for skills as measured by employment by occupation and qualification is the prime focus of 'Working Futures', the supply side is also considered (Wilson and others, 2020b). There are a number of components to the 'Working Futures' projections, but in essence the

[45] The first approach involves formal, national-level, quantitative, model-based projections. The second approach uses surveys of opinion of employers and other groups, including setting up 'observatories', focus groups, round tables and other Delphi style methods to reach a consensus view. This approach may include some quantitative aspects but the overall methodology is generally more qualitative in nature. The third approach involves ad hoc sectoral or occupational studies, typically involving both quantitative and qualitative methods, and often focussing on the situation in a particular area. It may also involve elements of the first 2 approaches. The fourth approach adopts qualitative methods based on scenario development exercises, often based on expert opinions.

projections are produced via several stages. The process begins with the Cambridge Econometrics (CE) multi-sectoral macroeconomic model of the UK economy (Multi-sectoral Dynamic Model – MDM-E3). Taking sectoral interlinkages into account, the estimates of future employment are econometrically derived from modelling economic behaviour over time. Estimates of employment demand by sector are available at the national and regional levels. To derive estimates of future occupational and qualification demand, past trends in the share of people working in various occupations in each sector are extrapolated and adjusted to deal with the effects of relatively large growth rates (which might be reasonably expected to diminish over time). While supply-side constraints are imposed to deal with the flow of people through the education sector studying at various qualification levels and the expected outflow of people from certain occupations due, for the most part, to retirement. This latter constraint is important in deriving estimates of replacement demand.

All of the above feeds into the set of estimates of future skill demand at the national, regional/local, and sectoral levels 10 years ahead. This component is more limited in nature due to data limitations on skills, where skill demand is measured with reference to employment by occupation and qualification with estimates produced of expansion demand (for example, the change in the overall number of people employed in an occupation), replacement demand (for example, the number of people who will need to be replaced over the time period because of people exiting an occupation) and the net requirement (that is, expansion demand plus replacement demand). The trends in such structures are then analysed using simple statistical techniques rather than sophisticated econometric methods. Further details of how the projections of future skill demand can be found in the various technical reports which accompany publication of the main ‘Working Futures’ results (Wilson and others, 2020b).

Methodologically, a combination of econometrics and statistical techniques, together with an element of judgement, is used to project occupational patterns forward based on the forecast changes in employment by region (Dickerson and Wilson, 2017, p. 4). In practice, the process is a complex one drawing on large amounts of data from different sources that need to be modelled and transformed to produce a consistent set of projections, as specified in the various technical reports. In particular, periodic changes to various data collections and classifications require time series to be recalibrated given the importance of past trends on expected future skill demand.

While it is not without its limitations, the method used in the ‘Working Futures’ study is considered ‘best practice’ worldwide (Cedefop, 2010; OECD, 2016; Wilson, 2013; Wilson and others, 2017). This method has been formally evaluated in countries such as the Netherlands and the US. Yet, such exercises are not straightforward. Wilson and his colleagues (2017, p. 7) suggest that ‘many of the more critical assessments of such work have failed to appreciate the difficulties of evaluating why such projections may turn out

differently from actual outcomes.' Cedefop (2021b, p. 11) relevantly observe that 'dynamics not captured by data feeding forecasts, unexpected developments, and changing preferences and policy priorities, plus a range of other factors, make it likely the future will unfold in ways different from what the forecasts show'.

To better understand some of the limitations of this approach, it is important to understand what quantitative models *can* and *cannot* do (Wilson, 2013, pp. 103-105; Richardson and Tan, 2007). For instance, Wilson (2008, p. 7) identifies 7 reasons for favouring a quantitative modelling approach to skills anticipation, as well as 6 problems or pitfalls associated with using such methods. Among the strengths identified in the literature is the fact that models such as the MDM-E3 are grounded in real data. Moreover, these models are usually comprehensive, covering the whole economy with consistent scenarios across all sectors. Such models typically also provide detailed sectoral information. Additionally, because the models are theoretically-grounded, there is logical consistency and any underlying assumptions about the future are made explicit (Wilson, 2008, p. 6). In this respect, projections can help facilitate systematic thinking, serving as the basis for informed debate. This may include providing counterfactuals when assessing the potential impact of policies, such as what would have happened in the absence of a particular policy intervention. In contrast, other more qualitative methods tend to be less constrained but they are also more speculative.

In terms of potential pitfalls, this type of approach requires expertise, has large data requirements, requires substantial prior investment in data collection, and development and ongoing maintenance is resource-intensive over many years (Cedefop, 2017a, p. 2). To be effective, quantitative forecasting models needs good quality data on the current occupational structure as well as lengthy time series. The models also require good quality information about emerging trends with sectors (Cedefop, 2017a, p. 2). Additionally, as with any type of forecasting, the 'Working Futures' projections are subject to potential bias and errors.[46] Another limitation of using quantitative modelling is the possibly limited relevance of the past (Wilson, 2008, p. 6; Miller, 2006, pp. 95-96). Common to such modelling approaches, the MDM-E3 model sees the future as a set of key indicators driving factors to be analysed and projected, where projections are based on an assumption of a continuation of historical patterns. The projections typically reveal relatively small annual changes in job growth (Dickerson and Wilson, 2017; Wilson, 2013) that may conceal more dynamic changes and churns such as job shifts from less to more successful firms, from contracting to growing sectors, or from declining to emerging occupations (WEF, 2020). On this, Dickerson and Wilson (2017, p. 1) note 'skills investment takes time, and the past may not necessarily provide a good indicator of the future'. While both the supply and the demand for skills are dynamic, they may well

[46] For a general review of economic forecasting and projection, see Chadha (2017). For a review on labour market forecasting, see Cörvers and Heijke (2004).

develop independently of each other as they respond to different key drivers or trends (OECD, 2016; Wilson, 2013).

While quantitative forecasts provide a useful indication of employment prospects in the labour market, methodologically, they are not well suited to anticipating rare, high-impact or disruptive events (for example, such as the Covid-19 pandemic) (Wilson, 2008). On this, Goodwin and Wright (2010) point out that all forecasting methods, including the use of expert judgement, statistical forecasting, Delphi and prediction markets, contain fundamental weaknesses, where non-forecasting methods, such as scenario planning, are also not particularly well-suited to anticipating of rare events.

Crucially, however, the historic patterns and trends used to generate the 'Working Futures' projections are expected to continue in the foreseeable future. While trends do inevitably bend, quantitative models can provide insights into what causes these trends to bend, by embedding the models in a theoretical understanding of drivers of outcomes and behaviours (Wilson, 2008). There remain limits, however, to understanding of how the labour market operates. There are also data limitations because the data used to build models were not always collected with modelling in mind (Wilson, 2008, p. 6). Importantly, quantitative projections cannot provide precise indications of education and training requirements (Wilson, 2013, pp.103-105).

Building on the literature about the general strengths and limitations of quantitative modelling, the particular strengths of the 'Working Futures' projections can be summarised as follows. First, the projections are firmly grounded on an understanding of how the (real) economy as a whole is changing, where this is operationalised consistent with international best practice. Secondly, there is versatility in the way that various anticipated change can be managed through the MDM-3E model. The model has been under continuous development to reflect changes in the structure of the UK economy and make use of the latest data available (such as the latest chained volume measure data and the latest input-output estimates). Third, the process for generating the projections is adaptable with reference to the way in which 'Working Futures' accommodates the numerous changes in the way, for example, sectors, occupations, and geographical areas are classified. Fourth, there is consistency with national accounts, where despite the model being large (comprising over 5,000 behavioural and technical relationships) the equations are all solved together so that the final results are consistent with the various identities required by the national accounts. A fifth strength is its specificity with increasing levels of disaggregation by occupation (4-digit SOC), sector (87 sectors are distinguished at the UK level) and local areas (46 sectors are distinguished at the regional level) so that a wide range of policy needs can be met. A further strength lies in its transparency. The technical reports set out the methodological approach used to generate the detailed historical employment database, as well as the models and procedures used to produce the projections, the working assumptions adopted, the

limitations on the estimates produced, and comparisons with official estimates. On this last point, the technical reports are explicit about the limitations of the projections. Amongst other things, the authors point to the data limitations with which they need to contend in producing the results which policy makers require (Wilson and others, 2020a, sections 13-15). In particular, given the various dimensions required in the full 'Working Futures' database, this results in a database with a huge number of time series such that the detailed breakdowns can only ever be indicative since they are based on survey estimates that were not designed to produce precise estimates at this level of detail. Also, if strict rules regarding statistical robustness were to be applied, the level of sectoral and occupational disaggregation would be limited. In addition, one of the main limitations concerns the conceptual difficulties in modelling labour supply by level of skill. For example, most occupations are undertaken by people with a wide range of occupations with result that quantitative modelling of the supply of people into an occupation (or sector) is almost impossible.[47]

While 'Working Futures' is the most detailed and comprehensive set of UK labour market projections in the public domain (Dickerson and Wilson, 2017), the projections are about the art of the possible to satisfy a range of policy needs. Given the data which are currently available it provides a set of indicative estimates of the likely number of people who will be employed by sector, occupation and qualification. One could critique the approach from 3 perspectives. First, the use of extrapolation techniques versus econometric or some other form of modelling approach to derive estimates of future employment by occupation and qualification. In relation to this point, it is difficult to see how the use of a different approach would overcome the data limitations mentioned above. Neither is it clear whether this would produce estimates which are very different from those resulting from the use of extrapolation methods (Wilson and Homenidou, 2012).

Secondly, the model relies upon occupation and qualification as (proxy) measures of skill. In relation to this point, it is clear that the skills requirement approach has gained increasing credence as a means of identifying skill demand (Autor and Acemoglu, 2011; Handel, 2017). The concentration here is upon the specific skills people require rather than the jobs or occupations in which they are employed. For example, the US Bureau of Labor (US BLS) has invested heavily in developing systems focussing on the skills required within different occupations and sectors.[48] While the DfE might consider investing in a similar approach to that used in the US (for which more details are provided in the next section), this would require a large investment and would take a long time to develop. Yet, ultimately, people are employed in jobs (as approximated in classifications of occupations) which configure skills in a certain manner. Ultimately, in order to make

[47] As already outlined in the previous section.
[48] See Dickerson and Wilson (2017) for a description of the US approach to skill requirements within occupations and sectors.

sense of the skills requirement data, an indication of the number of people employed in various jobs is required (as ‘Working Futures’ provides). This provides the framework for thinking about how the skill content of those jobs is changing; but, in the first instance, an indication of the scale of the change in the number of people employed in various jobs is required.

Thirdly, while the projections are grounded in a forecast of the future macroeconomic and labour market context, the ‘Working Futures’ study is much better at anticipating short-term changes rather than long-term patterns (Wilson, 2008). For this reason, they are not particularly good at dealing with sudden disruptions, for instance the present uncertainties associated with the UK departure from the EU and the Covid-19 pandemic. Nevertheless, changes in occupational employment structure are largely driven by longer term trends, where these trends are remarkably stable. For instance, even during the 2008 Global Financial Crisis (GFC), the underlying trends remained robust (Dickerson and Wilson, 2017, p. 5). Moreover, other approaches to skills anticipation are likely to suffer from the same difficulties in anticipating future uncertainties.

Clearly, a wide variety of policy makers have and continue to derive benefit from the types of estimates ‘Working Futures’ type projection exercises provide (Cedefop, 2021c). The general approach in the study is similar to the methodology used by the US BLS, and also considered best practice worldwide (Cedefop, 2010). Here, it is worth mentioning that a number of other countries have adopted the general approach used in the UK for example in the Netherlands (Bakens and others, 2020), Ireland (SOLAS, 2021), Bulgaria, Czech Republic, Hungary, Cyprus, Iceland and Malta.

As Dickerson and Wilson (2017) note, to produce robust quantitative projections of skills demands, aggregate macroeconomic, sectoral and regional data need to be combined with information on current developments in sectoral employment by occupation and qualification. Crucial to this task is detailed occupational and skills analyses. Equally, qualitative information such as insights on the current employment structure, any recent developments and future prospects can also be useful, as such insights can be incorporated into the projections (Dickerson and Wilson, 2017, p. 2). The ‘Working Futures’ study could be further strengthened and extended by improving the data on skills and by complementing existing quantitative evidence with insights on recent developments and future prospects. The next section sets out details about some of the alternative methodologies that could be used to complement the quantitative modelling.

In summary, the rationale behind ‘Working Futures’ is that a comprehensive, systematic, consistent and transparent set of projections can help to inform stakeholders about the future they are likely to face. The detailed projections present a carefully considered view of what the future might look like, assuming that past patterns of behaviour and performance are continued over the longer term. To this end, many of the trends and

patterns used to derive the 'Working Futures' projections are extremely robust. Nevertheless, the results should be regarded as indicative of general trends and orders of magnitude. They are not intended to be prescriptive. If policies and patterns of behaviour are changed, then alternative futures can result (Wilson and others, 2020a). Taking into consideration both its strengths and limitations, the 'Working Futures' projections provide a benchmark for debate and reflection that can be used in conjunction with other qualitative and/or quantitative evidence to inform policy development, and other choices and decisions.

D4. Alternative methodologies to complement and extend the DfE's current quantitative skills projections

There exist a number of alternative quantitative and qualitative methodologies to anticipate education and training needs that may be used to complement the 'Working Futures' quantitative modelling, each with their own strengths and limitations.[49] A joint publication from the European Training Foundation (ETF), Cedefop and the International Labour Organisation (ILO) contends that 'the right mix and complementarity of different methods is essential for a reliable and comprehensive overview of skills demand and matching' (Bakule and others, 2015). On this, the OECD observes that most countries rely on more than one method or data source, reducing potential bias and expanding the scope of the exercise. In most cases, these are quantitative sources of information, with few countries systematically considering qualitative sources of information (OECD, 2016).

Importantly, Cedefop suggests that while there is no single best approach, best practice combines quantitative and qualitative elements, where a mix of methods and tools can provide better results (Cedefop, 2017a, p. 2). Cedefop also note that 'some methods are better at describing the current skill supply and demand situation, whereas others are better at producing long-term projections' (Cedefop, 2017a, p. 2). An important caveat here is that multiple activities, methods and timeframes can lead to inconsistent results that are difficult to reconcile, in addition to any coordination issues (Cedefop, 2017a, p. 2). Importantly, there is consensus in the literature that while alternative approaches such as ad hoc and/or tailored exercises can provide useful insights, they are generally regarded as *complements* to the model-based projections, rather than *substitutes* for them (Dickerson and Wilson, 2017; van Breugel, 2017; Wilson, 2008).

In the previous section, conceptual difficulties in modelling skill requirements was identified as one of the limitations of the current approach to the 'Working Futures' study.

[49] For a discussion on the merits of different quantitative and qualitative approaches, see Wilson (2013); van Breugel (2017). In addition, for a discussion on strengths and weaknesses of the various approaches, see Rihova (2015).

Due to the lack of suitable available data, the 'Working Futures' projections rely upon occupational classification and qualifications held as measures of skill, where both are known to be poor proxies for skill. This is because qualifications are usually obtained while in education and any knowledge or abilities acquired while studying may become obsolete, forgotten or may be irrelevant to the current job. The standard occupational classification (SOC) is also an imperfect measure of workers' skills (Dickerson and Morris, 2017, p. 1). This is because it is unidimensional, static (revised only every decade) and it does not capture the range or changing nature of skills used in jobs over time (Dickerson and Morris, 2019).

On robust and detailed information on the occupational structure of employment, Dickerson and Wilson (2017) are critical of using the LFS both because of its limited sample size and the fact that it is based on individuals self-reporting. They suggest that skills anticipation in the UK could be improved by carrying out larger, regular, systematic surveys of employers, not to take their views or opinions (as the UK Employer Skills Surveys have intended to do),[50] but to measure the skills employers currently require by analysing their actual staffing patterns. This, however, is expensive and to be effective, large sample sizes are required to get sufficiently robust detailed sectoral and occupational-level data (Dickerson and Wilson, 2017, p. 8).

To help in making decisions about how to extend and complement the 'Working Futures' study, it is useful to consider how some OECD countries have moved beyond occupational titles and formal qualifications to examine the specific skills people require to do their jobs rather than the jobs they are employed in or qualifications they hold. This is known as a skills requirement approach or the tasks-based approach (Autor, 2013; Autor and Acemoglu, 2011; Autor and others, 2003; Handel, 2017).

While work is underway in a number of countries (Bisello and others, 2021),[51] the US BLS is viewed as an exemplar in assessing changing skill requirements. It has invested heavily in developing systems focussing on the skills required within different occupations and sectors.[52] In brief, the current US approach is comprised of 3 elements: the Occupational Employment Statistics (OES) Survey; US BLS models and systems for projecting the labour market; and the Occupational Information Network (O*NET) system for identifying skill requirements within occupations (Dickerson and Wilson, 2017, pp. 5-7). The OES survey provides a detailed view of current occupational employment within

[50] While employer surveys are popular, employers are not always very well placed to provide robust answers to questions about skills issues, especially when concerned with the future. For this reason, employer surveys are better suited to assessing employers' current skills problems rather than anticipated future requirements. On this point, see Wilson and others (2017, p. 36).
[51] Also see Fana and others (2020) for exercise collecting information on task profiles using national data from 5 EU countries (France, Germany, Italy, Spain and the UK).
[52] See Dickerson and Wilson (2017) for a detailed description of the US approach to skill requirements within occupations and sectors.

sectors, then US BLS sectoral experts help to assess how this might change in the future. These views are then combined with a set of projections from a multi-sectoral macroeconomic model to generate detailed occupational employment projections at the 4-digit level US equivalent of Standard Occupation Classification (SOC). The US Occupational Network (O*NET) is the main source of skills information in the USA,[53] where information is gathered from self-reported assessments by job incumbents and combined with professional assessments by job evaluation analysts. It provides almost 250 measures of skills, abilities, work activities, training, work context and job characteristics for each of around 1,000 different US 2-digit occupations. Importantly, O*NET has been in development for several decades and is constantly being revised.

There is currently no UK equivalent of O*NET (Dickerson and Morris, 2017). While there is no doubt that development of an O*NET-type system for the UK would be welcomed by many, this would be very expensive and take a long time to develop (Wilson and others, 2017, p. 37). In the absence of a UK equivalent of O*NET, some initial work in this area has been undertaken whereby O*NET data has been linked to UK LFS data to conduct similar exercises for the UK labour market (for example, see Bakhshi and others, 2017; Dickerson and Morris, 2017, 2019; Dickerson and others, 2012; Hillage and Cross, 2015). To apply O*NET skills to the UK context, an additional step of translating the US occupations into the UK SOC system in required, which comes with its own set of challenges in terms of harmonisation. It has been suggested that there is merit in the UK more systematically exploiting the O*NET data at the UK level, which may be done without the need for large additional investment (Wilson and others, 2017, p. 38). This type of research, however, generally assumes that, on average, the tasks and skills of an occupation in the US are similar to the tasks and skills in the corresponding occupation in the UK. While there is some evidence in support of this assumption (for example, see Dickerson and Morris, 2019; Dickerson and Wilson, 2017; Taylor and others, 2008), further research to test this assumption is required.

In addition to more systematically exploiting the O*NET data at the UK-level, there are several other approaches that could be used to complement the ‘Working Futures’ projections. Again, it is useful to look at the US, where a combination of both quantitative and qualitative methods is used. Specialist analysts concentrate on each sector to examine all the evidence on how the demand for skills is changing. This is then combined with the multi-sectoral model to take account of changing economic forces in a systematic and transparent manner (Dickerson and Wilson, 2017, p. 9). The DfE may wish to consider funding similar detailed occupational level, qualitative judgements on changing skill requirements, which could then feed into the ‘Working Futures’ modelling.

[53] For detailed information on the US approach to skills anticipation including O*NET, see Dickerson and Morris (2017); Dickerson and Wilson (2017); Hillage and Cross (2015); Tippins and Hilton (2010); Wilson (2010).

One alternative non-model based quantitative approach involves forecasting skills based on online job vacancy postings (for example, see Cárdenas, 2020; Djumalieva and Sleeman, 2018a, 2018b; ILO, 2020a; WEF, 2020). With this emerging approach, web scraping of job portals and other labour market information are used to provide a variety of useful information about employers' requirements, often in real-time (real casting), including about new job titles and skills in current demand, skill shortages/recruitment difficulties.[54] For example, the World Economic Forum (2020), using data from Burning Glass Technologies and LinkedIn, is using 'real casting' to track recent trends in employment in order to try to identify sets of professions with increasing job prospects across key economies globally (WEF, 2020). There exist, however, a number of limitations and important caveats when using this relatively new approach including that the skills and qualifications required to get a job may not be the same as those required to perform the job (credentialism). Crucially, vacancies posted via online job portals tend to be skewed towards high skilled and white-collar occupations. They fail, therefore, to capture job vacancies from all segments of the labour market. Additionally, job advertisements rarely contain a full list of skills or prerequisite qualifications, with descriptions often limited to the most essential ones. Moreover, terminology used in the descriptions typically do not align well with classification frameworks used by governmental statistical agencies (such as ISCO, ISCED, SOC). It is also difficult to ascertain where jobs are actually located. While it is not recommended that data scraping should replace the model-based projections, as it is available in real time, it could be used to pick up emerging trends that are not yet evident in administrative data such as the LFS.

There are also a number of more *qualitative* approaches that can be used to complement and enhance quantitative model-based projections. These, however, tend to be used less frequently for anticipating long-term skill needs (Bakule and others, 2015, p. 32). While qualitative approaches tend to be less constrained than quantitative models, they are more speculative and rely on high quality inputs from, and engagement with, experts and stakeholders (Cedefop, 2017a, p. 2; van Breugel, 2017). The most popular and useful of these include: Delphi analysis (asking experts); in-depth sectoral case studies (involving interviews and other methods); scenario development; observatories; focus groups; and round tables (Cedefop, 2017a, p. 2).

Among these, scenario development, where specialised foresight tools are used to construct and explore alternative images of the future (as used in this DfE study), is popular. Through a creative but structured process of imagining disruptive but plausible

[54] For instance, this information might be used to update occupational classifications and/or monitor composition and skill trends by occupations, which may be helpful to education and training providers to assist in updating curriculum based on employer requirements. Whereas policymakers might be able to draw on this information to identify barriers or lack of skills that prevent people from entering or remaining in the labour market. The information may also provide additional insights into trends in local and regional labour markets.

and consistent futures, scenarios are used primarily to identify strategic needs, options and implications for decision-making in the present (Rhisiart and others, 2017). As mentioned above, quantitative modelling approaches tend to see the future as a set of key indicators and driving factors to be analysed and projected. While in scenario development, the scenarios are seen not so much as outcomes rather as catalysts for discussion (Wilson, 2008, p. 10). Miller (2006, p. 96) argues that 'the distinctiveness of futures studies is in providing a rigorous approach to the plausibility of different configurations for the future'. Just as model-based projections are better suited to the short-run, scenario development are better suited to longer-term horizon scanning. Cedefop have, for instance, recently used scenario analysis to encourage reflection on long-term trends and their likely effects, using the digital and green transitions and the transformative and uncertain impact of the Covid-19 pandemic as starting points in constructing future scenarios for skills (Cedefop, 2021b).

While scenarios have the potential to overcome some of the pitfalls of forecasting approaches (such as quantitative modelling), they face a number of drawbacks, in particular how to imagine and then select a few distinctive stories about the long-term future from among the infinite number that is possible (for example, see Bakule and others, 2015; Miller, 2006, pp. 98-99). Moreover, assumptions about how change takes place and how trends interact are often not transparent. One of the difficulties in developing scenarios can be deciding which factors are important and the key trends or drivers of future change. There is a danger that the scenarios might reflect the current concerns and direction of thinking of the participants.[55] On this, the subjective nature of the scenario approach can be strengthened by grounding the scenarios in an assessment of reality, based on robust data (Wilson, 2008, p. 10). This confirms a key point made earlier whereby alternative approaches such as scenario building are best used as complementary exercises to quantitative modelling, where the data generated from the modelling is used as a starting point for building the various scenarios.

Other types of complementary exercises include firm-level and sectoral studies (Wilson and others, 2015), as well as rapid skills needs-assessments. These exercises tend to be undertaken on a more ad hoc basis in response to unforeseen disruptions. Relevantly, due to the unprecedented fall in economic activity globally, and a sharp rise in unemployment and unemployment due to the pandemic, the ILO has advocated the need for rapid skill assessments to help in responding to the emerging skill needs for recovery and reconstruction.[56]

Drawing from the evidence, the degree of emphasis that should be placed on quantitative versus qualitative evidence depends on many factors, with responsiveness, data and

[55] See Tichy (2004), who recommend basing foresights on a mixture of experts with different types of knowledge and affiliations.
[56] For details on conducting rapid skill assessments, see ILO (2020b).

resource availability being key among them. Useful in helping to determine the relevant mix of approaches, Wilson (2008, p. 12) undertook a comparison of the pros and cons of alternative approaches to anticipating skills requirements (Table 3).

Table 3: Comparison of the pros and cons of alternative approaches to anticipating skill requirements

Alternative approaches	Advantages	Disadvantages
Formal, national level, quantitative, model-based projections	comprehensive, consistent, transparent, quantitative	Data hungry, costly, not everything can be quantified, may give a misleading impression of precision
In-depth sectoral or occupational studies (using variety of quantitative – model-based - as well as more qualitative methods)	Strong on sectoral specifics	Rely on input from sectoral stakeholders and experts Partial, can be inconsistent across sectors
Surveys of households (censuses of populations, labour force surveys)	Detailed source of information of the occupational structure of employed workforce	Can be problems with sample size, particularly for small geographical areas, can provide fuzzy/erratic picture of trends in occupational structure
Surveys of employers or other groups, asking questions of fact or opinion about skills, skills deficiencies and skills gaps	Direct 'user/customer' involvement, potential to link survey data to other datasets including administrative data, PIACC	Can be very subjective, inconsistent, can too easy focus on the margins (in other words, current vacancies) rather than skill needs within the whole workforce
Focus groups, round tables, observatories, Delphi style methods, scenario development	Holistic, less demanding data requirements, direct 'user/customer' involvement	Non-systematic, can be inconsistent, can be subjective and reliant on getting right mix of experts
Web-scraping/text mining from online job portals/platforms	Can be inexpensive, often real-time, can provide insights into regional labour markets and emerging jobs/skills	Partial, skewed towards certain occupations/sectors, may give a misleading impression of precision, lack of transparency around algorithms used in portals/platforms, can be difficult to combine/compare data across different portals/platforms, data proprietorship and accessibility issues

Source: Wilson (2008, p. 12, Table 2.1), revised and updated by current authors to add web scraping.

D5. Insight from labour market and sectoral experts

As outlined in the methodology section, semi-structured interviews were conducted with 23 labour market and sectoral experts. The experts were asked about their knowledge of the 'Working Futures' study; what, if any, gaps exist in data needed to better foresee future jobs and skills requirements; their opinions on relative strengths and weaknesses of current quantitative techniques used in labour market analysis; and what they thought would be the ideal mix of quantitative and qualitative techniques for best identifying how the labour market might develop over the next 15 to 20 years.

Consistent with the evidence review, the main point to emerge from the interviews with the labour market and sectoral experts was consensus in that robust quantitative data on the current position and trends in the UK labour market, such as the 'Working Futures' projections, remain indispensable.[57] Some felt that such projections are best used for short- to medium-term anticipation exercises, rather than for longer-term planning purposes, and that there needed to be caveats around the credence given to projections.[58]

The experts saw merit in combining the model-based projections with other sources of evidence.[59] On this point, they shared the opinion that such alternative exercises were best used to complement, rather than replace, quantitative projections. [60] Furthermore, many of the experts pointed out that most alternative approaches would necessarily rely on the projections as the starting point or underpinning context for such exercises.[61] Experts generally thought favourably of foresight and scenario planning exercises, although some admitted not being very familiar with these methodologies.

The need to obtain a better understanding of what is happening in terms of the skill mix *within* firms was mentioned by several experts, where they called for funding for firm-level case study research, including around what is happening with job transitions.[62] On this, several experts commented on the value in talking to workers themselves about the content of their jobs, as they were best placed to explain the sorts of changes they are happening with occupations.[63] As 1 expert said, 'how can you plan qualifications if you don't know what is happening within firms?'[64] Conducting sectoral and regional case studies were also deemed very useful in understanding skill challenges.[65] Several

[57] All of the experts held this view.
[58] INT-2, INT-3, INT-4, INT-5, INT-8, INT-9, INT-10, INT-15, INT-21, INT-22.
[59] All experts held this view.
[60] All experts held this view.
[61] INT-2, INT-3, INT-4, INT-5, INT-6, INT-8, INT-9, INT-10, INT-11, INT-13, INT-21.
[62] INT-1, INT-2, INT-4, INT-5, INT-6, INT-7, INT-9, INT-10, INT-11, INT-12, INT-14, INT-16, INT-18, INT-22, INT-23.
[63] INT-1, INT-2, INT-5, INT-6, INT-10, INT-17.
[64] INT-5.
[65] INT-2, INT-3, INT-4, INT-5, INT-6, INT-7, INT-9, INT-10, INT-11, INT-12, INT-14, INT-16, INT-18, INT-20, INT-22, INT-23, INT-24.

experts saw merit in conducting research on firm best practice around skills development so this could be shared with other firms in the same or different sectors. Moreover, research should be conducted in firms of different sizes, with ownership structures and from different sectors. [66] Combining complementary research with the projections in a systematic, rather than ad hoc way was considered important. [67] A number of experts provided examples of innovative qualitative research underway in other countries, including in Norway, Belgium, Germany, Sweden, and Spain.[68]

A number of experts mentioned the US O*NET data and how it would be desirable to have a similar UK-specific equivalent.[69] They also acknowledged that establishing such data was extremely expensive, development would require a long lead time and this approach was not without its own set of problems.[70] While several experts were aware of research applying O*NET data to either UK and/or EU LFS data, they thought that methodological refinements were necessary, because various studies produced wide ranging estimates about such factors as the extent of job loss due to automation and the extent of skills upgrading/polarisation in the future.[71]

Several experts mentioned the potential of using big data, such as job vacancies, as an emerging approach to gathering timely labour market intelligence. [72] Those experts more familiar with this approach felt that while this type of information could be informative, the nature of the data means that it is likely more relevant for the short to medium-term, rather than longer horizon scanning.[73] Consistent with the evidence review, several of the experts mentioned the skewed nature of online vacancy and other data; they cautioned against extrapolating any findings from this type of data across all sectors of the economy. [74]

Several experts emphasised the importance of investing in regular exercises, as well as making data available as soon as possible, and for it to be made available as widely as possible.[75]

[66] INT-2, INT-5, INT-12.
[67] INT-2, INT-3, INT-4, INT-5, INT-10, INT-21, INT-22.
[68] INT-1, INT-2, INT-7, INT-6, INT-10, INT-12, INT-16.
[69] INT-1, INT-2, INT-3, INT-4, INT-5, INT-10, INT-13, INT-15.
[70] INT-1, INT-2, INT-3, INT-4, INT-5, INT-6, INT-10, INT-13, INT-15.
[71] INT-2, INT-3, INT-5, INT-6, INT-10, INT-21.
[72] INT-2, INT-3, INT-5, INT-6, INT-9, INT-10, INT-15, INT-21, INT-22.
[73] INT-2, INT-3, INT-5, INT-10, INT-21.
[74] INT-2, INT-3, INT-5, INT-10, INT-21.
[75] INT-4, INT-5, INT-9, INT-15, INT-22.

D6. Degree of emphasis on quantitative versus qualitative evidence

A range of other approaches exist, both qualitative and quantitative in approach, which the DfE could combine with the 'Working Futures' study to develop a more comprehensive picture of future labour market and skills needs.

In order to make a final assessment about the degree of emphasis that might place on quantitative versus qualitative evidence going forwards, a range of factors need to be taken into consideration. Crucially, it is not a case of simply substituting qualitative methodologies for quantitative methodologies. Each methodology has its own set of strengths and weaknesses, where some are better suited to anticipating short- to medium labour market trends, while others are better suited to longer term and more speculative horizon scanning.

On achieving the right mix of approaches, van Breugel (2017, p. 18) provides some useful guidance. The first among them is related to the research objectives of the skills anticipation exercises, and whether quantitative or qualitative evidence, or both, is preferred. Other factors include the intended scope of the exercise, its time horizon and if and how frequently anticipation exercises will be repeated (van Breugel, 2017, p. 18). Van Breugel (2017, p. 18) further states that 'in order to satisfy as many end users in a wide variety of policy fields, the most suitable approach would include supply and demand of skills, the current and future situation, and repeated regularly'. Ideally, such exercises would generate aggregate national-level data, but also detailed data per sector and/or region. They should also generate skills information at occupational level and at educational level (van Breugel, 2017, p. 18).

Getting the 'ideal' mix of both quantitative and qualitative skills anticipation evidence is difficult. In addition to considering how many stakeholders are involved and their level of involvement in development, the ideal mix of evidence will be heavily dependent on resource availability, which includes not only the availability of sufficient and reliable data, but also on the capabilities of those involved (van Breugel, 2017, p. 18). Van Breugel (2017, p. 18) suggests that when the 'what skills' question and the 'how many individuals' question are both relevant, a mixed approach including both quantitative and qualitative methods would be more suitable and provide more comprehensive results.

Based on the findings from this review, and subject to policy priorities and resource availability, the DfE might want to consider funding a large-scale, regular survey of employers about skill requirements. They may also wish to fund extension work which applies the US O*NET to UK data to improve labour market intelligence on skill requirements within occupations. They may also wish to consider engaging sectoral

experts to help assess how skill requirements might change in the future, where these insights could feed into the process used to generate the projections.

Other complementary sources of evidence may include real-time web scraping of online vacancy data to improve intelligence about emerging skill requirements, case studies about skill use within and between firms and/or within and between sectors, as well as more ad hoc foresight or scenario exercises. Put simply, the more qualitative approaches tend to be less constrained and may be conducted on an ad hoc basis in response to emerging issues. Yet, they are also more speculative.

The ‘Working Futures’ projections play a fundamental role in providing benchmark or baseline data to inform relevant stakeholders. In this respect, ‘Working Futures’ serves as the foundation or bedrock for other complementary skills anticipation activities. Complementing the projections with other quantitative and qualitative evidence will provide a more comprehensive picture to the DfE of the future of the labour market and skills needs. Getting the right mix and complementarity of different methods is important and will be dependent on the objectives of the skills anticipation exercises and resource availability, among other factors.

References (Annex D.)

Autor, D.H. (2013) *The "task approach" to labor markets: an overview*. IZA Discussion Paper No. 7178. Bonn: Institute of Labour Studies.

Autor, D.H. and Acemoglu, D. (2011) 'Skills, Tasks and Technologies: Implications for Employment and Earnings', in Ashenfelter, O. and Card, D. (eds.) *Handbook of Labor Economics*, *Volume 4B*. Amsterdam: Elsevier, pp. 1043-1171.

Autor, D.H., Levy, F., and Murnane, R.J. (2003) 'The Skill Content of Recent Technological Change: An Empirical Exploration', *Quarterly Journal of Economics*, 118, pp. 1279–1333.

Bakens, J., Fouarge, D., and Goedhart, R. (2020) *Labour market forecasts by education and occupation up to 2024.* Research Centre for Education and the Labour Market Technical Reports No. 002. Maastricht: Maastricht University.

Bakule, M., Czesaná, V., Havlíčková, V., Kriechel, T., Rašovec, T., and Wilson, R. (2015) *Developing Skills Foresights, Scenarios and Forecasts. Guide to Anticipating and Matching Skills and Jobs*. Volume 2. Luxembourg: Publications Office of the European Union.

Bakhshi, H., Downing, J.M., Osborne, M.A., and Schneider, P. (2017) *The Future of Skills Employment in 2030*. London: Pearson and Nesta.

Bisello, M., Fana, M., Fernández-Macías, E., and Torrejón Pérez, S. (2021) *A comprehensive European database of tasks indices for socio-economic research*. JRC Working Paper Series on Labour, Education and Technology. Seville: European Commission.

Bonen, T. and Loree, J. (2021) *How to forecast skills in demand: A Primer*. Toronto: Future Skills Centre.

Cárdenas, J. (2020) *Possible uses of labour demand and supply information to reduce skill mismatches*. Working Paper WP2-2020-002. Columbia Científica and Alianza EFI.

Cedefop (European Centre for the Development of Vocational Training) (2010) *Skills supply and demand in Europe: medium-term forecast up to 2020*. Luxembourg: Publications Office of the European Union.

Cedefop (European Centre for the Development of Vocational Training) (2017a) *Skills anticipation: Looking to the future*. Briefing note, October 2017. Luxembourg: Publications Office of the European Union.

Cedefop (European Centre for the Development of Vocational Training) (2017b) *Making Labour Market and Skills Intelligence Policy Relevant: How Cedefop supports countries*. Available at: https://www.skilspanorama.cedefop.europa.eu, 17 October 2017.

Cedefop (European Centre for the Development of Vocational Training) (2018a) *Skills forecast trends and challenges to 2030*. Cedefop reference series, 108. Luxembourg: Publications Office of the European Union.

Cedefop (European Centre for the Development of Vocational Training) (2021b) *Digital, greener and more resilient: Insights from Cedefop's European skills forecast*. Luxembourg: Publications Office of the European Union.

Cedefop (European Centre for the Development of Vocational Training) (2021c) *Skills Forecast*. Available at: https://www.cedefop.europa.eu, 2021.

Chadha, J.S. (2017) 'Why forecast', *National Institute Economic Review*, 239, pp. 4-9.

Cörvers, F. and Heijke, H. (2004) *Forecasting the labour market by occupation and education: Some key issues*. Maastricht: University of Maastricht.

Dickerson, A. and Morris, D. (2017) *The Demand for Skills in the UK*. IZA Conference, November 2017. Bonn: Institute of Labour Studies.

Dickerson, A. and Morris, D. (2019) *The Changing Demand for Skills in the UK*. CVER Discussion Paper Series. Research Discussion Paper 020, April 2019. London: Centre for Vocational Education Research, LSE.

Dickerson, A. and Wilson, R. (2017) *How should we consider future skills demand?* Skills Demand Workshop 2017, 18 July, Westminster. Available at: https://www.warwick.ac.uk.

Dickerson, A., Wilson, R., Kik, G. and Dhillon, D. (2012) *Developing Occupational Skills Profiles for the UK: A Feasibility Study*. Evidence Report 44. February 2012. London: UK Commission for Employment and Skills.

Djumalieva, J. and Sleeman, C. (2018a) *Classifying occupations according to their skill requirements in job advertisements*. ESCoE Discussion Paper 2018-04, March 2018. London: Economic Statistics Centre of Excellence (ESCoE).

Djumalieva, J. and Sleeman, C. (2018b) *An open and data-driven taxonomy of skills extracted from online job adverts*. ESCoE Discussion Paper 2018-13, August 2018. London: Economic Statistics Centre of Excellence (ESCoE).

Ecken, P., von der Gracht, H., and Gnattzy, T. (2011) 'Desirability bias in foresight: Consequences for decision quality based on Delphi results', *Technology Forecasting and Social Change*, 78(9), pp. 1654-1670.

Fana, M., Cirillo, V., Guarascio, D., and Tubiana, M. (2020) *A comparative national tasks database*. JRC Working Paper Series on Labour, Education and Technology 2020/13. Seville: European Commission.

Goodwin, P. and Wright, G. (2010) 'The limits of forecasting methods in anticipating rare events', *Technological Forecasting and Social Change*, 77(3), pp. 355-368.

Handel, M.J. (2017) 'Measuring Job Content: Skills, Technology, and Management Practices', in Buchanan, J., Finegold, D., Mayhew, K., and Warhurst, C. (eds.) *Oxford Handbook of Skills and Training*. Oxford: Oxford Handbooks Online.

HESA (Higher Education Statistics Agency) (2021) What is the income of HE providers? Available at: https://www.hesa.ac.uk.

Hillage, J. and Cross, M. (2015) *Exploring the value of an O*NET resource for the UK*. Report from a workshop held in London, June 2015. Brighton: Institute for Employment Studies.

ILO (International Labour Organization) (2015) *Anticipating and matching skills and jobs*. Guidance Note. Geneva: International Labour Office.

ILO (International Labour Organization) (2020a) *The feasibility of using big data in anticipating and matching skills needs*. Geneva: International Labour Office.

ILO (International Labour Organization) (2020b) *Guidelines on Rapid Assessment of reskilling and upskilling needs in response to the COVID-19 crisis*. Geneva: International Labour Office.

Miller, R. (2006) 'Futures studies, scenarios and the "possibility-space" approach', in OECD, *Think Scenarios, Rethink Education*. Paris: Organisation for Economic Co-operation and Development Publishing, pp. 93-105.

OECD (Organisation for Economic Co-operation and Development) (2016) *Getting skills right: Assessing and anticipating changing skill needs*. Paris: Organisation for Economic Co-operation and Development Publishing.

Palinkas, L. A., Horwitz, S. M., Green, C. A., Wisdom, J. P., Duan, N., and Hoagwood, K. (2015) 'Purposeful Sampling for Qualitative Data Collection and Analysis in Mixed Method Implementation Research', *Administration and Policy in Mental Health and Mental Health Services Research*, 42(5), pp. 533-544.

Rhisiart, M., Stormer, E. and Daheim, C. (2017) 'From foresight to impact? The 2030 Future of Work Scenarios', *Technological Forecasting & Social Change*, 124, pp. 203-213.

Richardson, S. and Tan, Y. (2007) *Forecasting future demands: What we can and cannot know*. Adelaide: National Centre for Vocational Education Research, Flinders University.

Rihova, H. (2015) *Using Labour Market Information: Guide to Anticipating and Matching Skills and Jobs*. Volume 1. Luxembourg: Publications Office of the European Union.

ScMI (Scenario Management International) (2021) *Scenario-Manager™ – our software for scenario development and assessment*. Available at: https://www.scmi.de.

SOLAS (2021) *SOLAS Learning Works*. Available at: https://www.solas.ie.

Taylor, P.J., Li, W.-D., Shi, K., and Borman, W.C. (2008) 'The transportability of job information across countries', *Personnel Psychology*, 61(1), pp. 69-111.

Tichy, G. (2004) 'Over-optimism among experts in assessment and foresight', *Technological Forecasting and Social Change*, 71(4), pp. 341-363.

Tippins, N. and Hilton, M.L. (eds.) (2010) A Database for a Changing Economy: Review of the Occupational Information Network (O*NET). Washington D.C.: National Research Council, National Academic Press.

van Breugel, G. (2017) *Identification and anticipation of skills requirements: Instruments used by international institutions and developed countries*. Project document for Vocational Education and training for equality in Latin America and the Caribbean. Geneva: United Nations.

Warwick Institute for Economic Research (2020) *Working Futures, 2017-2027*. Available at: https://www.warwick.ac.uk, Warwick Institute for Economic Research, 10 December 2020.

WEF (World Economic Forum) (2020) *Jobs of Tomorrow: Mapping Opportunity in the New Economy*. Geneva: World Economic Forum.

Wilson, R.A. (2008) *UK approaches to skills needs analysis and forecasting: Lessons for the Czech Republic*. Coventry: Institute for Employment Research.

Wilson, R.A. (2010) *Lessons from America: A Research and Policy Briefing*. UK CES Briefing Paper Series. Wath upon Dearne: UK Commission for Employment and Skills.

Wilson, R.A. (2013) 'Skills anticipation – The future of work and education', *International Journal of Education Research*, 61, pp. 101-110.

Wilson, R.A. and Homenidou, K. (2012) *Working Futures 2010-2020: Technical Report on Methods and Sources Used*. Wath upon Dearne: UK Commission for Employment and Skills.

Wilson, R.A., Tarjáni, H., and Rihova, H. (2015) *Working at Sectoral Level. Guide to Anticipating and Matching Skills and Jobs*. Volume 3. Luxembourg: Publications Office of the European Union.

Wilson, R.A., Czesana, V., Simonva, Z., Kriechel, B., and Vetter, T. (2017) *Skills and lifelong learning: labour market anticipation*. Available at: https://gov.uk, 7 July 2017.

Wilson, R.A., Barnes, S.-A., May-Gillings, M., Bui, H., and Patel, S. (2020a) *Working Futures 2017-2027: Long-run labour market and skills projections for the UK. Main report*. London: Department for Education (DfE).

Wilson, R.A., May-Gillings, M., Patel, S., and Bui, H. (2020b) *Working Futures 2017-2020: Long-run labour market and skills projections for the UK. Technical report on sources and methods*. London: Department for Education (DfE).

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