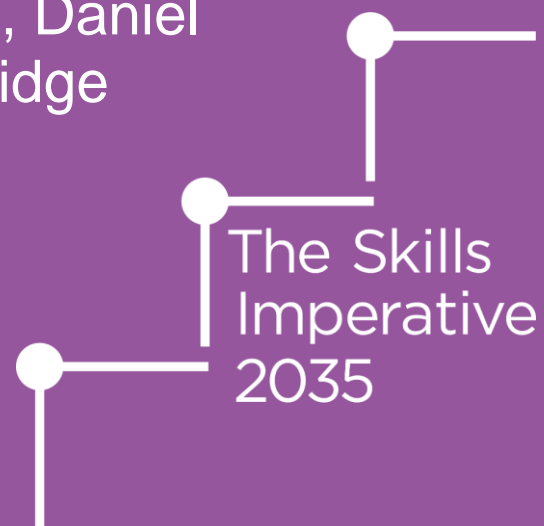


The Skills Imperative 2035: Occupational Outlook – Long- run employment prospects for the UK, Alternative Scenarios

Working Paper 2b

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Executive Summary

Key messages

Introduction and general approach

This report presents results for some *Alternative scenarios* which have been developed to explore the range of possible futures facing the UK economy and labour market over the next 10-15 years. It is a technical document, aimed at an expert audience interested in the details of how economic changes are impacting upon the occupational structure of employment.

It is part of a suite of reports. Working Paper 2a, also aimed at the same audience, describes the *Baseline projections*. This includes detailed projections to 2035 for 412 4-digit occupational categories (based on the latest SOC2020 system for classifying occupations). Here we explore the sensitivity of these results to alternative assumptions about the possible development of the economy over this period, as well as the ways this may affect the occupational structure of employment.

Working Paper 2b (this report) presents the results for the *Alternative scenarios*, based on assumptions which explore a more rapid take up of certain technologies and faster moves in both policy and practice towards the greening of the economy. This includes a *Human-centric* scenario in which investments are directed substantially towards improving provision of social services and more modestly towards technological opportunities and environmental ambitions.

Together, these scenarios provide a sound basis for discussions about skills provision in the future. Working Paper 2c, the *Technical report*, presents details of the data sources and methods used to generate the results. Finally, Working Paper 2 is a *Headline report* aimed at a more general audience. This brings together the results from the *Baseline projections* and *Alternative scenarios* to consider the overall implications for occupational employment.

The *Baseline projections* presents our assessment of the most likely path for the economy and labour market, given past patterns of behaviour, technological developments, the expected stance of government policy, the state of the world economy and demographic developments. It incorporates various ongoing trends, including automation, the take up of Artificial Intelligence (AI) and the greening of the economy.

The *Alternative scenarios* explore a range of possibilities, including:

- more rapid technological change, especially in the areas of automation and AI
- more rapid implementation of policies and practices related to the greening of the economy, in particular aiming to achieve the government's ambitious target of reaching 'net zero' by 2050¹
- different assumptions about the opportunities for new job generation, both in terms of technological opportunities and also from a more human-centric perspective.

¹ The UK Government's strategy to achieve net zero carbon emissions is set out in its Policy paper *Net Zero Strategy: Build Back Greener* which can be found at <https://www.gov.uk/government/publications/net-zero-strategy>

These factors will impact on both the level and structure of employment by **sector**. In addition, we explore possible impacts on the structure of employment within sectors. This is done by making different assumptions about what all this might mean for the **occupational** structure of employment within sectors.

Two main *Alternative scenarios* have been developed. These both build upon an interim scenario which focuses upon the potential job losses arising from automation and artificial intelligence (AI). We have deliberately avoided focussing upon a 'doomsday' scenario which would just focus upon these negative effects on employment.

The challenge is that the evidence on jobs at risk of automation is reasonably well explored because it amounts to assessing the task/skills content of existing roles. By itself, this tends towards a 'doomsday' scenario of dramatic job losses. However, previous experience suggests that in the long-run economies and labour markets have usually been able to adjust to such technological shocks, which also offer many opportunities for job creation. For example, the process of investment in technology is itself likely to create more high skilled jobs, as will the maintenance of this new technology. The same is true for many green initiatives, etc.

The *Technological opportunities scenario* (TS) focus on the new technologies and the move towards a greener economy. The *Human-centric scenario* (HS) focuses more upon the positive prospects for non-cognitive skills which are less easy to automate. The *Technological opportunities scenario* assumes greater emphasis on labour-augmenting and green technologies and less on social services than the *Human-centric scenario* one.

The projections should be regarded as indicative of likely developments for the economy and the labour market, rather than precise forecasts of what will inevitably happen. Many of the trends presented are resilient and are not sensitive to shocks unanticipated at the time they were developed. They present a view of medium to longer-term trends for the UK economy and labour market (10-15 years ahead). The results should be regarded as a robust benchmark for debate and further analysis.

Baseline projections results

The key messages from the *Baseline projections* are that the economy is changing slowly but steadily and inexorably, and that by 2035, the structure of the labour market and employment will have altered substantially.

The *Baseline projections* show significant changes to the industrial structure of employment by 2035. The projected changes in employment generally reflect the trends expected for output, with the strongest growth rates in *Construction, Business and other services*, and *Non-market services (Public administration, Education and Health)*. There are other substantial changes to the structure of employment. *Manufacturing* employment is projected to fall by over 10 per cent by 2035. In contrast, *Business and other services* is projected to grow by over a million jobs between 2020 and 2035, and *Non-market services* by only slightly less. We see equally dramatic changes at a more detailed level by 2035 (results are produced for 75 2-digit SIC categories).

In the *Baseline projections* almost all the 2½ million growth in job numbers will be for skilled, white-collar, non-manual workers. Nearly 90 per cent of the net increase in employment will be for *Professional and Associate professional* jobs. Reductions in employment levels are projected for *Administrative and secretarial* and *Skilled trades occupations*. This reflects ongoing trends towards automation, as well as the falling share of manufacturing and other

non-service sectors in the economy. There is some hollowing out of the middle of the occupational structure, but some increases in employment for certain elementary jobs and lower-skilled care workers.

The Alternative scenarios

The *Baseline projections* are our best estimate of the future, based on what we know now, but there are likely to be other events which may realistically happen in the future, but where the detail is not yet known (e.g. how the UK might deliver its 'net zero' commitment). One of the aims of this research programme is to explore a range of possible futures. We have therefore produced two main *Alternative scenarios*, which build on the *Baseline projections*, but consider other possible outcomes for macroeconomic and sectoral employment prospects.

While the adoption of new technologies in the labour market will lead to some loss of jobs, many new job opportunities will be created as well. The two main *Alternative scenarios* are therefore designed in such a way that these effects more or less balance out by 2035, but exhibiting different industrial employment structures. Details of the design of the scenarios are set in Box 1.

It is important to emphasise that the projections are predominantly demand-led and focus on employment. They explore what the alternative structure of the UK economy as defined in the different scenarios implies about future employment patterns. A deeper question (and inquiry) will then follow in the next stages of the wider *Skills Imperative 2035* research programme to consider whether action is needed (to support the skills development) to realise such a future. This will focus on 1) what skills will be needed; and 2) whether action by government/others will be needed to support the development of these skills.

Box 1: Design of the *Alternative scenarios*

Both the main *Alternative scenarios* assume an acceleration in take-up of automation related technologies, including Artificial Intelligence. However, the starting point of both scenarios is an intermediate scenario (the ***Automation scenario***), which focuses attention purely on the negative employment effects, based on a review of jobs most at risk. This scenario does not assume any job creation. The main purpose of this intermediate scenario is purely illustrative, to highlight areas where jobs are at greatest risk of automation. By itself it is not regarded as a realistic prospect.

The two main *Alternative scenarios* consider the impact of both job destruction and job creation. They are as follows:

1. The *Technological opportunities scenario* – builds on this intermediate scenario, which incorporates job losses from automation, but recognises that technology developments will also open up many opportunities and will create new jobs. It focuses on the positive aspects of transformations in the management of new technologies and transition to a low-carbon economy.

2. The *Human-centric scenario* – builds on the same intermediate scenario but combining this with assumptions which place greater emphasis on non-cognitive skills, which are less vulnerable to displacement, especially in the provision of better-quality *Education, Health and care services*.

There is little evidence to inform where these new jobs might emerge or their likely scale. We have therefore made the assumption that in both the *Technological opportunities* and *Human-centric scenarios* the new jobs created are sufficient to roughly offset the negative effects imposed in the *Automation scenario* in the long run (by 2035). The total number of jobs is therefore roughly the same in all the main scenarios, focusing attention on changes to the composition rather than the size of the labour market.

By separating out the negative and positive impacts, we aim to focus on how the structure of employment is likely to be disrupted, highlighting those areas where significant job losses might be expected and contrasting them with those with where job gains are anticipated. These are pragmatic assumptions in the face of very limited hard evidence on detailed impacts on employment structure in the future.

Macroeconomic differences in the *Alternative scenarios*

The interim *Automation scenario* projects the loss of over 2 million jobs by 2035. This primarily affects male employment. All broad sectors of the economy see job losses in this scenario but *Non-market services* are less affected.

Relative to the *Baseline*, the *Technological opportunities* and *Human-centric scenarios* project higher growth in female employment compared to male employment. This reflects the shift in emphasis to sectors in which women have historically been employed. The *Human-centric scenario* projects the gender gap in employment to shrink to just 1 percentage point by 2035, with women projected to hold a continued higher share of part-time employment compared to men.

The unemployment rate is projected to decrease in the *Baseline projections* and the main two *Alternative scenarios*, from around 4.5 per cent in 2020 to around 3 per cent in 2035. In the *Baseline projections*, male unemployment is projected to fall more than female unemployment by 2035. In the *Technological opportunities scenario*, male and female unemployment are projected to fall at similar rates, while in the *Human-centric scenario*, female unemployment is projected to fall substantially more than male unemployment.

Sectoral output implications in the *Alternative scenarios*

Output is projected to increase faster in the two main scenarios compared to the *Baseline projections*. Total output is 7.5 per cent higher in the *Technological opportunities scenario* and 6.2 per cent higher in the *Human-centric* one compared to the *Baseline projections*.

Output is higher across all industries for both the *Technological opportunities* and *Human-centric scenarios* but the industries which are most impacted vary. For example, in the *Technological opportunities* scenario, Construction is some 17 per cent higher by 2035, while for the *Human-centric scenario*, *Non-market services* is 12 per cent higher.

When looking across the six broad sectors of the economy in the *Technological opportunities* and *Human-centric scenarios*, gross value added (GVA) is projected to grow more strongly over the period 2020-25 than over 2025-35 across all sectors, with the exception of *Primary sector and utilities* as the economy recovers from the pandemic. In terms of GVA growth, *Construction* is the fastest-growing amongst the six broad sectors. This is particularly strong in the *Technological opportunities scenario* (3.5 per cent pa over 2020-35, equivalent to a 67 per cent increase over 2020), because of continued demand for housing to address UK-wide shortages for a population with growing incomes (who might be looking at leaving multigenerational family homes or equipping their homes with the latest energy saving solutions and technologies in the future) and anticipated demand for new decarbonisation infrastructure.

Sectoral employment prospects

There are also some significant differences between the scenarios in terms of impact on employment. By 2035, some 2 million additional jobs are estimated to be lost due to faster adoption of technology (as shown in the intermediate *Automation scenario* compared with the *Baseline*). This is focused in *Business and other services* (-890,000 jobs) and *Trade and accommodation services* (-650,000 jobs). In the *Technological opportunities scenario* these are offset by significant job gains in *Non-market services* (670,000) as well as in other parts of *Business and other services* (650,000). In the *Human-centric scenario* the main area of job gains is in *Non-market services* (in excess of a million jobs). *Health* and *Education* are the two main beneficiaries. The largest declines are in the *Retail trade*.

In the *Technological opportunities* and *Human-centric scenarios*, employment is projected to grow across all sectors, except in *Manufacturing*, which is projected to decline over 2020-35 (while still seeing GVA growth). Employment growth in all sectors in the two *Alternative scenarios* is projected to be stronger in the short term (2020-25) than in the longer term (2025-35).

Relative to the *Baseline projections*, the *Technological opportunities scenario* projects stronger employment growth in *Non-market services* and *Primary sector and utilities*, as well as slightly slower decline in employment in *Manufacturing*. In contrast, the *Human-centric scenario* projects stronger employment growth only in *Non-market services*, though this accounts for nearly 1 million more jobs by 2035 compared to the *Baseline projections*.

Employment losses due to automation are projected to be offset by growth in other sectors, shifting many jobs to *Non-market services* in the *Technological opportunities scenario* and especially the *Human-centric scenario*. Employment is projected to decrease the most in *Wholesale trade, Retail trade*, and certain *Manufacturing* sectors over 2020-35 in both the main scenarios, Employment is projected to increase most in *Food and beverage services, Land transport*, and certain *Non-market services* sectors, especially *Health and Education*.

Occupational employment prospects

These implications for sectors are then used to generate implications for occupations, including exploring different assumptions about how these developments might affect occupational patterns *within* sectors.

In all the scenarios these projections imply significant changes in the skills required to succeed in the future labour market of 2035.

The results across the *Alternative scenarios* amplify the changes projected in the *Baseline projections*. Job losses in areas such as *Administrative and secretarial* and *Skilled trades* are most marked in the *Automation scenario*, and also a key feature of the two other scenarios. Growing job numbers for *Professional and Associate professional* as well as *Caring and Other leisure service occupations* are all reinforced in the *Technological opportunities* and *Human-centric scenarios*.

Replacement demands

However, as in the *Baseline projections* it is important to bear in mind that Replacement Demands will easily outweigh any net changes in projected employment levels for all occupations (expansion demands). There will be significant job openings and requirements for skills even in areas which are expected to see significant job losses. On average replacement demands are larger than expansion demands by almost an order of magnitude (7-fold).

4-digit Occupational employment prospects

At the more detailed level, if the 4-digit occupations are ranked by employment size, the rankings change only slightly in the *Baseline projections* between 2020 and 2035. *Care workers and home carers* are forecast to become the largest 4-digit occupational group by 2035, overtaking *Sales and retail assistants*. The rankings barely change at all between scenarios.

Similarly, if we rank the 4-digit occupations according to the largest absolute growth between 2020 and 2035, these look very similar across scenarios. Just two occupations: 2319 *Teaching professionals n.e.c.* (not elsewhere classified) and 1251 *Property, housing and estate managers* fail to be in the top 20 categories in all three scenarios (they are absent only from the *Automation Scenario*). The top 10 occupations include: *Care workers and home carers, Sales and retail assistants, Other administrative occupations n.e.c., Programmers and software development professionals, Nursing auxiliaries and assistants, Financial managers and directors, Book-keepers, Payroll managers and wages clerks, Customer service occupations n.e.c., Warehouse operatives and Secondary education teaching professionals*.

It is a similar story if we focus on the 20 4-digit occupations facing the largest absolute levels of job loss. There is an almost identical list of 4-digit occupations in all the scenarios. These

are all occupations concentrated in SMG4.2, *Secretarial occupations*, SMG5.3 *Skilled trades occupations* SMG 7.1 *Sales occupations* and SMG 9.2 *Elementary occupations*. Just a few switch in and out of the top 20 in terms of job losses.

However, because of replacement demand, all of these will still be substantial areas of employment in 2035 with significant job openings and skill requirements. They include *Medical secretaries, Waiters and waitresses, Security guards and related occupations, School secretaries, Sales and retail assistants, Cleaners and domestics, Kitchen and catering assistants, Warehouse operatives, Personal assistants and other secretaries and Receptionists*.

1 Introduction

Key messages

The National Foundation for Educational Research (NFER) is leading this five-year research programme. The study aims to identify which employment skills will be most needed in future and what the potential supply of these skills may be, where the skills gaps are, and which groups are most at risk of not having the skills needed. It will also investigate how the education system can support the development of the essential employment skills needed in future. This part of the work programme focuses upon projecting the detailed structure of employment up to the year 2035.

This report describes the development of *Alternative scenarios* for the quantitative projections of the UK economy and labour market, which have been prepared by the Institute for Employment Research at the University of Warwick (IER), working in collaboration with Cambridge Econometrics (CE).

These projections will form a key input into thinking about how the UK economy and labour market may respond to major technological, environmental and demographic developments over the coming decades and what this will mean for essential employment skills.

A key aim is to provide government, policy makers, education and training providers as well as employers with practical insights about how the demand for essential employment skills is likely to evolve.

These *Alternative scenarios* explore the sensitivity of the results to different assumptions about technological change, the greening of the economy and the ambitious 'net zero' target set for emissions as well as variations in the way investments are directed towards improving provision of social services in the *Human-centric scenario*.

1.1 Background and context

This report describes some *Alternative scenarios* for the UK economy and labour market, prepared using CE's MDM-E3 macroeconomic model. This complements the *Baseline projections* report, which describes in detail the *Baseline projections* focusing on employment by sector. The results also depend upon alternative assumptions made about the occupational employment patterns within sectors which are described in detail here.

1.2. Outline of this report

The remainder of this report is structured as follows.

Section 2 sets out the general approach to developing the macroeconomic elements of the scenarios. This includes discussion of the main objectives of the scenarios and their limitations. Two main alternatives have been produced, plus an intermediate scenario which focuses on the negative aspects of automation and related technologies in terms of employment impact.

Section 3 outlines the different assumptions made regarding occupational employment structure. There is not sufficient information to differentiate these between the scenarios.² The adjustments made to occupational patterns at both 2- and 4-digit level are therefore identical across the three *Alternative scenarios*.

Section 4 describes the main features of the macroeconomic and sectoral projections in the three *Alternative scenarios* that have been developed.

Section 5 presents the implications for occupational employment, first at the broad level and then for detailed occupations at the unit group level (412 categories).

The full suite of reports comprises:

- **Working Paper 2** – henceforth referred to as the *Headline report* (Wilson *et al.*, (2022)). This presents the main findings about the likely size and composition of the labour market in 2035. It draws on the *Baseline projections* and *Alternative scenarios* reports to describe the likely range of potential outcomes for the future labour market and considers what the implications of these changes will be.
- **Working Paper 2a** – Summarises the main findings for the UK in the *Baseline projections* (Wilson *et al.*, (2022a)). It presents *Baseline projections* for the macroeconomy, sectoral employment and the labour force, based on our assessment of the most likely path the economy will take over the next 15 years or so given what we know about changes to the future policy landscape. It includes tables of data for selected years, together with a written commentary explaining and interpreting the forecasts. It covers the whole of the UK and the constituent countries which make it up.
- **Working Paper 2b** – This is the present document. It summarises the findings for the UK for some *Alternative scenarios* that we have considered (Wilson *et al.*, (2022b)). These build on our *Baseline projections* but consider other possible outcomes such as a more rapid adoption of technology, greater focus on green initiatives and the provision of better-quality *Education, Health and Care services*.
- **Working Paper 2c** – A detailed *Technical report* which provides further information on the data sources and methodology used to generate the projections (Wilson *et al.*, (2022c)).

² There isn't any robust information on which to base such assumptions, especially at the 4-digit level. There is some research which suggests which occupations might be vulnerable to automation, etc., and also which might benefit as new job opportunities open up, but nothing concrete on which to differentiate them across the scenarios.

2 Scenario assumptions

Key messages

As well as our *Baseline projections*, we consider various alternative futures (scenarios) for the UK economy. These scenarios consider how automation, and the responses to it, might reshape the UK economy, changing the future composition of jobs as well as different assumptions regarding the move towards the greening of the economy and how and where new jobs might be generated.

Our focus is on changes in employment structure rather than overall employment levels. By design the two main scenarios assume a similar total number of jobs by 2035 as in the *Baseline*.

The existing literature on automation tends to focus on the jobs that are at risk of being replaced by new technologies. This is modelled in an intermediate *Automation scenario*, which assumes jobs will be lost but no new jobs will be created as a result of adopting new technologies in the labour market.

The remaining two scenarios assume that there are also positive benefits of faster automation. They assume the same level of job losses as in the *Automation scenario* but differ in how and where the new job opportunities might arise in their place:

- *Technological opportunities*: is a scenario in which investments are directed to capitalise on labour-augmenting technologies, support the net-zero transition, and provide better social services in the UK.
- *Human-centric*: is a scenario in which investments are directed substantially towards improving provision of social services and more modestly towards technological opportunities and environmental ambitions.

In this way, the two main scenarios consider how automation might either create jobs (*Technological opportunities*) or afford the space to create value through jobs that are difficult to replace (in a *Human-centric* manner).

2.1 Introduction

This chapter describes the methodology used to produce alternative economic scenarios for the UK and its regions using CE's MDM-E3 model. This complements the *Baseline projections* described previously in the *Baseline projections report* (Wilson *et al.*, 2022a).

Section 2.2 presents the objectives of this part of the modelling exercise. Section 2.3 describes the features of the three *Alternative scenarios*. Sections 2.4 and 2.5 then describe the assumptions on the impact of automation and the creation of new jobs.

2.2 Objectives

The purpose of the scenarios is to explore alternative macroeconomic futures and their potential to transform the labour market to 2035 and then to examine their implications for the occupational structure of employment. The macro scenarios represent deviations from economic trends captured in the *Baseline projections*. They operationalise assumptions about possible structural changes in the economy from an industrial perspective.

The macro scenario outputs are used as inputs to further analysis of the implications for the future occupational structure and skills requirements of the UK. Some consideration of these elements is included as part of the narrative. However, these features are not formally modelled or analysed quantitatively as part of the macroeconomic modelling because they will feature in other parts of the research programme.

The central proposition behind our Nuffield grant application was that more rapid adoption of new technologies, demographic changes and the green agenda are expected to disrupt the labour market in the coming decades. What we have presented in the *Baseline projections* incorporates some of these factors (demographic change, Brexit, the pandemic and reactions to it, plus a continuation of existing trends of change due to automation and related technology and policies and practices linked to the green agenda).

In the *Alternative scenarios*, we allow for a more rapid adoption of AI/automation, as well as the likely step changes that we need to meet our 'net zero' commitment towards 'greening' the economy. Both remain somewhat speculative and dependent on future government policy and practice living up to its aspirations.

The *Alternative scenarios* attempt to explore the possibilities of faster rates of adoption of technology (e.g. some adoption of autonomous vehicles and greater use of AI) and changes in behaviour/policy to achieve the 'net zero' target (e.g. greater investment in new wind farms/nuclear, etc. to replace the power produced by coal power stations, faster adoption of greener solutions like electric cars, etc.). In practice, there are no simple levers in the model that we are using to produce these projections that we can pull to execute such change. Rather it is necessary to alter various exogenous inputs into the model, or amend some of its parameters, in order to achieve the desired outcomes. These adjustments are described in detail in the remainder of this section.

In the accompanying *Headline report*, we bring the results of this exercise together with the main findings in the *Baseline projections* report, presenting the projected future changes as a range of possibilities rather than a single estimate.

The *Alternative scenarios* are simulations of a future in which the rate of automation increases relative to the *Baseline projections*, with more in the way of both:

- job destruction from the adoption of labour-displacing/replacing technologies, such as artificial intelligence (AI) and advanced robotics
- job opportunities, whether from labour-augmenting technologies themselves or because of:
 - growth in the green economy from more rapid decarbonisation (at the expense of other parts of the economy such as fossil fuel extraction)
 - a growing premium attached to tasks/skills that are not easily replaced by such technologies.

The modelling thus focuses on three major trends: automation, decarbonisation and potential renewed investment in *Education, Health and Care*.

Relative to the *Baseline projections*, these effects come about through some combination of: automation and green technologies becoming market-viable (such that private businesses can reap competitiveness gains from making such investments); policy/regulatory requirements (especially with greater ambition, and more stringent requirements, for decarbonisation); and an augmented role for tasks/skills that remain the preserve of humans (raising employers' demand for such workers, to meet an identified business opportunity).

The starting point for the two main scenarios is an intermediate *Automation scenario*. This models the job losses from the adoption of labour-displacing/replacing technologies, assuming no new job creation. The two main *Alternative scenarios* both build on this scenario. These are labelled the *Technological opportunities* and *Human-centric scenarios*. In both the main scenarios we assume that total demand for labour (measured by the total number of jobs in 2035) roughly the same as in the *Baseline projections*. This focuses attention on the structure of employment in 2035 rather than its overall level. This highlights potential changes in the nature of work, with possible winners and losers from the transition. We thus produce scenarios that affect the composition of UK employment, rather than its size.

The rationale for this approach is that the evidence on jobs at risk of automation (i.e. potential losses) is reasonably well-explored, because it amounts to assessing the task/skills content of existing roles. On this evidence alone, the implication is of dramatic job losses with relatively little to say about the potential scale of new jobs created. However, historical experience suggests that in the long-run economies and labour markets have usually been able to adjust to such technological shocks, which also offer many opportunities for job creation. For example, the process of investment in technology is itself likely to create more high skilled jobs, as will the operation and maintenance of these new technologies. The same is true for many green initiatives, etc.³

In the absence of evidence to say how large these opportunities might be, the *Technological opportunities* and *Human-centric scenarios* impose the assumption of no significant net change in employment between the *Alternative scenarios* and the *Baseline projections* by 2035. In effect, this creates scenarios of how the UK economy (and, in turn, its demand for jobs and skills) might change, focusing upon the implications for the structure/composition of employment in 2035 rather than how the overall size of the labour market may change. This provides results which emphasise, changing jobs *requirements* (re-composition and reorientation) rather than changes in the total *number* of jobs.

In developing our two main *Alternative scenarios*, we have deliberately avoided making a 'doomsday' scenario, which focuses upon significant job losses as a result of automation, etc., without some significant offset of jobs created elsewhere.

The *Automation scenario* is the starting point for both the main scenarios modelled. The *Technological opportunities* and the *Human-centric scenarios*, make use of identical assumptions about job destruction (from the intermediate *Automation scenario*) but differ in their assumptions about new job opportunities. They combine the three major trends and the

³ For example, in the early 1970s microelectronics were predicted to lead to mass unemployment, (e.g. Ian Barron and Ray Curnow, *The Future with Micro-electronics : Forecasting the Effects of Information Technology* (London. Frances Pinter, 1981), p. 191. and C. Jenkins and B. Sherman, *The Collapse of Work* (London, Eyre Methuen, 1979)). A more considered review by Whitley, J.D. and Wilson, R.A, (1982) (*Quantifying the employment effects of micro-electronics*. *Futures*, Volume 14, Issue 6, December 1982, pp. 486-495) argued that this ignored all the positive benefits of the introduction of such technology and concluded that there would be no such jobs Armageddon. The latter view was borne out by subsequent events. More recently, the Resolution Foundation in its *Stagnation nation* report notes the example of a paper by Deloitte, *Agiletown: (The relentless march of technology and London's response*, November 2014), which suggested that some 35 per cent of UK jobs were at risk of automation by 2034, a message which was picked up by Monetary Policy Committee members, politicians, and researchers alike and led to a flurry of interest in the economic and political implications of the risk of elevated automation-driven unemployment. However, mass unemployment has not yet come to pass.

aforementioned assumption of no net employment impact relative to *Baseline projections* by the end of the projection period (2035).

The three scenarios are as follows:

1. **Automation scenario**, a scenario in which the adoption of automation technologies accelerates to reach its maximum potential. All activities performed by humans and feasibly replaced by technologies are automated. This involves investment in productivity-enhancing automation technologies. However, no intervention takes place to address the substantial scale of job losses, leading to high levels of technological unemployment. This scenario reveals the sectors in which jobs are most at risk across the economy, as the starting point for the other two scenarios.
2. **Technological opportunities scenario**, a scenario with accelerated technological change also creating new jobs to support economic growth in the following ways:
 - improved management of technologies (such as data science, engineering and customer support for personal applications and technology solutions), leading the UK to reap various competitive advantages in core economic sectors⁴
 - the transition to a low-carbon economy (including increased investment in renewables and low-carbon or zero-emissions solutions, as well as stronger enforcement of regulations and standards to comply with climate commitments)
 - the provision of better-quality *Education, Health and Care services*, in which workers are especially difficult to replace with technology or, in the case of education, critical to the development and transformation (reskilling) of the workforce.
3. **Human-centric scenario**, in which technological displacement places a relatively greater premium on non-cognitive or 'soft' skills, which are harder for automation to replicate and therefore less susceptible to replacement. In such a scenario, the UK places greater emphasis on high-quality provision of *Education, Healthcare and Residential and social care services*, while still making some investment towards realising technological opportunities and environmental ambitions (albeit more modestly than in the *Technological opportunities scenario*). The intent behind this scenario is to provide a contrast to the *Technological opportunities scenario*. Rather than afford opportunities for technology to create/enhance jobs, this *Human-centric scenario* places more emphasis on the kinds of jobs that are less susceptible to technological change. The scenario thus represents a doubling down on skills unique to humans.

The next two sections describe the assumptions about automation and job destruction, and new job opportunities, respectively.

2.3 Impacts of automation

The motivation for the modelling exercise is the prospect of large-scale automation, to an extent and at a pace that could lead to widespread economic change. Automation puts certain jobs at risk, and this is modelled identically in all three *Alternative scenarios*. The

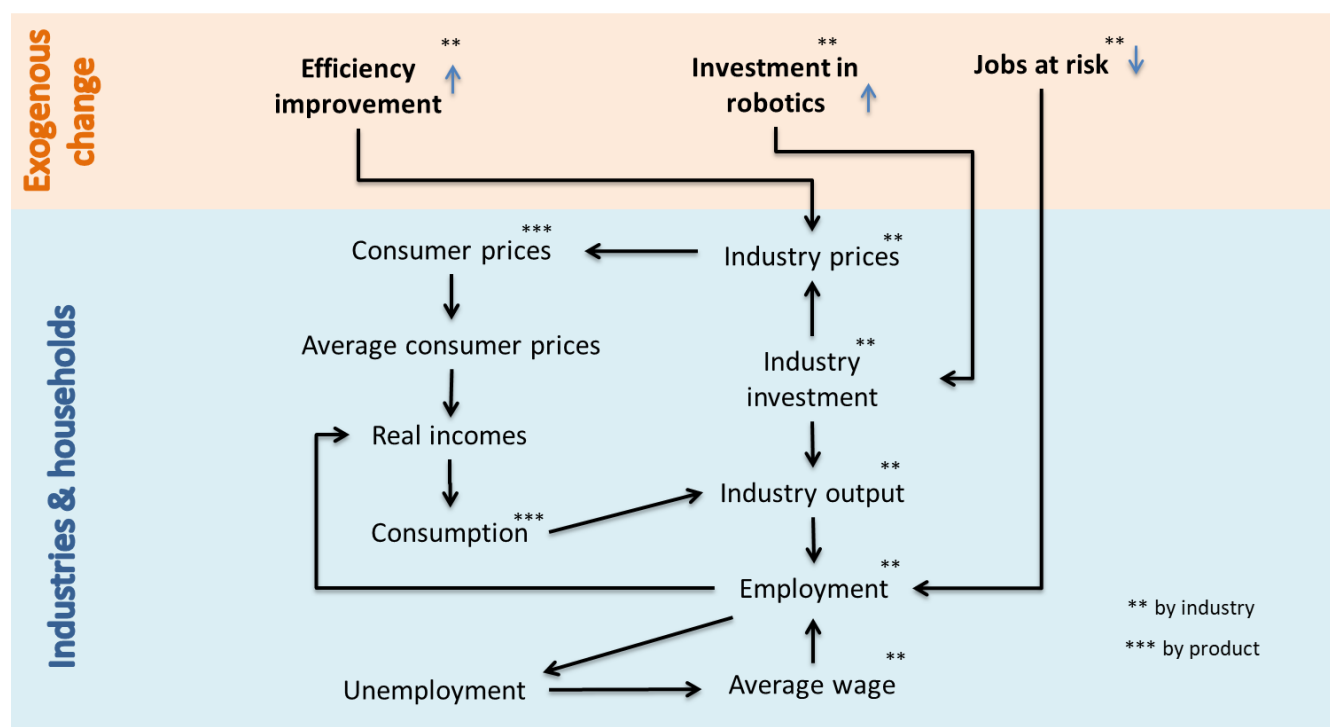
⁴ OECD (2017, 2019) analysis identified various UK competitive advantages while noting that these may not be sustained in an age of increasing globalisation and international competition. With new technological opportunities, these advantages may be sustained over the longer term.

Technological opportunities and *Human-centric scenarios* then differ in how automation might create alternative employment opportunities in place of these lost jobs.

Drawing on the available evidence, we have considered the following direct impacts of automation:

1. automation renders at least some jobs obsolete, which reduces real incomes and thus consumption and output (further reducing employment)
2. new automation technologies require investment, which adds to aggregate demand
3. efficiencies (productivity improvements) arising from the new automation technologies alter production processes and prices

Figure 2.1: Channels of automation impact



Source(s): Cambridge Econometrics.

2.3.1 Jobs at risk

Previous CE modelling of automation relied principally on PwC (2017) to inform estimates of jobs at risk. In that analysis, PwC (2017) employed a task-based approach to identify jobs vulnerable to automation. PwC’s analysis suggested that some 30 per cent of UK jobs were at potential high risk of automation by the mid-2030s. This share is somewhat lower than those estimated for the US and Germany but higher than for Japan. This is mainly due to the UK economy being more services-based with fewer automatable jobs than other European countries but more than in Asian and Nordic countries (PwC, 2018). As PwC (2017) noted, this analysis still depends on what automation (AI/robotics) technologies might be capable of in the future.

PwC (2018) took this analysis further to consider this automation as occurring in three waves:

1. **Algorithms:** The first (and current) wave of automation that involves straightforward computational tasks on structured data. This wave also includes more recent commoditisation of big data and machine learning techniques.
2. **Augmentation:** This wave is expected to more drastically alter many tasks, especially those which are routine and repeatable. Information entry and exchange will be increasingly automated while advances in AI could lead machines to develop certain algorithms themselves. While robots are not expected to become fully autonomous during this wave, technological advances are expected to substantially augment the scale and efficiency of automated tasks.
3. **Autonomy:** The third and final wave is expected to emerge at an economy-wide level (some technologies are already in the pilot stage) in the 2030s, further automating tasks involving physical labour and significant manual dexterity. During this wave, computing will evolve from being able to analyse structured data (as in the first wave) to being able to respond and make decisions in the face of dynamic situations.

In the UK, 2 per cent of jobs could be at potential high risk of automation from the first wave (algorithms). The augmentation wave will raise this share to 20 per cent, while the final autonomy wave will increase this to 30 per cent.

PwC's (2021) most recent estimates project that automation may displace a more modest 2-2.5 million jobs in the UK by the 2030s (compared to 10 million jobs suggested by PwC's earlier work in 2017 and 2018). Using this latest finding, we modelled the following (aggregate) pattern of initial job losses (as percentage reductions from the *Baseline projections*):

- 2022: 0.5 per cent (representing the algorithms wave)
- 2030: 4 per cent (augmentation wave)
- 2035: 6 per cent (autonomy wave)

The pattern of job losses by sector follows PwC's earlier (2017 and 2018) analyses.

2.3.2 Investment costs of new automation technologies

Automation technologies incur investment costs which must be borne by the sectors in which the automation occurs. This additional investment contributes to aggregate demand while the deployment of automation technologies is underway. Thereafter, firms within those sectors incur annual maintenance costs.

While there is substantial heterogeneity in technologies, and thus investment costs, our evidence review for this report suggests the following purchase costs based on information from the International Federation of Robots (IFR) (2020) and Robotiq (2021):

- services automation: £50,689 per unit (in 2019 prices), derived by dividing the sales value by the number of units sold, as reported by the IFR (2020)
- industrial automation: £101,378 per unit (in 2019 prices), derived by applying a cost differential of two to the above cost of services automation, based on analysis by Robotiq (2021).

We assume that these costs will fall over time due to production efficiencies at a rate of 5 per cent per annum (pa) over the forecast period. This is in line with short-term forecasts by the IFR (2020) which suggest implied unit costs falling over 2020-23 (the period covered by

their analysis) at 3.5-5.8 per cent pa for different types of services automation. In comparison, an independent analysis by Statista (2021) estimated the cost of industrial automation to have fallen by about 5 per cent pa over 2014-17 and to be expected to fall more rapidly at 10 per cent pa over 2017-25. A 5 per cent pa rate is thus consistent with existing findings while being at the conservative end for future production/cost efficiencies.

A combination of diversity in future technologies (e.g. industrial robots versus AI) and uncertainty (about the future nature of these technologies) makes it difficult to establish a firm estimate of maintenance costs. Nevertheless, such an assumption is necessary as part of a macroeconomic modelling exercise. Here, we assume that annual maintenance costs of the new automation technologies will be 10 per cent of the purchase cost. This figure is broadly consistent with Kopacek (1993) and also lies between implied figures of 20 per cent, as in Zhao *et al.*, (2021), and of 4 per cent, as in Perzylo *et al.*, (2019). The final results are not, in any case, sensitive to this assumption.

Based on Acemoglu and Restrepo (2020), we assume a replacement rate of 3.3 workers per unit.

2.3.3 Productivity improvements

The final input assumption to the job-replacement side of the *Automation scenario* is the additional productivity conferred on those who remain in the workforce. This reflects a potential increase in the economy's overall productive capacity due to technology uptake replacing the least productive workers and labour-technology complementarity which enhances the productivity of the remaining workers. It is to be distinguished from the real productivity of a unit of labour-replacing technology compared to a worker.

Here, we assume that the transformed workforce will become 50 per cent more productive by 2035. We consider this to be a conservative assumption given the replacement rate of 3.3 from Acemoglu and Restrepo (2020) and the fact that technologies do not have the same physical limits as humans.

2.4 Creation of new job opportunities

While automation is likely to lead to large-scale job displacement, new job opportunities will also arise, either complemented by the technologies or because of a renewed emphasis on skills not (so) susceptible to replacement. In other words, technologies may not be entirely labour-replacing or direct substitutes for workers: they can be labour-augmenting or complementary to the human workforce.

The modelling assumptions concerning new job creation concern:

- how new jobs will be created
- the absolute number of new jobs
- the sectoral distribution of those new jobs.

2.4.1 Support for job creation

This section describes our approach to generate the two scenarios under the aforementioned constraint that total UK employment is similar in the two main scenarios compared to the *Baseline projections*. In doing so, we consider how the composition, rather than the size, of UK employment might change over time.

In contrast to the evidence base on jobs at risk, the potential for job creation through automation remains uncertain and under-explored. Automation could augment the existing

labour force and/or increase the value and output of jobs that are more immune to automation.

We assume that new job opportunities are generated from new investments, in addition to investments in automation technologies mentioned in Section 2.3.2.

New investment will be targeted at specific industries where new opportunities are expected to emerge, and the number of new jobs is determined by the industry-specific employment multiplier of investment (i.e. the number of jobs supported by each £1m of investment). These new jobs may be within the same industries where jobs are displaced by automation or in a different industry entirely.

In addition, investment could be in the form of direct investment by firms in equipment, recruitment and training or contribution to a government scheme to prepare workers with the right skills for the future of work.

We assume that investment is entirely funded by the private sector for market sectors, spurred by a combination of higher financial return (from the technologies/opportunities becoming viable) and policy/regulatory requirements (especially with respect to decarbonisation). For a small number of service sectors where provision is shared between the government and non-profit institutions serving households (NPISH), the funding contribution is determined by the current split in demand fulfilled by these providers.

2.4.2 New job opportunities

Taking into account the three major transformations described as part of the scenario narrative, we assume three corresponding types of new job:

- automation-driven: jobs in *service industries* especially *IT, Scientific research, Education, and Health and social work*, to complement the deployment and use of technologies, in line with PwC (2021), WEF (2018) and McKinsey (2017)
- decarbonisation-driven: jobs in ‘green’ occupations such as *Scientific researchers, Machine operators and repairers, Agricultural producers and Regulatory professionals*, to support more concerted decarbonisation efforts, based on Sofroniou and Anderson (2021)⁵
- population-serving: jobs in services predominantly provided by the Government to serve the population, i.e. *Healthcare, and Residential and social care* to provide greater provision for an ageing population, as well as education and training to help develop and retrain the future workforce with the necessary skills.

Table 2.1 shows the industries that emerge from this assessment, noting that some fall into more than one of the three groups mentioned above.

In the *Technological opportunities scenario*, the extent to which new jobs are created in an industry is determined by the following factors (with the outcome being equally influenced by each):

- industries in which the UK has a comparative advantage (as judged by higher projected future demand for their output in the *Baseline projections*) are likely to see stronger job creation

⁵ For the modelling assumptions, we made a qualitative assessment of which industries these occupations most closely map to, based on whether they are likely to account for a large proportion of the workforce.

- industries in which the UK is likely to develop a comparative advantage (as judged by higher future investment needs or ambitions in the *Baseline projections*) are likely to invest in more jobs to reap these future gains
- industries at low risk of automation, requiring skills which are difficult to replace with technology, provide a new source of job opportunities, leading to growth in provision in these sectors.

In contrast to the *Technological opportunities scenario*, in which a third of the investment is expected in public service sectors, in the *Human-centric scenario*, 60 per cent of the investment is expected in *public service sectors* (including *Education, Health, and Residential and social care*), which is then projected to bolster employment in those sectors. This proportion is similar to the current market share of private provision (by NPISHs) in these sectors, which serves as an upper limit for the assumption.

Table 2.1 Sectors with potential for new job opportunities

Broad sector	Industry	Automation-driven	Decarbonisation-driven	Population-serving
Primary sector & utilities	Crop & animal products		X	
	Forestry & logging		X	
	Mineral extraction		X	
Manufacturing	Food & drink products		X	
	Paper		X	
	Chemicals		X	
	Rubber & plastic		X	
	Metal products		X	
	Computers		X	
	Electrical equipment		X	
	Machinery		X	
Other manufacturing & repair		X		
Construction	Construction		X	
Trade, accommodation & transport	Land transport		X	
	IT services	X	X	

Broad sector	Industry	Automation-driven	Decarbonisation-driven	Population-serving
Business & other services	Financial & insurance services	X	X	
	Legal & accounting	X	X	
	Architecture & related	X	X	
	Other professional services	X	X	
	Arts & entertainment		X	
Non-market services	Public administration & defence		X	
	Education	X		X
	Health	X		X
	Residential & social care	X		X

Source(s): Cambridge Econometrics.

3 Alternative assumptions about occupational employment patterns

Key messages

Although there is great deal of research on this topic, including the review published in Working Paper 1, as well as the literature review conducted in this phase of the project, it has not produced much concrete evidence on which to base adjustments to the trends set out in our *Baseline projections*. Using the results of these literature reviews we identified a number of occupations at both the 2- and 4-digit levels where there is some consensus of significant changes in employment shares (both positive and negative).

The rationale behind selecting the adjustments made for these occupations is based on the following considerations/drivers:

- Occupations at risk of automatisisation
- High-tech intensive occupations
- Green occupations
- Ageing of the population and consequent increase in care and health related jobs
- Labour market flexibility
- Rising female labour market participation.

We have also considered the trends over the past decade based on data from the Labour Force Survey. However, this is limited, as data classified to the latest SOC2020 are only available for 2021.

We have translated LFS data for 2011-2020 for 4-digit unit groups classified using the old SOC2010 system on to SOC2020 using a mapping developed with the Office for National Statistics.

Based on this information we identified just under 100 unit groups where some significant break with trend seems likely.

Some 44 occupations are expected to see more rapid declines in employment shares between 2020 and 2035. For 52 unit groups we anticipate significant increases in employment shares.

Together these occupations accounted for around a third of all jobs in 2020.

The same adjustments to occupational employment shares were made for all three of the *Alternative scenarios*. This was done in two stages, first at the 2-digit level and then for 4-digit within 2-digit shares.

3.1 Introduction

In the scenario developed for the *Baseline projections* (Wilson *et al.*, 2022), we have assumed that the patterns of occupational employment at the 4-digit level remain fixed at their 2021 values. This is because we have no information on trends at this more detailed level. Data on the 4-digit occupational categories using the new SOC2020 classification are only available for 2021.

In this section, we consider some alternative assumptions about detailed (4-digit level) occupational employment patterns within the broader 2-digit categories in the projections. In addition, we consider possible alternative trends at the broader 2-digit level.

In practice, there is not a great deal of firm evidence on which to base any such amendments to the trend-based extrapolations used in the *Baseline projections*, especially at the most detailed 4-digit level. Although there has been a great deal of research on this general topic, including the extensive literature review presented in *Working Paper 1* (Taylor *et al.*, (2022)), very little of this provides much guidance on the scale of such impacts at a detailed occupational level.

Section 3.2 presents a summary of the possible impact of new technologies and other factors on occupational employment over the next decade, based on the earlier literature review and some further analysis. There are some general implications that can be drawn out. We focus on the ways in which AI and other technologies, or other disruptive exogenous factors, may impinge on occupational employment structure at both the 2- and 4-digit levels of SOC2020. This includes factors linked to the so called 'greening of the economy', as well as demographic and other issues that are expected to disrupt previous trends.

In addition, we have conducted a detailed analysis of recent historical trends at the 4-digit level as indicated by the Labour Force Survey (LFS). This involves reclassifying the historical information using SOC2010 on to the new SOC2020 system. We have then carried out a shift-share analysis to identify in which of the 4-digit categories we can observe significant occupational effects over the period 2011-2021. The key issue is whether these historical occupational effects observed between 2011 and 2021 will continue into the future. This is summarised in Section 3.3 which focuses on the 4-digit results, using the shift-share analysis of the historical LFS data (2001-2021).

3.2 Possible disruptive effects from the literature review and other empirical evidence

We began by conducting a review of international sources to consider possible changes in occupational employment patterns to be introduced in our *Alternative scenarios* for the Nuffield labour market projections for the UK. These included analyses carried out for the US O*NET system,⁶ recent projections conducted by the World Bank (2020),⁷ and numerous papers related to the future of work. In addition, we have conducted a historical trend analysis for 2011-2021 based on LFS data, as well as considering evidence on recent trends on employers' requirements.⁸ We have also drawn upon other work conducted as part of the present research programme.⁹

In general, these sources suggest similar expected future trends in the labour market. People working in automatable occupations are likely to be replaced by new technologies,

⁶ O*NET. 2022. 'Bright Outlook Occupations' Retrieved March 30, 2022 (<https://www.onetonline.org/find/bright?b=0&g=Go>).

⁷ World Economic Forum. 'The future of jobs report 2020.' Geneva, Switzerland: World Economic Forum, 2020.

⁸ The Institute for Employment Research (IER) has been developing a large vacancy database from the main UK job portals since February 2019. This database provides detailed information of employers' requirements.

⁹ See the two working papers prepared for *The Skills Imperative 2035* research programme funded by the Nuffield Foundation and its partners (Taylor *et al.*, (2022) and Wilson *et al.*, (2022)).

including the application of Artificial Intelligence (AI). In addition, a surge in demand is expected for those in high-tech, green and human care-related jobs.

Each of these sources highlighted different occupations/roles which are expected to see significant increases or decreases in demand over the next decade or two. We have mapped these occupations into the SOC2020.¹⁰ This enables us to identify those UK occupations that are likely to experience a significant change in their shares of employment over the period to 2035.

Specifically, 44 occupations (out of the 412 occupations distinguished at SOC2020 4-digit level) have been identified as likely to experience significant job losses between 2021 and 2035. We have also identified 52 other occupations which are expected experience significant increases in employment share over the same period. These occupations are all set out in Table 3.1. In total, these occupations represented about 33.6 per cent of total employment in 2021.

¹⁰ This was done using the Computer Assisted Structured Coding Tool (CASCOT) developed by IER at Warwick and a manual review. CASCOT is a computer program designed to make the coding of text information to standard classifications simpler, quicker and more reliable. Details can be found at: <https://warwick.ac.uk/fac/soc/ier/software/cascot/>

Table 3.1: Selected occupations where significant changes in employment shares are expected

Occupational unit group	Percentage share 2021	Expected significant increases/decreases
1131 Financial managers and directors	1.26	Increases
1136 Human resource managers and directors	0.59	Increases
1137 Information technology directors	0.40	Increases
1254 Waste disposal and environmental services managers	0.03	Increases
2123 Electrical engineers	0.11	Increases
2124 Electronics engineers	0.07	Increases
2125 Production and process engineers	0.14	Increases
2126 Aerospace engineers	0.16	Increases
2127 Engineering project managers and project engineers	0.11	Increases
2129 Engineering professionals n.e.c.	0.47	Increases
2131 IT project managers	0.20	Increases
2132 IT managers	0.76	Increases
2133 IT business analysts, architects and systems designers	0.74	Increases
2134 Programmers and software development professionals	1.44	Increases
2135 Cyber security professionals	0.11	Increases
2136 IT quality and testing professionals	0.12	Increases
2137 IT network professionals	0.08	Increases
2139 Information technology professionals n.e.c.	0.50	Increases
2141 Web design professionals	0.08	Increases
2142 Graphic and multimedia designers	0.33	Increases
2151 Conservation professionals	0.07	Increases
2152 Environment professionals	0.15	Increases
2161 Research and development (R&D) managers	0.21	Increases
2162 Other researchers, unspecified discipline	0.19	Increases
2231 Midwifery nurses	0.13	Increases
2232 Community nurses	0.25	Increases
2233 Specialist nurses	0.22	Increases
2234 Nurse practitioners	0.16	Increases
2235 Mental health nurses	0.14	Increases
2319 Teaching professionals n.e.c.	0.85	Increases
2431 Management consultants and business analysts	0.55	Increases
2433 Actuaries, economists and statisticians	0.18	Increases
2434 Business and related research professionals	0.15	Increases
2440 Business and financial project management professionals	0.93	Increases
2469 Welfare professionals n.e.c.	0.07	Increases
2481 Quality control and planning engineers	0.08	Increases
2483 Environmental health professionals	0.02	Increases

Occupational unit group	Percentage share 2021	Expected significant increases/decreases
3111 Laboratory technicians	0.25	Increases
3112 Electrical and electronics technicians	0.06	Increases
3113 Engineering technicians	0.18	Increases
3119 Science, engineering and production technicians n.e.c.	0.11	Increases
3131 IT operations technicians	0.26	Increases
3132 IT user support technicians	0.38	Increases
3133 Database administrators and web content technicians	0.16	Increases
3544 Data analysts	0.18	Increases
3554 Marketing associate professionals	0.56	Increases
5245 Security system installers and repairers	0.05	Increases
5246 Electrical service and maintenance mechanics and repairers	0.11	Increases
6131 Nursing auxiliaries and assistants	1.51	Increases
6135 Care workers and home carers	2.58	Increases
6136 Senior care workers	0.35	Increases
6137 Care escorts	0.08	Increases
1121 Production managers and directors in manufacturing	0.66	Decreases
2463 Clergy	0.17	Decreases
2471 Librarians	0.07	Decreases
2472 Archivists and curators	0.05	Decreases
3417 Photographers, audio-visual and broadcasting equipment operators	0.20	Decreases
4122 Book-keepers, payroll managers and wages clerks	1.43	Decreases
4123 Bank and post office clerks	0.32	Decreases
4131 Records clerks and assistants	0.42	Decreases
4135 Library clerks and assistants	0.08	Decreases
4152 Data entry administrators	0.13	Decreases
4159 Other administrative occupations n.e.c.	1.84	Decreases
4211 Medical secretaries	0.23	Decreases
4212 Legal secretaries	0.13	Decreases
4213 School secretaries	0.28	Decreases
4214 Company secretaries and administrators	0.07	Decreases
4215 Personal assistants and other secretaries	0.52	Decreases
4216 Receptionists	0.67	Decreases
5111 Farmers	0.31	Decreases
5431 Butchers	0.10	Decreases
7111 Sales and retail assistants	2.93	Decreases
7113 Telephone salespersons	0.22	Decreases
7124 Market and street traders and assistants	0.07	Decreases
7131 Shopkeepers and owners – retail and wholesale	0.36	Decreases

Occupational unit group	Percentage share 2021	Expected significant increases/decreases
7132 Sales supervisors – retail and wholesale	0.59	Decreases
8111 Food, drink and tobacco process operatives	0.41	Decreases
8112 Textile process operatives	0.04	Decreases
8113 Chemical and related process operatives	0.12	Decreases
8114 Plastics process operatives	0.06	Decreases
8115 Metal making and treating process operatives	0.05	Decreases
8119 Process operatives n.e.c.	0.08	Decreases
8120 Metal working machine operatives	0.13	Decreases
8131 Paper and wood machine operatives	0.08	Decreases
8139 Plant and machine operatives n.e.c.	0.07	Decreases
8141 Assemblers (electrical and electronic products)	0.07	Decreases
8142 Assemblers (vehicles and metal goods)	0.10	Decreases
8146 Sewing machinists	0.07	Decreases
8149 Assemblers and routine operatives n.e.c.	0.11	Decreases
8160 Production, factory and assembly supervisors	0.09	Decreases
8213 Taxi and cab drivers and chauffeurs	0.44	Decreases
9211 Postal workers, mail sorters and messengers	0.50	Decreases
9219 Elementary administration occupations n.e.c.	0.17	Decreases
9224 Launderers, dry cleaners and pressers	0.06	Decreases
9229 Elementary cleaning occupations n.e.c.	0.03	Decreases
9241 Shelf fillers	0.17	Decreases

Source: IER estimates.

The rationale behind selecting the adjustments made for these occupations is based on the following considerations/drivers:

- Occupations at risk of automatisisation
- High-tech intensive occupations
- Green occupations
- Ageing of the population and care and health related jobs
- Labour market flexibility
- Rising female labour market participation
- Trend analysis of LFS data for the period 2011 to 2021
- Trend analysis of vacancy data for period 2019 to 2021.

These are discussed in turn.

Occupations at risk of automatisaion:

There is widespread agreement that (at least in developed countries) new technologies (automation and AI) will present further significant opportunities for employers to replace a number of people employed in jobs (or parts of jobs) by machines (Acemoglu and Restrepo, 2019; Lane and Saint-Martin, 2021; Lu and Zhou, 2021). Those jobs with a high component of manual and repetitive (automatable) tasks are at highest risk of being replaced by the new technologies. Paolillo *et al.*, (2022)¹¹, Kandars *et al.*, (2020)¹², Bakhshi *et al.*, (2017)¹³, among other authors, have indicated the automation risk (score or likelihood)¹⁴ of each occupation/role in the labour market. Those occupations/roles with higher automation risk across the studies are expected to experience significant reductions over the following years. These roles include *Data entry clerks, Administrative occupations, Accountants, Sales*, a large share of *Operative roles in the Manufacturing and related sectors*, etc. Of course, much of this is not new, but simply a continuation of trends observed over the past decade and more.

High-tech intensive occupations

It is expected that the introduction of new technologies will destroy some particular jobs and create labour market opportunities for other sets of occupations. Adopting the new technologies will increase the demand for a high-technical workforce that manages and develops these technologies. The World Bank (2020) have indicated the technologies likely to be adopted soon by companies worldwide. This study includes a wide range of technologies such cloud computing, encryption and cybersecurity, power storage and generation, e-commerce and digital trade, etc. It is expected that this phenomenon will positively impact roles such as *Engineering, Data analysts, Developers, Research and development, Digital marketing, Information security analysts*, etc. It is also expected that those technologies will negatively affect the demand for *Administrative and executive secretaries, Bank tellers and related clerks, Bookkeeping and payroll clerks*, among others.

Green occupations

The interventions by many governments to deal with climate change and the so called 'greening' of the economy is expected to have a significant effect on the labour market. The transition to 'net-zero' (2015 Paris Agreement) is modifying the demand for some jobs and skills, and also creating a number of new 'green' occupations. Recent studies suggest that the UK government's announcement on 'New plans to make UK world leader in green energy' have had a considerable impact on the labour demand for green roles or skills (Bosworth *et al.*, 2021).¹⁵ We used the most recent green occupational classification developed by IER (Cardenas-Rubio *et al.*, 2022).¹⁶ This classification uses the SOC 2020 to identify the occupations closely related to the green economy (green new and emerging occupations). Green-related occupations, such as *Environment professionals*, as well

¹¹ Paolillo, A., Colella, F., Nosengo, N., Schiano, F., Stewart, W., Zambrano, D., & Floreano, D. (2022). How to compete with robots by assessing job automation risks and resilient alternatives. *Science Robotics*, 7(65).

¹² Kandars K., Djumalieva, J., Sleeman, C. and Orlik, J. (2020). *Mapping Career Causeways: Supporting workers at risk*. London: Nesta

¹³ Bakhshi, H., Downing, J., Osborne, M. and Schneider, P. (2017). *The Future of Skills: Employment in 2030*. London: Pearson and Nesta

¹⁴ This score is based on the number of tasks that could be carry out by the emerging technologies.

¹⁵ Bosworth, D., Cardenas-Rubio, J., Owen, D., Dickinson, P., and Hogarth, T. (2021). Prepared for EngineeringUK.

¹⁶ Cardenas-Rubio, J. Warhust, C., and Anderson, P. (2022). *Green Jobs in Scotland*. (forthcoming)

Engineering technicians and professionals, Waste disposal and environmental services managers, are among the kind of jobs that are more closely related to the green economy and are expected to be positively affected in the future.

Ageing population and care and health related jobs

The ageing of the population is expected to continue, and with it, the increasing need for *Care and healthcare* workers that attend to the needs of this population (Government Office for Science, 2016).¹⁷ Bakhshi *et al.*, (2017) have concluded this will lead to increasing demand for *Health professionals* (such as *Medical practitioners, Therapy professionals*, etc.) as well as *Welfare professionals* and *Health and Social services managers and directors*.

The above four key drivers (automatisation, high-tech, greening of the economy and ageing) were used to suggest *Alternative scenarios* at 2-digit and 4-digit level. A fifth and sixth driver were considered in order to suggest alternative scenarios at 2-digit level disaggregated by type of contract and gender.

Labour market flexibility

There is widespread agreement that the labour market is becoming more flexible, and forms of work such as self-employment, part-time and zero-hours contracts are becoming more important. Boeri *et al.*, (2020)¹⁸ mentioned that most OECD countries have experienced a significant change in the composition of self-employment in the last 20 years. Global phenomena like the surge of online freelancer platforms such as *freelancer.com*, *upwork.com* etc., will ease the flexibilisation of the labour market (Baldwin and Dingel, 2021; Baldwin *et al.*, 2021)¹⁹ ²⁰. Usually, these platforms are focused on a specific segment of the labour market (e.g., *Programmers, data analysts*, etc.), thus those occupations will likely experience a higher increase in flexible job offers. The US Bureau of Labor Statistics (BLS, 2018)²¹ also suggested occupations (such as personal care services, building cleaning and maintenance, etc.) that will experience a considerable increase in self-employment.

Female labour market participation

It is well-known that female labour participation has increased globally and considerably during the last decades. This trend is to set continue in the following decades (Balliester and Elsheikhi, 2018).²² Thus, the changes introduced in the adjusted shares for female full-time, part-time and self-employ jobs have been made slightly higher than those for men since women's participation in the labour market is expected to increase significantly.

In addition, we conducted a trend analysis of the proportion of part-time jobs offered in the UK by occupation (at 2-digit level), using the vacancy data that IER has collected from 2019. In general, elementary occupations, transport, and customer service occupations were

¹⁷ Government Office for Science. (2016). Future of an ageing population. Oxford Inst. Popul. Ageing.

¹⁸ Boeri, T., Giupponi, G., Krueger, A. B., & Machin, S. (2020). Solo self-employment and alternative work arrangements: A cross-country perspective on the changing composition of jobs. *Journal of Economic Perspectives*, 34(1), 170-95.

¹⁹ Baldwin, R., & Dingel, J. I. (2021). Telemigration and development: On the offshorability of teleworkable jobs. In *Robots and AI* (pp. 150-179). Routledge.

²⁰ Baldwin, R. E., Cardenas-Rubio, J., & Fernández, C. (2021). Telemigration and Digitally Enabled Service Exports: Opportunities for Colombia. Graduate Institute of International and Development Studies, Centre for Trade and Economic Integration.

²¹ BLS (2018). 'Small-business options: Occupational outlook for self-employed workers' Retrieved June 08, 2018 (<https://www.bls.gov/careeroutlook/2018/article/self-employment.htm>).

²² Balliester, T., & Elsheikhi, A. (2018). The future of work: a literature review. ILO research department working paper, 29, 1-54.

selected using this method. Based on the above literature review and empirical results we adjusted the occupational shares by type of contract at 2-digit level.

Recent historical trends

In addition to the above key drivers, we analysed the historical data for 2011-2021 in the UK LFS and also considered the 'Bright Outlook Occupations' listed on the O*NET in order to identify other occupations not previously selected.

Detailed historical data from the LFS have been converted to SOC2020 4-digit categories for 2011-2021, using a mapping developed by the Office for National Statistics²³. We conducted a linear (trend) regression by occupation using historical data 2011-2021. This trend analysis coincided in most cases with our previous thoughts about which occupations are likely to decrease or increase in the future. However, the trend analysis also shows other occupations that were not considered before.

The results of this analysis of historical trends for the last decade (for a selection of occupations only) are shown in Tables 3.2 and Table 3.3. The trend analysis 2011-2021 indicates that *Farmers, Sales and retail assistants, Shopkeepers and owners – retail and wholesale, Sales supervisors – retail and wholesale and Shelf fillers occupations* are the ones experiencing large employment declines which are likely to continue in the following years. These occupations also have a relatively high negative occupation effect between 2011 and 2021. Conversely, *Financial managers and directors, Human resource managers and directors and Teaching professionals n.e.c.* might be expected to continue increasing given the employment trends and the occupational effects between 2011 and 2021.

Table 3.2 The 20 occupations with the most negative and significant employment trends 2011 to 2021

SOC Unit Group	Trend coefficient
7111 Sales and retail assistants	-19,279
6112 Teaching assistants	-10,220
4215 Personal assistants and other secretaries	-9,137
4111 National government administrative occupations	-6,844
4123 Bank and post office clerks	-6,560
7131 Shopkeepers and owners – retail and wholesale	-4,295
9241 Shelf fillers	-3,940
9132 Packers, bottlers, canners and fillers	-3,660
5111 Farmers	-3,641
7132 Sales supervisors – retail and wholesale	-3,500
5231 Vehicle technicians, mechanics and electricians	-2,847
9232 School midday and crossing patrol occupations	-2,781

²³ While in principle this produces a time series for 2011-2021 it appears that there is a discontinuity between the 2020 estimates and those for 2021 which are based on data coded directly to SOC2020. These results need to be treated with caution.

8222 Fork-lift truck drivers	-2,735
5213 Welding trades	-2,709
6221 Hairdressers and barbers	-2,676
5435 Cooks	-2,649
6114 Childminders	-2,616
4112 Local government administrative occupations	-2,259
9211 Postal workers, mail sorters and messengers	-2,175
5422 Printers	-2,063

Source: IER estimates.

Table 3.3 The 20 occupations with the most positive and significant employment trends 2011 to 2021

SOC Unit Group	Trend coefficient
2134 Programmers and software development professionals	21,273
1131 Financial managers and directors	14,693
6131 Nursing auxiliaries and assistants	11,481
2440 Business and financial project management professionals	11,451
2133 IT business analysts, architects and systems designers	11,162
6135 Care workers and home carers	11,123
8214 Delivery drivers and couriers	10,115
7219 Customer service occupations n.e.c.	9,618
1136 Human resource managers and directors	8,793
2319 Teaching professionals n.e.c.	8,178
1132 Marketing, sales and advertising directors	8,004
1137 Information technology directors	7,969
2422 Finance and investment analysts and advisers	7,488
2311 Higher education teaching professionals	7,483
2482 Quality assurance and regulatory professionals	6,729
4122 Book-keepers, payroll managers and wages clerks	6,449
2129 Engineering professionals n.e.c.	6,241
3554 Marketing associate professionals	5,898
3534 Financial accounts managers	5,760
4143 Customer service managers	5,548

Source: IER estimates.

3.3 Summary of occupational adjustments imposed

The *Alternative scenarios* for occupational employment shares have therefore been developed based on:

- The historical patterns from 2011-2021 LFS and vacancy data, in particular focussing upon the observed occupational effects for each of the 412 Unit Groups – where these are significant in the historical period this may indicate the potential for further significant change over the period 2021-2035
- Any evidence from the literature review, O*NET, etc., – occupations which other researchers have identified as having the potential for significant changes in occupational employment shares.

It is important to note that the results from the adjustments for the *Alternative scenarios* are constrained to match the E3ME results by industry, gender, status and region. For this reason, it was necessary to manually evaluate each occupational group, since adjusting the share of one occupation will also affect the other occupational groups. In some cases, the final output was not economically intuitive.

For instance, suppose we wished to increase the share of *Health professionals* from 14 to 20 per cent. This means that we would need to reduce the share of other occupations by 6 percentage points. When we apply this decrease proportionally distributed across occupations, the results might be counterintuitive. Some occupational groups might end up with negative or very small values in the employment level. All these cases were evaluated, and corresponding adjustments were made.

These alternative assumptions have then been applied to the two CE macro scenarios to generate a range of possible implications by 2035. These results are presented in Section 5 below.

4 Macro and Sectoral Employment results

Key messages

The *Automation scenario* projects more than 2 million fewer jobs by 2035 than in the *Baseline*, affecting male employment more than females. All broad sectors of the economy see job losses in this scenario, but Non-market services are less affected.

Relative to the *Baseline projections*, the *Technological opportunities* and *Human-centric scenarios* project higher growth in female employment compared to male employment. This reflects the shift in emphasis to sectors in which women have historically been more employed. The *Human-centric scenario* projects the gender gap in employment to shrink to 1 percentage point by 2035, with women projected to hold a continued higher share of part-time employment compared to men.

The unemployment rate is projected to decrease in the *Baseline projections* and the main two *Alternative scenarios*, from around 4.5 per cent in 2020 to around 3 per cent in 2035. In the *Baseline projections*, unemployment for males was projected to fall more than for females by 2035. In the *Technological opportunities scenario*, male and female unemployment are projected to be similar in levels, while in the *Human-centric scenario*, female unemployment is projected to fall substantially more than male unemployment.

When looking across the six broad sectors of the economy in the *Technological opportunities* and *Human-centric scenarios*, gross value added (GVA) is projected to grow more strongly over 2020-25 than 2025-35 across all sectors, with the exception of Primary sector and utilities. In terms of GVA growth, *Construction* is the fastest-growing sector among the six broad sectors and is particularly strong in the *Technological opportunities scenario*, at 3.5 per cent pa over 2020-35. This is particularly strong in the *Technological opportunities scenario* (3.5 per cent pa over 2020-35, equivalent to a 67 per cent increase over 2020), because of continued demand for housing to address UK-wide shortages for a population with growing incomes (who might be looking at leaving multigenerational family homes or equipping their homes with the latest energy saving solutions and technologies in the future) and anticipated demand for new decarbonisation infrastructure.

In the *Technological opportunities* and *Human-centric scenarios*, employment is projected to grow across all sectors, except in Manufacturing, which is projected to decline over 2020-35 (while still seeing GVA growth). Employment growth in all sectors in the two scenarios is projected to be stronger in the short term (2020-25) than in the longer term (2025-35).

Relative to the *Baseline projections*, the *Technological opportunities scenario* projects stronger employment growth in *Non-market services* and *Primary sector and utilities*, but slightly slower decline in employment in *Manufacturing*. Conversely, the *Human-centric scenario* projects stronger employment growth only in *Non-market services*, though this accounts for nearly 1 million more jobs by 2035 compared to the *Baseline projections*.

Employment losses due to automation are projected to be offset by growth in other sectors, shifting many jobs to *Non-market services* in the *Technological opportunities scenario* and especially the *Human-centric scenario*. Employment is projected to decrease the most in *wholesale trade*, *Retail trade*, and certain *Manufacturing* sectors over 2020-35 in both scenarios. Employment is projected to increase most in *Food and beverage services*, *Land transport*, and certain *Non-market services* sectors, especially *Health and Education*.

4.1 Introduction

This chapter presents the results by six broad sectors, defined as follows (the corresponding divisions of the Standard Industrial Classification are in square brackets):

- Primary sector and utilities [01-09, 35-39]
- Manufacturing [10-33]
- Construction [41-43]
- Trade, accommodation and transport [45-56]
- Business and other services [58-82, 90-99]
- Public administration, education and health (or non-market services) [84-88]

Section 4.2 describes the results of the *Automation scenario*, in which increased automation leads to job losses across the economy. Section 4.3 presents a comparison of the *Technological opportunities* and *Human-centric scenarios* with the *Baseline projections* in terms of employment and unemployment, also examining differences in trends by gender and employment status. Section 4.4 provides a comparison of the scenarios in terms of output (Gross Value Added [GVA]) and employment by broad sector.

4.2 Automation scenario

The *Alternative scenarios* were modelled in two stages. The first stage was the pure *Automation scenario*, in which employment declines due to increasing automation. This increases productivity and leads to job losses in sectors susceptible to automation. The *Technological opportunities* and *Human-centric scenarios* were then developed in the second stage, to reflect investments that lead to increased employment, offsetting the automation losses from the first stage (see Chapter 2 for a more detailed description of the assumptions behind the scenario modelling). This section presents the results of the *Automation scenario* in terms of employment, unemployment, and GVA compared with the *Baseline projections*.

Compared to the *Baseline projections*, the *Automation scenario* projects more than two million fewer jobs in 2035, a decline of 5.4 per cent relative to the *Baseline projections* (see Table 4.1). The largest absolute decrease is in male full-time jobs (a decline of 827,000 jobs) followed by female full-time jobs (447,000 jobs). In terms of percentage differences, the decline is greater in male employment than in female employment. Men tend to work in jobs at higher risk of automation than women.

Table 4.1: Projected employment differences from *Baseline projections* in 2035, by gender and status

Employment	<i>Baseline projections</i> (000s)	<i>Automation scenario</i> (000s)	Absolute difference (000s)	Difference (%)
Male full-time	13,137	12,310	-827	-6.3
Female full-time	9,237	8,790	-447	-4.8
Male part-time	3,250	3,065	-185	-5.7
Female part-time	7,258	6,947	-311	-4.3
Male self-employed	2,954	2,781	-173	-5.9
Female self-employed	1,874	1,797	-77	-4.1
Total	37,710	35,689	-2,021	-5.4

Source: Cambridge Econometrics, MDM-E3 revision 13571.

Note: Values may not sum to listed totals due to rounding.

Table 4.2 shows the projected differences in unemployment by gender between the *Automation scenario* and the *Baseline projections*. The *Automation scenario* projects nearly one million more unemployed men and nearly 750,000 more unemployed women by 2035 compared to the *Baseline projections*. These figures are both more than twice as high as the levels projected in the *Baseline projections*. In terms of the unemployment rate, the *Automation scenario* projects a rate of 8.3 per cent for male workers and 7.5 per cent for female workers; substantially higher than the respective rates of 2.9 per cent and 3.0 per cent in the *Baseline projections*.

Table 4.2: Projected unemployment differences from *Baseline projections* in 2035, by gender

Unemployment	<i>Baseline projections</i> (000s)	<i>Automation scenario</i> (000s)	Absolute difference (000s)	Difference (%)
Male	530	1,490	960	181.0
Female	513	1,260	748	145.8
Unemployment rate (%)	<i>Baseline projections</i>	<i>Automation scenario</i>	Percentage point difference	
Male	2.9	8.3	5.4	
Female	3.0	7.5	4.5	

Source: Cambridge Econometrics, MDM-E3 revision 13571.

Note: Values may not sum to listed totals due to rounding.

Table 4.3 presents the projected differences in GVA by broad sector between the *Automation scenario* and the *Baseline projections*. Despite lower projected employment over the period, the *Automation scenario* projects GVA to be £23.5 billion higher in 2035 than the *Baseline projections* (in 2018 prices). The largest differences are in *Trade, accommodation and transport* (£6.6 billion higher than the *Baseline projections* in 2035) and *Business and other services* (£4.5 billion lower on the same basis). These results suggest that output in the *Trade, accommodation and transport* sector is set to benefit from productivity gains from greater automation due to their role in supporting technology deployment, while the *Business*

and other services sector is set to suffer from greater automation due to falling demand for these services from other sectors that have been automated.

Table 4.3: Projected GVA differences from *Baseline projections* in 2035, by broad sector

GVA	<i>Baseline projections</i> (£2018 billions)	<i>Automation scenario</i> (£2018 billions)	Absolute difference (£2018 billions)	Difference (%)
Primary sector & utilities	81.4	81.4	<0.1	<0.1
Manufacturing	219.2	219.8	0.6	0.3
Construction	158.2	160.1	1.8	1.1
Trade, accommodation & transport	401.4	408.0	6.6	1.6
Business & other services	776.9	772.4	-4.5	-0.6
Non-market services	445.4	446.9	1.5	0.3
Total*	2,327.7	2,351.1	23.4	1.0

Source: Cambridge Econometrics, MDM-E3 revision 13571.

Notes: * Total GVA is the sum of GVA by sector as well as ownership of dwellings and unallocated. The latter components are not listed in the table.

Table 4.4 shows the projected differences in employment by broad sector in 2035 compared to the *Baseline projections*. The largest absolute differences are in *Business and other services* (893,000 fewer jobs) and *Trade, accommodation and transport* (650,000 fewer jobs). These sectors are projected to shed the most jobs due to automation by 2035. All sectors are projected to have a decline of more than 6 per cent compared with the *Baseline projections*, except for *Non-market services*, which is projected to have just 1.3 per cent lower employment (123,000 jobs). *Non-market services* includes services such as *Education, Public administration, and Healthcare*, in which workers are less likely to be replaced by automation.

Table 4.4: Projected employment differences from *Baseline projections* in 2035, by broad sector

Employment	<i>Baseline projections</i> (000s)	<i>Automation scenario</i> (000s)	Absolute difference (000s)	Difference (%)
Primary sector & utilities	808	759	-49	-6.1
Manufacturing	2,341	2,200	-141	-6.0
Construction	2,583	2,418	-165	-6.4
Trade, accommodation & transport	9,859	9,209	-650	-6.6
Business & other services	12,347	11,454	-893	-7.2
Non-market services	9,772	9,649	-123	-1.3
Total	37,710	35,689	-2,021	-5.4

Source: Cambridge Econometrics, MDM-E3 revision 13571.

Note: Values may not sum to listed totals due to rounding.

The results presented in this section describe a scenario in which accelerated automation leads to changes in the economy; namely, a slight rise in GVA and a substantial decline in

employment. These results should be interpreted with caution because they do not account for policy action that might be taken by the UK government to address automation-driven job losses and to capitalise on the potential benefits of widespread automation throughout the economy. The next section describes the results of two such scenarios, in which the employment lost due to automation is offset by employment gains elsewhere.

4.3 *Technological opportunities and Human-centric scenarios*

4.3.1 Employment by gender and employment status

Employment by gender is projected based on historical shares in the data. Consequently, the results by gender reflect the historical composition of employment in each sector. Given the shifts in employment composition in the scenarios, it is quite possible the gender impacts could be quite different from historical experience.

Historically, levels of employment for men and women in the UK have been unequal, with men accounting for a larger share of jobs (51.8 per cent of total employment in 2020). Additionally, men accounted for approximately 60 per cent of full-time workers in 2020, while women accounted for just over 70 per cent of part-time workers. Of self-employed workers, men accounted for 61 per cent and women for 39 per cent.

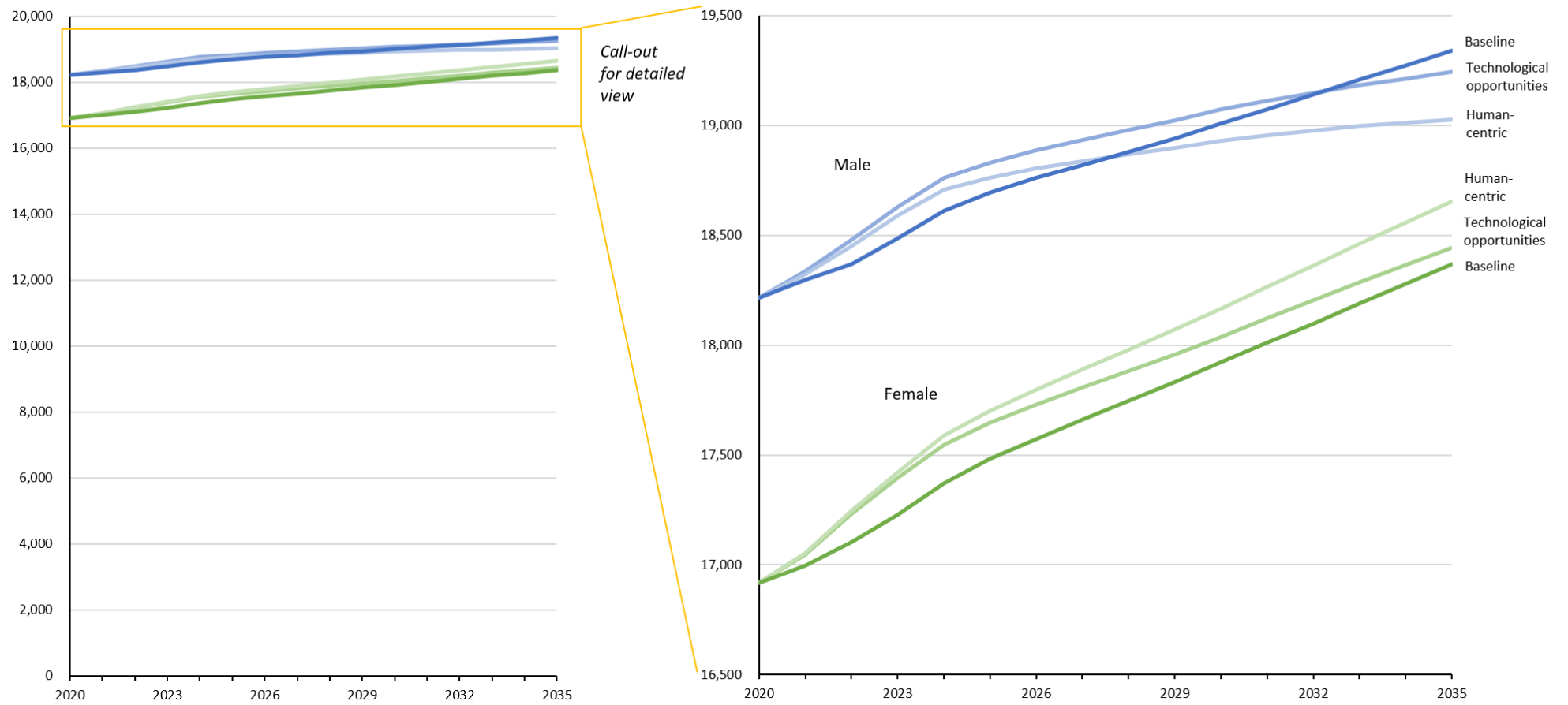
While total employment by 2035 is similar in the *Technological opportunities* and *Human-centric scenarios*, the breakdown by gender varies. The latter is predicated on greater investment in public services and other sectors that have historically employed more women. Female employment is therefore projected to increase the most in this scenario relative to the *Baseline projections*. It is also projected to increase relative to *Baseline projections* in the *Technological opportunities scenario*, though not as strongly as in the *Human-centric scenario*.

In both scenarios, employment is projected to increase between 2020 and 2035 for both men and women. In broad terms, the gender gap in employment remains relatively stable between 2020 and 2035 in the *Baseline projections* but closes somewhat in the two *Alternative scenarios* (see Figure 4.1). Growth in female employment is strongest in the *Human-centric scenario*, owing to the greater emphasis on sectors that have typically employed women. Of the three model runs (*Baseline projections* and *scenarios*), the *Human-centric scenario* thus projects the smallest eventual gap between male and female employment in 2035: a difference of just 1 percentage point (compared to a 2.6 percentage point gap in the *Baseline projections* and a 2.1 percentage point gap in the *Technological opportunities scenario*). As explained at the start of this section, this gender distribution is based on historical shares which could change in the face of the large shifts in employment seen in the scenario.

Both the *Technological opportunities* and *Human-centric scenarios* project stronger growth in male full-time employment in the short term, but slower growth in the longer term (relative to *Baseline projections*), due to the initial sectoral activity to put automation technologies in place occurring in male-dominated industries. Relative to the *Baseline projections*, female employment is projected to grow faster in both scenarios regardless of employment status. The *Technological opportunities scenario* projects 48,000 more female full-time jobs by 2035 than in the *Baseline projections*, while the *Human-centric scenario* projects 142,000 more female full-time jobs on the same basis. In line with historical trends, women are projected to account for a greater share of part-time employment than men in both *scenarios*.

The tables below present detailed results for employment by gender and type (full-time, part-time, and self-employed) for the *Technological opportunities* (Table 4.5) and *Human-centric* (Table 4.6) scenarios.

Figure 4.1: UK employment by gender, 2020-35 (000s)



Source(s): Cambridge Econometrics, MDM-E3 revision 13571.

Table 4.5: UK employment by gender and status, *Technological opportunities scenario*, 2020-35

Employment by gender (000s)	Full-time	Part-time	Self-employed	Total
2020				
Male	12,607	2,925	2,681	18,214
Female	8,190	7,044	1,683	16,918
Total	20,797	9,970	4,364	35,131
2025				
Male	12,952	3,048	2,829	18,829
Female	8,660	7,220	1,765	17,645
Total	21,612	10,267	4,595	36,474
2035				
Male	13,076	3,186	2,981	19,243
Female	9,285	7,264	1,896	18,445
Total	22,361	10,450	4,877	37,688
Share of total employment (%)	Full-time	Part-time	Self-employed	Total
2020				
Male	35.9	8.3	7.6	51.8
Female	23.3	20.1	4.8	48.2
Total	59.2	28.4	12.4	100.0
2025				
Male	35.5	8.4	7.8	51.6
Female	23.7	19.8	4.8	48.4
Total	59.3	28.1	12.6	100.0
2035				
Male	34.7	8.5	7.9	51.1
Female	24.6	19.3	5.0	48.9
Total	59.3	27.7	12.9	100.0
Change in employment (000s)	Full-time	Part-time	Self-employed	Total
2020-25				
Male	345	122	148	615
Female	470	175	83	728
Total	815	298	231	1,343
2025-35				
Male	124	138	152	414
Female	625	45	131	800
Total	749	183	282	1,214
2020-35				
Male	469	260	300	1,029
Female	1,095	220	213	1,528
Total	1,564	480	513	2,557

Source: Cambridge Econometrics, MDM-E3 revision 13571.

Table 4.6: UK employment by gender and status, *Human-centric scenario*, 2020-35

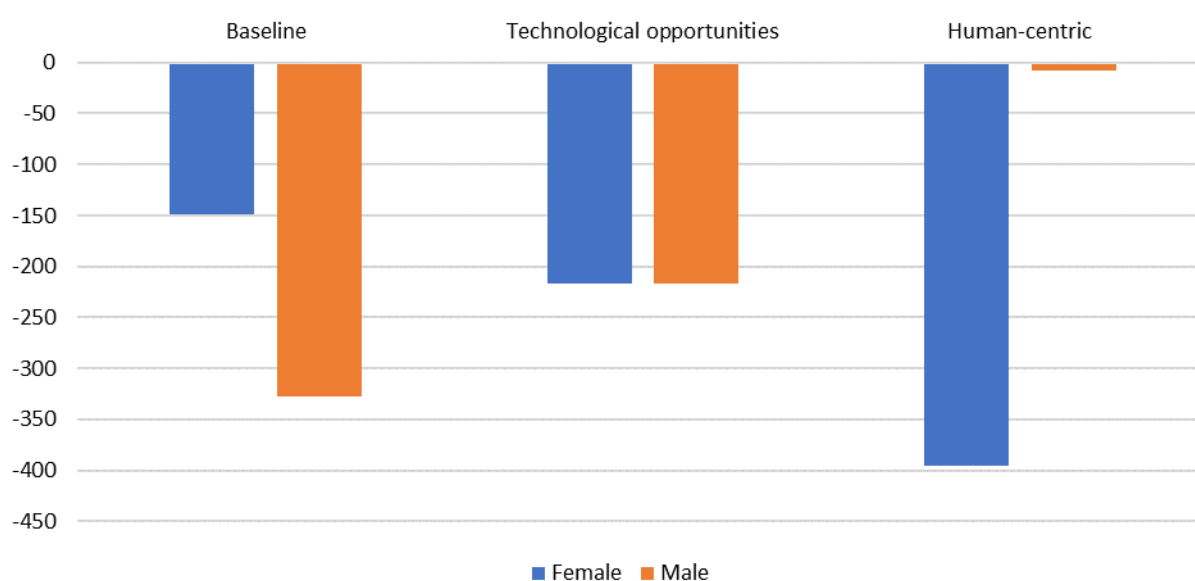
Employment by gender (000s)	Full-time	Part-time	Self-employed	Total
2020				
Male	12,607	2,925	2,681	18,214
Female	8,190	7,044	1,683	16,918
Total	20,797	9,970	4,364	35,131
2025				
Male	12,902	3,047	2,814	18,762
Female	8,682	7,250	1,766	17,699
Total	21,585	10,297	4,580	36,462
2035				
Male	12,913	3,186	2,928	19,027
Female	9,379	7,372	1,905	18,656
Total	22,292	10,557	4,834	37,683
Share of total employment (%)	Full-time	Part-time	Self-employed	Total
2020				
Male	35.9	8.3	7.6	51.8
Female	23.3	20.1	4.8	48.2
Total	59.2	28.4	12.4	100.0
2025				
Male	35.4	8.4	7.7	51.5
Female	23.8	19.9	4.8	48.5
Total	59.2	28.2	12.6	100.0
2035				
Male	34.3	8.5	7.8	50.5
Female	24.9	19.6	5.1	49.5
Total	59.2	28.0	12.8	100.0
Change in employment (000s)	Full-time	Part-time	Self-employed	Total
2020-25				
Male	295	121	133	549
Female	492	206	83	782
Total	787	328	216	1,331
2025-35				
Male	11	139	115	265
Female	696	121	139	957
Total	707	260	254	1,221
2020-35				
Male	306	260	247	813
Female	1,189	327	222	1,738
Total	1,494	588	470	2,552

Source(s): Cambridge Econometrics, MDM-E3 revision 13571.

4.3.2 Unemployment by gender

Both the *Technological opportunities* and *Human-centric scenarios* project a decrease in both male and female unemployment.²⁴ The unemployment rate is projected to decrease in the *Baseline projections* and the main two scenarios, from around 4.5 per cent in 2020 to around 3 per cent in 2035 (see Figure 4.3). In the *Baseline projections*, male unemployment decreases far more than female unemployment, but this is reversed in the *Human-centric scenario*, with almost all the reduction in unemployment projected to be among women (see Figure 4.2). The female unemployment rate in 2035 is projected to be highest in the *Baseline projections* (3.0 per cent) and lowest in the *Human-centric scenario* (1.6 per cent). This finding is opposite for men; the male unemployment rate in 2035 is projected to be highest in the *Human-centric scenario* (4.7 per cent) and lowest in the *Baseline projections* (2.9 per cent). In the *Technological opportunities scenario*, the decrease in unemployment over 2020-35 is projected to be similar for both men and women (a fall of 216,000 people in each case).

Figure 4.2: Changes in (ILO) unemployment by gender in the UK, 2020-35 (000s)

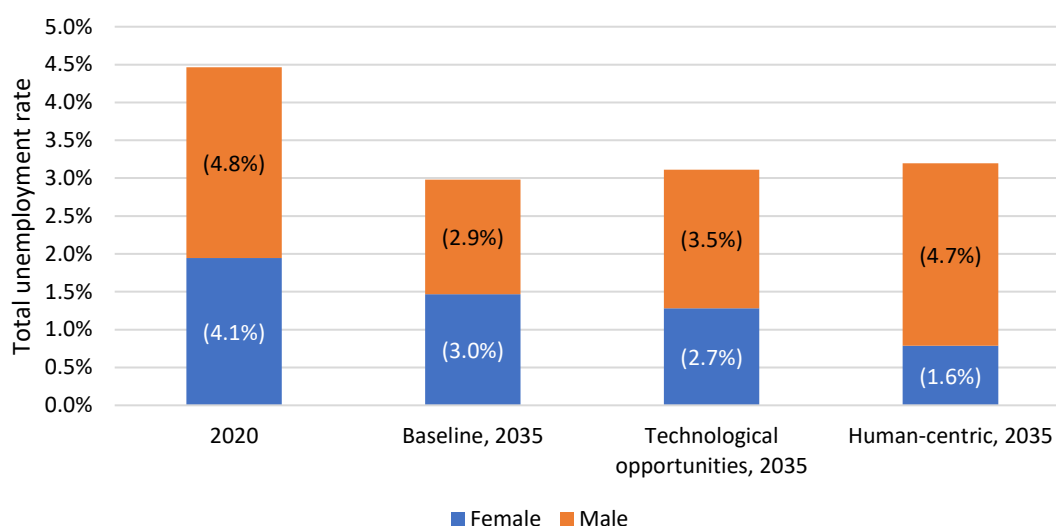


Source: Cambridge Econometrics, MDM-E3 revision 13571.

Note: Unemployment follows the International Labour Organisation (ILO) definition, of people of working age who are not in work but currently available and seeking work.

²⁴ Unemployment follows the International Labour Organisation (ILO) definition, of people of working age who are not in work but currently available and seeking work.

Figure 4.3: Unemployment rates by gender in the UK, 2020-35 (%)



Source: Cambridge Econometrics, MDM-E3 revision 13571.

Note: Numbers in parentheses represent gender-specific unemployment rates, while the height of the bars represents the total unemployment rate.

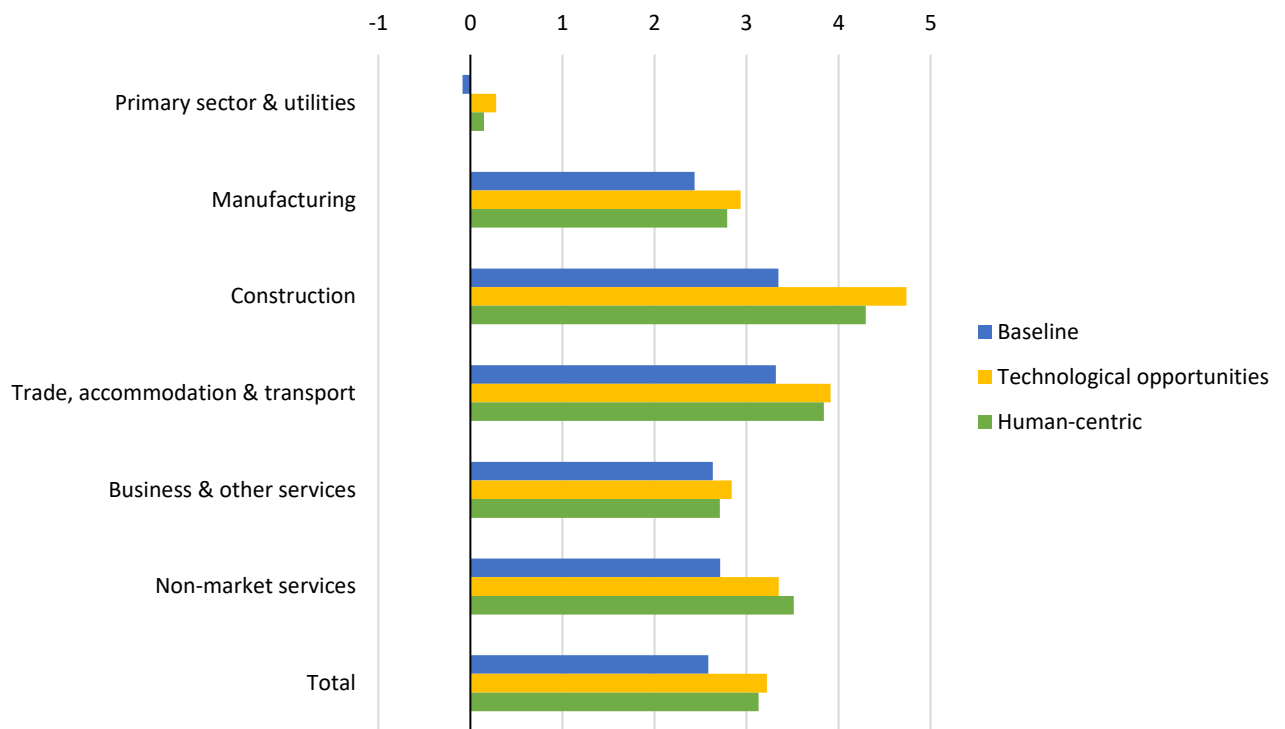
The next section focuses on the output and employment prospects for the same six broad sectors as above: *Primary sector and utilities; Manufacturing; Construction; Trade, accommodation and transport; Business and other services; and Public administration, education and health* (collectively referred to as *Non-market services*).²⁵

²⁵ These services are predominantly provided by the public sector and other non-market producers (i.e. non-profit institutions serving households [NPISH]).

4.3.3 Output by sector

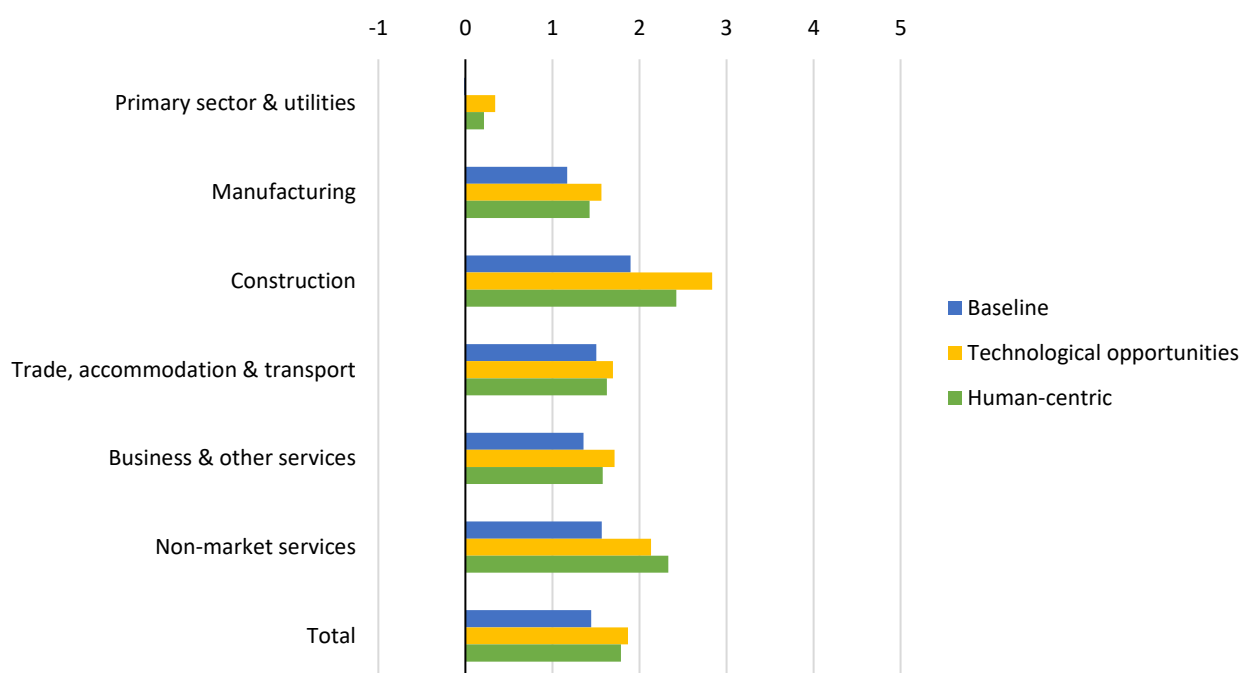
Figure 4.4 and Figure 4.5 summarise GVA (output) growth by broad sector over 2020-25 and 2025-35, respectively. Detailed results for GVA in levels and growth rates are presented in Table 4.7 and Table 4.8.

Figure 4.4: Average GVA growth in the UK by broad sector, 2020-25 (% pa)



Source: Cambridge Econometrics, MDM-E3 revision 13571.

Figure 4.5: Average GVA growth in the UK by broad sector, 2025-35 (% pa)



Source: Cambridge Econometrics, MDM-E3 revision 13571.

Total GVA growth is projected to be stronger in the *Technological opportunities* and *Human-centric scenarios* (around 2¼ per cent pa over 2020-35) than in the *Baseline projections* (1.8 per cent pa over 2020-35). In both scenarios, GVA is projected to grow more strongly over 2020-25 than 2025-35 across all sectors except *Primary sector and utilities*. In aggregate, GVA growth over 2020-35 in the *Technological opportunities scenario* is projected to be the strongest. This is also the case by broad sector with the exception of *Non-market services*, in which the *Human-centric scenario* sees somewhat stronger growth owing to its greater emphasis on such services. *Construction* is the highest growing sector among the six broad sectors in all scenarios and is particularly strong in the *Technological opportunities scenario* (3.5 per cent pa over 2020-35, equivalent to a 67 per cent increase over 2020), because of continued demand for housing to address UK-wide shortages for a population with growing incomes (who might be looking at leaving multigenerational family homes or equipping their homes with the latest energy saving solutions and technologies in the future) and anticipated demand for new decarbonisation infrastructure.

Table 4.7: UK GVA by broad sector, 2020-35 (£2018bn)

	2020	Baseline projections		Technological opportunities scenario		Human-centric scenario	
		2025	2035	2025	2035	2025	2035
Primary sector & utilities	81.8	81.5	81.4	83.0	85.9	82.5	84.2
Manufacturing	173.0	195.1	219.2	199.9	233.4	198.5	228.7
Construction	111.2	131.1	158.2	140.2	185.4	137.3	174.4
Trade, accommodation & transport	293.6	345.7	401.4	355.8	421.0	354.5	416.5
Business & other services	596.2	678.9	776.9	685.7	812.7	681.5	796.9
Non-market services	333.5	381.3	445.4	393.3	485.8	396.4	499.1
Total	1,774.9	2,016.3	2,327.7	2,079.7	2,502.8	2,070.8	2,472.5

Source: Cambridge Econometrics, MDM-E3 revision 13571.

Notes: GVA = gross value added

The sum of GVA of the six broad sectors differs from the UK total because the latter also includes the value added attributed to ownership of dwellings.

Table 4.8: UK GVA growth by broad sector, 2020-35 (% pa)

	Baseline projections			Technological opportunities scenario			Human-centric scenario		
	2020-25	2025-35	2020-35	2020-25	2025-35	2020-35	2020-25	2025-35	2020-35
Primary sector & utilities	-0.1	0.0	0.0	0.3	0.3	0.3	0.1	0.2	0.2
Manufacturing	2.4	1.2	1.6	2.9	1.6	2.0	2.8	1.4	1.9
Construction	3.3	1.9	2.4	4.7	2.8	3.5	4.3	2.4	3.0
Trade, accommodation & transport	3.3	1.5	2.1	3.9	1.7	2.4	3.8	1.6	2.4
Business & other services	2.6	1.4	1.8	2.8	1.7	2.1	2.7	1.6	2.0
Non-market services	2.7	1.6	1.9	3.4	2.1	2.5	3.5	2.3	2.7
Total	2.6	1.4	1.8	3.2	1.9	2.3	3.1	1.8	2.2

Source: Cambridge Econometrics, MDM-E3 revision 13571

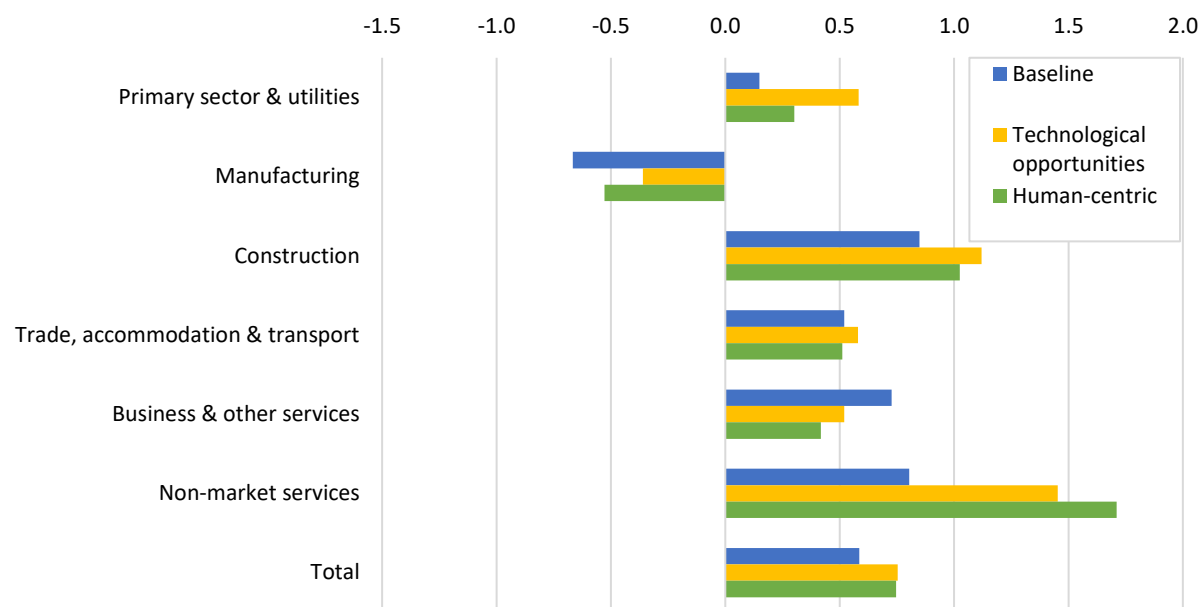
Notes: GVA = gross value added

The sum of GVA of the six broad sectors differs from the UK total because the latter also includes the value added attributed to ownership of dwellings.

4.3.4 Employment by sector

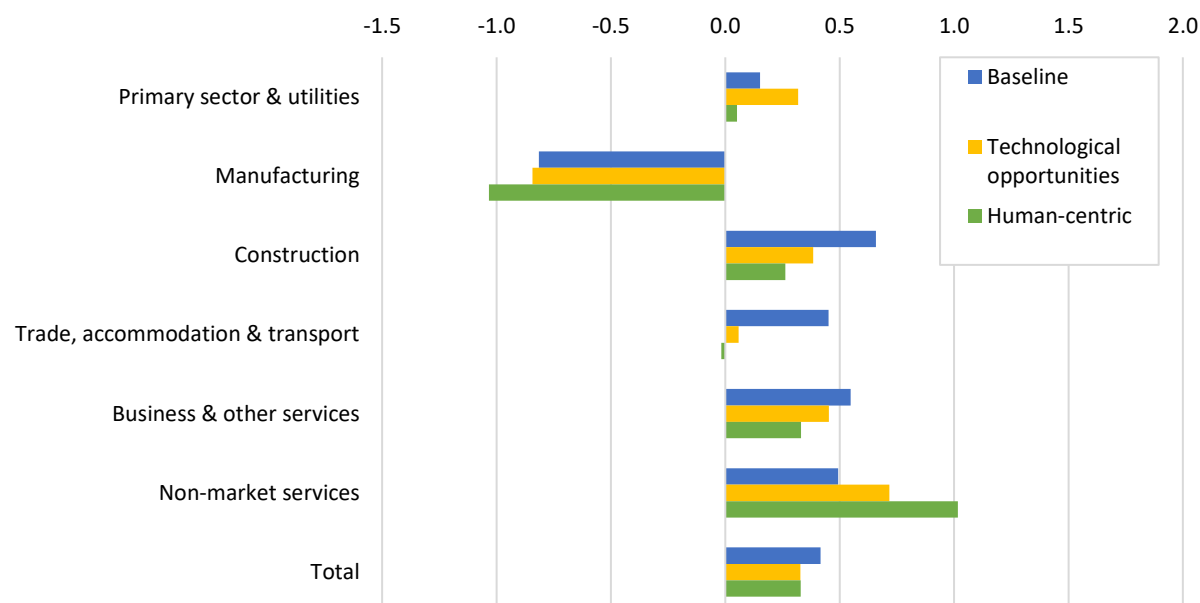
Figure 4.6 and Figure 4.7 summarise the results for employment by broad sector over 2020-25 and 2025-35, respectively. Detailed results (levels and growth rates) are presented in Table 4.9 and Table 4.10.

Figure 4.6: UK employment growth by broad sector, 2020-25 (% pa)



Source: Cambridge Econometrics, MDM-E3 revision 13571.

Figure 4.7: UK employment growth by broad sector, 2025-35 (% pa)



Source: Cambridge Econometrics, MDM-E3 revision 13571.

Table 4.9: UK employment by broad sector, 2020-35 (000s)

	2020	Baseline projections		Technological opportunities scenario		Human-centric scenario	
		2025	2035	2025	2035	2025	2035
Primary sector & utilities	790	796	808	813	840	802	806
Manufacturing	2,627	2,541	2,341	2,580	2,371	2,558	2,306
Construction	2,319	2,419	2,583	2,452	2,548	2,440	2,505
Trade, accommodation & transport	9,184	9,425	9,859	9,453	9,508	9,422	9,405
Business & other services	11,274	11,690	12,347	11,570	12,104	11,511	11,898
Non-market services	8,937	9,302	9,772	9,606	10,318	9,728	10,763
Total	35,131	36,173	37,710	36,474	37,688	36,461	37,683

Source: Cambridge Econometrics, MDM-E3 revision 13571.

Notes: Total employment and employment in public administration, education and health includes HM Forces. Sums of figures may not match reported totals due to rounding.

Table 4.10: UK employment growth by broad sector, 2020-35 (% pa)

	Baseline projections			Technological opportunities scenario			Human-centric scenario		
	2020-25	2025-35	2020-35	2020-25	2025-35	2020-35	2020-25	2025-35	2020-35
Primary sector & utilities	0.1	0.2	0.2	0.6	0.3	0.4	0.3	0.1	0.1
Manufacturing	-0.7	-0.8	-0.8	-0.4	-0.8	-0.7	-0.5	-1.0	-0.9
Construction	0.8	0.7	0.7	1.1	0.4	0.6	1.0	0.3	0.5
Trade, accommodation & transport	0.5	0.5	0.5	0.6	0.1	0.2	0.5	0.0	0.2
Business & other services	0.7	0.5	0.6	0.5	0.5	0.5	0.4	0.3	0.4
Non-market services	0.8	0.5	0.6	1.5	0.7	1.0	1.7	1.0	1.2
Total	0.6	0.4	0.5	0.8	0.3	0.5	0.7	0.3	0.5

Source: Cambridge Econometrics, MDM-E3 revision 13571.

Notes: Total employment and employment in public administration, education and health includes HM Forces. Sums of figures may not match reported totals due to rounding.

Both the main scenarios project continued growth in total employment. This also largely applies at a broad sector level, with all but *Manufacturing* expected to see employment growth over 2020-25. While *Manufacturing* GVA is projected to continue to rise (as in the previous section), continued increases in productivity are projected to lead to a steady decline in employment in these sectors.

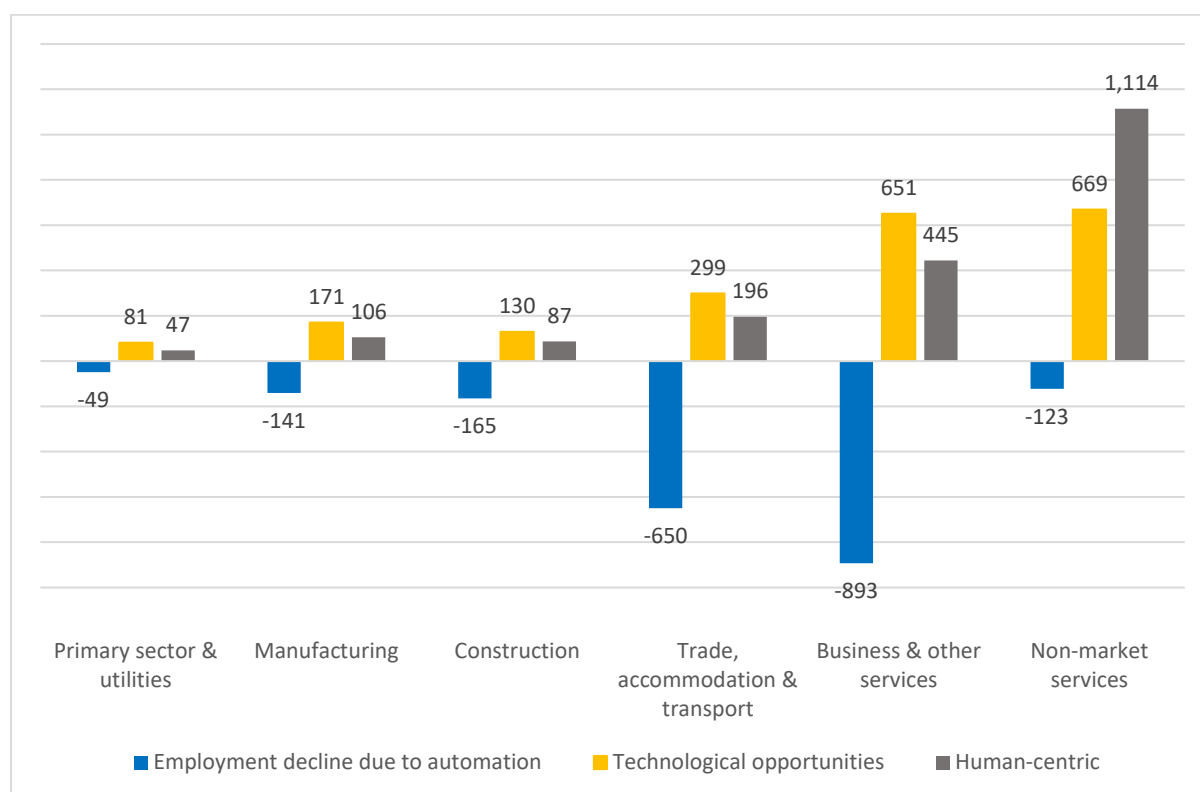
Employment growth in all sectors in the two *Alternative scenarios* is projected to be stronger (more positive/less negative) in the short term (2020-25) than in the longer term (2025-35). In line with this, the decline in employment in *Manufacturing* is also projected to be slower over 2020-25 than 2025-35. Relative to the *Baseline projections*, the *Technological opportunities scenario* projects stronger employment growth in *Non-market services* (due to increased provision of 'population-serving' services, augmented by automation and a somewhat stronger emphasis on human-specific skills, as described in Section 2.5.2) and *Primary sector and utilities* (mainly driven by investment in renewable technologies for electricity generation), as well as slightly slower decline in *Manufacturing* employment. The *Human-centric scenario* projects stronger employment growth relative to the *Baseline projections* only in *Non-market services*, though this accounts for nearly 1 million more jobs by 2035 compared to the *Baseline projections*.

Non-market services is expected to be the strongest growing sector in the two scenarios, with employment projected to grow by 1.0 per cent pa (1.4 million jobs) over 2020-35 in the *Technological opportunities scenario*, and by 1.2 per cent pa (1.8 million jobs) over 2020-35 in the *Human-centric scenario*.²⁶ This compares to an expected growth of 0.6 per cent pa (835,000 jobs) over 2020-35 in the *Baseline projections*. While employment in *Primary sector and utilities* is projected to grow faster in the *Technological opportunities scenario* (0.4 per cent pa [50,000 jobs] over 2020-35) than in the *Baseline projections* (0.2 per cent pa [18,000 jobs] over 2020-35), employment growth in this sector is expected to be slower in the *Human-centric scenario* (0.1 per cent pa [16,000 jobs] over 2020-35) than the *Baseline projections*.

The *Technological opportunities* and *Human-centric scenarios* project declines in employment due to automation (relative to *Baseline projections*), with these declines offset by employment increases elsewhere. Figure 4.8 presents, for both scenarios, the distribution of projected automation-driven decline in employment by 2035 and the concomitant growth in employment that offsets these losses by broad sector. These results show the redistribution of jobs across sectors by 2035. The *Technological opportunities scenario* projects net job losses in *Construction, Trade, accommodation and transport, and Business and other services*. These job losses are offset by net gains in *Primary sector and utilities, Manufacturing, and Non-market services*. The *Human-centric scenario* projects a net loss of jobs in all sectors except *Non-market services*, which offsets the losses in the other sectors.

²⁶ *Non-market services* refer to services being provided by the government e.g. healthcare, schools, etc. The increase in demand for jobs in these sectors is to reflect increased demand for 'population-serving' jobs as described in the narrative/assumptions in section 2.5.2. This also explains why there's an even stronger impact in the *Human-centric scenario*. The impact on *Construction* to build green infrastructure is accounted for elsewhere (*Construction* is reported as a separate sector).

Figure 4.8: Projected automation-driven employment declines and increases in 2035, by broad sector (000s)



Source: Cambridge Econometrics, MDM-E3 revision 13571.

Notes: The blue bars represent the projected decline in employment in 2035 for each of the six broad sectors due to automation (as compared with the Baseline projection). The orange and grey bars represent the concomitant increase in employment due to other factors (see Chapter 2 for a description of these) for the Technological opportunities and Human-centric scenarios, respectively.

Table 4.11 lists the detailed sectors with the largest projected increases and decreases in employment between 2020 and 2035 for both the *Technological opportunities* and *Human-centric scenarios*. The sectors with the largest declines in employment across the two scenarios are *Retail, Wholesale trade* and *Other manufacturing*, in which jobs are at higher risk of automation. *Retail trade* in particular has large projected declines in employment in both scenarios (losses of nearly 270,000 jobs between 2020 and 2035). This compares to a modest increase (18,300 jobs) in the *Baseline projections*. This difference in outcomes results from retail trade taking full advantage of automation technologies, obviating the need for workers; for example, with automated payment systems that require fewer workers to maintain and operate. The sectors with some of the largest increases in employment are *Food and beverage services* and *land transport*, which are sectors that benefit through supply chain and induced impacts. The other four sectors with large increases in employment fall under *Non-market services*, including *Health, Education, Social work, and Residential care*. These sectors benefit from employment growth driven by demographic changes (a growing and aging population), automation (demand for new roles that enhance labour-technology complementarity), and increased investment, especially in the *Human-centric scenario*. Appendix A provides a list of projected employment changes over 2020-35 by all detailed sectors for each scenario.

Table 4.11: Sectors with greatest employment growth and decline by detailed sector, 2020-35 (000s)

Sectors with greatest employment decline	<i>Baseline projections</i>	<i>Technological opportunities</i>	<i>Human-centric</i>
Retail trade [47]	18.3	-268.0	-269.6
Other transport equipment [30]	-22.3	-28.8	-29.0
Wholesale trade [46]	21.4	-27.3	-34.7
Metal products [25]	-40.6	-25.1	-34.2
Textiles [13]	-16.6	-23.1	-22.6
Machinery n.e.c. [28]	-19.8	-22.7	-26.3
Sectors with greatest employment growth	<i>Baseline projections</i>	<i>Technological opportunities</i>	<i>Human-centric</i>
Health [86]	368.7	580.7	845.4
Food and beverage services [56]	333.8	331.5	334.1
Education [85]	144.3	308.9	425.7
Social work [88]	151.3	198.5	270.9
Land transport, etc. [49]	75.2	185.1	115.6
Residential care [87]	136.4	174.4	232.1

Source: Cambridge Econometrics, MDM-E3 revision 13571.

Note: SIC 2007 codes are listed in square brackets after each sector.

5 Implications for Occupations

Key messages

With the exception of the *Automation scenario*, almost all the 2½ million growth in job numbers between 2020 and 2035 will be for skilled, white-collar, non-manual workers.

Nearly 90 per cent of the net increase in employment will be for *Professional and Associate professional* jobs in the *Baseline projections* and the two main scenarios considered.

Reductions in employment levels are projected for *Administrative and secretarial* and *Skilled trades occupations*. This reflects ongoing trends towards automation as well as the falling share of manufacturing and other non-service sectors in the economy.

The variations in industrial employment structure built into the scenarios are reinforced by the adjustments to occupational employment patterns within industries imposed, which serves to accelerate and accentuate the trends in occupational patterns driven by the sectoral changes projected.

In all the scenarios there is some hollowing out of the middle of the occupational structure with some increases in employment for some less skilled elementary jobs and lower skilled care workers. The hollowing out is most severe in the *Automation scenario*. The occupations most affected are traditional *Manual skilled and semi-skilled occupations*.

Job losses in areas such as *Administrative and secretarial* and *Skilled trades* are even more marked in the *Automation scenario*, and also a key feature of the *Technological opportunities* and *Human-centric scenarios*. Growing job numbers for *Professional and Associate professional* as well as *Caring and Other leisure service occupations* are all reinforced in the *Technological opportunities* and *Human-centric scenarios*.

As emphasised in the *Baseline projections* report it is important to bear in mind that Replacement Demands will easily outweigh any net changes in projected employment levels for all occupations, even in those areas where employment is projected to decline between 2020 and 2035. There will be significant job openings and requirements for skills even in areas such as *Administrative and secretarial* and *Skilled trade occupations* which are projected to see significant job losses in all the scenarios.

The results also draw out the implications for the more detailed SOC2020 Unit groups (4-digit level, 412 categories). These do not show much variation between scenarios. This is largely a consequence of the limited evidence on which to base any changes in 4-digit shares within 2-digit categories.

5.1 Introduction

This chapter presents the implications of the results for occupational employment. The impacts at the 2-digit level are considered in Section 5.2 while Section 5.3 focuses on the implications for 4-digit occupations.

5.2 Broad occupational implications

This chapter presents the implications of the results for occupational employment at a broad level, focusing on the implications at the 1- and 2-digit level SOC Major and Sub-Major Groups (SMGs).

In the previous sections we have developed and described 4 alternatives, including the *Baseline projections*. The first of the *Alternative scenarios* is the *Automation scenario*, which

focuses on the potentially negative impacts of such technology on employment. The *Technological opportunities scenario* adds to this by allowing for more positive job creative opportunities offered by these new technologies. Finally, the *Human-centric scenario*, also builds on the *Automation scenario*, but focussing more upon the creation of new jobs in the areas of *Health and Education*.

Comparisons across scenarios without occupational adjustments (*Baseline projections, Automation, Technological opportunities, Human-centric scenarios*)

This sub-section describes the implications of these alternative macroeconomic and sectoral employment scenarios, but assuming the same trends in occupational employment patterns within industries. In the following sub-section, the impact of the assumed changes in occupational patterns are assessed for the *Baseline projections* only. This is described as *Baseline adjusted projections* (BS*). In the next sub-section these are brought together to assess the range of possible outcomes, allowing for both differences in the level of total employment and sectoral employment levels, as well as changes in occupational employment patterns. These are described as *Automation adjusted scenario* (AS*), *Technological opportunities adjusted scenario* (TS*) and *Human-centric adjusted scenario* (HS*).

Comparing the *Automation scenario* with the *Baseline projections* shows the potential negative impact on jobs if automation and related technologies have the impact on employment that many have suggested, but without any offsetting positive effects from new jobs created by the opportunities offered by these new technologies. In total there are some 2 million fewer jobs by 2035 in the *Technological opportunities scenario*. This builds up from a negative impact of about 400,000 in 2025.

In Table 5.1, which does not include the occupational adjustments imposed, the effects across occupations are roughly proportionate to their employment levels. Differences in the impact on different industries mean that the percentage effects are slightly larger for occupations such as *Skilled trades* and *Process, plant and machine operatives*, but these are minor.

Table 5.2 provides additional detail, going down to 2-digit occupations (the sub-major groups). Even here, without any additional occupational adjustments imposed, the percentage impacts do not show much variation across the scenarios. *Secretarial and related* occupations see the largest percentage impact (a job loss of 8.6 per cent in the *Automation scenario* compared with the *Baseline projections*). *Leisure, travel and related personal service occupations* is the category with the smallest impact (-4.8 per cent). All else equal, the changes in industrial employment structure implied by the *Alternative scenarios* do not have a significant impact on occupational employment patterns.

The impact of the additional changes we have imposed on occupational patterns within industries is considered in Section 5.3 below.

The comparisons discussed so far have focused on total employment in 2035 or projected net changes in employment between 2020 and 2035. When we compare Replacement Demands over the 2020-35 period, the differences between the scenarios are even less marked (see Figure 5.3). Note that Total Requirements (or job openings) is the sum of projected net changes and replacement demands.

The time series profiles shown in Figure 5.4 for Major Groups, emphasise that the main differences are between the *Automation scenario* (which emphasises potential job losses)

and all the others. This also applies at the more detailed Sub-major Group level as shown in Figure 5.5 (000s) and Figure 5.6 (percentage shares of total employment).

Table 5.1: Employment in 2035 for Major Groups compared across the scenarios (no occupational adjustments)

Males and Females

Levels (000s)	Baseline (BS)	Automation (AS)	Technological opportunities (TS)	Human-centric (HS)
Managers, directors and senior officials	3,924	3,709	3,928	3,914
Professional occupations	9,792	9,262	9,778	9,772
Associate professional occupations	5,533	5,243	5,539	5,542
Administrative and secretarial	3,597	3,400	3,601	3,619
Skilled trades occupations	2,958	2,783	2,958	2,929
Caring, leisure and other service	3,419	3,252	3,419	3,440
Sales and customer service	2,835	2,694	2,835	2,848
Process, plant and machine operatives	1,952	1,831	1,939	1,924
Elementary occupations	3,558	3,371	3,550	3,554
All occupations	37,568	35,547	37,546	37,541

Shares (%)	Baseline (BS)	Automation (AS)	Technological opportunities (TS)	Human-centric (HS)
Managers, directors and senior officials	10%	10%	10%	10%
Professional occupations	26%	26%	26%	26%
Associate professional occupations	15%	15%	15%	15%
Administrative and secretarial	10%	10%	10%	10%
Skilled trades occupations	8%	8%	8%	8%
Caring, leisure and other service	9%	9%	9%	9%
Sales and customer service	8%	8%	8%	8%
Process, plant and machine operatives	5%	5%	5%	5%
Elementary occupations	9%	9%	9%	9%
All occupations	100%	100%	100%	100%

Change (000s) 2020-2035	Baseline (BS)	Automation (AS)	Technological opportunities (TS)	Human-centric (HS)
Managers, directors and senior officials	167	-48	170	156
Professional occupations	1,582	1,052	1,568	1,561
Associate professional occupations	755	466	762	765
Administrative and secretarial	-136	-333	-132	-114
Skilled trades occupations	-67	-243	-68	-97
Caring, leisure and other service	291	124	291	312
Sales and customer service	46	-95	46	59
Process, plant and machine operatives	-10	-130	-23	-37
Elementary occupations	-34	-221	-42	-38
All occupations	2,593	572	2,571	2,566

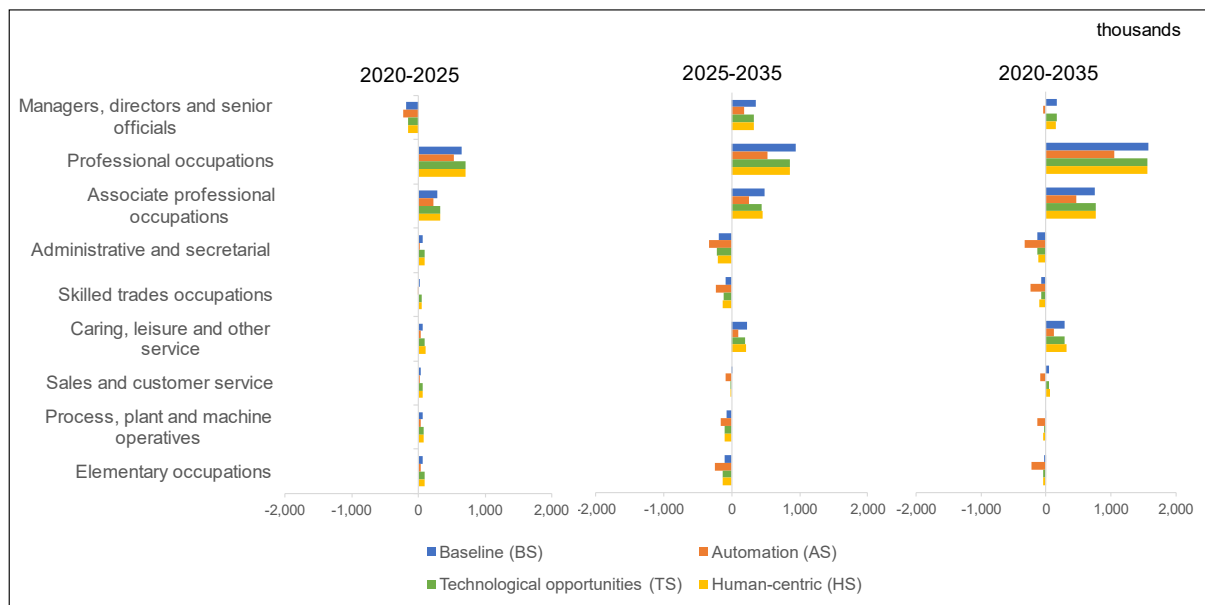
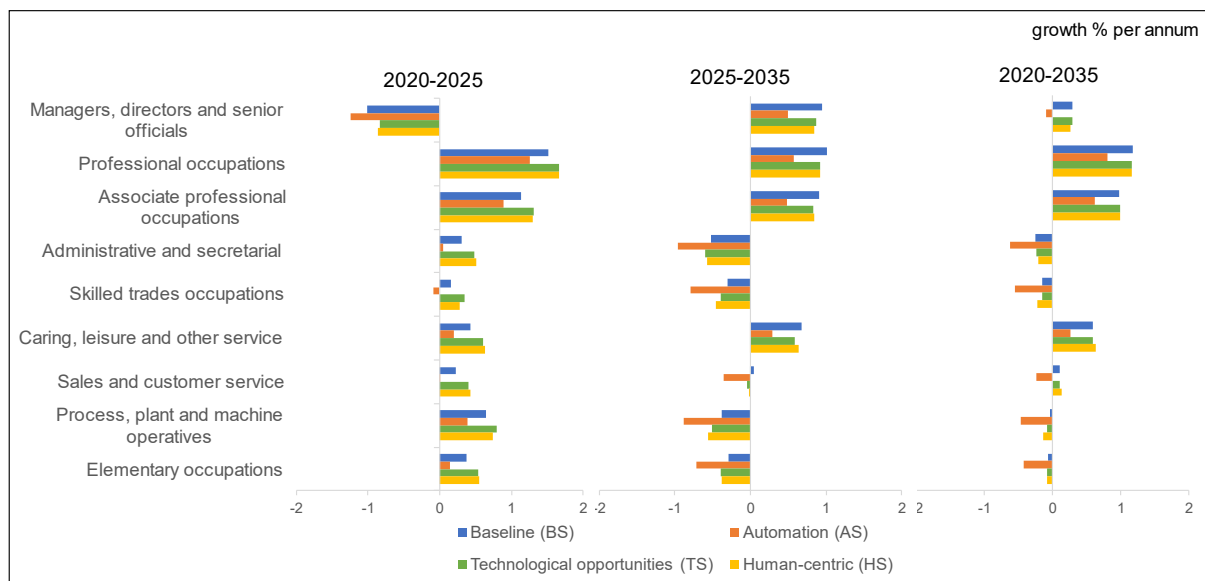
Source: IER estimates.

Table 5.2: Employment for Sub-major Groups in 2035 compared across the scenarios (no occupational adjustments)

Levels (000s)	Baseline (BS)	Automation (AS)	Technological opportunities (TS)	Human-centric (HS)
11 Corporate managers & directors	2,586	2,445	2,589	2,581
12 Other managers & proprietors	1,338	1,265	1,339	1,333
21 Science, research, engineering & technology professionals	3,065	2,887	3,059	3,042
22 Health professionals	1,774	1,685	1,775	1,783
23 Teaching & other educational professionals	1,947	1,845	1,934	1,942
24 Business, media & public service professionals	3,006	2,845	3,010	3,005
31 Science, engineering & technology associate professionals	711	671	710	707
32 Health & social care associate professionals	1,279	1,217	1,281	1,290
33 Protective service occupations	360	339	358	357
34 Culture, media & sports occupations	757	720	761	759
35 Business & public service associate professionals	2,425	2,297	2,429	2,429
41 Administrative occupations	3,117	2,959	3,120	3,132
42 Secretarial & related occupations	480	442	481	486
51 Skilled agricultural & related trades	407	384	408	404
52 Skilled metal, electrical & electronic trades	1,022	959	1,019	1,008
53 Skilled construction & building trades	835	784	838	826
54 Textiles, printing & other skilled trades	694	655	693	691
61 Caring personal service occupations	2,688	2,555	2,687	2,706
62 Leisure, travel & related personal service occupations	701	669	701	704
63 Community & civil enforcement occupations	30	29	30	30
71 Sales occupations	2,086	1,985	2,087	2,098
72 Customer service occupations	749	710	748	750
81 Process, plant & machine operatives	757	713	755	751
82 Transport & mobile machine drivers & operatives	1,195	1,119	1,184	1,174
91 Elementary trades & related occupations	944	894	942	942
92 Elementary administration & service occupations	2,614	2,477	2,608	2,612
All occupations	37,568	35,547	37,546	37,541

Source: IER estimates.

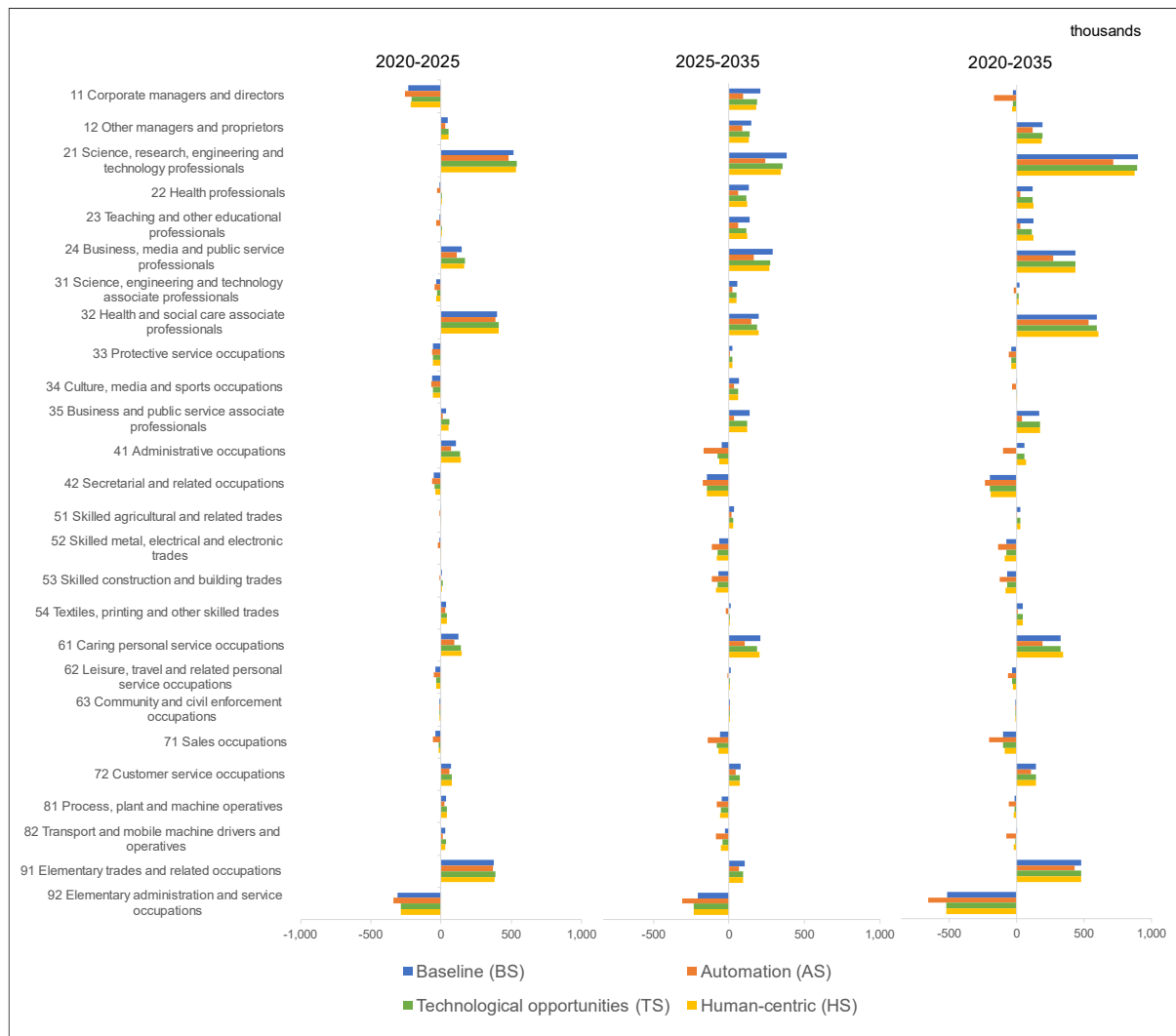
Figure 5.1: Net Changes in employment, Major Groups, All scenarios, 2020-2035



Source: IER estimates.

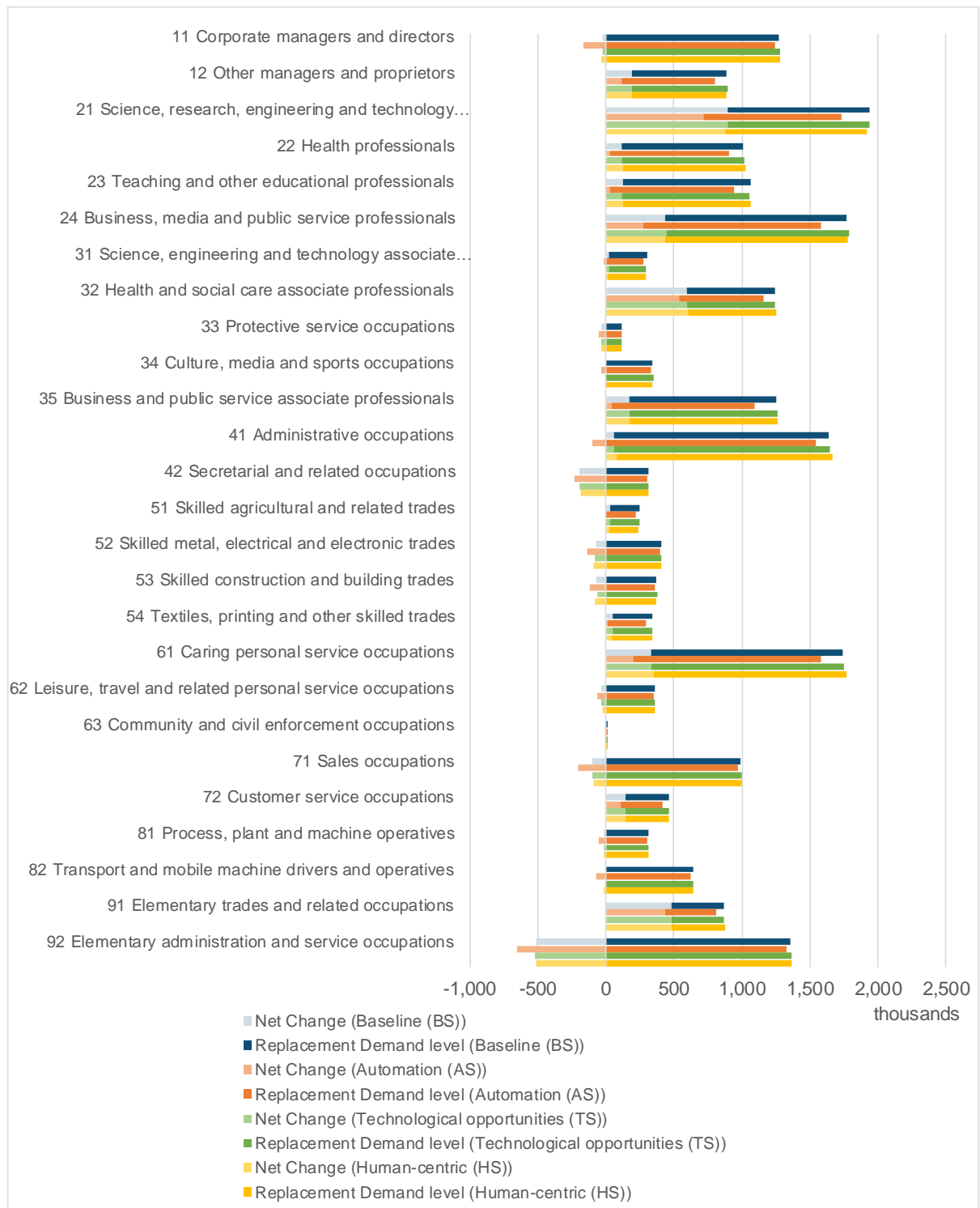
Note: The negative change for the Managers group for 2020-25 reflects primarily a statistical problem in the LFS data for 2020 compared with 2021.

Figure 5.2: Net Changes in employment, Sub-major Groups, 2020-2035



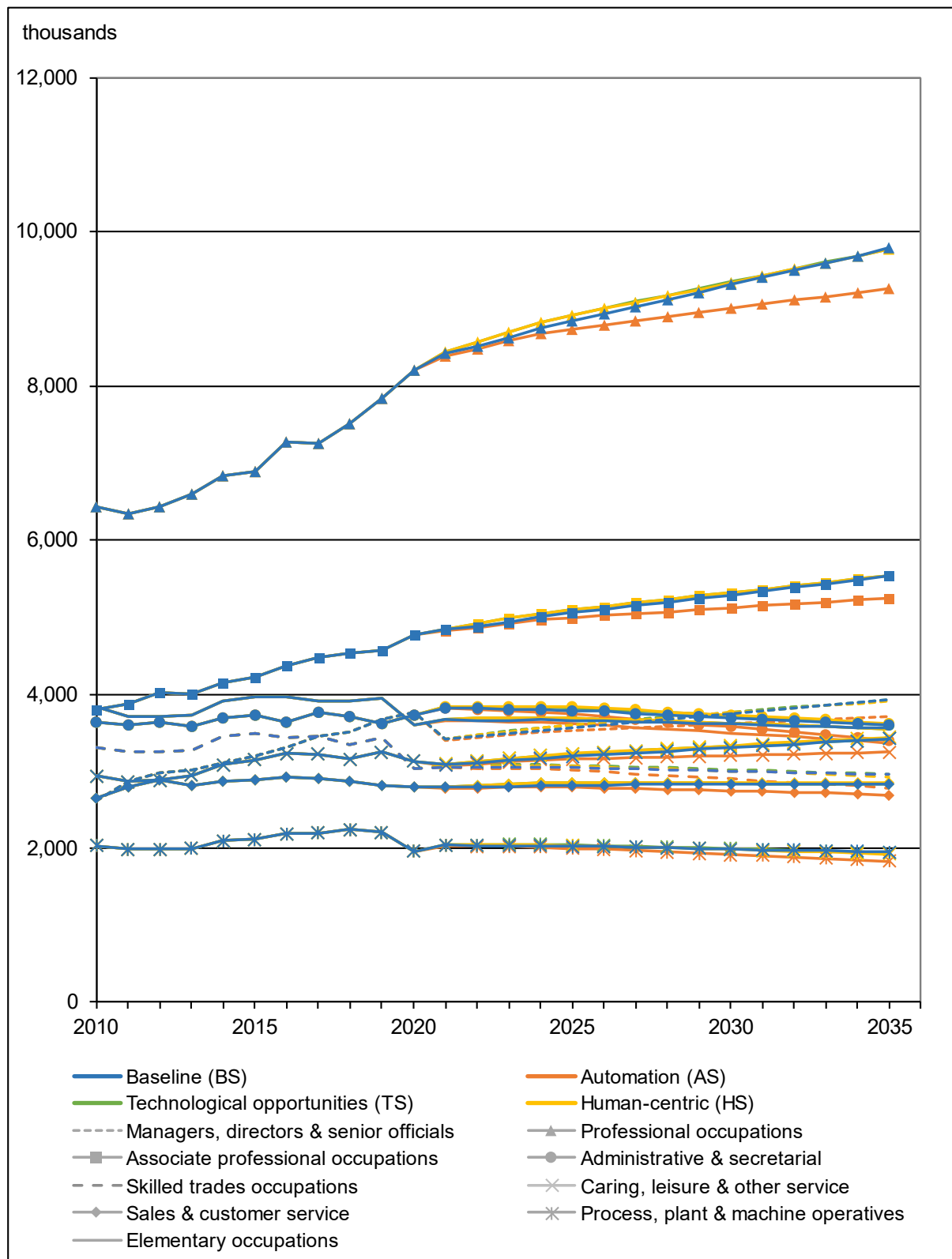
Source: IER estimates.

Figure 5.3: Replacement Demands by SOC2020 Sub-major Groups compared across scenarios, 2020-2035



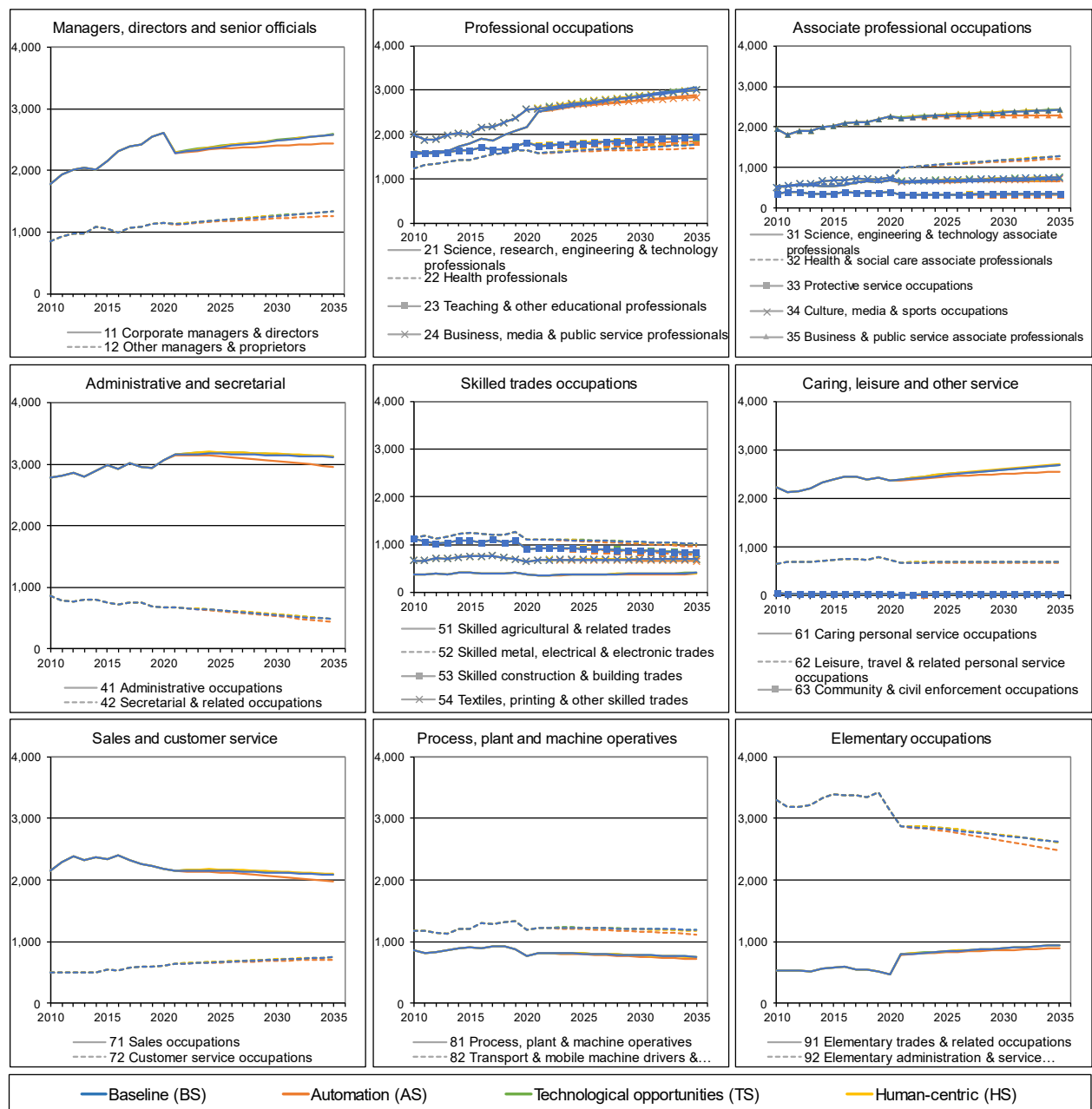
Source: IER estimates.

Figure 5.4: Time series profiles, Major Groups, 2020-35



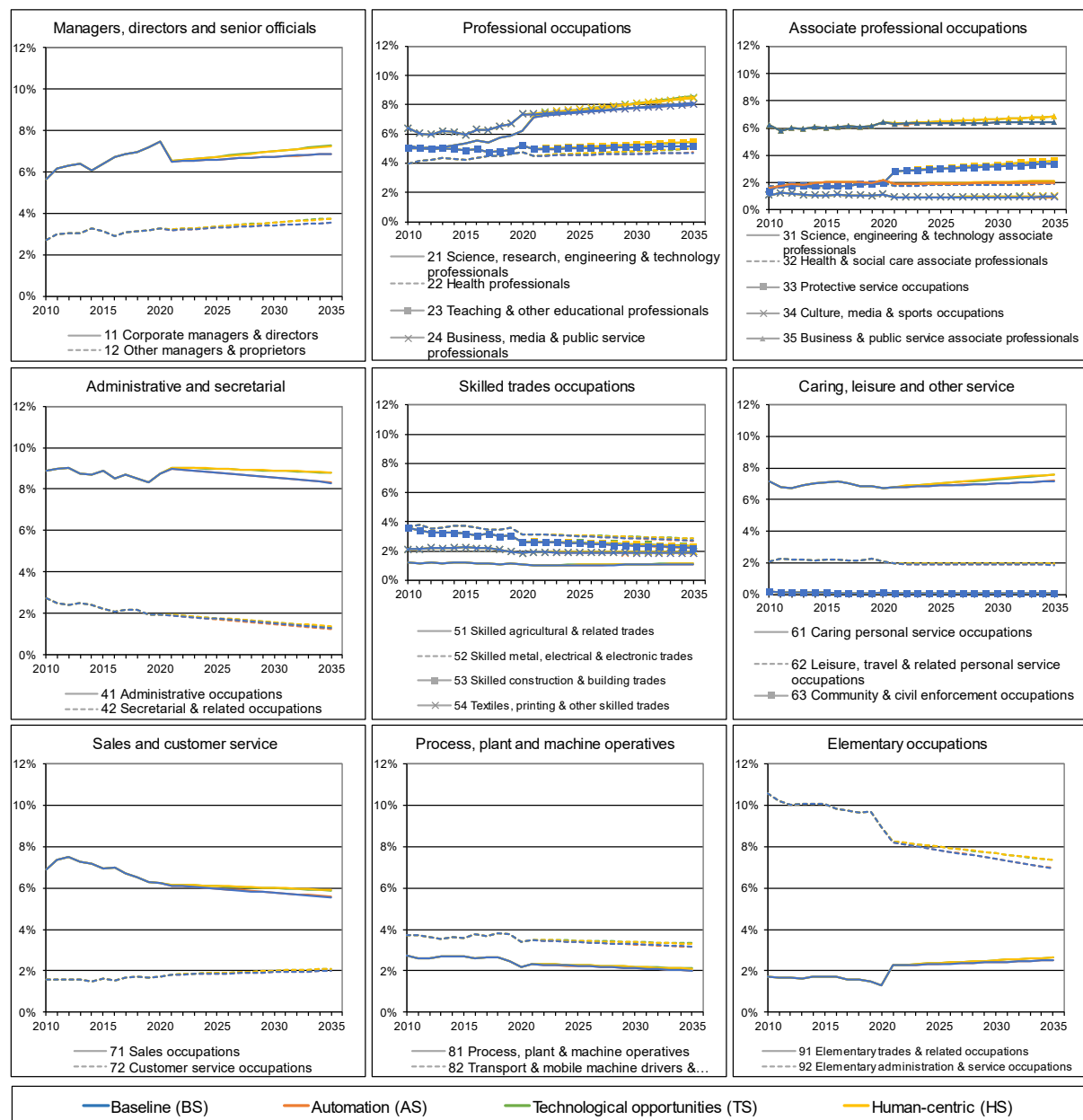
Source: IER estimates.

Figure 5.5: Time series profiles, Sub-major groups, 000s



Source: IER estimates.

Figure 5.6: Time series profiles, Sub-major groups, Percentage shares



Source: IER estimates.

Comparisons for *Baseline projections* – with and without occupational adjustments

The next two tables focus on just two scenarios *Baseline projections (BS)* and *Baseline adjusted projections (BS*)*. These show the impact of the detailed occupational adjustments that have been imposed, based on the review of the literature about occupations most at risk of change, etc. These adjustments have been imposed, both at the 2-digit level and within 2-digits for 4-digit occupations. The results shown in these tables show the impact on the *Baseline projections* of imposing these adjustments.

Table 5.3: Employment in 2035 for Major Groups compared between *Baseline projections* and *Baseline adjusted projections* (occupational adjustments only)

Levels (000s)	<i>Baseline projections</i>	<i>Baseline adjusted</i>
Managers, directors and senior officials	3,924	3,821
Professional occupations	9,792	10,326
Associate professional occupations	5,533	5,612
Administrative and secretarial	3,597	3,460
Skilled trades occupations	2,958	2,828
Caring, leisure and other service	3,419	3,596
Sales and customer service	2,835	2,639
Process, plant and machine operatives	1,952	1,911
Elementary occupations	3,558	3,376
All occupations	37,568	37,568

Shares (%)	<i>Baseline projections</i>	<i>Baseline adjusted</i>
Managers, directors and senior officials	10%	10%
Professional occupations	26%	27%
Associate professional occupations	15%	15%
Administrative and secretarial	10%	9%
Skilled trades occupations	8%	8%
Caring, leisure and other service	9%	10%
Sales and customer service	8%	7%
Process, plant and machine operatives	5%	5%
Elementary occupations	9%	9%
All occupations	100%	100%

Change (000s) 2020-2035	<i>Baseline projections</i>	<i>Baseline adjusted</i>
Managers, directors and senior officials	167	63
Professional occupations	1,582	2,116
Associate professional occupations	755	834
Administrative and secretarial	-136	-274
Skilled trades occupations	-67	-198
Caring, leisure and other service	291	468
Sales and customer service	46	-150
Process, plant and machine operatives	-10	-51
Elementary occupations	-34	-216
All occupations	2,593	2,593

Source: IER estimates.

Comparing *Baseline adjusted projections* with *Baseline projections* shows the impact of the additional changes we have imposed on occupational patterns within industries by assumption. These adjustments are based upon our review of the literature on occupations at greatest risk of change. The adjustments to occupational employment shares sum to zero across all occupations.

Table 5.3 focuses on the 9 Major Groups. *Professional occupations* are the main beneficiaries, increasing their overall share of employment in 2035 by just under 1½ percentage points. *Caring, leisure and other service occupations* gain ½ a percentage point. In contrast, *Skilled trades occupations*, *Sales and customer service occupations* and *Elementary occupations* lose a ½ percent share, with *Administrative and secretarial* and *Skilled trades occupations* not far behind. In terms of numbers of jobs, *Professional occupations* are projected to gain over half a million jobs by 2035, while *Sales and customer service occupations* and *Elementary occupations* both lose almost 200,000 jobs by 2035.

Table 5.4 provides additional detail, going down to 2-digit occupations (the sub-major groups). *Science, research, engineering and technology professionals* is the group that shows the greatest job gains (almost half a million). *Science, engineering and technology associate professionals* and *Caring personal service occupations* also gain over 200,000 jobs. The job losses hit *Business and public service associate professionals*, *Administrative occupations* and *Sales occupations* hardest with losses of between 150,000 and 200,000.

In the next sub-section these adjustments are combined with the impact of the macroeconomic scenarios presented in the first sub-section.

Table 5.4: Employment for Sub-major Groups in 2035 compared between *Baseline projections and Baseline adjusted projections (occupational adjustments only)*

Males and Females

Levels (000s)	<i>Baseline projections</i>	<i>Baseline adjusted</i>	Difference
11 Corporate managers & directors	2,586	2,505	-81
12 Other managers & proprietors	1,338	1,315	-22
21 Science, research, engineering & technology professionals	3,065	3,536	471
22 Health professionals	1,774	1,873	99
23 Teaching & other educational professionals	1,947	2,048	101
24 Business, media & public service professionals	3,006	2,869	-137
31 Science, engineering & technology associate professionals	711	923	212
32 Health & social care associate professionals	1,279	1,387	108
33 Protective service occupations	360	331	-29
34 Culture, media & sports occupations	757	703	-54
35 Business & public service associate professionals	2,425	2,267	-158
41 Administrative occupations	3,117	2,961	-156
42 Secretarial & related occupations	480	498	19
51 Skilled agricultural & related trades	407	382	-25
52 Skilled metal, electrical & electronic trades	1,022	965	-57
53 Skilled construction & building trades	835	843	8
54 Textiles, printing & other skilled trades	694	637	-57
61 Caring personal service occupations	2,688	2,889	201
62 Leisure, travel & related personal service occupations	701	678	-23
63 Community & civil enforcement occupations	30	29	-1
71 Sales occupations	2,086	1,889	-197
72 Customer service occupations	749	750	1
81 Process, plant & machine operatives	757	659	-98
82 Transport & mobile machine drivers & operatives	1,195	1,252	57
91 Elementary trades & related occupations	944	828	-116
92 Elementary administration & service occupations	2,614	2,548	-66
All occupations	37,568	37,568	0

Source: IER estimates.

Comparisons of *Baseline* projections and scenarios with occupational adjustments (*Automation, Technological opportunities and Human-centric scenarios*)

Comparing *Automation adjusted scenarios* with *Baseline projections* shows the potential negative impact on jobs if automation and related technologies have the impact on employment that many have suggested, but without any offsetting positive effects from new jobs created by the opportunities offered by these new technologies. In addition, it includes the adjustments to occupational employment patterns imposed by assumption, based on the literature review.

Table 5.5 shows that, in total there are some 2 million fewer jobs by 2035 in the *Technological opportunities scenario*. This builds up from a negative impact of about 400,000 in 2025. It is the same effect as discussed in Section 2 above as the occupational adjustments do not impact on total employment levels. The largest impacts are for *Managers, directors and senior officials, Administrative and secretarial, Skilled trades, and Sales and customer service and Elementary occupations*, each of which loses around 300,000 jobs or more compared with the *Baseline projections*.

Unlike the discussion in Section 2, the effects across occupations vary quite significantly because of the additional occupational adjustments imposed. The largest percentage impacts are for Sales and customer service occupations (-13 per cent) although both *Skilled trade* and *Elementary occupations* have negative impacts of over 11 per cent, while for *Managers, directors and senior officials* and *Process, plant and machine operatives* there is a job loss of almost 9 per cent by 2035. *Professional occupations* fare best with minimal job losses.

Tables 5.6, 5.6a and 5.6b provide additional detail for 2-digit occupations (sub-major groups). Without the additional occupational adjustments imposed, the percentage impacts show much more significant variation across occupations and the scenarios. *Science, engineering and technology associate professionals* are the occupational group with the largest positive impact (around 18 per cent). In contrast, *Process, plant and machine operatives* and *Elementary trades and related occupations* are projected to see significant job losses in the *Automation adjusted scenario*.

As noted in the earlier discussion, the comparisons above focus on total employment in 2035 or projected net changes in employment between 2020 and 2035. When we compare Replacement Demands over the 2020-35 period, the differences between the scenarios are less marked (see Figure 5.9). The main exception to this is *Science, engineering and technology associate professionals* for whom the combination of industrial and occupational adjustments in the scenarios makes a significant impact on Total Requirements of between 400,000 and 600,000 jobs by 2035. Total Requirements (or job openings) is the sum of projected net changes and replacement demands.

The time series profiles shown in Figure 5.10 for Major Groups, confirm that the main differences are between the *Automation adjusted scenario* (which emphasises potential job losses) and all the others, including the *Baseline projections*. This also applies at the more detailed Sub-major Group level as shown in Figure 5.11 (000s) and Figure 5.12 (percentage shares of total employment). However, there are more notable differences between the occupations than was the case without imposition of additional occupational adjustments.

Table 5.5: Employment in 2035 for Major Groups compared across the scenarios (with occupational adjustments) and *Baseline projections*

Levels (000s)	Baseline (BS)	Automation adjusted (AS*)	Technological opportunities adjusted (TS*)	Human-centric adjusted (HS*)
Managers, directors and senior officials	3,924	3,612	3,825	3,813
Professional occupations	9,792	9,766	10,312	10,305
Associate professional occupations	5,533	5,315	5,618	5,618
Administrative and secretarial	3,597	3,290	3,483	3,501
Skilled trades occupations	2,958	2,660	2,828	2,799
Caring, leisure and other service	3,419	3,410	3,586	3,607
Sales and customer service	2,835	2,509	2,639	2,652
Process, plant and machine operatives	1,952	1,794	1,898	1,885
Elementary occupations	3,558	3,190	3,357	3,362
All occupations	37,568	35,547	37,546	37,541

Shares (%)	Baseline (BS)	Automation adjusted (AS*)	Technological opportunities adjusted (TS*)	Human-centric adjusted (HS*)
Managers, directors and senior officials	10%	10%	10%	10%
Professional occupations	26%	27%	27%	27%
Associate professional occupations	15%	15%	15%	15%
Administrative and secretarial	10%	9%	9%	9%
Skilled trades occupations	8%	7%	8%	7%
Caring, leisure and other service	9%	10%	10%	10%
Sales and customer service	8%	7%	7%	7%
Process, plant and machine operatives	5%	5%	5%	5%
Elementary occupations	9%	9%	9%	9%
All occupations	100%	100%	100%	100%

Change (000s) 2020-2035	Baseline (BS)	Automation adjusted (AS*)	Technological opportunities adjusted (TS*)	Human-centric adjusted (HS*)
Managers, directors and senior officials	167	-146	67	55
Professional occupations	1,582	1,555	2,102	2,094
Associate professional occupations	755	538	840	841
Administrative and secretarial	-136	-443	-250	-232
Skilled trades occupations	-67	-366	-198	-226
Caring, leisure and other service	291	282	458	479
Sales and customer service	46	-280	-150	-137
Process, plant and machine operatives	-10	-168	-64	-77
Elementary occupations	-34	-402	-235	-230
All occupations	2,593	572	2,571	2,566

Source: IER estimates.

Notes: Including occupational adjustments.

Table 5.5a: Percentage impact, Automation adjusted scenario compared to *Baseline projections*

% impact	2025	2035
Managers, directors and senior officials	-2.1	-8.6
Professional occupations	0.4	-0.3
Associate professional occupations	-0.8	-4.1
Administrative and secretarial	-2.1	-9.3
Skilled trades occupations	-2.4	-11.2
Caring, leisure and other service	0.3	-0.2
Sales and customer service	-3.0	-13.0
Process, plant and machine operatives	-1.9	-8.8
Elementary occupations	-2.6	-11.6
All occupations	-1.2	-5.7

Source: IER estimates.

Table 5.6: Employment for Sub-major Groups in 2035 compared across the scenarios (with occupational adjustments) and *Baseline projections*

Males and Females

Levels (000s)	Baseline (BS)	Automation adjusted (AS*)	Technological opportunities adjusted (TS*)	Human-centric adjusted (HS*)
11 Corporate managers & directors	2,586	2,368	2,508	2,501
12 Other managers & proprietors	1,338	1,244	1,317	1,312
21 Science, research, engineering & tech	3,065	3,332	3,530	3,511
22 Health professionals	1,774	1,777	1,874	1,880
23 Teaching & other educational profess	1,947	1,942	2,035	2,044
24 Business, media & public service prof	3,006	2,716	2,873	2,869
31 Science, engineering & technology as	711	870	922	918
32 Health & social care associate profes	1,279	1,318	1,389	1,397
33 Protective service occupations	360	312	330	329
34 Culture, media & sports occupations	757	669	706	705
35 Business & public service associate p	2,425	2,147	2,271	2,270
41 Administrative occupations	3,117	2,811	2,964	2,976
42 Secretarial & related occupations	480	479	519	525
51 Skilled agricultural & related trades	407	361	383	379
52 Skilled metal, electrical & electronic tr	1,022	905	962	952
53 Skilled construction & building trades	835	792	846	834
54 Textiles, printing & other skilled trades	694	602	636	634
61 Caring personal service occupations	2,688	2,736	2,878	2,897
62 Leisure, travel & related personal serv	701	647	679	681
63 Community & civil enforcement occup	30	27	29	29
71 Sales occupations	2,086	1,797	1,890	1,900
72 Customer service occupations	749	712	749	752
81 Process, plant & machine operatives	757	620	657	652
82 Transport & mobile machine drivers &	1,195	1,174	1,242	1,233
91 Elementary trades & related occupatio	944	784	826	826
92 Elementary administration & service c	2,614	2,405	2,531	2,535
All occupations	37,568	35,547	37,546	37,541

Source: IER estimates.

Table 5.6a: Differences between the scenarios (with occupational adjustments) and Baseline projections

Males and Females Levels (000s)	2035	Differences in 2035		
	BS	AS*	TS*	HS*
11 Corporate managers & directors	2,586	-218	-79	-86
12 Other managers & proprietors	1,338	-94	-21	-26
21 Science, research, engineering & technology professionals	3,065	266	464	446
22 Health professionals	1,774	2	99	106
23 Teaching & other educational professionals	1,947	-5	89	98
24 Business, media & public service professionals	3,006	-290	-133	-137
31 Science, engineering & technology associate professionals	711	159	211	207
32 Health & social care associate professionals	1,279	38	109	118
33 Protective service occupations	360	-48	-30	-31
34 Culture, media & sports occupations	757	-88	-50	-52
35 Business & public service associate professionals	2,425	-279	-154	-155
41 Administrative occupations	3,117	-306	-154	-141
42 Secretarial & related occupations	480	-1	39	45
51 Skilled agricultural & related trades	407	-46	-24	-27
52 Skilled metal, electrical & electronic trades	1,022	-117	-60	-71
53 Skilled construction & building trades	835	-44	11	-1
54 Textiles, printing & other skilled trades	694	-92	-58	-60
61 Caring personal service occupations	2,688	49	191	210
62 Leisure, travel & related personal service occupations	701	-54	-21	-20
63 Community & civil enforcement occupations	30	-3	-2	-2
71 Sales occupations	2,086	-289	-196	-187
72 Customer service occupations	749	-36	0	4
81 Process, plant & machine operatives	757	-137	-100	-105
82 Transport & mobile machine drivers & operatives	1,195	-20	47	38
91 Elementary trades & related occupations	944	-160	-118	-118
92 Elementary administration & service occupations	2,614	-209	-83	-79
All occupations	37,568	-2,021	-22	-27

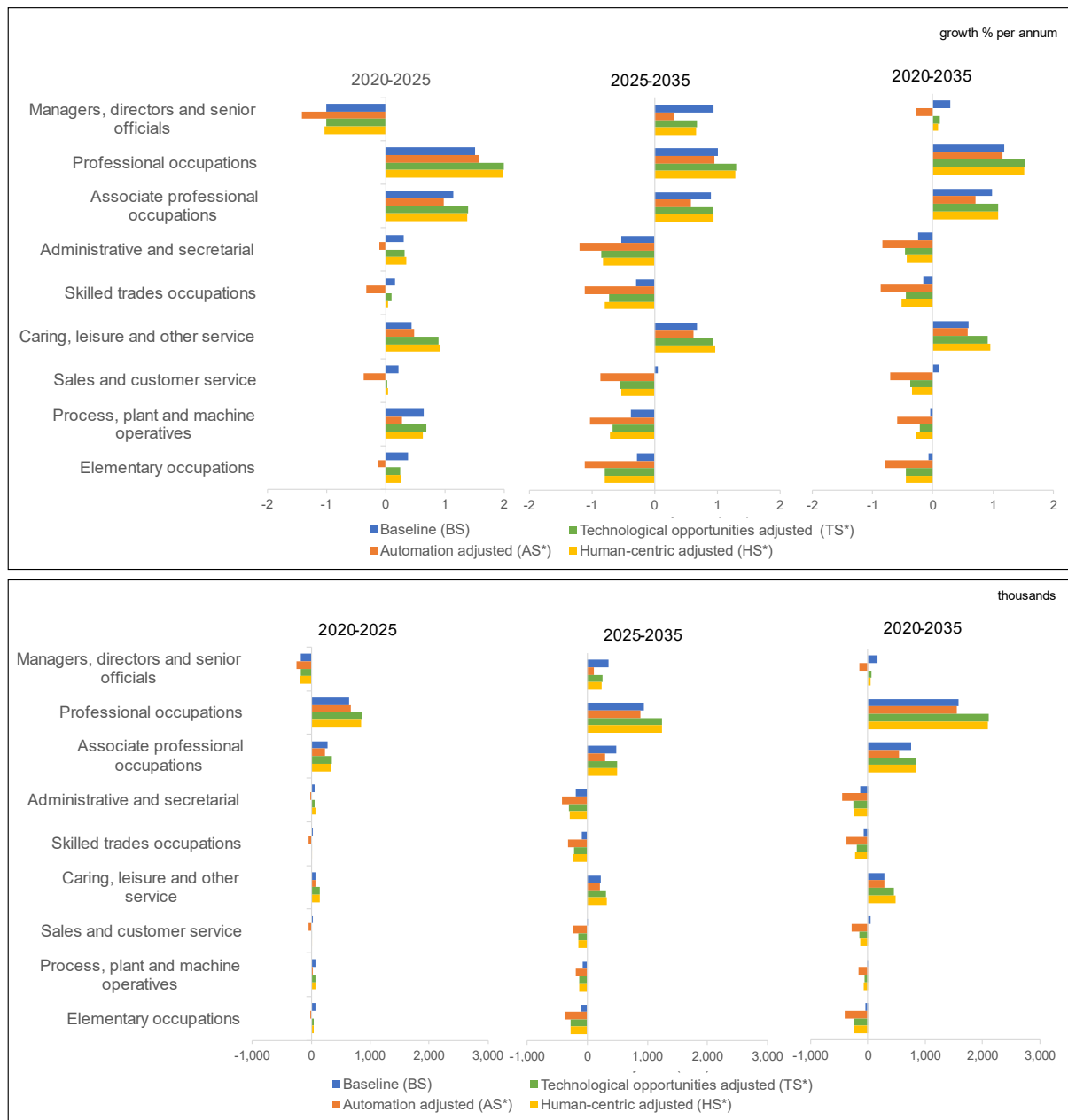
Source: IER estimates.

Table 5.6b: Percentage impact, *Automation adjusted scenarios* and Sub-major groups

% impact	2025	2035
11 Corporate managers & directors	-2.2	-9.2
12 Other managers & proprietors	-1.8	-7.6
21 Science, research, engineering & technology professionals	3.4	8.0
22 Health professionals	0.4	0.1
23 Teaching & other educational professionals	0.3	-0.3
24 Business, media & public service professionals	-2.7	-10.7
31 Science, engineering & technology associate professionals	7.0	18.3
32 Health & social care associate professionals	1.4	2.9
33 Protective service occupations	-3.8	-15.4
34 Culture, media & sports occupations	-3.2	-13.2
35 Business & public service associate professionals	-3.2	-13.0
41 Administrative occupations	-2.5	-10.9
42 Secretarial & related occupations	0.0	-0.2
51 Skilled agricultural & related trades	-2.9	-12.7
52 Skilled metal, electrical & electronic trades	-2.8	-12.9
53 Skilled construction & building trades	-0.9	-5.5
54 Textiles, printing & other skilled trades	-3.6	-15.3
61 Caring personal service occupations	0.9	1.8
62 Leisure, travel & related personal service occupations	-2.0	-8.3
63 Community & civil enforcement occupations	-2.8	-11.7
71 Sales occupations	-3.7	-16.1
72 Customer service occupations	-1.0	-5.1
81 Process, plant & machine operatives	-4.8	-22.1
82 Transport & mobile machine drivers & operatives	0.0	-1.7
91 Elementary trades & related occupations	-5.2	-20.3
92 Elementary administration & service occupations	-1.9	-8.7
All occupations	-1.2	-5.7

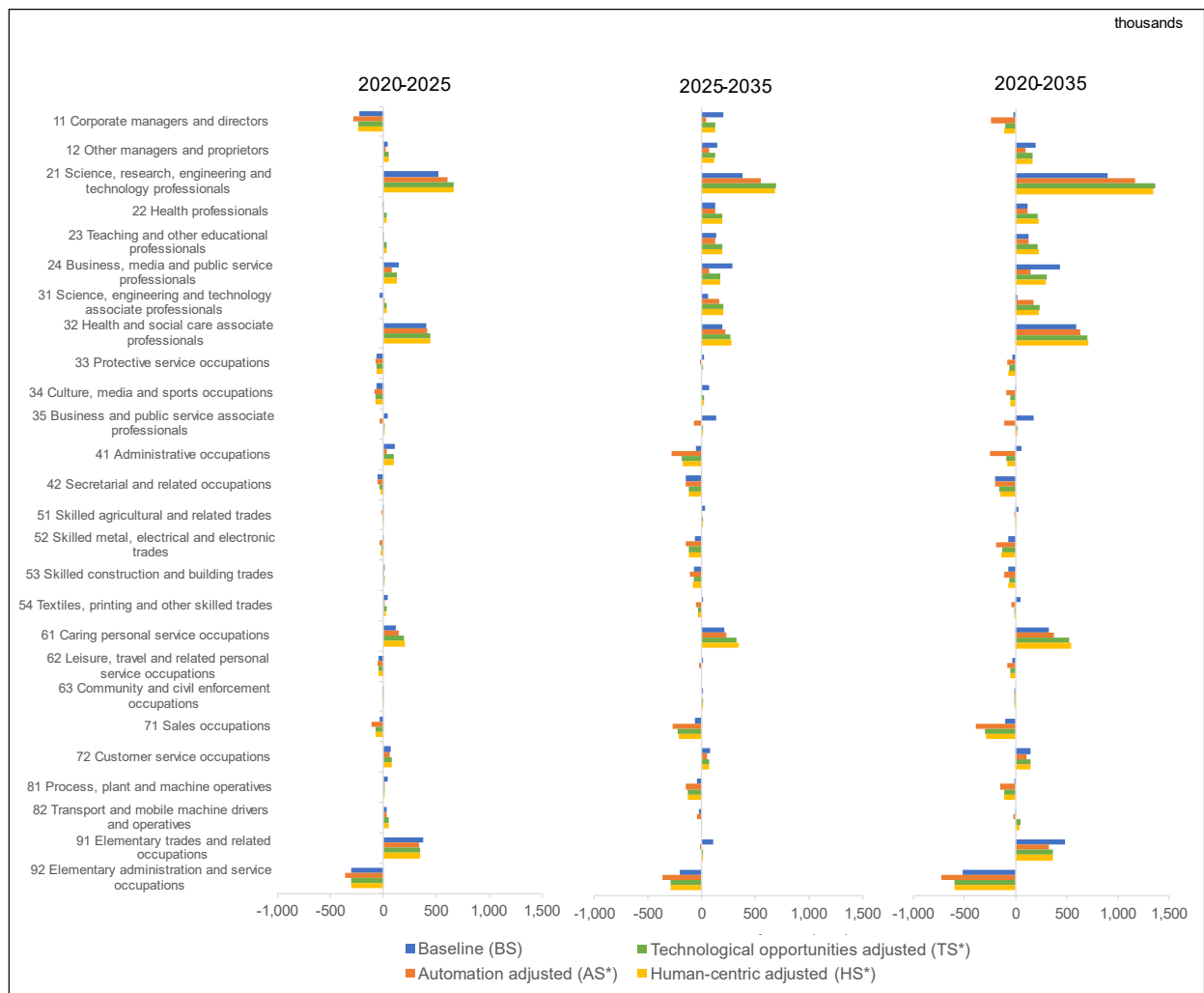
Source: IER estimates.

Figure 5.7: Net Changes in employment, Major Groups, All scenarios, 2020-2035



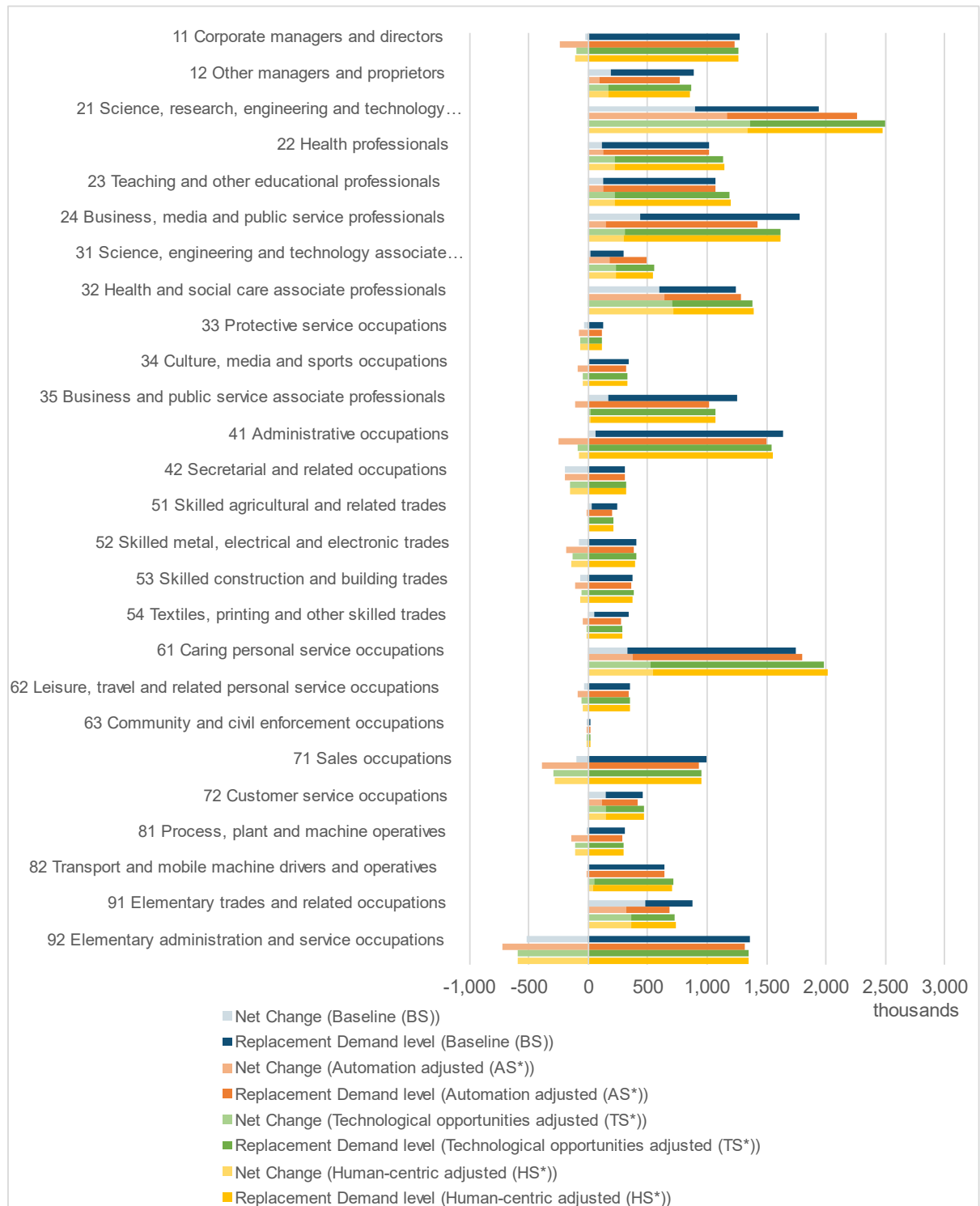
Source: IER estimates.

Figure 5.8: Net changes in employment, Sub-major Groups, 2020-2035



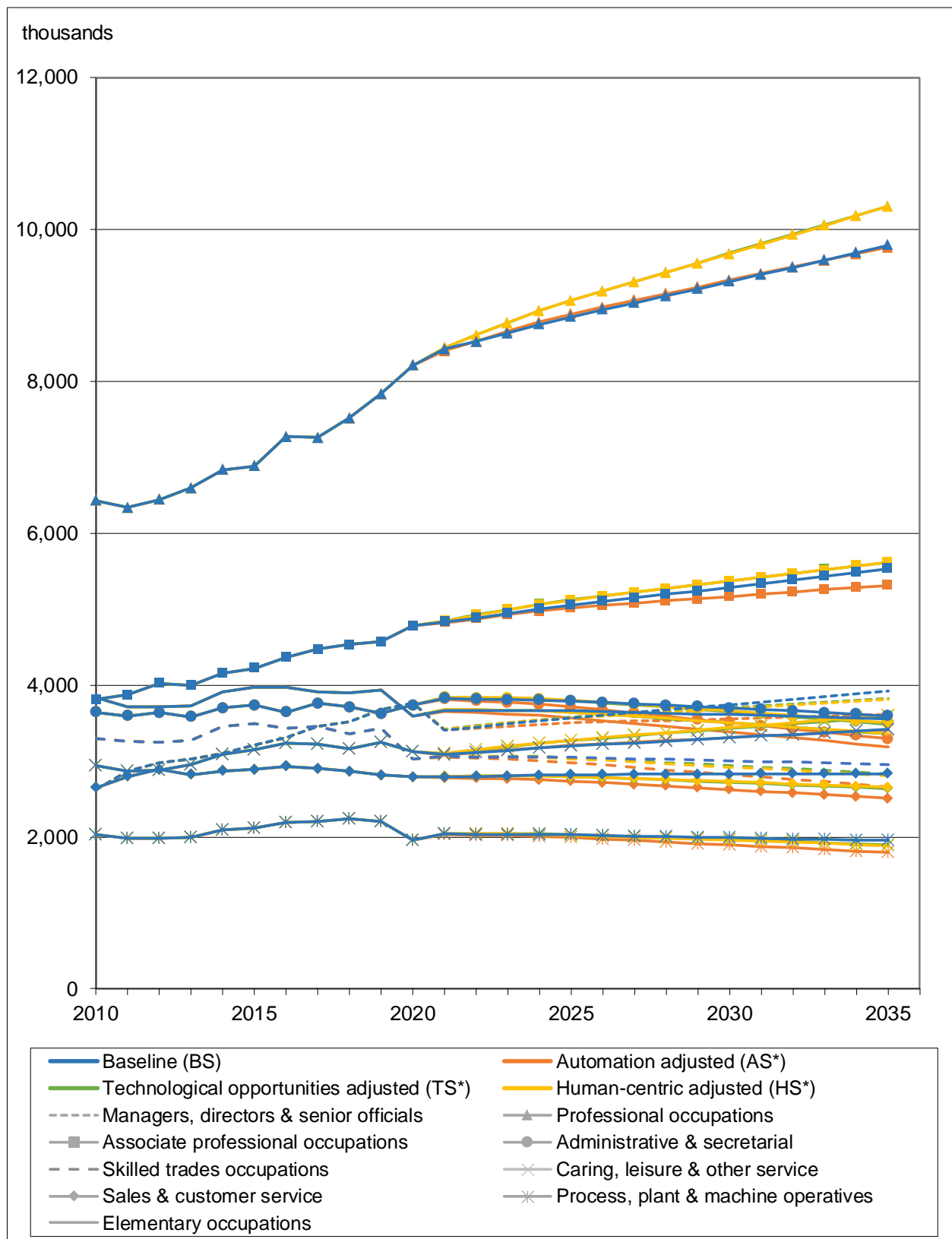
Source: IER estimates.

Figure 5.9: Net requirements by SOC2020 Sub-major Groups compared across scenarios, 2020-2035



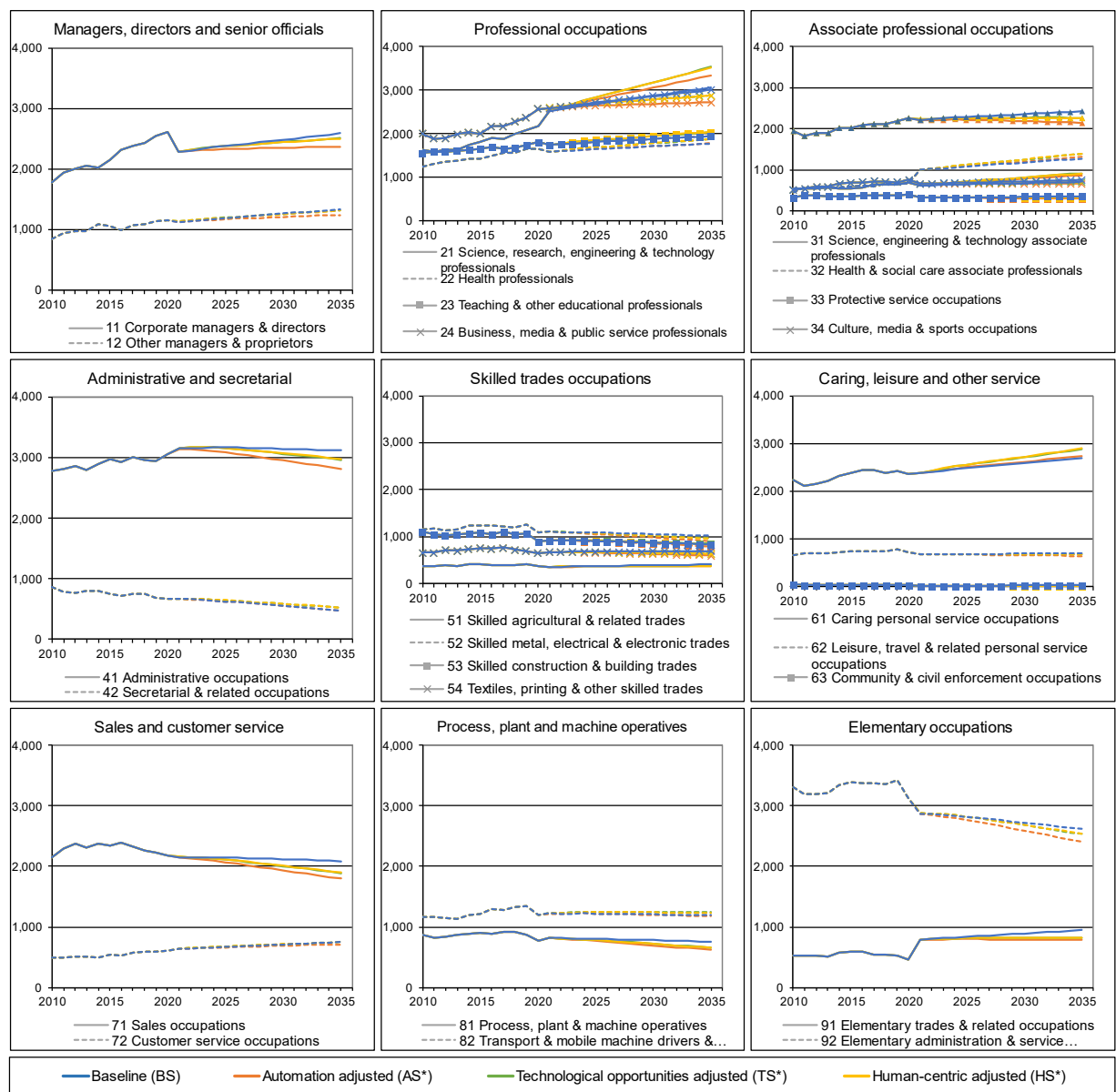
Source: IER estimates.

Figure 5.10: Time series profiles, Major Groups, 2020-35



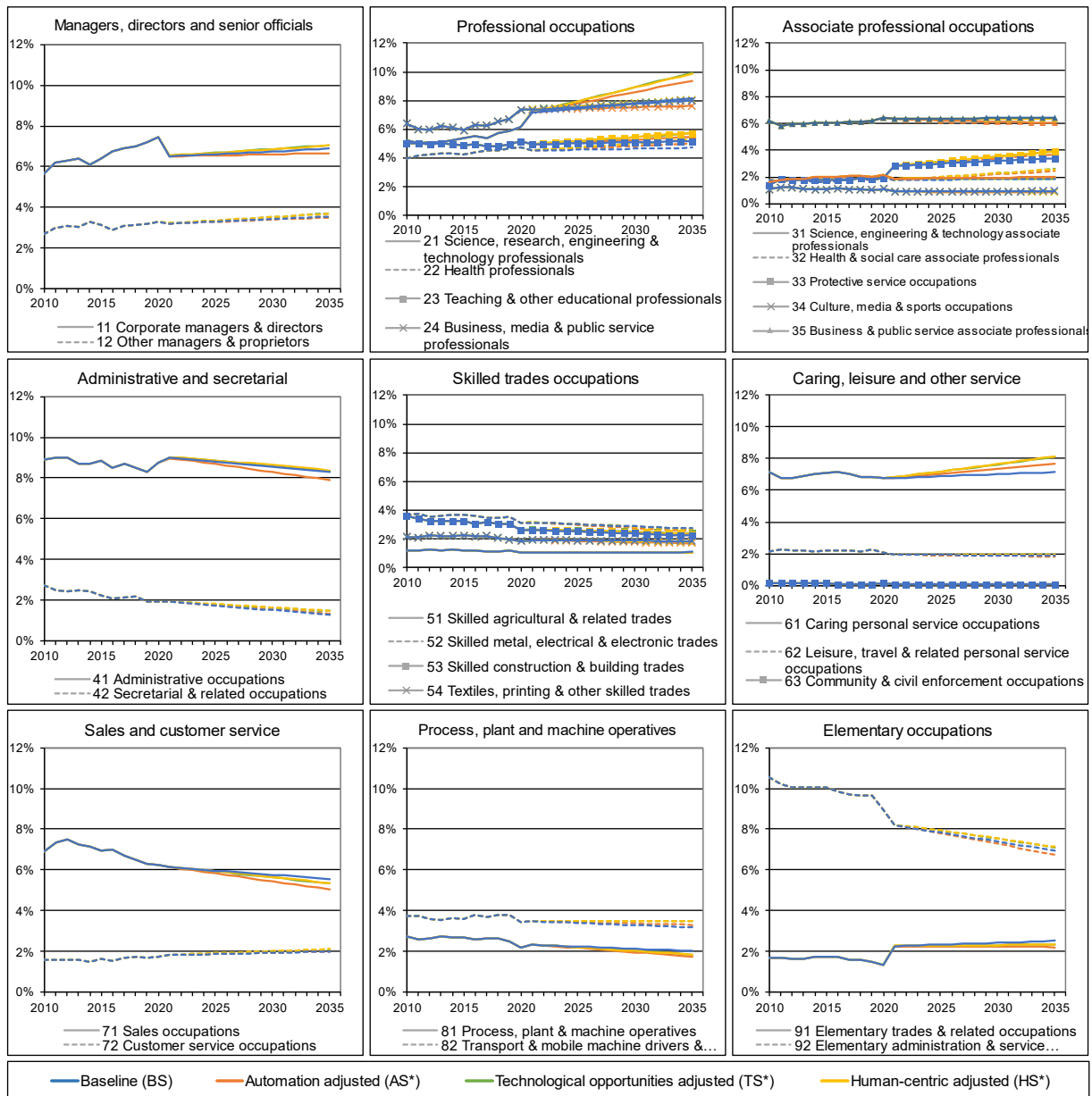
Source: IER estimates.

Figure 5.11: Time series profiles, Sub-major groups, 000s



Source: IER estimates.

Figure 5.12: Time series profiles, Sub-major groups, percentage shares



Source: IER estimates.

Table 5.7: Comparison between *Automation adjusted scenario*, *Technological opportunities adjusted scenario* and *Human-centric adjusted scenario*

Differences compared with Automation adjusted (AS*)

Human-centric adjusted (HS*)

Males and Females

Levels (000s)	2025	2035
Managers, directors and senior officials	68	200
Professional occupations	176	539
Associate professional occupations	102	303
Administrative and secretarial	86	210
Skilled trades occupations	54	139
Caring, leisure and other service	70	197
Sales and customer service	58	143
Process, plant and machine operatives	35	91
Elementary occupations	71	172
All occupations	721	1,994

Differences compared with Automation adjusted (AS*)

Technological opportunities adjusted (TS*)

Males and Females

Levels (000s)	2025	2035
Managers, directors and senior officials	74	213
Professional occupations	181	546
Associate professional occupations	104	302
Administrative and secretarial	81	193
Skilled trades occupations	65	168
Caring, leisure and other service	65	176
Sales and customer service	55	130
Process, plant and machine operatives	40	104
Elementary occupations	70	168
All occupations	734	1,999

Source: IER estimates.

6 Implications for Occupational Unit Groups

Key messages

At the more detailed level of the 412 4-digit unit groups the results are relatively stable across the scenarios. If the unit groups are ranked by employment size, the rankings change only slightly between scenarios. Similarly, if we rank the 4-digit occupations according to the largest absolute growth between 2020 and 2035, these look very similar across all the scenarios. However, the magnitude of these changes does vary across scenarios.

The top 10 occupations include:

- *Care workers and home carers*
- *Sales and retail assistants*
- *Other administrative occupations n.e.c.*
- *Programmers and software development professionals*
- *Nursing auxiliaries and assistants*
- *Financial managers and directors*
- *Book-keepers, payroll managers and wages clerks*
- *Customer service occupations n.e.c.*
- *Warehouse operatives*
- *Secondary education teaching professionals.*

It is a similar story if we focus on those 4-digit occupations facing the largest absolute levels of job loss. There is an almost identical list of 4-digit occupations in all the scenarios. These are all occupations concentrated in SMG4.2, Secretarial occupations, SMG5.3 Skills trades occupations SMG 7.1 Sales occupations and SMG 9.2 Elementary occupations.

Just a few occupations switch in and out of the top 20 in terms of job losses. However, all of these will still be substantial areas of employment in 2035 because of replacement demands, which result in significant job openings and skill requirements. They include:

- *Medical secretaries*
- *Waiters and waitresses*
- *Security guards and related occupations*
- *School secretaries*
- *Sales and retail assistants*
- *Cleaners and domestics*
- *Kitchen and catering assistants*
- *Warehouse operatives*
- *Personal assistants and other secretaries*
- *Receptionists.*

6.1 Introduction

This chapter presents the implications of the results for occupational employment in more detail for the 412 SOC2020 Unit Groups. Because of the large number of occupations involved it is only possible to present a selection of results here. This section focuses on three groups of occupations. The first group is composed of those occupations 'at risk of change' where we have imposed assumptions based on a literature review and other empirical evidence (Section 6.2). These are the unit group occupations which are expected to be most likely to experience significant changes compared with past trends. The second group is a 'Top 20' selection based on 'importance' as defined in different ways (e.g. by the largest employment levels, changes, etc). Finally, the last set of occupations is selected based on the most significant differences between the scenarios.

The focus in this section is on 2021 rather than 2020 as the employment estimates for the former year are based on data classified using the new SOC2020, as opposed to those for 2020 which are based on using a cross-walk to the old SOC2010 classification. The latter are regarded as less reliable.

6.2 Comparisons focussing on those occupations 'at risk'

At the more detailed 4-digit level of SOC2020 only limited interventions have been attempted in the light of the paucity of evidence for making such changes. In the *Baseline projections*, the shares of 4-digit occupations within the 2-digit SMGs are assumed fixed between 2021 and 2035. In the *Alternative scenarios* this assumption is relaxed, as described in Chapter 3.

As mentioned in Section 3.2, 44 occupations have been identified as likely to experience significant job losses between 2021 and 2035, whilst 52 other occupations are expected to experience significant increases in employment share over the same period, driven by global trends such as the introduction of new technologies, greening of the economy, ageing population and surge of *Care and health-related services* (see Table 3.1 above for details). Among these occupations, we have selected the Top 10 occupations that are expected to be more affected by these trends in terms of percentage change based on the *Baseline projections*. We also compare these results across different *scenarios*.

Table 6.1 focuses on the ten occupations where we have made the largest positive interventions. It shows that the occupation with the expected highest rate of increase (percentage change, 2021-2035) is *IT managers*, followed by *Environment professionals* and *Programmers and software development professionals*, etc. The *Baseline projections* suggest that there will be some 116,000 more jobs for *Care workers and home carers*, 109,000 more jobs for *Programmers and software development professionals* and 68,000 more jobs for *Nursing auxiliaries and assistants* between 2021 and 2035.

The main *Alternative scenarios* (*Technological opportunities* and *Human-centric scenarios*) show a higher share of employment for all these occupational groups compared to the results in the *Baseline projections*. However, the magnitude of these changes (absolute change 2021-2035) varies across the different scenarios. In the intermediate *Automation scenario*, IT occupations such as *IT managers*, *Programmers and software development professionals* and *IT user support technicians* are projected to increase by about 59,000, 94,000 and 75,000 jobs, respectively. These increases are considerably higher in both the *Technological opportunities* and *Human-centric scenarios*.

Table 6.2 shows that the ten occupations which have the largest negative interventions. The largest expected rates of decrease (percentage change, 2021-2035) are for *Personal*

assistants and other secretaries, School secretaries and Receptionists. The *Baseline projections* already projected that there will be some 52,000 fewer jobs by 2035 for *Personal assistants and other secretaries*.

All occupations listed in Table 6.2 are projected to experience declines in employment levels in all of the different scenarios. *Sales and retail assistants* will experience the largest employment decreases in absolute terms across the *Alternative scenarios*, followed by *Receptionists* and *Personal assistants*.

The interventions to amend occupational shares are identical in all three *Alternative scenarios*. This explains the significant increase in occupational employment in the *Automation scenario* compared with the *Baseline projections* for 6135 *Care workers and home carers*. The *Automation scenario* might in practice be more likely to be associated with some of the more negative interventions rather than the positive one made for this occupational category.

Table 6.1: Occupations with the expected highest (percentage) growth, 2021-2035

2035 Employment Levels (000s)	<i>Baseline projections</i> (BS)	<i>Automation</i> (AS)	<i>Technological opportunities</i> (TS)	<i>Human-centric</i> (HS)
2132 IT managers	326	326	346	344
2152 Environment professionals	64	110	116	116
2134 Programmers and software development professionals	615	599	634	631
1136 Human resource managers and directors	235	253	268	267
1131 Financial managers and directors	503	508	538	537
1137 Information technology directors	157	164	174	174
3132 IT user support technicians	150	208	220	219
6131 Nursing auxiliaries and assistants	599	599	630	635
6135 Care workers and home carers	1,022	1,075	1,131	1,138
2319 Teaching professionals n.e.c.	335	371	389	391

Shares (%)	<i>Baseline projections</i> (BS)	<i>Automation</i> (AS)	<i>Technological opportunities</i> (TS)	<i>Human-centric</i> (HS)
2132 IT managers	0.87%	0.92%	0.92%	0.92%
2152 Environment professionals	0.17%	0.31%	0.31%	0.31%
2134 Programmers and software development professionals	1.64%	1.68%	1.69%	1.68%
1136 Human resource managers and directors	0.63%	0.71%	0.71%	0.71%
1131 Financial managers and directors	1.34%	1.43%	1.43%	1.43%
1137 Information technology directors	0.42%	0.46%	0.46%	0.46%
3132 IT user support technicians	0.40%	0.58%	0.59%	0.58%
6131 Nursing auxiliaries and assistants	1.59%	1.69%	1.68%	1.69%
6135 Care workers and home carers	2.72%	3.02%	3.01%	3.03%
2319 Teaching professionals n.e.c.	0.89%	1.04%	1.04%	1.04%

Change (000s) 2021-2035	Baseline projections (BS)	Automation (AS)	Technological opportunities (TS)	Human-centric (HS)
2132 IT managers	58.1	59.4	77.4	75.7
2152 Environment professionals	11.4	57.4	63.7	63.1
2134 Programmers and software development professionals	109.5	94.8	127.8	124.6
1136 Human resource managers and directors	27.4	45.8	59.6	58.9
1131 Financial managers and directors	58.6	65.2	92.8	91.4
1137 Information technology directors	18.3	25.8	34.7	34.3
3132 IT user support technicians	17.5	75.3	86.9	86.0
6131 Nursing auxiliaries and assistants	68.4	70.3	98.3	102.5
6135 Care workers and home carers	116.7	172.1	222.6	230.0
2319 Teaching professionals n.e.c.	35.5	72.5	88.7	90.4

Source: IER estimates.

Notes: The focus is on 2021-35 because the 4-digit SOC2020 data for 2020 are unreliable. The tables above are in order of percentage increase.

Table 6.2: Occupations with the expected highest (percentage) decline, 2021-2035

2035 Employment Levels (000s)	Baseline projections (BS)	Automation (AS)	Technological opportunities (TS)	Human-centric (HS)
4215 Personal assistants and other secretaries	130	127	138	139
4213 School secretaries	70	70	76	77
4216 Receptionists	168	164	178	180
7111 Sales and retail assistants	1,000	897	944	949
4123 Bank and post office clerks	111	77	81	82
4152 Data entry administrators	46	15	16	16
4122 Book-keepers, payroll managers and wages clerks	497	447	471	473
4131 Records clerks and assistants	145	109	115	116
4159 Other administrative occupations n.e.c.	639	578	609	612
1121 Production managers and directors in manufacturing	261	213	225	225

Shares (%)	Baseline projections (BS)	Automation (AS)	Technological opportunities (TS)	Human-centric (HS)
4215 Personal assistants and other secretaries	0.3%	0.4%	0.4%	0.4%
4213 School secretaries	0.2%	0.2%	0.2%	0.2%
4216 Receptionists	0.4%	0.5%	0.5%	0.5%
7111 Sales and retail assistants	2.7%	2.5%	2.5%	2.5%
4123 Bank and post office clerks	0.3%	0.2%	0.2%	0.2%
4152 Data entry administrators	0.1%	0.0%	0.0%	0.0%
4122 Book-keepers, payroll managers and wages clerks	1.3%	1.3%	1.3%	1.3%
4131 Records clerks and assistants	0.4%	0.3%	0.3%	0.3%
4159 Other administrative occupations n.e.c.	1.7%	1.6%	1.6%	1.6%
1121 Production managers and directors in manufacturing	0.7%	0.6%	0.6%	0.6%

Change (000s) 2021-2035	Baseline projections (BS)	Automation (AS)	Technological opportunities (TS)	Human-centric (HS)
4215 Personal assistants and other secretaries	-52.02	-54.04	-44.42	-43.00
4213 School secretaries	-28.29	-28.20	-22.86	-22.08
4216 Receptionists	-67.61	-71.02	-58.58	-56.74
7111 Sales and retail assistants	-30.93	-130.48	-89.53	-84.81
4123 Bank and post office clerks	-1.35	-35.13	-31.58	-31.24
4152 Data entry administrators	-0.55	-31.19	-30.65	-30.59
4122 Book-keepers, payroll managers and wages clerks	-6.01	-54.62	-33.26	-31.30
4131 Records clerks and assistants	-1.76	-37.16	-32.06	-31.58
4159 Other administrative occupations n.e.c.	-7.73	-66.70	-39.02	-36.49
1121 Production managers and directors in manufacturing	30.37	-16.85	-5.53	-6.09

Source: IER estimates.

Notes: The focus is on 2021-35 because the 4-digit SOC2020 data for 2020 are unreliable. The tables above are in order of percentage decrease.

6.3 'Top 20' selections based on 'importance'

Tables 6.3 to Table 6.8 show the projections for SOC2020 Unit groups (4-digit level) across different scenarios, based on 'importance' (as defined by the scale and rate of change between 2021 and 2035). Table 6.3 presents information on the top 20 occupations in 2035 in terms of employment levels. The ranking across scenarios (at least at the Top 20) does not change much. *Care workers and home carers* are projected to become the largest 4-digit occupational group by 2035, overtaking *Sales and retail assistants*.

Care workers and home carers occupations are projected to account for between 1,022,000 and 1,138,000 jobs, followed by *Sales and retail assistants* (897,000 and 1,000,000 jobs) and *Other administrative occupations n.e.c.* (between 578,000 and 639,000 jobs). There are some variations in the level of employment between scenarios. For instance, in the *Human-centric scenario*, a higher employment level is expected for occupations such as *Care workers and home carers*, *Teaching professionals n.e.c.* and *Nursing auxiliaries and assistants* compared with the *Baseline projections*.

Table 6.4 and Table 6.5 display the top 20 occupations with the highest projected employment growth and declines in absolute terms, respectively. These tables suggest that occupations in *Health services* and *Digital-related occupations* will increase considerably between 2021 and 2035. In contrast, low-skilled and *Automatable (operative) occupations* will tend to have the largest declines in absolute terms. Specifically, occupations such as *Care workers and home carers*, *Programmers and software and development professionals* and *Higher level teaching assistants* will experience the largest employment increases in absolute terms, whilst *Warehouse operatives*, *Personal assistants and other secretaries*, *Receptionists* and *Sales and retail assistants* will experience the largest employment declines.

Table 6.6 and Table 6.7 show the top 20 occupations with the highest projected employment growth and declines in relative terms (i.e. percentage rates of change), respectively. Independently of the scenario, it can be observed that *Health and social care associate professionals* such as *Higher level teaching assistants*, *Veterinary nurses*, and *Early education and childcare practitioners*, are expected to experience considerable positive

growth rates by 2035 (between 27.9 per cent and 39.8 per cent). *Science, research, engineering and technology professionals* such as *Biological scientists*, and *Physical scientists*, among others, are also expected to experience a high positive growth rate by 2035 (between 15.0 and 45.4 per cent). In the *Baseline projections*, *Conservation professionals* are expected to increase by approximately 21.7%. Whilst, in the rest of the scenarios, this group is expected to increase dramatically (between 214 per cent and 231 per cent). In contrast, *Secretarial and related occupations* such as *Receptionists*, *School secretaries*, *Company secretaries and administrators* etc., are expected to experience the highest negative growth rates by 2035 (between -13.4 per cent and -30.2 per cent).

Table 6.8 presents the Top 20 4-digit occupations in terms of replacement demand 2021-2035 (absolute values). Between 2020 to 2035, *Care workers and home carers* is the category with the highest increases in replacement demand in all *Alternative scenarios* (between +508,000 and +530,000 job openings), followed by *Sales and retail assistants* (between +416,000 and +447,000 job openings) and *Other administrative occupations n.e.c.* (between +289,000 and +304,000 job openings).

Table 6.3 Top 20 4-digit occupations in terms of Employment levels in 2035

Levels (000s)	Baseline projections (BS)	Automation (AS)	Technological opportunities (TS)	Human-centric (HS)
6135 Care workers and home carers	1022	1075	1131	1138
7111 Sales and retail assistants	1000	897	944	949
4159 Other administrative occupations n.e.c.	639	578	609	612
2134 Programmers and software development professionals	615	599	634	631
6131 Nursing auxiliaries and assistants	599	599	630	635
1131 Financial managers and directors	503	508	538	537
4122 Book-keepers, payroll managers and wages clerks	497	447	471	473
7219 Customer service occupations n.e.c.	460	433	456	458
9252 Warehouse operatives	444	415	436	437
2313 Secondary education teaching professionals	422	411	431	432
2314 Primary education teaching professionals	405	395	414	415
9263 Kitchen and catering assistants	400	373	393	394
3556 Sales accounts and business development managers	388	339	358	358
2440 Business and financial project management professionals	379	362	383	382
9131 Industrial cleaning process occupations	371	336	354	354
7112 Retail cashiers and check-out operators	352	316	333	334
1150 Managers and directors in retail and wholesale	343	295	312	312
2319 Teaching professionals n.e.c.	335	371	389	391
9223 Cleaners and domestics	325	303	319	320
8214 Delivery drivers and couriers	304	299	316	314

Source: IER estimates.

Notes: The focus is on 2021-35 because the 4-digit SOC2020 data for 2020 are unreliable.

Table 6.4 Top 20 4-digit occupations based on employment growth, 2021-2035, 000s

Change (000s) 2021-2035	Baseline projections (BS)	Automation (AS)	Technological opportunities (TS)	Human-centric (HS)
6135 Care workers and home carers	117	172	223	230
2134 Programmers and software development professionals	110	95	128	125
3231 Higher level teaching assistants	83	95	114	116
6131 Nursing auxiliaries and assistants	68	70	98	102
7219 Customer service occupations n.e.c.	68	43	63	65
9131 Industrial cleaning process occupations	59	25	41	41
1131 Financial managers and directors	59	65	93	91
2132 IT managers	58	59	77	76
2133 IT business analysts, architects and systems designers	57	58	76	74
3229 Welfare and housing associate professionals n.e.c.	55	63	76	78
2440 Business and financial project management professionals	53	37	57	56
2313 Secondary education teaching professionals	45	35	53	55
2314 Primary education teaching professionals	43	34	51	53
2422 Finance and investment analysts and advisers	42	19	34	34
1150 Managers and directors in retail and wholesale	40	-7	8	8
2139 Information technology professionals n.e.c.	38	46	58	57
2129 Engineering professionals n.e.c.	36	44	56	55
2319 Teaching professionals n.e.c.	36	72	89	90
2421 Chartered and certified accountants	33	17	29	29
1251 Property, housing and estate managers	33	10	20	20

Source: IER estimates.

Notes: The focus is on 2021-35 because the 4-digit SOC2020 data for 2020 are unreliable.

Table 6.5 Top 20 4-digit occupations 2021-2035, largest declines, 000s

Change (000s) 2021-2035	Baseline projections (BS)	Automation (AS)	Technological opportunities (TS)	Human-centric (HS)
7112 Retail cashiers and check-out operators	-11	-46	-31	-29
5231 Vehicle technicians, mechanics and electricians	-12	-39	-32	-33
5223 Metal working production and maintenance fitters	-13	-42	-34	-36
4212 Legal secretaries	-13	-12	-9	-9
5315 Plumbers & heating and ventilating installers and repairers	-14	-20	-13	-14
9211 Postal workers, mail sorters and messengers	-16	-31	-25	-25
9265 Bar staff	-17	-28	-21	-20
5241 Electricians and electrical fitters	-18	-14	-1	-3
5316 Carpenters and joiners	-18	-27	-17	-19
5319 Construction and building trades n.e.c.	-20	-29	-18	-21
4211 Medical secretaries	-23	-22	-18	-17
9264 Waiters and waitresses	-24	-38	-28	-28
9231 Security guards and related occupations	-24	-39	-29	-28
4213 School secretaries	-28	-28	-23	-22
7111 Sales and retail assistants	-31	-130	-90	-85
9223 Cleaners and domestics	-32	-53	-39	-38
9263 Kitchen and catering assistants	-40	-65	-48	-47
9252 Warehouse operatives	-44	-72	-53	-53
4215 Personal assistants and other secretaries	-52	-54	-44	-43
4216 Receptionists	-68	-71	-59	-57

Source: IER estimates.

Notes: The focus is on 2021-35 because the 4-digit SOC2020 data for 2020 are unreliable.

Table 6.6 Top 20 4-digit occupations by growth, 2021-2035 (per cent change)

% change 2021-2035	Baseline projections (BS)	Automation (AS)	Technological opportunities (TS)	Human-centric (HS)
3231 Higher level teaching assistants	28	32	38	39
3240 Veterinary nurses	28	32	39	39
3232 Early education and childcare practitioners	28	32	38	39
3221 Youth and community workers	28	32	38	39
3222 Child and early years officers	28	32	38	39
3229 Welfare and housing associate professionals n.e.c.	28	32	38	39
3213 Medical and dental technicians	28	32	38	39
3219 Health associate professionals n.e.c.	28	32	39	39
3224 Counsellors	28	32	38	39
3214 Complementary health associate professionals	28	32	39	39
3212 Pharmaceutical technicians	28	32	39	39
3223 Housing officers	28	32	38	39
3211 Dispensing opticians	28	33	39	40
2162 Other researchers, unspecified discipline	22	38	45	45
2113 Biochemists and biomedical scientists	22	15	21	21
2115 Social and humanities scientists	22	15	21	21
2112 Biological scientists	22	15	21	21
2119 Natural and social science professionals n.e.c.	22	15	21	21
2114 Physical scientists	22	15	21	21
2151 Conservation professionals	22	215	232	230

Source: IER estimates.

Notes: The focus is on 2021-35 because the 4-digit SOC2020 data for 2020 are unreliable.

Table 6.7 Top 20 4-digit occupations, 2021-2035 (largest per cent declines)

% change 2021-2035	Baseline projections (BS)	Automation (AS)	Technological opportunities (TS)	Human-centric (HS)
9233 Exam invigilators	-9.1	-14.7	-10.7	-10.5
5322 Floorers and wall tilers	-9.6	-14.1	-8.7	-10.0
5315 Plumbers & heating and ventilating installers and repairers	-9.6	-14.2	-8.8	-10.1
5314 Roofers, roof tilers and slaters	-9.6	-14.1	-8.7	-10.0
5321 Plasterers	-9.6	-14.2	-8.7	-10.0
5323 Painters and decorators	-9.6	-14.2	-8.8	-10.0
5312 Stonemasons and related trades	-9.6	-13.8	-8.3	-9.6
5319 Construction and building trades n.e.c.	-9.6	-14.3	-8.8	-10.1
5316 Carpenters and joiners	-9.6	-14.3	-8.8	-10.1
5313 Bricklayers	-9.6	-14.2	-8.7	-10.0
5317 Glaziers, window fabricators and fitters	-9.6	-14.2	-8.8	-10.0
5330 Construction and building trades supervisors	-9.6	-14.2	-8.7	-10.0
5311 Steel erectors	-9.6	-13.2	-7.7	-9.0
4216 Receptionists	-28.7	-30.2	-24.8	-24.0
4211 Medical secretaries	-28.7	-28.0	-22.4	-21.6
4213 School secretaries	-28.7	-28.6	-23.1	-22.3
4217 Typists and related keyboard occupations	-28.7	-16.5	-25.6	-26.9
4215 Personal assistants and other secretaries	-28.7	-29.9	-24.4	-23.6
4214 Company secretaries and administrators	-28.7	-20.5	-14.3	-13.4
4212 Legal secretaries	-28.7	-25.6	-19.8	-19.0

Source: IER estimates.

Notes: The focus is on 2021-35 because the 4-digit SOC2020 data for 2020 are unreliable.

Table 6.8 Top 20 4-digit occupations by size of Replacement Demand, 2021-2035 (000s)

Change (000s) 2021-2035	Baseline projections (BS)	Automation (AS)	Technological opportunities (TS)	Human-centric (HS)
6135 Care workers and home carers	508	512	528	530
7111 Sales and retail assistants	447	416	428	429
4159 Other administrative occupations n.e.c.	304	289	298	299
6131 Nursing auxiliaries and assistants	297	300	309	310
4122 Book-keepers, payroll managers and wages clerks	236	225	232	233
1131 Financial managers and directors	232	222	230	230
9252 Warehouse operatives	215	207	213	214
2134 Programmers and software development professionals	199	210	218	217
9263 Kitchen and catering assistants	194	187	192	193
2313 Secondary education teaching professionals	191	192	197	198
2314 Primary education teaching professionals	184	184	190	190
3231 Higher level teaching assistants	183	186	192	193
7219 Customer service occupations n.e.c.	182	179	185	185
3556 Sales accounts and business development managers	162	153	158	158
2440 Business and financial project management professionals	159	151	156	156
1150 Managers and directors in retail and wholesale	158	152	157	157
9223 Cleaners and domestics	158	152	156	156
7112 Retail cashiers and check-out operators	157	146	151	151
8214 Delivery drivers and couriers	154	154	159	158
2319 Teaching professionals n.e.c.	152	152	157	157

Source: IER estimates.

Notes: The focus is on 2021-35 because the 4-digit SOC2020 data for 2020 are unreliable.

6.4 Unit Groups with significant differences between scenarios

Tables 6.9 to 6.16 present further comparisons between the *Automation, Technological opportunities, Human-centric* and *Baseline projections*, focussing upon those occupations that exhibit the largest differences between the scenarios. Tables 6.9 to 6.11 show the top 20 occupations in which the employment level is projected to be higher (in absolute terms) in the *Automation, Technological opportunities* and *Human-centric* scenarios compared with the *Baseline projections*. These tables generally show that when compared with the *Baseline projections*, the level of employment projected in the three *Alternative scenarios* is considerably higher for *IT user support technicians, Waste disposal and environmental services managers, and Care workers and home carers*. There are some considerable differences between scenarios. For instance, the *Automation scenario* projects the creation of 57,000 more jobs for *IT user support technicians* compared with the *Baseline projections* (highest positive difference). The highest employment difference in the *Technological opportunities* and *Human-centric* scenarios is found in *Care workers and home carers*. A few occupations are not present in all three rankings. For instance, in the *Baseline projections – Automation scenario* comparison, *Cyber security professionals* are one of the occupations with the highest employment differences (+ 17,000 jobs in the *Automation scenario*) (Table 6.9). However, in the *Baseline projections – Technological opportunities scenario* and *Baseline projections – Human-centric scenario* comparisons, the *Cyber security professionals* category is not listed in these rankings (Table 6.10 and Table 6.11).

Tables 6.12 to 6.14 show the top 20 occupations in which the employment level is projected to be lower (in absolute terms) in the *Automation, Technological opportunities* and *Human-centric* scenarios compared with the *Baseline projections*. The employment level for *Sales and retail assistants* is projected to be lower in all these comparisons. For instance, the *Automation scenario* projects 103,000 fewer jobs for *Sales and retail assistants* compared with the *Baseline projections*. There are also some considerable differences between scenarios. Some occupations drop out of the top 20 categories in all three rankings. This is the case, for instance, for *Industrial cleaning process occupations*. In the *Baseline projections – Automation scenario* comparison, *Industrial cleaning process occupations* are one of the occupations with the highest employment differences (-35,000 jobs in the *Automation scenario*) (Table 6.12). However, in the *Baseline projections – Technological opportunities* and *Baseline projections – Human-centric scenario* comparisons, the *Industrial cleaning process occupations* category is not listed in these rankings (Table 6.13 and Table 6.14).

Finally, Table 6.15 and Table 6.16 show the percentage *Automation scenario* impact (the results are quantitatively similar between *Technological opportunities* and *Human-centric scenarios*). The occupations with the largest positive impacts are related to the green economy, engineering and health care services. Specifically, the largest (percentage) positive impacts are for *IT user support technicians* (78.9 per cent), followed by *Environmental health professionals* (63.3 per cent) and *Conservation professionals* (61.2 per cent) (Table 6.15). Table 6.16 shows that *Process, plant and machine operatives* and *Elementary occupations* and *Skilled trades occupations* will be more negatively affected in the *Automation scenario*. The most significant (percentage) negative impacts are for *Mining and quarry workers and related operatives* (-621.9 per cent), followed by *Elementary cleaning occupations n.e.c.* (-220.3 per cent) and *Data entry administrators* (-208.9 per cent).

Table 6.9 Employment level (positive) differences between *Baseline projections* and *Automation scenarios* (000s)

Levels (000s)	2035	
	<i>Baseline projections</i> BS	<i>Automation adjusted scenario</i> AS*-BS
3132 IT user support technicians	150	57
1254 Waste disposal and environmental services managers	14	53
6135 Care workers and home carers	1,022	52
2151 Conservation professionals	30	48
2152 Environment professionals	64	46
3131 IT operations technicians	104	40
2319 Teaching professionals n.e.c.	335	36
3133 Database administrators and web content technicians	63	28
3119 Science, engineering and production technicians n.e.c.	44	22
1136 Human resource managers and directors	235	18
2124 Electronics engineers	31	18
2141 Web design professionals	34	18
2483 Environmental health professionals	10	17
2231 Midwifery nurses	51	17
2235 Mental health nurses	53	17
2123 Electrical engineers	47	17
2127 Engineering project managers and project engineers	47	17
2135 Cyber security professionals	47	17
2136 IT quality and testing professionals	51	17
2234 Nurse practitioners	65	16

Source: IER estimates.

Notes: The focus is on 2021-35 because the 4-digit SOC2020 data for 2020 are unreliable.

Table 6.10 Employment level (positive) differences between *Baseline projections* and *Technological opportunities scenarios* (000s)

Levels (000s)	2035	
	<i>Baseline projections</i> BS	<i>Technological opportunities adjusted</i> TS*-BS
6135 Care workers and home carers	1,022	108
3132 IT user support technicians	150	70
1254 Waste disposal and environmental services managers	14	56
2319 Teaching professionals n.e.c.	335	54
2151 Conservation professionals	30	52
2152 Environment professionals	64	52
3131 IT operations technicians	104	48
1131 Financial managers and directors	503	35
3133 Database administrators and web content technicians	63	33
1136 Human resource managers and directors	235	33
3231 Higher level teaching assistants	379	32
6131 Nursing auxiliaries and assistants	599	31
3119 Science, engineering and production technicians n.e.c.	44	26
3229 Welfare and housing associate professionals n.e.c.	252	21
2231 Midwifery nurses	51	21
2235 Mental health nurses	53	21
2234 Nurse practitioners	65	21
2232 Community nurses	97	21
2124 Electronics engineers	31	21
2141 Web design professionals	34	21

Source: IER estimates.

Notes: The focus is on 2021-35 because the 4-digit SOC2020 data for 2020 are unreliable.

Table 6.11 Employment level (positive) differences between *Baseline projections* and *Human-centric scenarios* (000s)

Levels (000s)	2035	
	<i>Baseline projections BS</i>	<i>Human-centric adjusted HS*-BS</i>
6135 Care workers and home carers	1,022	116
3132 IT user support technicians	150	69
1254 Waste disposal and environmental services managers	14	56
2319 Teaching professionals n.e.c.	335	56
2151 Conservation professionals	30	52
2152 Environment professionals	64	52
3131 IT operations technicians	104	48
6131 Nursing auxiliaries and assistants	599	36
3231 Higher level teaching assistants	379	35
1131 Financial managers and directors	503	34
3133 Database administrators and web content technicians	63	33
1136 Human resource managers and directors	235	32
3119 Science, engineering and production technicians n.e.c.	44	26
3229 Welfare and housing associate professionals n.e.c.	252	23
2232 Community nurses	97	21
2234 Nurse practitioners	65	21
2235 Mental health nurses	53	21
2231 Midwifery nurses	51	21
2124 Electronics engineers	31	20
2141 Web design professionals	34	20

Source: IER estimates.

Notes: The focus is on 2021-35 because the 4-digit SOC2020 data for 2020 are unreliable.

Table 6.12 Employment level (negative) differences between *Baseline projections* and *Automation scenarios* (000s)

Levels (000s)	Baseline projections BS	Automation adjusted AS*-BS
7111. Sales and retail assistants	1,000	-103
4159. Other administrative occupations n.e.c.	639	-61
7132. Sales supervisors – retail and wholesale	200	-53
4122. Book-keepers, payroll managers and wages clerks	497	-50
3556. Sales accounts and business development managers	388	-49
1150. Managers and directors in retail and wholesale	343	-48
1121. Production managers and directors in manufacturing	261	-48
9132. Packers, bottlers, canners and fillers	147	-40
9139. Elementary process plant occupations n.e.c.	117	-38
7131. Shopkeepers and owners – retail and wholesale	121	-38
1132. Marketing, sales and advertising directors	264	-37
4131. Records clerks and assistants	145	-36
7112. Retail cashiers and check-out operators	352	-36
9131. Industrial cleaning process occupations	371	-35
4123. Bank and post office clerks	111	-34
3417. Photographers, audio-visual and broadcasting equipment operators	82	-33
4152. Data entry administrators	46	-31
9252. Warehouse operatives	444	-30
5223. Metal working production and maintenance fitters	164	-29
2432. Marketing and commercial managers	165	-28

Source: IER estimates.

Notes: The focus is on 2021-35 because the 4-digit SOC2020 data for 2020 are unreliable.

Table 6.13 Employment level (negative) differences between *Baseline projections* and *Technological opportunities scenarios* (000s)

Levels (000s)	<i>Baseline projections</i> BS	<i>Technological opportunities adjusted</i> TS*-BS
7111. Sales and retail assistants	1,000	-56
7132. Sales supervisors – retail and wholesale	200	-45
1121. Production managers and directors in manufacturing	261	-35
9132. Packers, bottlers, canners and fillers	147	-34
9139. Elementary process plant occupations n.e.c.	117	-34
7131. Shopkeepers and owners – retail and wholesale	121	-34
1150. Managers and directors in retail and wholesale	343	-31
4152. Data entry administrators	46	-30
3417. Photographers, audio-visual and broadcasting equipment operators	82	-30
3556. Sales accounts and business development managers	388	-30
4123. Bank and post office clerks	111	-30
4131. Records clerks and assistants	145	-30
4159. Other administrative occupations n.e.c.	639	-30
1132. Marketing, sales and advertising directors	264	-24
4122. Book-keepers, payroll managers and wages clerks	497	-26
5223. Metal working production and maintenance fitters	164	-21
5231. Vehicle technicians, mechanics and electricians	151	-19
2432. Marketing and commercial managers	165	-20
2461. Social workers	139	-18
7112. Retail cashiers and check-out operators	352	-19

Source: IER estimates.

Notes: The focus is on 2021-35 because the 4-digit SOC2020 data for 2020 are unreliable.

Table 6.14 Employment level (negative) differences between *Baseline projections* and *Human-centric scenarios* (000s)

Levels (000s)	Baseline projections BS	Human-centric adjusted HS*-BS
7111. Sales and retail assistants	1,000	-51
7132. Sales supervisors – retail and wholesale	200	-44
1121. Production managers and directors in manufacturing	261	-36
9132. Packers, bottlers, canners and fillers	147	-34
9139. Elementary process plant occupations n.e.c.	117	-34
7131. Shopkeepers and owners – retail and wholesale	121	-33
1150. Managers and directors in retail and wholesale	343	-32
4152. Data entry administrators	46	-30
3417. Photographers, audio-visual and broadcasting equipment operators	82	-30
3556. Sales accounts and business development managers	388	-30
4123. Bank and post office clerks	111	-30
4131. Records clerks and assistants	145	-29
4159. Other administrative occupations n.e.c.	639	-27
1132. Marketing, sales and advertising directors	264	-24
4122. Book-keepers, payroll managers and wages clerks	497	-24
5223. Metal working production and maintenance fitters	164	-23
5231. Vehicle technicians, mechanics and electricians	151	-21
2432. Marketing and commercial managers	165	-20
2461. Social workers	139	-18
7112. Retail cashiers and check-out operators	352	-18

Source: IER estimates.

Notes: The focus is on 2021-35 because the 4-digit SOC2020 data for 2020 are unreliable.

Table 6.15 Percentage (positive) impact, *Automation adjusted scenario* (per cent)

% impact compared with <i>Baseline projections</i> in 2035	<i>Automation adjusted AS*</i>
1254. Waste disposal and environmental services managers	78.9
2483. Environmental health professionals	63.3
2151. Conservation professionals	61.2
8134. Water and sewerage plant operatives	44.6
2152. Environment professionals	41.8
2124. Electronics engineers	36.8
3112. Electrical and electronics technicians	34.7
6137. Care escorts	34.0
5245. Security system installers and repairers	34.0
2141. Web design professionals	34.0
3119. Science, engineering and production technicians n.e.c.	33.5
2137. IT network professionals	33.0
3133. Database administrators and web content technicians	30.5
3131. IT operations technicians	27.7
3132. IT user support technicians	27.6
2123. Electrical engineers	26.4
2127. Engineering project managers and project engineers	26.3
2135. Cyber security professionals	26.2
2231. Midwifery nurses	24.8
2136. IT quality and testing professionals	24.5

Source: IER estimates.

Notes: The focus is on 2021-35 because the 4-digit SOC2020 data for 2020 are unreliable.

Table 6.16 Percentage (negative) impact, *Automation scenario* (per cent)

% impact compared with <i>Baseline projections</i> in 2035	<i>Automation adjusted AS*</i>
8132. Mining and quarry workers and related operatives	-621.9
9229. Elementary cleaning occupations n.e.c.	-220.3
4152. Data entry administrators	-208.9
8112. Textile process operatives	-130.9
8115. Metal making and treating process operatives	-84.8
8114. Plastics process operatives	-80.1
9224. Launderers, dry cleaners and pressers	-75.4
3417. Photographers, audio-visual and broadcasting equipment operators	-66.3
8146. Sewing machinists	-64.2
7124. Market and street traders and assistants	-62.1
5423. Print finishing and binding workers	-60.7
5431. Butchers	-59.0
8141. Assemblers (electrical and electronic products)	-57.9
8139. Plant and machine operatives n.e.c.	-56.1
5413. Tailors and dressmakers	-49.8
9139. Elementary process plant occupations n.e.c.	-48.4
8119. Process operatives n.e.c.	-48.1
8131. Paper and wood machine operatives	-47.1
7131. Shopkeepers and owners – retail and wholesale	-45.7
4123. Bank and post office clerks	-44.2

Source: IER estimates.

Notes: The focus is on 2021-35 because the 4-digit SOC2020 data for 2020 are unreliable.

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Appendix A

Changes in employment by *Baseline projections* and scenario and detailed sector, 2020-35 (000s)

Sector	<i>Baseline projections</i>	<i>Automation scenario</i>	<i>Technological opportunities</i>	<i>Human-centric</i>
01-03: Agriculture, etc.	13.2	2.0	69.0	40.1
05-09: Mining and quarrying	-15.1	-16.6	-6.1	-10.5
10: Food products	-2.4	-29.6	-5.2	-14.2
11-12: Beverages and tobacco	-1.0	-4.1	-1.5	-2.5
13: Textiles	-16.6	-20.1	-23.1	-22.6
14-15: Wearing apparel; Leather, etc.	-13.0	-15.8	-19.1	-18.5
16: Wood and cork	-4.7	-12.0	-2.4	-6.0
17: Paper, etc.	-2.8	-7.2	-1.7	-3.7
18: Printing and recording	-19.0	-21.6	-17.5	-17.7
19-20: Coke and petroleum; Chemicals, etc.	-13.8	-22.7	-17.8	-20.6
21: Pharmaceuticals	1.1	-2.2	-1.4	-0.7
22: Rubber and plastic	-23.4	-36.9	-3.8	-16.3
23: Other non-metallic	-12.1	-18.7	-2.5	-8.6
24: Basic metals	-8.5	-11.6	-5.0	-7.1
25: Metal products	-40.6	-54.2	-25.1	-34.2
26: Computer, etc.	-11.0	-22.6	-18.1	-19.2
27: Electrical equipment	-3.9	-10.2	-5.9	-7.6
28: Machinery n.e.c.	-19.8	-25.2	-22.7	-26.3
29: Motor vehicles, etc.	-12.3	-22.4	-21.0	-21.5
30: Other transport equipment	-22.3	-29.3	-28.8	-29.0
31: Furniture	-16.9	-17.6	-10.8	-13.5
32: Other manufacturing	-18.3	-16.5	-9.6	-12.5
33: Repair and installation	-24.7	-26.4	-13.3	-18.7
35: Electricity, gas, etc.	-7.4	-9.2	-7.7	-8.1
36: Water	6.0	-1.4	-1.0	-1.0
37: Sewerage	3.2	-0.6	-0.4	-0.4
38-39: Waste management	18.3	-5.4	-4.1	-4.0
41: Construction	97.4	40.5	87.3	70.4
42: Civil engineering	31.7	10.3	26.8	22.0
43: Specialised construction	134.9	48.3	114.6	93.7
45: Motor vehicle trade	39.1	-3.8	30.5	19.0
46: Wholesale trade	21.4	-52.8	-27.3	-34.7
47: Retail trade	18.3	-267.8	-268.0	-269.6
49: Land transport, etc.	75.2	8.9	185.1	115.6
50: Water transport	-3.9	-5.2	-5.0	-5.0
51: Air transport	8.0	-2.1	-0.6	-1.2
52: Warehousing, etc.	43.3	-33.1	-4.9	-15.1
53: Postal and courier	30.0	-13.9	1.6	-4.0
55: Accommodation	109.6	66.7	81.3	81.6
56: Food and beverage services	333.8	328.4	331.5	334.1

Sector	Baseline projections	Automation scenario	Technological opportunities	Human-centric
58: Publishing activities	1.0	-7.8	-6.5	-6.8
59: Film and music	6.2	-3.7	-1.7	-2.2
60: Broadcasting	1.0	-1.8	-1.3	-1.4
61: Telecommunications	32.0	5.5	33.9	25.9
62: Computing services	130.9	28.3	139.1	107.6
63: Information services	18.2	5.5	19.7	15.6
64: Financial services	-5.7	-44.7	-0.3	-19.2
65: Insurance and pensions	-4.5	-14.9	-3.7	-8.5
66: Auxiliary financial services	-3.7	-44.8	-3.1	-21.0
68: Real estate	29.2	-21.8	-19.8	-20.5
69: Legal and accounting	86.0	48.8	104.1	82.5
70: Head offices, etc.	64.0	12.2	41.2	33.7
71: Architectural and related	21.6	-45.2	30.4	1.6
72: Scientific research and development	45.2	40.5	55.5	49.9
73: Advertising, etc.	60.0	50.3	71.6	63.5
74: Other professional	68.1	60.0	82.5	73.7
75: Veterinary	35.3	31.4	41.3	37.5
77: Rental and leasing	22.3	7.7	13.4	11.8
78: Employment activities	133.1	43.4	78.0	68.6
79: Travel, etc.	13.2	4.3	7.7	6.8
80: Security, etc.	28.1	9.1	16.4	14.4
81: Services to buildings	106.8	30.8	59.5	51.7
82: Office administrative	73.5	24.3	43.4	38.1
84: Public administration and defence	33.9	-187.8	118.4	51.6
85: Education	144.3	360.9	308.9	425.7
86: Health	368.7	323.9	580.7	845.4
87: Residential care	136.4	103.2	174.4	232.1
88: Social work	151.3	111.6	198.5	270.9
90: Arts and entertainment	3.1	-3.2	7.0	4.0
91: Libraries, etc.	8.6	2.4	12.4	9.5
92: Gambling and betting	18.2	1.7	4.2	4.1
93: Sport and recreation	88.9	6.4	18.4	17.8
94: Membership organisations	-3.8	-18.2	-6.4	-6.6
95: Repair of goods	3.5	0.0	3.3	3.1
96-99: Other personal services	-7.6	-27.2	-10.4	-10.7
Total	2,578.6	557.5	2,556.9	2,551.7

Source: Cambridge Econometrics, MDM-E3 revision 13571.

Notes: Key comparisons should focus on comparing the technological opportunities and Human-centric scenarios with the Baseline.

The Automation scenario should be analysed differently compared to the technological opportunities and Human-centric scenarios, as these latter two scenarios are built on top of the results of the Automation scenario. The results of the Automation scenario can be compared against the Baseline projections results. The results of the technological opportunities and Human-centric scenarios can be compared against each other and the Baseline projections results.

Numbers before each sector correspond to 2-digit SIC 2007 codes.

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