UK COMMISSION FOR EMPLOYMENT AND SKILLS

Appendix F Trends and Disruptions: Full report

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Intelligence Investment Impact

Appendix F

Trends and disruptions: Full report

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1 Introduction

The Future of Work research commissioned by The UK Commission for Employment and Skills (UKCES) looks ahead to the labour market of 2030. It analyses stable trends that are already shaping the future of UK jobs and skills and identifies the plausible disruptions to these trends. It plots four anticipated scenarios of what the UK's work landscape might look like in 2030, and importantly, the skills that will be required under these conditions.

The full report of the study with the scenarios and the key findings report are available at www.ukces.org.uk/thefutureofwork

This report is one output of *The Future of Work* study. It sets out the 13 trends identified by the research as the most influential and plausible impacting the jobs and skills landscape in the UK until 2030. It also provides detail on the ten key disruptions selected, that if they were to occur, may lead to abrupt changes that are more difficult to foresee.

What will the UK's future job landscape look in 2030? Which skills will be needed to drive the competitiveness of UK businesses and to promote the employability of the UK's working age population?

It is not possible to predict the future. We live in a dynamic and turbulent world where changes occur rapidly and on a continual basis. However, it is important to take the long-term perspective into account. For instance, employers need to think about new strategies and new business models to prepare themselves for tomorrow's markets. Long-term developments have to be taken into account, especially when investing in innovation. Businesses increasingly require an internationally competitive skills base to be successful.

Skills development is an important long-term issue. Education and training providers need to be aware of the potential future requirements of the labour market in order to ensure that they offer individuals the skills that will be required in the future. An individual's decision on the skill level they aim to achieve and their subject specialisation determines, to a certain degree, their career pipeline throughout their working lives.

There are many local and global trends that are already visible today that point towards forthcoming changes in business and society. These will have significant impact on UK jobs and skills over the long-term. These include:

- Emerging economies acquiring shares in global production chains;
- Demographic change and migration changing the face of the workforce;

- Technological developments weakening the once clear differentiation of sectors and traditional modes of working;
- The structure of businesses evolving and developing into more flexible and networked models;
- Employees becoming more mobile (through preference or necessity) leading to higher job turnover rates.

These rapid, complex shifts are affecting labour markets around the world. The way in which work is organised, and the change in the nature and mix of necessary skills, presents important opportunities and risks to the UK.

Selection of trends and disruptions

The Future of Work full evidence report, available www.ukces.org.uk/thefutureofwork, provides in depth information on the process of selecting the most influential trends driving, and disruptions potentially affecting, the long-term future of UK jobs and skills

In brief, the selection process was based on a broad literature review of global and UK specific foresight studies published from 2010 onwards[1]. A 360° view on the topic of UK jobs and skills was used, taking into consideration all possible influencing trends according to the STEEP framework: social, technological, economic, ecological and political factors.

The analysis followed a "zooming in" approach, looking first at the more distant environment, e.g. global economic developments and climate change, and then zooming down to factors more specific to job and skills in the UK.

Interviews with 23 senior UK and international figures validated and enriched the collection of trends and descriptions.

Thus, the trends and disruptions were initially selected by taking a comprehensive view of their long-term impact on UK jobs and skills. Secondly, the plausibility of the trends and disruptions were considered.

For the trends, plausibility was taken to mean certainty about their occurrence. For the disruptions plausibility was taken to mean that their occurrence is conceivable under certain conditions.

For both, trends and disruptions, the expected developments generally apply across the UK labour market, but may vary for different sectors and occupations[2].

[1] For the trend selection, the literature base is supplemented by *Z_punkt Megatrends Update*, a compilation of the twenty most important megatrends that are on the strategic radar of many international companies; as well as the *Z_punkt Trendradar 2020*, which includes descriptions of more than 170 trends. For the disruption selection, the literature is complemented by the *iKnow* database *WiWe Bank*[1] with more than 800 emerging issues, wild cards and weak signals.
[2] A more detailed analysis of the impacts on selected sectors and occupations can be found in the full evidence report available www.ukces.org.uk/thefutureofwork

The following two sections present the trends and disruptions. They are documented by recent evidence, which is then used to extrapolate their expected future development.

Also included is a list of their underlying drivers, and their implications for UK jobs and skills. As jobs and skills are strongly interconnected, these implications are also strongly interlinked.

The trends are evidence based, referenced by the broad literature that was initially scanned, while additional sources have also been included. In addition, the insights from key informant interviews are included, particularly where interviewees provided specific insights on the implications for jobs and skills in the UK. To guarantee anonymity, no references were added to the insights from the key informant interviews[3].

[3] If there are no references in the implications section of the trends and disruptions the insights come particularly from key informant interviews.

2 Trends shaping the future of UK jobs and skills over the long-term

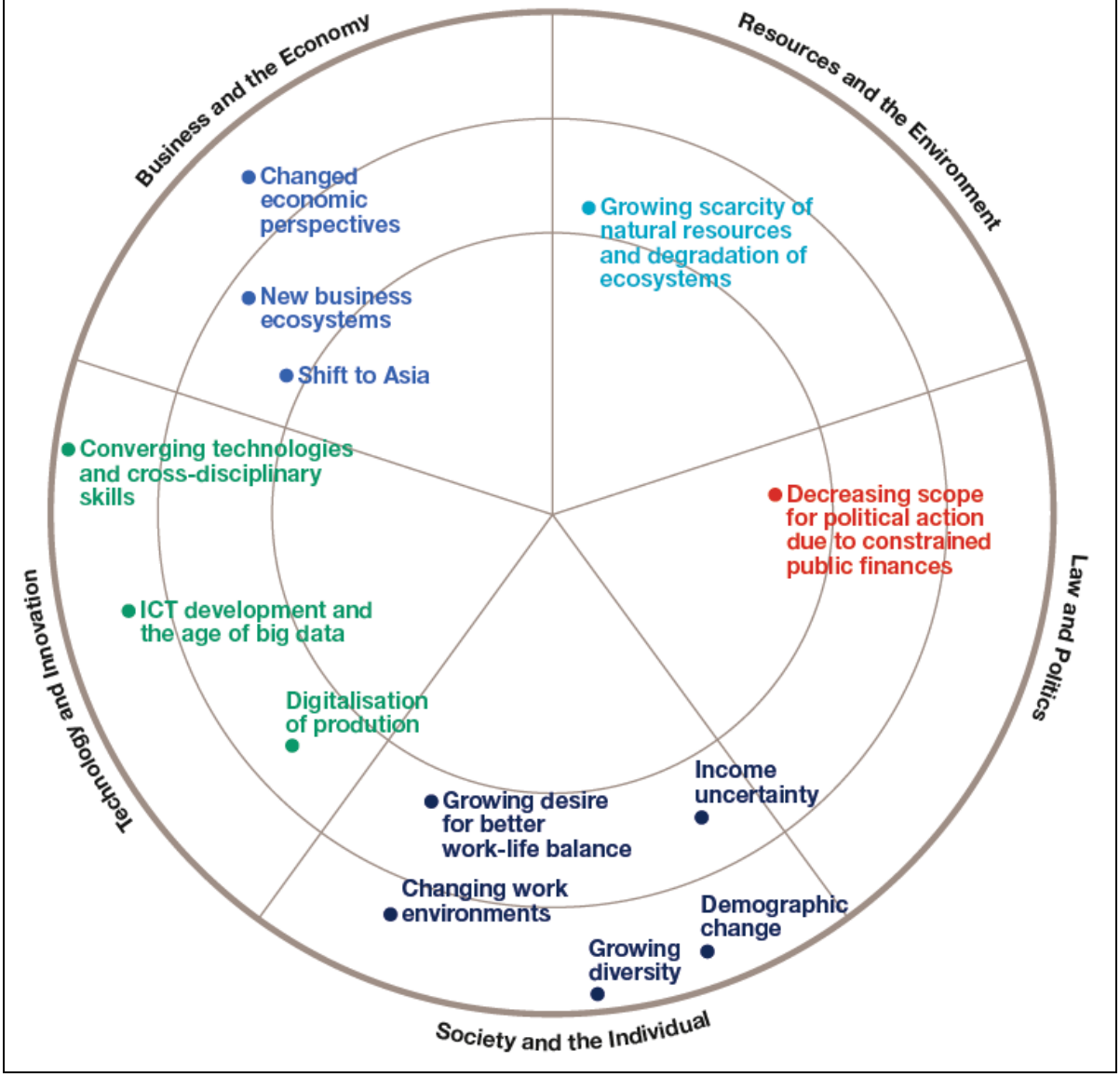
2.1 Introduction

A trend is a development lasting several years that is empirically documented. Trends usually run a steady course, and cyclical changes and fluctuations do not affect them, nor are they subject to changes in course or sharp rises. As a rule trends follow a clear direction, their course is robust. Trends describe a continuation of events according to the principle “business as usual”.

The 13 trends that were considered to have both the highest plausibility of occurrence and to be the strongest drivers of future jobs and skills in the UK were selected. To cover this broad field, the trends are inter-sectorally relevant and stable over the long-term.

These were selected from an initial longer list which included trends deemed to have less potential for impact on the labour market of 2030, including changing household and family structures, increasing borderless risks, such as global crime, and the growing importance of social enterprise.

Figure 2.1: Trends driving the future of UK jobs and skills



Overview of the trends

Demographic change

The UK's population and labour force are experiencing a marked aging process as the "baby boom" generation reaches state pension age and older people participate in the labour market for longer. While, as in other industrialised nations, the population and workforce are aging, migration is helping to remedy skill shortages.

Growing diversity

As women around the world continue to seek equal rights within society, the workplace and at home, traditional gender roles are increasingly challenged. The role of women in the UK labour market will continue to grow in scale and importance. Rising global mobility of workers and new technologies are bringing together different and sometimes conflicting cultures, religions, races and languages.

Income uncertainty

Households in the UK face growing income uncertainty due to low economic growth, fleeting job security and expected increases in taxes. Against this backdrop, income and wealth inequality in and between UK regions is becoming more important. As the length of this period of financial uncertainty is unclear, thrift-oriented motives for purchasing decisions may become more widespread.

Growing desire for a better work-life balance

Better work-life balance is becoming increasingly important. More flexible working arrangements, that enable family friendly work patterns, are on the rise. Successful flexibility arrangements address both personal and company goals. As organisations seek to hire and retain strong performers, there is a growing understanding of the need to offer soft benefits in addition to traditional incentives.

Changing work environments

Work places and working modes are under pressure to increase flexibility and to adapt to business volatility. Outsourcing and the increasing internationalisation of business are leading to a rise in project and teamwork with external collaborators. As a result, decision-making is occurring more broadly in companies across those with various levels of responsibility. Additionally, as an increasing number of tasks become knowledge work continuous digital training becomes necessary.

Converging technologies and cross-disciplinary skills

The boundaries between disciplines, such as natural sciences and informatics, are becoming increasingly blurred. As the disciplines converge, so do the technologies. This convergence, particularly at the intersection between nanotechnology, biotechnology, information technology and cognitive science, disrupts existing business models, but also creates completely new markets and novel application fields.

Digitalisation of production

The digitalisation of production processes is driving a new era of industrialisation. With real time data exchange between machines, materials, and products-in-the-making, increasingly autonomous production systems and factories become possible. Moreover, additive manufacturing techniques (also known as 3D printing) enable new forms of decentralised, yet complex production processes.

Information and Communications Technology (ICT) development and the age of Big Data

The development of ICT continues to be characterised by performance increases, miniaturisation, and nanotechnology. The increasing number of smart mobile devices combined with faster mobile Internet access allows for ubiquitous communication and access to information and media. Effective data management is becoming of critical importance as the amount of data collected and stored, as well as the ability to analyse this data, increases.

Changed economic perspectives

Due to globalisation and technological change, the economy and financial system are increasing in complexity. This is compounded by challenges arising out of greater global volatility and low economic growth within established economies. As the innovation necessary for continuing expansion of the economy is requiring increasingly higher levels of economic and financial complexity, there is also a growing business awareness of the need for more resilient value chains that are safeguarded by risk management policies and strategies.

Shift to Asia

Economic power is shifting towards emerging countries, parallel to the relative loss of importance of the G7 economies. The markets of emerging countries promise high growth and profitable investment opportunities.

New business ecosystems

A new organisational paradigm sees companies increasingly defined as ‘network orchestrators’. The skills and resources they can connect to, through activities like crowdsourcing, become more important than the skills and resources they own. Collaboration in value creation networks is enabled by the virtualisation of business processes, fuelled by the rise of the digital economy.

Growing scarcity of natural resources and degradation of ecosystems

Global economic growth is leading to a growing worldwide demand for natural resources and raw materials. Over exploitation implies higher extraction costs and degradation of ecosystems. The prices of these resources will become more volatile.

Decreasing scope for political action due to constrained public finances

Government scope to invest in employment and education initiatives is increasingly challenged by the competing fiscal pressures of growing social transfer payments, pension burdens and public debt.

The following sections provide more detail, including supporting evidence, on each trend.

2.2 Demographic Change

Description	The UK's population and labour force are experiencing a marked aging process as the "baby boom" generation reaches state pension age and older people participate in the labour market for longer. While, as in other industrialised nations, the population and workforce are aging, migration is helping to remedy skill shortages.
Recent developments	• UK's population continues to grow steadily, due to natural increase and an assumed continued positive net inward flow of migrants (in the year ending March 2012 there was a net flow of 183,000 migrants to the UK; ONS, 2012a). • The age structure of the UK population, and of the workforce, is shifting toward older age cohorts. There are also fewer young people in employment due to higher education and the post-2008 crisis hitting job perspectives of the younger hard[4]. Comparing the period April to June 2008 with April to June 2013 there were 76,000 fewer people aged 16 to 64 in employment. In contrast, over the same period the number of people aged 65 and over in employment rose by 317,000 (ONS, 2013a). The abolition of the compulsory retirement age in 2011 is a contributing factor (BBC, 2011). People aged 65 and over in employment now number just over 1 million in the UK. The number of people in employment aged 16 and over in the UK in April to June 2013 was 29.8 million, a rise of 301,000 from the previous year (ONS, 2013a). • Migration is contributing to a steady supply of younger workers to the UK labour market (particularly from A8 countries[5]), as the majority of migrants entering the UK are between the ages of 20 and 29. However, the UK is still experiencing a distinct aging of the workforce (ONS 2013b; ONS, 2011a). • Urbanisation is continuing in the UK and leading to a process of population contraction in many areas. This is especially noticeable as London continues to rapidly grow (census data recorded London's population at 8.2 million in 2011, a 12 per cent increase from 2001 when the population was 7.3 million; ONS, 2012b) often at the expense of rural areas, as the relative population growth is higher in

[4] Higher education participation rate of the 17-30 year old rose from 43 per cent in 2006/07 to 49 per cent in 20011/12 (BIS 2013). However, there is also a great youth unemployment problem (Crowley *et al.*, 2013), with about a million 16-24 year old unemployed or 21.4 per cent, in the second quarter of 2013.

[5] A8 countries commonly refer to the eight Eastern European countries that joined the European Union in 2004, (Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, Slovenia), with low per capita incomes comparative to existing EU members.

some small or medium sized cities of England and Wales (Smith, 2012).

Expected future developments

- UK population projections show an annual average growth rate of 0.6 per cent between mid-2012 and mid-2022, when the population is forecast to reach 68 million. The four nations of the UK will experience different growth rates; England's population is forecast to increase by 7 per cent by mid-2022, Northern Ireland by 5 per cent, and Scotland and Wales by 4 per cent (ONS, 2013c). Further, by 2030 the UK's population is projected to reach 71.4 million, an increase of around 9 million over 20 years period from 2010 to 2030 (ONS, 2011a).
- The continued aging of the UK's population is projected to shift the median age from 39.7 years in 2010, to 39.9 years in 2020, and to 42.2 years by 2030 (ONS, 2011a). Additional projections place almost a quarter of the population in the 65 and over age group by 2030 (Hackett *et al*., 2012), in comparison with today's figure of nearly 18 per cent (ONS, 2012d). Latest population prospects expect this group to grow by 42 per cent until 2030 (ONS, 2013c). By 2032, there is expected to be around 15.6 million people of state pension age (SPA), from 12.3 million in 2012; a 27 per cent increase from 2012 (ONS, 2013c).
- With the average age of the UK's labour force increasing over the coming decade, today's largest age band of workers is set to shift from 44-46 to 54-56 by 2020 (Duckworth *et al*., 2010).
- The UK is projected to receive a 165,000 population boost each year from 2018-19 onwards (assuming that this trend maintains until 2030) due to positive net migration, with England receiving the large majority of migrants (150,000). Of those migrating to the UK, the largest age cohort will be those aged 20-24 at 64,600 per year from mid-2019 onwards, followed by 25-29 year olds at 28,500 per year, and 15-19 year olds at 27,600 per year (ONS, 2013b).
- The urban population of the UK is forecast to increase from 80 per cent in 2010 to 82 per cent by 2025. London is projected to become the UK's first megacity in around 2025 when the population is expected to reach 10.3 million, an increase of almost 26 per cent from 8.2 million in 2011 (ONS, 2012b; UNDESA, 2011).

Drivers

- Global and EU wide diverging opportunities for employment and better livelihoods
- UK wide diverging job opportunities between rural regions and cities (particularly between greater London and other areas)

- Improved health conditions leading to greater longevity

Implications for Jobs

- The growing population will lead to increased consumption within the UK, pushing the demand for food, energy, housing and infrastructure. This will create additional jobs e.g. in the construction sector, but also in retail and energy.
- There will be a continued increase in care occupations including those that assist the sick and elderly. The health sector is expected to bear the brunt of the impacts, while having to manage the increasing numbers and demands of the aging population, as well as the increasing number of workers in the sector who will be reaching retiring age themselves, and the increasing number being recruited by other countries (Hackett *et al*., 2012; Miller *et al*., 2010). There will be an increasing need for migrant workers to fill these job gaps, particularly in the low and high skill level jobs.
- As overall workforce participation rates are expected to decline to a degree (as baby boomers retire and there are fewer new entrants to the workforce) employers may find it increasingly difficult to fill vacant roles. The gap will widen as more employees move into part time employment in later life. However in contrast, fitter retirees will increasingly, voluntarily or dictated by financial reasons, seek employment opportunities (Mortensen and Vilella-Vila, 2012).
- As employees work into their later years job compensation and 'phasing out' options may need to be considered in order to address declining productivity and physical capacity. Already today, wage development in the UK peaks for men between the ages of 40-49, and for women between the ages of 30-39 (ONS, 2012c). Further, the 'phasing out' of elder employees, moving into part time before retiring, will allow younger workers to take on leadership positions earlier, reducing intergenerational tensions as well as potential inefficiencies in the workforce.
- Migrants to the UK will continue to be able to fill gaps in the labour market, especially in very high skilled and low skilled occupations. The impact of migration will contribute to an hourglass shaped skills distribution, raising the proportions of the low skilled and high skilled population, while relatively reducing the intermediate skills population (Bosworth, 2012).
- Due to the need to save for the prolonged retirement age, an increasing demand for financial products will create jobs in the financial sector (PwC, 2010a).

Implications for Skills

- It is possible that with an increase of the retirement age to 70 the proportion of the lower qualified would also rise until 2020, as on average younger people are more highly qualified than the older population. However in the longer term this effect will abate, due to a continuous improvement in qualification levels across all age groups (Bosworth, 2012).
- As people live and work longer, they will require lifelong learning and training. Both employers and individuals will be required to update, upgrade, and learn new skills and competencies as job requirements change over time.
- Skills for leading multi-generational workforces and collaboration within multi-generational groups will become an important success factor. This includes cross-generational skills learning. Further, with technological changes occurring at an increasingly rapid pace, the acquisition of new skills will become routinely necessary in the work-life of every employee. In particular, there will be a need to learn complete new skill sets for radical new technologies, which will also require new learning approaches. Thereby placing an onus on the ability to learn as a cognitive skill.
- Consideration and emphasis may need to be placed on ensuring the availability of age appropriate work, including training for new tasks, managing job transitions and leadership challenges.
- As high-skilled workers from the baby-boomer generation reach retirement age it is likely to lead to large skill gaps in many occupations, especially in the STEM (science, technology, engineering and mathematics) professions (Business Europe, 2011; Intel, 2012).
- Continued urbanisation may lead to regional disparities in educational opportunities, as some higher education facilities may look to locate themselves near to the infrastructure and services provided by cities. Consequently, rural people may face increased barriers to gaining access to skills.

2.3 Growing Diversity

Description	As women around the world continue to seek equal rights within society, the workplace and at home, traditional gender roles are increasingly challenged. The role of women in the UK labour market will continue to grow in scale and importance. Rising global mobility of workers and new technologies are bringing together different and sometimes conflicting cultures, religions, races and languages.
Recent developments	• The breakdown of traditional gender roles is becoming increasingly apparent, especially in the workplace, as the once clearly defined roles for men and women converge. Labour market participation rates of men and women have almost continually narrowed since the early 1970's. Today, working women represent almost 47 per cent of all those in employment, in comparison to 37 per cent in 1971 (CIPD, 2013a). As more women enter the workforce, men are taking greater involvement in family life, currently making up around 10 per cent of those caring for children while their partner is at work. The number of men who stay at home to look after family members in the UK rose 19,000 between 2011 and 2012 to a total of 227,000 (ONS, 2013d). • The increasing participation of women in higher education is assisting their rise in ranks within the workforce. Looking at the top of the career ladder, we see the following picture: Women currently comprise nearly 19 per cent of board members of the 50 largest companies listed on the FTSE 100 index in the UK. This figure has risen sharply over recent years from 12 per cent in 2007. To further lift the ratio, the government has recommended a target of 25 per cent by 2015. However, only 6.4 per cent of chief executives of the 50 largest companies listed on the FTSE 100 are women. But public awareness is high: 93 per cent of people in the UK are in favour of equal representation in company leadership positions, given equal competencies (EC, 2013a). • The UK's ethnic make-up is changing, 2011 census data for England and Wales showed all ethnicities other than white British increasing their population share over the previous decade: white British 80.5 per cent (2001: 87 per cent); Asian 6.8 per cent (2001: 4.4 per cent); black 3.4 per cent (2001: 2.2 per cent); Chinese 0.7 per cent (2001: 0.4 per cent); Arab 0.4 per cent (2001: not listed); other 0.6 per cent (2001: 0.4 per cent). Further, a regional divide is clearly visible: white British in London make-up nearly 45 per cent of the population (2001: 58 per cent) in comparison to 80 per cent across all of England and

Wales. While in London, 37 per cent of the population are foreign-born, across the whole of England and Wales 13 per cent are foreign-born, and in the northeast this figure is a mere 5 per cent (ONS, 2012d). In the work place the number of foreign-born people of working age in 2011 was 6 million – about 20 per cent of all employed people (a large increase from 2.9 million in 1993; Rienzo, 2012).

Expected future developments

- An increasing number of women will enter the workforce over the coming two decades – 56 per cent of the net increase in jobs between 2010 and 2020 are expected to be filled by women (Wilson *et al*., 2012), a tendency which will maintain until 2030. As woman continue to enrol and complete further education in higher numbers – in 2010-2011 female students made-up 55 per cent of full-time undergraduates enrolled at UK universities (HESA, 2013) – it is expected that women's roles and ranks within the workplace will increase. The skills level gap between the genders is widening until 2020 with 46 per cent (2010: 35 per cent) of females higher skilled compared to 42 per cent (2010: 33 per cent) of males (Bosworth, 2012). Consequently, women are projected to secure a disproportionate share of new jobs in higher-level occupations and are expected to experience a faster improvement in qualification attainment.
- While statistics on the UK labour market show that the gender pay gap is narrowing (ONS, 2012c) as the importance of women within the workforce further increases, issues of gender pay gaps and sexual discrimination are expected to continue to be increasingly addressed (Perfect, 2011).
- As increased policy efforts focus on assisting the successful integration of migrants into the UK's social fabric, it can be expected that foreign-born workers will continue to rise up the ladders of the UK workforce (Rolfe et al., 2013). In particular, efforts to ensure equal education opportunities for all people in the UK may allow those born in a foreign country or into first (or higher) generation migrant families better access to more highly skilled forms of employment.
- As religious groups within the UK continue to increase (e.g. the Muslim population in UK is projected to rise from 2.9 million in 2010 to 5.6 million by 2030; Grim and Karim, 2011) competing and merging value systems will develop.
- Cross-country collaboration will increase further in multi-national companies, driven by outsourcing and global supply chains. Also day-

	to-day virtual teamwork requires intercultural competences and respect to diversity issues (Hay Group, 2011a).
Drivers	• Improvements in access to education opportunities and family friendly policies • Increasing economic necessity for women to enter the workforce (and often for a dual household income) • Global and EU wide diverging opportunities for employment and better livelihoods
Implications for Jobs	• Occupations and working arrangements that facilitate a successful balance between employees' careers and their private lives are expected to rise. This includes the need for provision of flexible working options and support in child and elderly care by the employer. This will lead to a rise in social care jobs (SFH and LMI Team, 2011). Furthermore it is necessary for a higher acceptance of women in occupations that are traditionally male dominated (e.g. to overcome shortages in STEM jobs). • There will be a need for employers to update, and in some cases even rethink, codes of conduct in order to provide discrimination free environment, including provisions to encourage integration of employees from different cultural and religious backgrounds. • There will be a rise in the number of jobs across all sectors that facilitate the integration of other nationalities into the UK labour market, e.g. translation services, language teaching (People 1st, 2010; PwC, 2010a). • Companies will increasingly need to cater to the needs of different ethnic markets, both nationally as well as internationally, in order to remain profitable. New occupations and an increasingly globalised workforce will develop as a result (People 1st, 2010; PwC, 2010a).
Implications for Skills	• There is a growing need for the acquisition and integration of 'soft' skills within the workforce as the numbers of women in the workforce further increase (Expert Group on Future Skills Needs, 2013). Leadership skills in reintegrating employees after periods of parental leave will be increasingly necessary. There will also be a need for efficient re- and up skilling of returnees to work where skill requirements have changed over their period of absence (Duckworth *et al*., 2010). • Increasing migration encourages a rise in multi-cultural social and communication skills within the workforce. This is particularly important for those in managerial roles (Expert Group on Future Skills

Needs, 2013). The growing need for language, cultural and religious knowledge is becoming evident, as well as the need for strong leadership support for diversity.

- There is a growing need to recognise and understand foreign qualifications (certificates, diplomas, degrees) and the competencies they signal, as well as to provide UK-specific training courses to cover any knowledge gaps.

2.4 Income uncertainty

Description	Households in the UK face growing income uncertainty due to low economic growth, fleeting job security and expected increases in taxes. Against this backdrop, income and wealth inequality in and between UK regions is becoming more important.
Recent developments	• Over recent decades there have been significant changes to the structure of the UK economy (in particular, a considerable shift in emphasis to the financial sector) and changes in the rate at which pay has risen across different sectors. Compounding issues of pay distribution was the global financial crisis, which drove GDP into negative growth in 2008, an occurrence that is intermittently continuing. Against this backdrop, between 2009 and 2012 national income per head in the UK dropped by around 13 per cent (Lansley and Reed, 2013). • The current financial climate in the UK has left many individuals with concerns over their income security. While it is clear that unemployment has been rising (currently around 8 per cent for those 16 and over and around 21 per cent for those aged 16-24), a more telling measure of income uncertainty can perhaps be explained by job turnover: voluntary job turnover almost halved between 1997 and 2012 from 3 per cent to 1.6 per cent (CIPD, 2013a). Additionally the ONS reports that in 2009/10 over 12 per cent of UK people were finding it quite or very difficult to manage financially (Self *et al.*, 2012). • Underemployment is a further measure of labour market slack (where workers are willing to supply more hours than employers are prepared to offer, or to work below their skill level). Labour market evidence for the recent recession indicates that the underemployment rate in the UK workforce increased from 6.2 per cent in 2008 to 9.9 per cent in 2012 (Bell and Blanchflower, 2013) Increasing underemployment could result in a fall in real wages, if there are no protective policies in place. • Inequality of income between the workforces is a significant factor in the UK and those in the lower income deciles experience little mobility up the employment ladder. Of those workers who were in the bottom income decile in 2001, 33 per cent were still there in 2008 and 60 per cent remained in the bottom three deciles (Hackett *et al.*, 2012). Between 2008 and 2010 income growth occurred across much of the income distribution, but the highest was recorded at the very top.

	While there was relatively robust growth at the bottom of the income distribution, the growth is being attributed to increases in benefits and tax credits seen to compensate some of the hard hitting impacts of the recession (Jin *et al*., 2011). Further, relative to other leading economies, the UK has a high proportion of workers (21.6 per cent) in low-wage jobs, second only to the U.S. (CIPD, 2013a). • The UK has experienced a weakening of collective bargaining – a strong means to reduce in-work poverty and income inequality (Coats, 2013) – over recent decades as well as seeing diminishing coverage of collective agreements. Since 1996 the proportion of all employees covered by a collective agreement has dropped from 36 per cent to 31 per cent (Lansley and Reed, 2013).
Expected future developments	• Pressure on household net income (pension plans, etc.) is forecast to continue to raise owing to, amongst other things, changes in employment structures, the UK's current tax and benefit policy, and the projected increases in high and low-paid jobs (at the expense of middle-income jobs; Brewer *et al*., 2012). In terms of employment structures, the rise in temporary employment and self-employment in the UK leads to an accompanying rise in associated negative social impacts such as lower average wages, less employment protection, and reduced social security provisions (Brewer *et al*., 2012). • Without effective policies in place inequality of income between groups within the workforce is expected to continue to rise. In 2010 the annual income of FTSE 100 chief executives was 145 times greater than the national median full-time income (£3,747,000 in comparison to £25,800). The wage gap is forecast to continue increasing, with the ratio becoming 214:1 by 2020. If recent trends continue in the UK, by 2030 the highest 0.1 per cent who currently receives 5 per cent of the national income will see this rise to 14 per cent (HPC, 2011). • Membership of institutions with stronger bargaining power (such as trade unions) tends to rise in times of a prolonged income squeeze, as the demand from workers for representation to secure a fair workplace and employment conditions increases (Coats, 2013).
Drivers	• Globalisation 2.0 with increasing competition with emerging economies • Shareholder value driven business strategies • Rise in flexible and temporary working conditions
Implications for	• As the power balance shifts more towards employers, who also face

Jobs	increasing cost pressures, there is likely to be a subsequent rise in temporary employment contracts. Such contracts adversely affect lower-end jobs, while high-end jobs sometimes benefit (e.g. micropreneurs; Lansley and Reed, 2013). • With increasing pressure on consumers' income, there is a push for lower-priced products and services leading to downward pressure on wages for associated jobs. A shift towards low-cost products and services will lead to a rise in associated jobs, such as in the retail sector or household related services.
Implications for Skills	• Polarisation of demand for skill sets in the UK with a higher proportion at the very top and very bottom, leading to an hourglass skills distribution (Hackett *et al.*, 2012). • A shift towards low-cost products and services leads to a demand for skills that allow for highly efficient and productive working: tasks have to be carried out in a highly organised way and in many cases rather self organised when the number of team leaders or the middle management is thinned out. • Individuals will increasingly need knowledge of which skills they require to be attractive on the job market. As inequality increases, those in lower socio-economic groups may require additional support and training in soft skills. For example, job acquisition expertise will need to improve as people find it increasingly necessary to master the required practices to obtain employment (i.e. job interview skills, networking strategies, etc.; Campbell *et al.*, 2010; Hackett *et al.*, 2012). However, as pressure increases on household income levels, there will be a strong impact on individuals' ability to afford higher education. Decreasing financial capabilities mean some employers will also have reduced capacity to invest in education. • Micropreneurs may be required to demonstrate certified competences in order to be seen as trustworthy suppliers.

2.5 Growing Desire for a Better Work-life Balance

Description	Better work-life balance is becoming increasingly important. More flexible working arrangements, that enable family friendly work patterns, are on the rise. Successful flexibility arrangements address both personal and company goals. As organisations seek to hire and retain strong performers, there is a growing understanding of the need to offer soft benefits in addition to traditional incentives.
Recent developments	• There is a declining demarcation between work and private life due to a shift to project work with distributed responsibilities, higher perceived pressure on work performance, and the opening of intra-firm communication to employees homes via email and mobile phones (among other factors). Imbalances between work and private life increase levels of stress and dissatisfaction, in turn affecting long-term health. According to the CIPD (2013b), 57 per cent of UK employees report the right balance between their home and work lives, while 41 per cent of employees report excessive pressure at work either once or twice a week or every day. • There has been a substantial rise in demand to achieve a better work-life balance from employees but also from responsible employers. This is particularly so for women in the workforce: 68 per cent of women without children would prefer more free time over more money, even more than those with children where this figure is slightly less at 62 per cent (Adachi *et al.*, 2013). • Increasing numbers of workers are choosing part-time and self-employment, over the traditional nine-to-five working day five-days a week, in order to maximise work-life balance and take advantage of the perceived health benefits including reduced stress, depression and burnout. Part-time employment by both men and woman has increased over the last 30 years, but is traditionally higher for women with around 40 per cent of women working part-time in the UK. However, male part-time employment is growing particularly quickly albeit from a low base (CIPD, 2013a). • With more and more women entering the workforce, and with people choosing to start families later in their working years, as opposed to the start of their careers, the demands to combine family life with careers are rising. Employers are responding by offering an increasing range of family-friendly work policies and patterns to both men and women. In the UK 91 per cent of employers offer at least one form of flexible employment options, 60 per cent of employees

use a form of flexible working, and 83 per cent of flexible working requests are approved (Gregory *et al.*, 2011).

- Interestingly however, the Additional Paternity Leave (APL) legislation (which came into force in the UK in April 2010) has thus far had minimal uptake by fathers. In 2011/12 less than 1 per cent of the 285,000 fathers eligible to take APL did so (TUC, 2013).

Expected future developments

- As flexibility continues to be a decisive factor when choosing a job, the rise in limited project contracts, freelancing and part time employment is expected to continue. With almost one in three jobs in the UK currently part-time, numbers of part-time and self-employed workers are projected to continue to increase (Andre *et al.*, 2013; EC, 2012).
- There is expected to be a continued rise in the need to offer future employees non-traditional incentives as employers compete on a global stage for the most talented employees. Employees are actively searching for employers that offer flexible working patterns and family-friendly work policies and patterns (so that employees can manage their child care needs, and their increasing needs to provide care to aging relatives). Generation Y[6], who since the 2010s are entering the workforce in large numbers, will further drive this trend: 92 per cent of them place flexibility as a top priority when selecting workplaces (Adachi *et al.*, 2013).
- The acceleration of living and working environments, increasing pressure and continuous learning requirements in the workplace is contributing to the need for employees to successfully adapt to these more stressful work environments. If such issues are left unchecked, they can lead to increased health related issues and decreases in productivity. It was found that employees who regularly work 11-hour days or longer are 67 per cent more likely to develop heart disease than those working 7 or 8-hour days (BWC, 2013). By encouraging employees to unbury the boundaries between work and private life, and switching off the 'always on' working mentality, organisations can experience better and more sustainable results. Of those employees in the UK who experience excessive pressure at work every day, a mere 22 per cent are able to achieve a productive work life balance (CIPD, 2013b).

Drivers

- Declining demarcation between work and private life, 24/7 customer expectation society

[6] Generation Y are commonly referred to as those people born between 1982 and 2000.

- Men and women starting families later in life
- War for talent and retaining qualified employees
- Increased focus on wellness and healthy lifestyle choices

Implications for Jobs

- Employers will increasingly need to draw on more creative solutions to recruit, retain and motivate workers, including a rising onus on employers to actively show corporate social responsibility when recruiting (Khallash and Kruse, 2012). In terms of employment modes, there will be a continued rise in job sharing, part-time employment, flexitime (etc.), and contract based work as well as new and innovative employment models (Gratton, 2010).
- HR departments will be required to cover more tasks and demands: they will need to be well versed in new employment policies and legislation relating to flexible employment rights and options (CIPD, 2013a). Additionally, they will need to care for the well being of employees, including health and personal issues, to ensure a happy and productive workforce in a more comprehensive way than before. As a result of these demands, precautionary health services will be a rising job market. Organisations could either directly order these services or provide employees with vouchers or reimbursement.
- As employees continue to strive for greater amounts of leisure time, employers and government are faced with the challenge of ensuring continued productivity and growth.

Implications for Skills

- Innovative management techniques will be necessary as higher-level staff grapple to manage a more flexible and disjointed workforce (Intel, 2012).
- Leaders and HR departments will increasingly need to have the skills to actively care for their employees' state of health and to offer workplace adaptation to reduce the health burden and increase the resilience of the workforce (Khallash and Kruse, 2012).
- Employees will need to be able to show strong self-organisation and multi-tasking skills. Employees who are contracted on a project by project basis, in particular, will need to have a greater breadth of skills to draw upon and will need to rely increasingly on further education and lifelong learning initiatives to upgrade their existing talents (e-skills UK, 2009; SES, 2012). Education providers should cater for this rising need by offering courses that specialise in such skills.

2.6 Changing Work Environments

Description	Work places and working modes are under pressure to increase flexibility and to adapt to business volatility. Outsourcing and the increasing internationalisation of business are leading to a rise in project and teamwork with external collaborators. As a result, decision-making is occurring more broadly in companies across those with various levels of responsibility. Additionally, as an increasing number of tasks become knowledge work continuous digital training becomes necessary.
Recent developments	• Over recent years UK workplaces have become increasingly volatile, undergoing frequent and significant organisational change. Due to the continuous drive to increase productivity and flexibility, both companies and individuals are constantly in the dual processes of change and adaptation. Between 2010 and 2013, 63 per cent of employees surveyed by CBE (2013) reported experiencing frequent changes in organisational objectives. • Increasing demands for further flexibility from employers and employees alike and the spread of enabling ICT infrastructure, such as cloud solutions (Sodexo, 2013), are altering the workplace and leading to more flexible working arrangements. Working days are becoming less rigid and less orientated around a traditional nine-to-five working day at a fixed location, at least for an increasing share of white-collar workers. The labour force can be flexibly deployed as required. In the UK, 77 per cent of employees work in organisations that have some type of flexible working arrangement (Thompson *et al*., 2013). • With process automation, more and more workers are increasingly working with data and information. As work is progressively done by collaborations of knowledge workers, employees are working in a more self-determined fashion and more business decisions are being made lower down in organisations (CBE, 2013). As a result, traditional hierarchies within the workplace are also undergoing change. • Internationalisation of business and a tendency for outsourcing leads to a higher degree of interdependency of work and interaction with a broader and more diverse network. More and more teamwork is exceeding the traditional borders of the branch. CBE (2013) reports that in 2013 67 per cent of employees were working in more actively collaborative ways, while 57 per cent reported an increase in their number of co-workers who work from different geographical locations.

New forms of leadership are required to manage a more diverse workforce, operating from different locations on a project-by-project base (Thompson *et al*., 2013).

- The increasing need to analyse data and information and make decisions is driving the demand for continuous skills training. In 2010/11, learners within UK work places achieved nearly 585,000 workplace-learning qualifications (BIS, 2012a). This need for increased onsite training has seen the associated rise in new forms of, and approaches to, learning.

Expected future developments

- Working methods and employment structures are expected to continue to become increasingly flexible. In the knowledge sector, future companies will operate from a slimmed-down pool of employees, backed up by colleagues from branches in other countries and external consultants for specific projects – allowing corporate divisions to be rapidly created and disbanded at will. Knoll Workplace Research forecasts that by 2020 employers will provide opportunities for flexible working hours to the majority of UK knowledge workers (Ouye, 2011).
- Workplaces will continue to both drive and adapt to the rapid changes in the working environment as they face an increasing demand to handle the growing amount of information. Within this continually changing environment those who demonstrate capability and willingness to adapt will ultimately hold higher resilience in overcoming crises.
- With over 50 per cent of the workforce in 2020 expected to be Generation Y members, who have grown up connected, collaborative and mobile, organisations must continue to ensure they are able to easily and effectively adapt to rapid social and technological change (Morgan, 2013). Bite sized and gamified learning will help employees to update their competences and capabilities.
- New managerial and organisational patterns will emerge with the continued desire for anytime, anywhere working arrangements. These will include new forms of leadership specialising in motivation and guidance. Managers will increasingly opt for target agreements that define tasks or job scopes, specifying when and in which manner outcomes must be delivered. Effective policies to manage more mobile workers will become increasingly necessary, with organisations needing to place strategic emphasis on management, scheduling and technology guidance (Citrix, 2012; Thompson *et al*.,

2013).

Drivers	• Innovations in information and communication technologies • Increasing desire for greater autonomy • Greater connectivity and mobility • Desire to reduce costs (ancillary wage costs, equipment, offices and energy)
Implications for Jobs	• Continued rise in collaborative methods of working and more distributed, global workplaces. Jobs and organisations will become increasingly more fluid as people move from project to project. It will become even more necessary to focus on creating a positive work based culture and to foster team building (Intel, 2012). Managers and organisations will need to place additional focus on developing individual packages for employees as well as finding effective ways of switching from time based monitoring to results based monitoring. • Work will continue to become more pervasive as ICT technologies make it increasing difficult to 'switch off'.
Implications for Skills	• The need to identify and build new skills for the workplaces of the future is evident. CEB (2013) identify the following ten skills as the most necessary for success in the changing work environment: Prioritisation of work, teamwork, organisational awareness, problem solving, self-awareness, proactivity, influence, decision making, learning agility and technical expertise. Or in short, the key qualities for success in the future workplace will be: the ability to quickly adapt to changes in the working environment, to excel in collaborative working modes and strong analytical skills to assess problems and make decisions. • With the rise in project based skill requirements and as people change jobs more frequently and thus need a varied portfolio of skills, higher education providers will increasingly need to provide new methods of cross-crediting, accumulation and transfer of skill units. Online learning works well to train IT skills that need to be updated regularly to follow the fast pace of IT upgrades (e-skills UK, 2009). But online learning typically lacks the provision of the soft skills necessary for individuals to be 'presentable' in the workplace. Soft skills – which are critical for project work and collaboration – will need to be developed through both innovative and traditional delivery methods.

2.7 Converging Technologies and Cross-Disciplinary Skills

Description	The boundaries between disciplines, such as natural sciences and informatics, are becoming increasingly blurred. As the disciplines converge, so do the technologies. This convergence, particularly at the intersection between nanotechnology, biotechnology, information technology and cognitive science, disrupts existing business models, but also creates completely new markets and novel application fields.
Recent developments	• Over the past decades, innovation in the natural sciences has been increasingly generated through the convergence of single disciplines into interdisciplinary fields of research and development (R&D). With information technology as an enabling technology, advances in a variety of technology fields will be of key importance in the 21st century. Among them the most prominent will be biotechnology and the life sciences, as well as cognitive sciences, material sciences and nanotechnology (Burd, 2013; EC, 2011; Lee and Olson, 2010). An example for a product stemming from this convergence process is DNA sequencing with its rapidly declining cost curve (NHGRI, 2013). • Although the strong financial sector may be the reason for relatively low innovation intensity, the UK is still well positioned in R&D among the EU member countries. It holds a strategic view in regard to innovation, as well as a developed mix of policy instruments. The UK leads the debate and practice in many fields, including procurement of innovation, tax incentives for R&D, and university knowledge exchange income (EC, 2013b). • The UK occupies a particularly strong position in the life sciences and biotechnology sectors (BIA, 2012b). It has a number of globally leading universities, among them 4 of the top 10 universities in the world and 19 of the top 100 universities[7] (QS, 2012). In the UK, the life science industry generates an annual turnover of over £50bn[8] and employs 167,500 people in over 4,500 companies (BIS, 2013). One of Europe's leading biotech clusters is found in the area around Cambridge (Aschoff *et al.*, 2010). Further, UK industry and government have also invested heavily in the research and development of nanotechnology (KTN, 2010).
Expected future developments	• Fostering the most productive environment for innovation and effective research and innovation will remain a key goal for industry as

[7] The ranking is comprehensive over all faculties and is based on the criteria academic and employer reputation, faculty-student ratio, and internationality (QS, 2012).

[8] Billion or bn is used in this report as equivalent to thousand million.

	well as government organisations. In the UK, for example, the Biotechnology and Biological Sciences Research Council (BBSRC) is advancing world-class bioscience through its support for high-quality research, people and institutions (BBSRC, 2010). While the BBSRC's *Strategic Plan 2010-2015* will reach the end of its planning timeframe in the near future, the next strategic plan will be likely to point in a similar direction (BBSRC, 2013). • At the European level, the European Framework Programme 8, *Horizon 2020*, will focus over the period 2014 to 2020 on providing support for crosscutting actions to capture the accumulated benefits from combining several Key Enabling Technologies, such as biotechnology, nanotechnology, or ICT (EC, 2013b). • Networking and the cooperation of industry and research institutions, both inside the UK as well as internationally, are becoming increasingly important in enabling cross-disciplinary innovation potential (IBLF, 2013). • Besides R&D, innovative products and processes will considerably impact on the fields in which they are applied. For example, developments in bioscience, pharmaceuticals and technology will improve services and outcomes for patients on the one hand, but change the work of doctors, nurses and carers on the other. With advances in genomics and proteomics (the study of proteins encoded by a genome) such changes will be very apparent, particularly in regards to personalised medicine (SFH and LMI Team, 2012). • Research and development activities are becoming more internationally mobile. The relocation of research and development activities from western European countries to eastern European or Asian countries is likely to have an impact on domestic research and development activities, especially if activities are relocated within a multi-national company to a foreign subsidiary (Gomory and Baumol, 2013).
Drivers	• Higher educational attainment • Advancing IT-revolution and digital society • Continuing specialisation and division of labour
Implications for Jobs	• There will be strong demand for high skilled labour for research and development, especially professional scientists and engineers due to rapid technological change, and innovation, research and development in the biotechnology and life sciences sectors (Hogarth *et al.*, 2010).

- Even though the UK educational system is able to produce a steady stream of high-skilled graduates specialised in key technologies, they will only be able to put their skills to use in the UK economy if the labour market can offer a corresponding supply of jobs. Otherwise, the threat of "brain drain", losing high-skilled young potentials to foreign competing economies, could challenge the innovative potential of the UK economy in these key technology fields.
- With a host of new knowledge being generated in ever more specialised fields of study, there will be increasing demand for specialists at the intersection of the sciences and for business to turn insights gained into successful business ideas. Also, science communication is likely to become a growing profession, as more and more universities, government organisations and businesses need to explain the relevance of complicated scientific findings to stakeholders.
- As investments in R&D continue there will be increasing demand for security specialists to protect generated intellectual property.
- With successful treatment of widespread diseases based on breakthroughs in biotechnology, workforce reduction based on early retirement due to chronic diseases may decrease.

Implications for Skills

- The convergence of technologies and disciplines is intensifying the need for multi-disciplinary teams with individuals qualified at postgraduate level including engineers, bio-scientists, bio-engineers, data artists and ICT specialists (to name only a few of the possible specialisations that will be required). Good communication skills are necessary in order to ensure smooth operation and collaboration in such multi-disciplinary teams, (Hogarth *et al.*, 2010).
- A number of the described developments could have significant implications on the skills utilised across the life sciences sector, especially in health care, with new skill sets emerging and some existing skill sets no longer needed. For example, a demand for new skill sets will be found in genomics and proteomics as personalised medicine diffuses into mainstream medical treatment (SFH and LMI Team, 2012). This will require skills for the development of personalised medical solutions based on genomics and proteomics as well as skills for the implementation of these solutions in a clinical setting.
- Continuing scientific and technological developments require the ability to connect and keep up to date with specialised and general

knowledge. This enables individuals to become a specialist in a certain field, without losing the perspective for connections to other fields of expertise.

- The speed of technological development and the need to be innovative are also impacting on skill demands necessary for leadership positions. Notwithstanding the lack of detailed knowledge, leaders must be knowledgeable enough to be able to recognise and evaluate the potential of new technologies. This requires an increasing openness for visionary ideas. Leaders will also need to be good communicators, encouraging collaboration, openness and innovation inside their own organisation, while also being able to successfully network with other organisations in order to truly harness the potential of converging technologies (Hay Group, 2011).
- The growth of sectors and business activities based on converging technologies is also likely to create demand for knowledge intensive services and skills that can support this development (including legal services for intellectual property and other issues, research and development, marketing and strategic management consulting).

2.8 Digitalisation of Production

Description	The digitalisation of production processes is driving a new era of industrialisation. With real time data exchange between machines, materials, and products-in-the-making, increasingly autonomous production systems and factories become possible. Moreover, additive manufacturing techniques (also known as 3D printing) enable new forms of decentralised, yet complex production processes.
Recent developments	• Over the past decades, manufacturing has undergone the continuing trend of automation and robotising increasingly complex production tasks based on developments in electronics and the use of information technologies (Schlick *et al.*, 2012). Today, there are an estimated 1.2m robots being used in manufacturing around the world (NIC, 2012). • Globally, a steady and continuing increase in automating production processes is evident, especially within the manufacturing sector. However the UK is lagging behind other industrialised nations in this area. Internationally the quantity of robots deployed within the manufacturing sector is often used as a measurable indicator of automation levels. In comparison to other European countries (and many other industrial nations) the UK has a distinct lack of robot utilisation with the manufacturing sector. In 2010, the UK deployed 25 robots per 10,000 employees in the non-automotive manufacturing sector, in contrast to the top European deployer at 127 per 10,000 employees (Germany; EAMA, 2011). Further, in 2013, the UK had an estimated installed base of only 10,800 multipurpose industrial robots in comparison to 143,300 in Germany (IFR, 2010). • The success of the Toyota production system with its just in time production and shop floor management has been a major factor in manufacturing over the past two decades. It led not only to a rise in productivity but also to communication on a more equal footing between workers and leadership. Both pillars were also the foundation for the rise of mass customisation in manufacturing (Spath *et al.*, 2013). • With additive manufacturing techniques [9], the digitalisation of production emerged as a potentially disruptive technology over the past decades, although it is currently still in its infancy and mostly

[9] Additive manufacturing techniques are the industrial application of 3D printing. It is a layer-by-layer production process of three-dimensional objects on the basis of digital construction plans.

used for rapid prototyping (Economist, 2012; Feloy and DSouza, 2013).

Expected future developments

- Developments in sensor and RFID (Radio-frequency identification) technology are beginning to allow for real-time track and trace in logistics and are seen as the basis for the emergence of an "Internet of Things" in which by 2020 an estimated 50bn items will be connected to each other (Cisco, 2011).
- The gradual introduction of these technologies and processes into production will increase the already staggering amount of process complexity to a degree that will become too challenging for central planning and control. The envisioned solution is the decentralisation of production: (semi-)autonomous, self-regulating, sensor-based production systems, also called cyber-physical systems, allow for more flexibility of production and for the automation of small series manufacturing. These developments are seen as a new step for industrialisation (Spath *et al.*, 2013; Gray, 2013; Mintchell, 2013; Sorbie, 2013).
- Additive manufacturing will most likely only diffuse slowly into the broader production environment. But a number of prominent examples of the use of 3D printing in critical areas are promising signals for such a development. Tests of 3D-printed rocket parts at NASA, for example, have shown that such parts are as durable as those traditionally manufactured, but are produced at a 70 per cent reduction in costs (NASA, 2013). In the aviation sector, GE is close to manufacturing 3D-printed parts for jet turbines (LaMonica, 2013).

Drivers

- Advancing IT-revolution and digital society
- Individualisation
- New materials

Implications for Jobs

- In terms of jobs, manufacturing is projected to maintain its share of output but with a falling share of employment in the UK (Wilson and Homenidou, 2012). Job losses are forecast especially for manual workers. Automation and productivity gains due to new technologies are the major reason for the continuing reduction in employment, particularly in routine jobs. However industrial and technological change is increasing demand for high- and medium-skilled workers (Cedefop, 2010b; Expert Group on Future Skills Needs 2013; Wilson and Homenidou, 2012).
- Thus, high-tech manufacturing remains a motor for high-skilled production jobs, but a sufficient reservoir of skilled labour is also

necessary for the survival and further development of high-tech manufacturing in the UK. A 2013 RSA report estimates that mid-sized manufacturers in the UK could develop and implement more high-tech manufacturing. This would lead to a re-industrialisation by near shoring decentralised production and could lead to employment increases in manufacturing of between 100 and 200,000 workers over the coming decade (Livesay and Thompson, 2013).

- However, some economists, such as Brynjolfsson and McAfee (2011), point out the possibility of a "great decoupling" from technological progress and productivity on the one hand and the need for many different types of jobs on the other hand, potentially leading to a decrease in the total quantity of jobs.

Implications for Skills

- With continuing automation, the core value that labour can add is not in the processes that can be automated, but in non-routine processes, in uniquely human, analytical or interactive contributions that result in discovery, innovation, teaming, leading, selling and learning (Austin, 2010). The jobs that technology will not easily replace are those requiring people to think, communicate, organise and decide (Cedefop, 2013). Examples for such jobs range from the creative engineer or designer to managerial positions.
- Advanced manufacturing, or the industries and businesses which use a high level of design or scientific skills to produce innovative and technologically complex products and processes, will require employees to possess high value added manufacturing skills, such as composites manufacture and development, plastic electronics and nanotechnology (Semta, 2010). Plastic electronics will need skills in the fields of chemistry, physics, material science, electronic, engineering together with process engineering and semiconductor, display or printing industries. Skill requirements within the composite workforce change over time: from the current R&D related skills of design engineers to multi-skilled craft and technician level workers with both CNC and composite experience for more automated processes in the future (Feloy and DSouza, 2013).
- In a semi-autonomous manufacturing environment, the remaining shop floor workers will have more responsibilities that require control, maintenance and problem-solving skills. Also, with small numbers of employees on the shop floor and flat hierarchies, communication skills will become increasingly important. This is true for both production workers and management, and will need to be combined with a

general understanding of the work processes of the company.

- Digitalisation will also impact upon the skills needed in manual labour outside of the manufacturing sector. The increased use of automation within buildings, for example, requires changes in construction work as well as in installation, maintenance and repair. Digitalised tools such as sensors will also require new skills in order to be used effectively. Additionally, supportive digital technologies, such as digital failure reports or head-up displays that guide the worker in navigating complex work processes will be available. Thus, the technical profile of trades and crafts jobs will increase. There is also an increased role for technical customer support roles to guide costumers in their use and operation of these technologies.

2.9 ICT development and the Age of Big Data

Description	The development of ICT continues to be characterised by performance increases, miniaturisation, and nanotechnology. The increasing number of smart mobile devices combined with faster mobile Internet access allows for ubiquitous communication and access to information and media. Effective data management is becoming of critical importance as the amount of data collected and stored, as well as the ability to analyse this data, increases.
Recent developments	• Over the past decades, information technology has rapidly spread across the globe with a tremendous growth in computing power and the number of users. Today, there are 2.3 billion Internet users worldwide, about 32 per cent of the world's population. In the one year between 2011 and 2012, the average fixed broadband speed grew by 30 per cent globally. In 2012 mobile network connection speed more than doubled, and smart mobile devices represented 18 per cent of all handsets in use worldwide (Cisco, 2013). • ICT usage has become ubiquitous within businesses in the UK: in 2011, 94 per cent of businesses had Internet access and 93 per cent had a broadband connection, while 81 per cent had a website (CIPD, 2013a). Furthermore, ICT has penetrated most processes across a variety of sectors. The impact is apparent in retail, where online shopping is changing the traditional landscape of brick-and-mortar retailing, but it is also visible in logistics, media, and banking. Often, the implementation of ICT solutions in new business models involves the removal of an intermediary party in the provision of goods and services. This is again very apparent in e-commerce, but also in insurance, banking, and tourism. • The UK ICT industry is of considerable importance to the UK economy. In 2011, it contributed about 8 per cent of gross value added to the economy and over 1.3 million people are employed in the UK's ICT sector (UK T&I, 2012).
Expected future developments	• Over the coming 15-20 years, the hardware, software, and connectivity aspects of ICT will continue to experience massive growth in capability and complexity as well as more widespread diffusion (NIC, 2012). But it is not only hardware based performance that will increase, the amount of data generated, shared, and stored is also expected to rise. It is projected that by 2017, the annual amount of data traversing the global networks will exceed the accumulated amount of data from 1984 to 2012 (Cisco, 2013). Much of this data

will need to be stored, analysed or will be waiting for analysis (Bamford, 2013). Due to Big Data, there will be better understanding of an individual customer's preferences and purchasing decisions, opening the door for new forms of marketing and the highly customised provision of digital services (McKinsey, 2011a). For example, the use of e-commerce websites that are dynamically adaptable to each individual visitor.

- ICT and the growing connectivity of devices will allow for radically altered business models. This may be through using the central steering of de-centralised devices as is done in virtual power plants – e.g. remotely connecting a number of micro-CHPs – that compete with conventional large power plants. Or it may be through the location data of Wi-Fi networks and mobile phones as in Google's location based services for traffic jam projections. Not only is efficient data management becoming ever more important in the age of Big Data, but knowing how to turn data into insights that increase the efficiency of existing business and generate ideas for new business opportunities is crucial for the success of almost any company (Avanade, 2012).

Drivers

- Advancing IT-revolution and digital society
- Globalisation 2.0 driving global supply chains and competition

Implications for Jobs

- The developments in ICT have tended to favour higher skills and displace lower skilled jobs. One could therefore call the nature of this technological change 'skill-biased'. While many lower skilled jobs such as secretarial and clerical work have been replaced through developments in ICT, information technology also creates new markets for information services which were previously not possible or feasible, such as design and programming of websites or 'apps', as well as disruptive business ideas like the platform airb'n'b[10]. These new businesses often generate jobs of a professional, associate professional and managerial nature (Wilson and Homenidou, 2012). As this development continues, lower skilled jobs in other areas are likely to be replaced. For example, the increasing concentration of businesses, competition from e-commerce companies and new ICT based interfaces such as customer self-services (e.g. automated checkouts) may very well reduce the need for more traditional occupations in sales and retail (Wilson and Homenidou, 2012).

[10] airb'n'b provides a platform for collective consumption and sharing of rooms and flats, thus challenging traditional business models in the tourism sector.

- Global data networks have not only connected the world's information but they are also generating global labour markets for a variety of jobs, such as programming or graphic design, for example, where a geographically defined presence is not necessary and where results delivery can be made electronically. In these jobs, international competition is increasing the pressure to raise productivity, especially in developed countries with already relatively high wages. ICT also facilitates hyper specialisation, whereby routine elements of high-level jobs are outsourced, thereby allowing a higher productivity of high-level jobs.
- As the rapidly growing and evolving ICT sector continues to transform the economy, the demand for ICT specialists is likely to grow within companies but also in business consulting services specialised in the implementation of ICT in business processes. According to Hollingworth and Harvey-Prices (2013), the ICT sector in the UK requires nearly 300,000 recruits until 2020 at professional, manager and associate professional level.
- As IT architectures connected to the Internet are increasingly necessary for business they are becoming increasingly vulnerable to cyber crime. Consequently, IT security jobs will increase in demand (Hollingworth and Harvey-Prices, 2013).
- The ICT workforce is very homogenous, mostly consisting of young, male employees (EUSP, 2012). This could lead to a bias in hiring practices. Therefore, the prevention of discrimination in hiring practices, for example due to sex or age, is of importance in order to increase diversity.
- In the EU, the fall in the number of computing graduates across the EU-27 countries may present challenges to the future of technical skills supply. This could lead to a potential skill shortage as well as aggravate pre-existing skill shortages in the ICT labour market (EUSP, 2012). In the UK, 17 per cent of the vacancies in the digital sector cannot be filled due to skills shortages, with the most common skills lacking being job specific, and advanced IT or software skills (Hollingworth and Harvey-Prices, 2013).
- IT management policies, specifically the administration of data access rights, can create an unequal power balance within organisations. These distorted power balances have the potential to create new or increase existing tensions inside organisations. Therefore, a (re-)negotiation of the distribution of power and influence in the

organisational structure may become increasingly necessary as organisations adopt stricter data access and restriction policies.

- Social networking technology could create new opportunities for collective bargaining initiatives by (re-)connecting interest groups in the workforce. This may be especially relevant with the rising number of Generation Y workers entering the workforce.

Implications for Skills

- The rapid development of the ICT sector and the diffusion of ICT into virtually every corner of the economy requires a high proportion of workers to possess ICT skills (Hogarth *et al.*, 2010). ICT skills requirements continue to rise in the UK (SES, 2012), on the European level (EUSP, 2012), as well as around the world. Programming – or more generally IT skills – is becoming the new literacy (Prensky, 2013). Thus, narrowing the IT skills gap is also a prerequisite for a more equal distribution of productivity gained through ICT.
- Besides programmers, software development professionals, data security experts, web design and web development professionals represent the crucial skills (EUSP, 2012); Big Data skills - the ability to interpret the huge amount of data collected around the world, and around the clock, - are of crucial importance (McKinsey, 2011a). Companies need to develop new skills to turn data into business. Investments are needed in a wide range of staff skills, from maths and statistics to business operations and to visual design and reporting (Avanade, 2012). The growing demand for simulation and the increased use of, for example, bioinformatics is also increasing the demand for people with programming skills and a general understanding of a specialised field of study (Hogarth *et al.*, 2010).
- Due to the constant development of information technology, individuals must constantly update their knowledge and skills to remain attractive to the labour market. This is not only the case for high skilled labour in technology-driven sectors, but for the general population increased levels of digital competence and the ability to continually adapt and learn new competences are increasingly becoming a requirement (EUPS, 2013).
- The skill bias is evident in fields where computer technology complements workers who perform non-routine tasks that require flexibility, creativity, analytical and problem solving capabilities and complex communications; time previously spent on routine tasks can be directed towards other tasks. This changes the skills and capability profiles required within many occupations and raise the demand for

graduates (Hackett *et al.*, 2012).

2.10 Changed Economic Perspectives

Description	Due to globalisation and technological change, the economy and financial system are increasing in complexity. This is compounded by challenges arising out of greater global volatility and low economic growth within established economies. As the innovation necessary for continuing expansion of the economy is requiring increasingly higher levels of economic and financial complexity, there is also a growing business awareness of the need for more resilient value chains that are safeguarded by risk management policies and strategies.
Recent developments	• The period between the 1980's and 2008, called the 'Great Moderation' in Western economic history, was characterised by relatively mild business cycle volatility in several developed economies accompanied by relatively low inflation and reliable fiscal, monetary, and economic policy decisions. The global financial crisis can arguably be seen as marking the end this period (Aizenman *et al.*, 2010; den Haan and Sterk, 2011). The increased level of economic uncertainty has contributed to the UK's slow economic recovery (Haddow *et al.*, 2013). • Expectations for future growth, of both individual and societal prosperity, have been based on the relatively high economic growth of the past. However, on average growth rates have been weakening over time in developed economies (World Bank, 2012). Moreover, the UK economy is now mostly de-industrialised with manufacturing accounting for a mere 9 per cent of GDP, leaving the economy especially vulnerable to economic shocks in the services sector (CIPD, 2013a).
Expected future developments	• The still visible aftermath of the global financial crisis, including the still smouldering crisis in the Euro-zone, will for the foreseeable future continue to feed the uncertainty in the economy and draw out the recovery process of the UK economy (Haddow, 2013; IMF, 2013a; Wilson and Homenidou, 2012). • Growing levels of economic and financial complexity[11] are necessary in order to achieve the degree of innovation that is needed for continuous economic growth in developed economies (Cowen, 2011; Hausmann *et al*., 2013). However, this will also lead to a higher risk of

[11] Technological innovation often requires considerable investment of financial resources and a variety of rare materials and intermediate products. To increase the options for investments and financing, increasingly complex financial tools are developed that create unclear interlinkages between the real economy and the financial sector. Also, supply chains grow in length and are spread out all over the world so that when looking upstream it is often unclear how many and which suppliers are present in the supply chain.

	economic shocks at a crisis level and will probably lead to greater volatility of economic development (NIC, 2012). • As businesses are facing increased uncertainty, they are adapting their processes to allow greater flexibility on the one hand. On the other hand, many companies are also beginning to realise the need to integrate resilience into their management of business structures and processes.
Drivers	• Globalisation 2.0: increasingly interlinked global economy with shifts in economic centres of power • Higher speed of innovation
Implications for Jobs	• Slow economic recovery could amplify the underuse of human capital caused by the recession. Those with higher skills compete for jobs that, in better times, would be filled by the less skilled, and the result is the displacement of the latter. Thus, the weaker employability of the less qualified is accentuated, while the human capital of the more skilled is not used to its potential. Dynamic effects with long-term impacts may arise if this 'decanting downwards' hampers life-long learning and thereby undermines organisational and individual commitments to develop human capital (Mortensen and Vilella-Vila, 2012). • The slow recovery could also amplify the ''hysteresis'' phenomenon, a decline in the employability of those losing their jobs, because long-term unemployment leads to an erosion of skills, detrimental effects of detachment from working life and the loss of a network of contacts that would facilitate in job searching (Mortensen and Vilella-Vila, 2012). Here, employment policies are needed that activate the long-term unemployed through active and passive measures. • The aftermath of the global economic downturn is changing the commercial and business environment (Skills for Justice, 2010). In order to gain more flexibility in the volatile development of the global economy, companies are striving to shift a part of their economic risks to their employees, e.g. through changing work time agreements and job benefits or through using more flexible work contracts such as zero-hour contracts. This may lead to a rise in self-employment and more people holding multiple jobs. Already in 2013, over 1 million people or 3.1 per cent of the UK workforce are employed under zero-hour contracts with 38 per cent of them wanting to work more (CIPD, 2013c). • With average growth rates of the economy decreasing over the long-

term, individual expectations of future earnings – or life-time earnings – will need to be adjusted, with spending and saving patterns adapted accordingly.

Implications for Skills

- With micropreneurism[12] becoming increasingly important, the demand for the skills necessary for successful self-employment increases. This opens the market for business services for small enterprises, but also for business coaching and further education.
- As employees carry more economic risks in their jobs, they need to develop skills for managing these risks. More self-responsibility and pro-activeness will be necessary in regard to financial matters, skills development, and maintaining physical and mental health. This involves developing a new perspective of one's life and adopting the paradigm of becoming a manager or entrepreneur of one's skills.
- For businesses facing increased uncertainty, the need for risk management skills and the ability to manage complexity become of critical importance. Whether such skills can be developed in-house, or be acquired through hiring consultants will depend on the specific needs of the individual company. But these skills will need to become a significant part of business-oriented higher education.
- According to Pringle *et al*. (2011), the support for educational infrastructure in combination with combined human capital and labour market interventions are a strong lever to contribute to a rebalancing of the economy.

[12] Micropreneurs are entrepreneurs starting and managing a business that will very likely remain small, but gives them the liberty to follow their interests and/or be their own masters.

2.11 Shift to Asia

Description	Economic power is shifting towards emerging countries, parallel to the relative loss of importance of the G7 economies. The markets of emerging countries promise high growth and profitable investment opportunities.
Recent developments	• Economic globalisation allowed many Asian nations to become the extended workbench of the West – often through joint ventures of Western multi-nationals with local companies – and their economies have experienced astounding growth. • Today, Asian companies (and especially Chinese companies) are increasing investment in foreign markets. In Europe, companies in the UK have been the main target for companies from China for mergers and acquisitions. Further, the UK has received the second highest amount of foreign direct investment from China in the EU (Clegg and Voss, 2012).
Expected future developments	• The population of Asia is forecast to grow by 590 million people or 14 per cent until 2030, compared to a population growth of 8.7 per cent in the UK (UN, 2012). This indicates a strong growth of the workforce in Asia compared to the UK. • Income levels are rising in Asia alongside economic growth. By 2030, Asia is projected to account for 66 per cent of the global middle-class and for 59 per cent of middle-class consumption, compared to 28 per cent and 23 per cent in 2009 (Pezzini, 2012). • China is projected to overtake the U.S. as the largest economy in the second half of the 2020s (NIC, 2012), effectively doubling its GDP in purchasing power parity terms compared to 2011 (PwC, 2013a). • India's economy is expected to remain the third largest economy in 2030, its GDP triple that of 2011. According to PwC (2013a), it is likely that the UK economy will defend its ranking as the ninth largest economy with a GDP increase of about 53 per cent until 2030. • Chinese global patent filings have increased massively over the past decade. Their share of all globally filed patents rose from 15.1 per cent in 2008 to 24.6 per cent in 2011. It is estimated that foreign and domestic patent filings in China could surpass 3.7m by 2015 (status quo: 1.6m filings in 2012; EUCOC, 2012; WIPO, 2012).
Drivers	• Dynamics of population growth in Asian countries • Globalization 2.0: economies around the world are becoming increasingly interlinked; growing economic capabilities in emerging

countries in Asia; economic centres of power are shifting.

Implications for Jobs

- In the UK, it is likely that low-skilled labour will find it increasingly difficult to find decent employment outside of the service sector, particularly if the number of low-skilled manufacturing jobs continues to decrease due to further relocation of production (NIC, 2012). Moreover, international competition will also put increasing pressure on wages in high-skilled jobs, as a growing high-skilled workforce in emerging countries will soon be able to offer results similar to their counterparts in the developed economies (Duckworth *et al.*, 2010). Earnings expectations will need to be adapted accordingly.
- If UK investments by Asian investors result in a net higher investment volume in the UK, a positive impulse for the UK labour market is to be expected.

Implications for Skills

- Globalisation has opened up international competition between workers of different skill levels. According to Bosworth (2012), in comparison to the OECD average in 2020 the UK will have a similar proportion of low skilled people between 25-64 years old, a much smaller proportion with intermediate skills but a greater proportion with higher skills (improving from a rank of 13th in 2010 to a projected 11th in 2020). With increasing educational levels of the workforce in Asia and other emerging economies the international competition between workers will increasingly begin to affect intermediate and high skill workers in the UK. Therefore, it is vital for individuals to develop a marketable skill-set and keep this skill-set up-to-date through life-long learning and training. Company HR departments will have to implement development plans tailored to the individual needs of their employees and the specific needs of the company in order to maintain an edge in international competition (Expert Group on Future Skills Needs, 2013; PwC, 2011; Duckworth *et al.*, 2010).
- As international competition for innovation continues to increase, creativity and specialisation will become even more important than they are today. Focusing on techniques for innovation in education and training will be of great importance, especially for (engineering) jobs in manufacturing and R&D, but also across all sectors (Expert Group on Future Skills Needs, 2013).
- With the growing number of attractive employment opportunities in Asia, the supply of migrant labour at all skills levels may decline in the future (Belt *et al.*, 2010). In addition there may be an increase in the outward migration of UK nationals to Asia, as individuals and

companies seek to capitalise from the growing economic market. These two factors could lead to skills shortages in the UK.

- The need to develop intercultural competence and relevant foreign language skills at an individual level in order to be effective both in culturally diverse intra-company teams and in inter-company contacts is increasing (Duckworth *et al.*, 2010). This is also an issue for diversity management in companies and the portfolio of education and training providers.
- With the growing number of Asian companies establishing branches or subsidiaries in the UK or acquiring UK companies in order to gain a foothold in the UK market, Asian management styles – with specific employment and skill policies, based on the Kaizen-philosophy for example – could become more visible in the UK. Company cultures and individual employees would need to adapt accordingly.

2.12 New Business Ecosystems

Description	A new organisational paradigm sees companies increasingly defined as 'network orchestrators'. The skills and resources they can connect to, through activities like crowdsourcing, become more important than the skills and resources they own. Collaboration in value creation networks is enabled by the virtualisation of business processes, fuelled by the rise of the digital economy.
Recent developments	• Outsourcing and, more specifically, offshoring have long been common trends in the economies of industrialised countries, including the UK, especially in low-skill sectors such as textiles (Heathfield, n.d.; Hudson, 2010). Yet in recent years, this trend is increasingly affecting higher skilled jobs. As work is more organised into project structures in contrast to standardised office tasks, outsourced satellite teams are better able to cooperate with internal core teams. Even the core competencies of companies can be outsourced in this way, as shown by IBM: the software giant is planning to cut thousands of jobs in favour of a global liquid workforce (Hill and Orlofsky, 2012). Besides cutting costs, the move will make IBM's business much more flexible. • Open innovation plays an increasing role in companies' innovation processes. For example, in 2010 Procter & Gamble sourced more than 50 per cent of innovation externally via its open innovation programme "Connect + Develop", compared to less than 10 per cent in 2001 (Lindegaard, 2010). Further, crowdsourcing, i.e. the integration of voluntary individuals in product design processes, is gaining importance (Crowdsourcing, 2012). • Collaboration on innovation is more pronounced in the UK than elsewhere. In the period from 2006 to 2008, roughly 70 per cent of all innovative UK firms were engaged in national or international collaboration. That share was not above 50 per cent in any other OECD country (OECD, 2011). • Co-opetition (cooperation between competitors) is on the rise. As companies are facing dynamic and rapidly changing business environments that require them to be more flexible, cooperation between competitors is arising as a strategic alternative (Bobkoff, 2012). This can be witnessed in the car manufacturing industry's cross-group platform systems (e.g. Daimler and Renault-Nissan), joint investments in the aerospace industry or the recent Apple/Google purchase of Kodak patents (McLaughlin, 2013). • Innovation is increasingly created at the interfaces of sectors, as

	companies and technologies are progressively blending into one another. Thus, cooperation across sectors gains importance, as exemplified by some Apple product innovations (e.g. Siri in cars, iPod-Nike ecosystem).
Expected future developments	• The need for companies to be highly flexible in order to stay competitive will persist: competitive pressure in the globalised economy and volatile economic developments requires quick adaptation to changing markets. Fast technological progress necessitates the integration of multiple technologies into a given product, but also the need to almost continuously redesign and upgrade products at a rapid pace. A high degree of customisation of products and services calls for an in-depth marketing knowledge. • The nature of the firm will be progressively defined by its role as 'network orchestrator' (see Fung *et al*., 2008) as opposed to being defined by its product related core competences[13]. Firms are likely to be successful when they manage a network of partners that are integrated into the value creation process. Instead of protecting specialised core competencies of the firm, network value is generated by empowering the network partners to combine and share resources and intellectual properties and to co-create new products and services (Fjeldstad *et al.*, 2012). Firms will need to develop new capabilities to achieve strategic agility in the face of increasingly hyper-competitive environments (Doz and Kosonen, 2008) • On-going digitalisation of business processes facilitates the shift of many jobs and business functions to the network, such as manufacturing, research and development, customer services and accounting. • The highly networked companies are rather smaller ones. SMEs are growing and booming, while large multi-business companies tend to shrink. As company's core competences are more fluid the turnover rate of companies will be likely to increase.
Drivers	• Globalisation 2.0: competitive pressure in the globalised economy • Ever shorter innovation cycles • Digitalisation • Convergence of technologies
Implications for Jobs	• The value of an organisation will increasingly be held in its 'social capital', that is, the value of the networks and relationships held within

[13] This will not affect all companies in the same way, but at the least, many functions of a firm will be shifted to the network and need to be *orchestrated*.

businesses, across businesses and into the wider community and ecosystems. Teamwork in virtual teams will grow in importance. This teamwork will happen across businesses, functions and organisations (Gratton, 2010). At the same time, the jobs responsible for running processes and infrastructures that enable multi-actor cooperation are gaining in importance (Fjeldstad *et al.*, 2012).

- Jobs will be less and less dependent on physical attendance at the workplace. Where value-creation is organised mostly online via platforms or clouds, physical attendance in a specific location loses importance. Permanent job positions are shifted towards a liquid global workforce, whose members are competing with each other in terms of skills and delivery quality, speed and costs.
- Innovation and other functions of value creation will be increasingly carried out in an open manner (like in open innovation). As hierarchies are increasingly flattened, power and decision making is shifted at least partly, to the teams.
- While jobs with routine and manual functions tend to be either close to the market or in low wage regions globally, jobs in research and development (in particular), but also the creative roles of developing new business models and orchestrating the network may increasingly – but not necessarily – be located in the UK.

Implications for Skills

- Products, and production itself, create ever fewer added values for a company. Instead, orchestrating the partnership network by managing communication and organising knowledge networks are the key skills for the future. Interdisciplinary competences, i.e. profound understanding of the interfaces and differences between sectors, are growing in importance for future business ecosystems.
- Virtual teamwork strongly increases the complexity of work. Therefore executives will have to be able to manage and lead high-performing virtual teams (Gratton, 2010). The capacity to work flexibly and to be self-organised is key for professional success in the future (Fjeldstad *et al.*, 2012; Gratton, 2010).
- Skilled experts may face increasing competition from an equally skilled global workforce for day-wage tasks. Thus, self-marketing skills will grow in importance. Owning certifications for skills will become important in order to guarantee qualification for in-demand tasks.
- Generally, ICT skills will become progressively important in evolving business ecosystems, as work is organised virtually.
- Networked companies might be much more open to and able to pool

resources for the training of employees. This could lead to benefits of scale for investment in skills.

2.13 Growing Scarcity of Resources and Degradation of Ecosystems

Description	Global economic growth is leading to a growing worldwide demand for natural resources and raw materials. Over exploitation implies higher extraction costs and degradation of ecosystems. The prices of these resources will become more volatile.
Recent developments	• World primary energy consumption has increased drastically in the past two decades, from around 8,500 Mtoe (million tonne of oil equivalent) in 1990 to 12,700 Mtoe in 2010. Throughout that period, the share of renewables in global primary energy consumption has remained steady at 13 per cent (IEA, 2012). In the UK, the renewables share in gross final energy consumption has risen from 1.2 per cent in 2004 to 4.1 per cent in 2012 (MacLeay *et al.*, 2013; Eurostat, 2013). • Global resource extraction increased from about 7 Gt (gigatonne) in 1900 to about 49-60 Gt in 2000 (Fischer-Kowalski et al., 2011; SERI, 2009). Increasing expenditures for resource extraction and global disparities of exploitable commodities have been leading to price volatilities. For example, rare earth element prices spiked in 2011 at about 50 to 60 times the 2005 level, before dropping to a level about 10 to 20 times higher than in 2005 (Plumer, 2012). • Over the past 60 years, the production of food and other goods to meet human needs increased (e.g. fibre, timber, energy), but other ecosystem services such as those related to air, water and soil quality have declined. About 30 per cent of ecosystem services are currently declining and many others are in a reduced or degraded state (Gilbert, 2011; Watson *et al.*, 2011). • Global mean species abundance has decreased from around 90 per cent of the maximum potential in 1900 to about 72 per cent in 2000 (Bakkes, 2008). • In 2012, extreme droughts and flooding unsettled the UK, severely impairing ecosystem services (Vaughan, 2012).
Expected future developments	• In the period to 2035, global primary energy consumption is expected to rise from 12,700 Mtoe in 2010 to 17,200 Mtoe. Globally, the share of renewables in primary energy consumption will increase from 13 per cent to 18 per cent by 2035 (IEA, 2012). In the UK, the renewables share in gross final energy consumption is expected to rise from about 4 per cent in 2011 to 15 per cent by 2020, according to the UK renewable energy target, and by 2030, the renewables

	share should reach 30 per cent to 45 per cent share (CCC, 2011). • By 2030, global resource extraction will increase to about 100 Gt, and could increase further up to 140bn tons in 2050 (Fischer-Kowalski *et al*., 2011; SERI, 2009). • Globally, there is a risk of food shortages over the next decade due to rising population and climate change impacts. An Oxfam study predicts a climate change induced increase of rice, wheat and maize prices of between 110 per cent and 180 per cent between 2010 and 2030 (Carty, 2012). • If current trends were allowed to continue, water scarcity will increase. In a dry year in the 2020s the gap between water supply and demand in the UK could be nearly as large as the total current agricultural abstraction of 120bn litres per year (CCC, 2013). Those areas already under water stress in England and Wales will potentially see population growth of 40 per cent between 2008 and 2033 (EA, 2011). • The future development of biodiversity and ecosystem services is strongly dependent on external factors. Business as usual will unequivocally lead to the further degradation of ecosystem services.
Drivers	• Climate change • Global economic growth and associated growing energy demand • Increasing international competition and protectionist tendencies • Diffusion of resource-intensive lifestyles and diets • Growing population in the UK
Implications for Jobs	• Increasing demand and global competition for energy and other natural resources will foster economic activities that focus on resource and energy efficiency, recycling and recyclability, and waste reduction. The renewable energies sector is a key industry, promising future growth both in manufacturing and in installation and maintenance services. This development will generate new green jobs across different sectors from manufacturing to construction. Trade and craftsmen, in particular, tend to profit from the need to install and maintain technical solutions locally. • Water-intensive industries such as thermal power generation, pulp, textile, chemistry or steel may need to invest in water efficient solutions, generating jobs, particularly in manufacturing and engineering.
Implications for Skills	• Resources are becoming scarcer due to growing global demand. Increased focus on climate change and the need to reduce carbon emissions and energy consumption is generating a rising need for

skills and jobs related to climate and environmentally friendly solutions, technology and services (Expert Group on Future Skills Needs, 2013). This includes skills in material and resource efficiency necessary for engineering and design, but that can also be applied in most occupations across all sectors.

- Growing pressure on natural resources will increase the need for skills in environmental management in order to be able to monitor the company's environmental impacts and to develop strategies to improve the ecological footprint of production and products along the whole value chain.
- Labour demands of expanding UK low carbon energy sector could lead to competition for or shortages of scientists, engineers, technologists in other sectors.
- Resources could become a new arena for the UK financial industry, in turn requiring particular skills, like mathematics in combination with an in-depth understanding of the global resource market, and strategies to responsibly deal in these products.
- The importance of natural sciences such as biology, meteorology and climatology (but also e.g. materials sciences) are likely to grow.

2.14 Decreasing Scope for Political Action Due to Constrained Public Finances

Description	Government scope to invest in employment and education initiatives is increasingly challenged by the competing fiscal pressures of growing social transfer payments, pension burdens and public debt.
Recent developments	• After the deficit years of the early 1990's, the UK budget deficit had remained below 4 per cent since 1996. Yet at the onset of the financial crisis in late 2007, the UK budget deficit (excluding Royal Mail and AFP transfers) rose sharply to £157bn, corresponding to 11 per cent of GDP in the fiscal year 2009-10. In the fiscal years 2011-12 and 2012-13, public deficit amounted to roughly 7.5 per cent (ONS, 2013e). • Since the late 1980's, UK public expenditure (total managed expenditure, TME) had mainly hovered around or below 40 per cent of GDP, apart from a short period in the early 1990's when expenditure temporarily rose to 43 per cent. With the onset of the recent crisis, in fiscal year 2008-09 TME jumped to 47 per cent, the highest level since 1984-85 (HM Treasury, 2013). • Recent government budgets (i.e. since 2010) have been characterised by the recurring insight that previous budget projections were untenable (Rogers and Kollewe, 2013). Recently the public debt level has risen sharply, from roughly 30 per cent of GDP in the early 2000's to the current 75 per cent (ONS, 2013e): the highest level since the late 1960's. As one major means to reduce public spending, public sector employment has fallen by about 5 per cent (around 300,000 less employees) between 2010-11 and 2012-13 (Adam *et al*., 2013).
Expected future developments	• While in the emergency budget of 2010, a 2015/16 deficit of £20bn was forecast, the most recent budget of 2013 starts from the assumption of a deficit of £96bn in 2015/16, corresponding to a 5.5 per cent share of GDP (Rogers and Kollewe, 2013). According to IMF forecasts, the deficit quota will come down to normal levels (i.e. a deficit of 3 per cent of GDP or less), only towards the end of the decade (IMF, 2013b). • Despite comparatively strong forecasted economic growth – 1.8 per cent for 2012-2017, 2.6 per cent for 2018-2020 (highest among all G7 economies; OECD, 2013a) –, the OECD expects the UK to be the only G7 country unable to reduce its debt level by 2020. Instead, a growth of debt levels up to 117 per cent of GDP is expected by 2020,

followed by a reduction to approximately 100 per cent by 2030 (OECD, 2013a).

- In the event of higher interest rates, high debt levels could become a serious concern for the UK budget, curtailing the scope for political decision making in the future. Alternatively, taxes would have to be raised.
- The Office for Budget Responsibility predicts that public sector employment would fall by 900,000 between 2010-11 and 2017-18. IFS estimates that this number could be even 300,000 higher (Adam *et al*., 2013).
- The age structure of the UK population indicates that the UK will face growing burdens in the future (CIA, 2013). Retirement payments will increase, tax revenues could be negatively affected due to the shrinking workforce, and the potential of growing unemployment could increase social transfer payments.

Drivers

- High national debt levels
- Baby boomers reaching retirement age
- Low interest rates (savings devaluation)
- High interest rates (public debt service)

Implications for Jobs

- Public funding for measures for the promotion of job creation, and generally any labour market measures, are hard to implement when faced with severe budget constraints. There will be fierce competition for public money and workforce under the different political action fields.
- Potentially raising taxes and/or the devaluation of financial assets could reduce individuals' purchasing power. As a consequence, the informal labour market, with individuals trying to increase their level of disposable income, could grow.
- Financial consulting could be a profiteer of persistently low interest rates or rising tax rates. Savings in individual pension funds will need to rise to counteract potentially decreasing state pension claims.
- According to the Office for Budget Responsibility, public sector employment will fall drastically in the future. According to current estimates, this will lead to around 1 million people needing to search for new jobs (Emmerson *et al*., 2013).

Implications for Skills

- Budget limitations will also impact on skill-building measures. Government-financed education and training activities could suffer from cuts in public budgets.
- If fiscal constraints lead to budget cutbacks in the education sector, there will be a potentially severe impact on the skill levels of future generations.
- There will be a much greater onus on the individual to invest in skills as both government and business become unwilling or unable to maintain their level of investment in human capital.
- Public sector workers need to invest in up-skilling to be able to integrate in the private sector labour market.

3 Disruptions with the potential to impact upon future jobs and skills in the UK

3.1 Introduction

Whereas trends lead to more or less clearly foreseeable changes, the impact of disruptions on the UK labour market, employment and skills in the year 2030 are complex and hardly calculable. Long-term processes of change are always at the mercy of uncertainties. New technologies, changing market structures, and innovative employment models are emerging. Bottlenecks affecting labour markets are not only conceivable but also probable. In the digital age, knowledge and technology are decidedly fluid.

If disruptions become virulent, they pose a significant hazard for economic markets and thus for employment. However, for those that recognise the change in due time, opportunities open up.

Ten disruptions were selected based on their conceptual plausibility to the UK context, and the severity of their impact on the future of jobs and skills in the UK if they were to occur. These were selected from a longer list that included possibilities such as climate change catastrophe, automated healthcare for the elderly and rapid growth in the informal economy[14].

The ten disruptions set out in more detail below would all most probably lead to significant deviations to business-as-usual as laid out in the trends. Particularly eight disruptions can be clearly related to seven trends (see table 3.1). Two disruptions touch upon further topics[15].

Table 3.1: Trend and Disruption Relationship

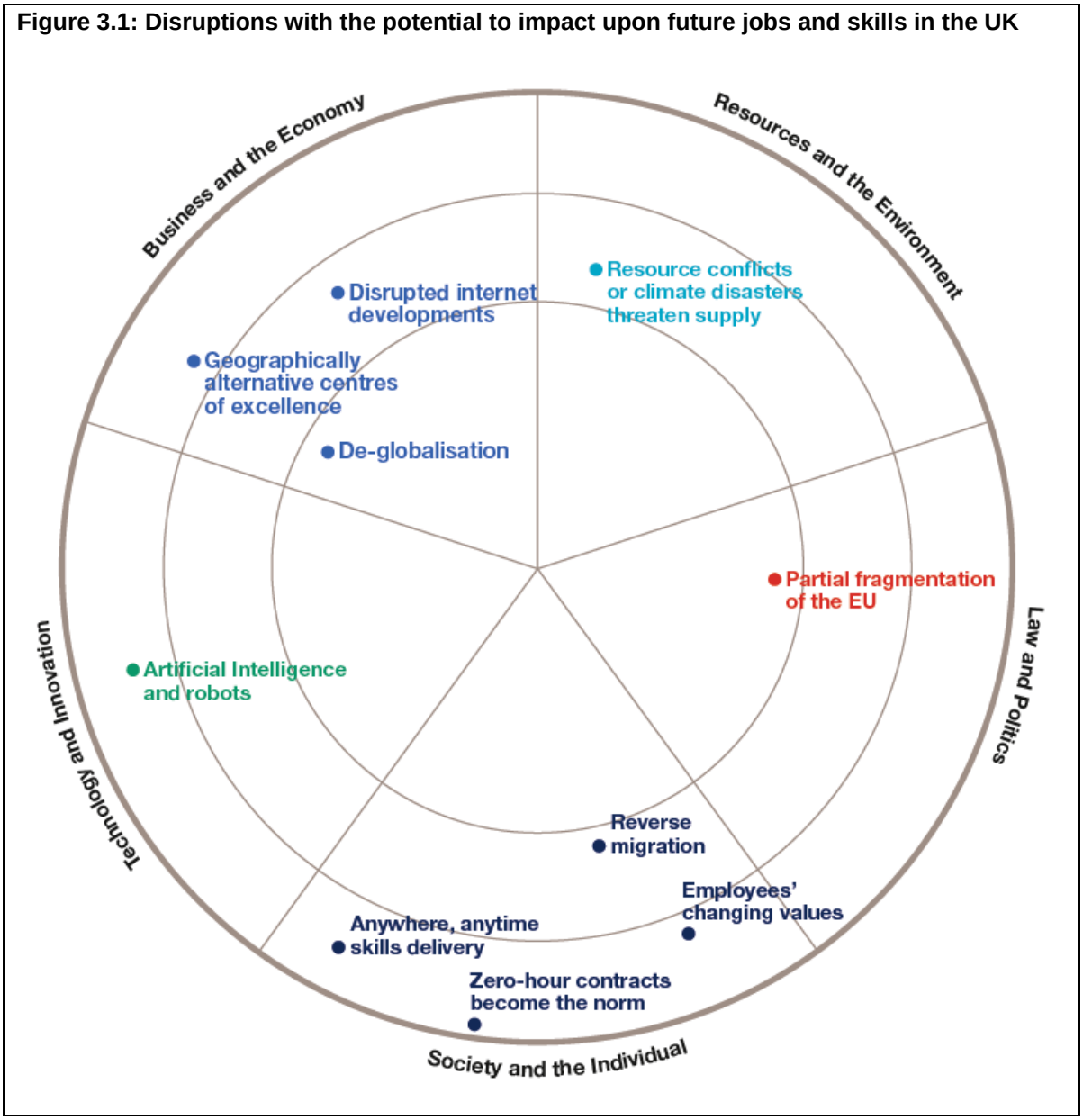
Trend	Related Disruption Radical deviation from trend assumptions
Demographic change	Reverse migration
Growing desire for a better work-life balance	Employees' changing values
Income uncertainty	Zero-hour contracts become the norm
Digitalisation of production	Artificial intelligence and robots
Shift to Asia	Geographically alternative centres of excellence De-globalisation
ICT development and big data	Disrupted internet developments

[14] For example, the emergence of shale gas as a major new source of energy through the use of hydraulic fracturing (fracking) and other techniques was considered as a disruptive development, in view of its impact on the US economy. This did not make the final list of disruptions because it was judged that other developments had more potential to impact on UK jobs and skills in 2030. UK shale gas reserves are believed to be substantial but not "game changing", whilst environmental concerns are likely to limit its exploitation to a greater extent than has been the case in the US.

[15] These are "Anywhere, Anytime Skills Delivery" and "Partial Fragmentation of the EU".

Scarcity of resources	Resource conflicts or climate disasters threaten supply

Figure 3.1: Disruptions with the potential to impact upon future jobs and skills in the UK



Overview of the disruptions

Reverse migration

With continued low economic growth rates in Western countries, global migration patterns may reverse. Immigrants in industrialised nations could migrate back to their country of origin (particularly to emerging economies) in search of work and prosperity.

Employees' changing values

More people are living their personal values and wanting to realise them in a meaningful way in the workplace both in high and low skilled positions. Individuals may increasingly look to select potential employers based on value priorities, disrupting the traditional employers' market. Hence, organisational cultures are forced to adapt their corporate values and policies.

Zero-hour contracts become the norm

With individuals facing such high competition in the job market, employers are able to structure employment conditions to meet their specific needs. Evident in a rise in the practice of zero-hour contracts, and similar flexible arrangements, coupled with the decline of investment (by employers) in up-skilling individuals.

Anywhere, anytime skills delivery

Traditional education and training providers are being challenged by the broad variety of non-traditional learning opportunities. New models of skills delivery are resulting from a rise in online educational opportunities, open universities and peer-to-peer learning.

Artificial intelligence and robots

Further advancements in the fields of robotics, algorithms and Artificial Intelligence may make it possible to automate processes and services that are presently provided by high-wage experts (e.g. surgery, diagnostics, legal advice).

De-globalisation

Increasing protectionist and nationalist tendencies, due to the persistent global economic crisis, may counteract international cooperation and trade.

Geographically alternative centres of excellence

As emerging countries develop the infrastructure necessary to push them to the next level of development, a new wave of cities are taking the competitive lead in specific production and innovation fields. Supportive government interventions (e.g. subsidies and tax incentives), large working age population, and cheaper production and labour costs encourage foreign investors and an increasing amount of business start-ups.

Disrupted internet developments

The 'smooth' development of the future Internet may be blocked as corporatisation and privacy issues dominate the online space. Incidents of cyber crime are rising: targeting Internet structures, organisations and individuals.

Resource conflicts or climate disasters threaten supply

As global resource requirements increase in line with global population growth, disputes surrounding the use of strategic resources may arise. Conservation and efficiency efforts do little to quell fears. Resource supply may become a crucial strategic focus for countries and organisations.

Partial fragmentation of the EU

The United Kingdom may leave the European Union, as may several peripheral countries. This could result in the emergence of a core Eurozone single market plus a detached United Kingdom.

The disruptions are set out in more detail below. In the ‘recent development’ section of each disruption, it is not a long visible development that is documented, but rather weak signals indicating a potential new development.

The probability of the developments shown in the ‘future development’ section is much lower than the corresponding section in the trend descriptions. The future assumptions shown are those that should, in particular, aid us in imagining the potential of these disruptions to alter the future UK jobs and skills landscape.

3.2 Reverse Migration

Description	With continued low economic growth rates in Western countries, global migration patterns may reverse. Immigrants in industrialised nations could migrate back to their country of origin (particularly to emerging economies) in search of work and prosperity.
Recent developments	• Immigrants or second-/third-generation migrants living in the UK or other Western countries are starting to see better employment prospects and interesting business opportunities in emerging countries such as India and Nigeria. The main reason is that job markets in emerging countries have been growing rapidly for some time, while job opportunities in Western countries like the UK are limited, due to the economic crisis. In 2010, 30,000 people left the UK to make a life in India (BBC, 2012; Vaidyanathan, 2012). Countries like India are also actively attracting their "diaspora" by offering them lifelong visas ("Overseas Citizen of India") that allows for keeping their British (or other) passport. • Growing anti-immigration sentiments and forceful expulsion policies (as shown for Chinese migrant workers, most who have an irregular immigration status, in the JRF study; Kagan et al., 2011) intensifies the immigrants' desire to leave the UK. • Reverse migration is evident in other European countries such as in Germany, where German educated highly skilled second generation Turks are emigrating from Germany to Turkey for better employment or entrepreneurial perspectives, and in former colonialist countries such as Portugal, where increasing numbers of Portuguese nationals are migrating to Mozambique in search of employment (Aydin, 2012; Filipe and Babo, 2013). • While until now, permanent migrants mostly migrated back at the end of their working life; in contrast reverse migrants are rather younger people of working age.
Potential future developments	• While the Office for National Statistics estimates a population of 71 million people in the UK in 2030 (compared to 62 million in 2010; ONS, 2011a) – about 4 million of this 9 million population increase is projected to come from net migration (ONS, 2013c) –, this number may be dramatically reduced if the developments described above accelerate, potentially leading to a net outward flow of migrants. This could even lead to a reduction of non-UK born workers from the 2011 level of 4 million (ONS, 2011b) or 14 per cent of the workforce.

- An active search by foreign companies for a “diaspora” workforce with language and cultural skills might push the reverse migration phenomena, as would a UK job market with low prospects and high entry barriers. Transnational companies from emerging countries with locations in the UK might be a gateway for sending a “diaspora” workforce to their countries of origins as expatriates.

Drivers

- Globalisation 2.0, with growing economic capabilities in emerging countries in Asia, economic centres of power are shifting
- Lack of inclusion of those parts of the workforce with a migration background, leading to limited career opportunities for the latter.

Implications for jobs

- Reverse migration would reduce the UK labour force potential and speed up ageing in the UK workforce as well as make the workforce less diverse and multicultural. The loss of a significant proportion of the high-skilled workforce could lead to skill-shortage vacancies hampering the innovation capacity of the UK economy. The labour force shortage would be felt particularly strongly in sectors that have high immigrant labour such as social care. This would aggravate the challenges stemming from needing to provide an increasing number of workers for an ageing population.
- Immigrants often have an above average involvement in small-scale entrepreneurial activity and also serial entrepreneurial activities. A reduction in the number of immigrants would also be likely to reduce the number of newly founded small businesses and thus weaken an important lever of job creation.
- The image of the UK as an attractive place to work with a multicultural workforce would suffer, leading to a downward spiral with increasing problems in being able to attract talent.
- However, positive impacts may also arise in terms of better connected and intensified international business relations: reverse migrants are able to retain their professional networks and relationships and fall back on UK suppliers in their new work places abroad or even build a bridgehead for the UK company in the home country, e.g. opening a sales agency.

Implications for skills

- Well-educated workers with strong potential (especially younger workers) could consider leaving the UK for better prospects in foreign labour markets. In particular second or higher generation migrants benefit from the high-level education system in UK and still have cultural and family links to their regions of origin. Native UK experts may follow quickly, thus intensifying the drain of the UK labour force

potential.

- In future, this could lead to a reduced number of eligible candidates for high-skill jobs, like IT specialists or engineers, leading to a potential jobs-skills mismatch.
- National or company skills retention is becoming more important, as well as skills acquisition by the lower skilled workforce to fill the gap left by reverse migrants. Therefore businesses need to make their workplace as attractive as possible but also be prepared by undertaking contingency planning.

3.3 Employees' Changing Values

Description	More people are living their personal values and wanting to realize them in a meaningful way in the workplace both in high and low skilled positions. Individuals may increasingly look to select potential employers based on value priorities, disrupting the traditional employers' market. Hence, organisational cultures are forced to adapt their corporate values and policies.
Recent developments	• A report by Net Impact (2012) outlines students' and workers' high preference for working at a company that acts in a socially and environmentally responsible manner. Employees, gaining direct positive social and environmental impact through their roles, have a significantly higher level of job satisfaction. The role of Generation Y[16] is discussed here exemplarily for people with a high appreciation of values. • Studies have shown that Generation Y members put a premium on work-life balance (rather than making career sacrifices), want greater flexibility, and are more globally minded than previous generations, and in general want more from their jobs than just financial reward (PwC, 2013b; Deloitte, 2013). Generation Y members value sustainable corporate culture and values, as well as learning and development opportunities when making job decisions (Johnson Controls, 2010). • Further, there is enormous growth in the number of graduates coming from this generation; some 230,000 graduates join the workforce in the UK each year (ILM, 2011). Even if, in the current crisis, the transformational process from education to reaching an appropriate job might include phases of underemployment (willingness of workers to work more hours than employers demand, or to work below their skill level; Bell and Blanchflower, 2013), these top talents are desperately needed in the UK's economy. • The issue of changing values among Generation Y members remains mostly limited to developed countries and, within these, to those who have attained higher education, but is also evident among the better educated in emerging countries (e.g. India, see TOI, 2013).

[16] The designation 'Generation Y' is used to cover those born between (approx.) 1980 and 2000 that grew up almost entirely in the digital age, primarily in developed countries. Currently, 12 million people over the age of 18 fall into the Generation Y age range in the UK (ONS, 2011a).

Potential future developments

- By 2030, Generation Y members will make up about 50 per cent of the working population in the UK (ONS, 2011a), dominating the talent pool. Should the present trend of increasing percentages of higher education persist, a much higher share of those entering the workforce will have graduated, and thus will focus more strongly on seeing their values realised when choosing an employer.
- The general focus of Generation Y members on corporate social responsibility, ecological footprints, and fair trade[17] could change the nature of business – corporations may be forced to act ethically if they want to attract not only top talents, but also medium-skilled employees.
- The current 'cultivated underclass', with its mismatch of educational and career achievements who never earn back the costs of their education, will disappear as fewer people will be able to afford higher education.

Drivers

- Growing global and sustainability awareness among younger generations
- Children growing up as digital natives with new technological capabilities, communication and networking skills
- In the developed countries, demographic change leads to lower numbers of new workers entering the labour market, making it a seller's market.

Implications for jobs

- In recruitment, it is likely that corporate values will become the most important hiring tool, making it difficult for 'unpopular' industries (e.g. defence industry) to attract the necessary talent. Job seekers may put their ethical convictions before their career goals and select their employer according to their values.
- With Generation Y members being much more mobile (Deloitte, 2011) and more likely to change jobs (e.g. for Germany, see IAB, 2011), talent retention will become much more competitive. But this job-hopping – within and outside the company – offers employers increased flexibility, making the adaptation to changes in consumer demands easier.
- The shift to sustainable consumption espoused by Generation Y members could result in reduced expenditure on imported consumer goods and higher spending on services, boosting green job growth.

[17] The assumption applied to this disruption, is that the societal and sustainability values are less dependent on the life cycle phase of employees, but are deeply founded with action guiding employment decisions through an employees whole life.

Implications for skills

- Generation Y's 'positive competition' attitude – pro-diversity, eager to learn – is a boost to skill development in organisations. Leaders have to recognise that skills are understood differently and processes have to be adapted: autonomy, recognition of individual needs, and collaboration are valued much higher than before.
- Members of Generation Y face global competition and will focus much more on finding a niche, i.e. developing distinctive capabilities in a very specific area. These advanced skills will be much more modular in character. Leaders need skills to manage personnel that are using different working technologies and modes.
- The lack of job security and the fact that Generation Y members are more mobile (e.g. more willing to emigrate) leads to a short-term focus, which has to be recognised by executives.

3.4 Zero-hour Contracts Become the Norm

Description	With individuals facing such high competition in the job market, employers are able to structure employment conditions to meet their specific needs. It is evident in a rise in the practice of zero-hour contracts, and similar flexible arrangements, coupled with the decline of investment (by employers) in up-skilling individuals.
Recent developments	• Persistent and rising un- and underemployment (willingness of workers to work more hours than employers demand, or to work below their skill level; Bell and Blanchflower, 2013) are shifting the balance of power in the job market. Individuals are under a much greater pressure to accept contracts that benefit employers much more than they do workers, particularly when competing for low-skilled jobs. • However, the phenomenon is not limited to low-skilled workers, underemployment is also on the rise among graduates in the UK (Mosca and Wright, 2013). • One prominent example for these lopsided contracts are zero-hour contracts, which offer employers the flexibility to meet fluctuating demands, yet under which people are not guaranteed a specific number of hours or times of work, or may have to work varied or extended longer hours from time to time. In the UK, these contracts are now used by some 23 per cent (CIPD, 2013c) or 27 per cent (REC, 2013) of all companies. • The use of zero-hour contracts in the UK increased greatly over the past decade, in particular in hotels and restaurants, and in the health and education sectors. In 2011, 8 per cent of all workplaces had at least some employees on zero-hour contracts[18], doubling from 4 per cent in 2004 (Pyper and McGuinness, 2013). Some companies, (e.g. McDonalds or the retailer Sports Direct), already employ 90 per cent of their workers under zero-hour contracts, with traditional employment contracts (regular full or part time with specified hours) limited to higher-level positions (Neville, 2013). • CIPD (2013c) reports that in 2013 just over 1 million people or 3.1 per cent of the UK workforce are employed under zero-hour contracts. 38 per cent of them are underemployed as they would like to work more hours. 60 per cent of these workers have the option for multiple

[18] According to a Unite survey in 2013, 22 per cent of workers employed by private businesses had deals that offered little or no guarantee of work and pay. This could be as many as 5.5 million Britons (Butler, 2013).

assignments when the primary employer has no work available.

- Similar developments towards increasing employer flexibility in low-skill employment are taking place in other countries, e.g. Germany's expansion of marginal (self-) employment. In the EU, underemployment increased from 18.5 per cent of all part-time workers in 2008 to 21.5 per cent in 2012 (Eurostat, 2012).

Potential future developments

- Future use of zero-hour contracts or similar contractual designs will depend greatly on the development of the regulatory landscape (for possible developments see Wright, 2013) and on a persistent labour surplus.
- Should legislation and the current growth trend remain unchanged, there would be some 25 million people on zero-hour contracts in the UK by 2020 (compared to some 250,000 to 1 or even 5.5 million in 2013; Cross, 2013; Neville, 2013; Butler, 2013) of an overall workforce numbering some 30 million. Even less aggressive growth would see at least 50 per cent of the workforce employed in zero-hour contracts by 2030[19].

Drivers

- High market volatility
- Strong labour surplus
- Weak position of individuals in collective bargaining

Implications for jobs

- Expansion of zero-hour contract types would keep employment costs down, making some industries more flexible (in particular the service industry). However, as employee loyalty is questionable and worker turnover is high, continuity and quality of service might suffer, leading to customer dissatisfaction.
- A possible outcome is a highly polarised labour market, with low- to medium-skilled workers in constant competition for more hours – either in zero-hour contracts (low and unskilled) or as freelancers – offering employers low wage bills and utmost flexibility. Full-hour contracts would be limited to a small minority of core staff in executive positions, similar to, e.g., Sport Direct today (only 10 per cent of all staff were on regular contracts as of 2013; Neville, 2013).
- Some top-level experts work voluntarily as micropreneurs, however usually backed with the financial security that allows them the freedom to not be entirely dependent on a continuous work (needing to work a set number of hours).
- Lower disposable incomes and difficult access to loans and

[19] Own calculation, assuming that three quarters of the workforce are employed in zero-hour contracts in the sectors: health and social care, retail, transport, accommodation and food service activities, education.

mortgages among zero-hours contract workers would reduce domestic demand and lead to an economic downturn with job growth losses (Orr, 2013). Pension safety is compromised, the state would have to make up – in some way or another – for the resulting shortfalls, leading to a higher tax burden, which would impact negatively on demand and job creation.

- While providing flexibility for employers, zero-hour contract workers need flexible support infrastructures (e.g. child care) to be able to meet employment demands.
- Underemployed graduates might increasingly opt for migration to gain better individual job opportunities, significantly reducing the available talent.

Implications for skills

- As a result, there may be little or no skills development in companies. Companies' investment in skills might be tightly concentrated on job-specific requirements. In the long run, this will lead to a jobs-skills mismatch, particularly in occupations that are reliant on continuous up-skilling like education and nursing or technical occupations.
- Uncertainty about one's personal income situation reduces the incentive to pay for one's own training, hurting overall skill levels, even when up-skilling would be necessary to improve individual employability. There is a strong need to establish skills literacy, giving individuals the competence and awareness to invest in their skills to increase employability.
- Zero-hour contract workers have to develop the organisational skills necessary to navigate complex work/life situations, and have to be able to adapt rapidly to changing workplace demands.
- Leadership has to be able to motivate, integrate, and manage staff with little company loyalty or solidarity.

3.5 Anywhere, Anytime Skills Delivery

Description	Traditional education and training providers are being challenged by the broad variety of non-traditional learning opportunities. New models of skills delivery are resulting from a rise in online educational opportunities, open universities and peer-to-peer learning.
Recent developments	• In recent years, the costs of traditional education have increased considerably. In the UK, average tuition fees more than trebled between 1998 and 2010, and have since risen again steeply (Bolton, 2013). Similar developments are evident in other developed countries (in the US, average student debt after graduation grew by 58 per cent between 2005 and 2012 (FICO, 2013)). As a result, many would-be students are being priced out of higher education. • At the same time, non-standard education and training have become more widely recognised, e.g. by the EU's ECVET[20] scheme (ECCTIS, 2013), and the Return on Educational Investment (ROEI) of non-traditional education has been found to be considerably higher than that for traditional education (McKendrick, 2012). • Technology has enabled a revolution in distance learning: free or fee-based Massive Open Online Courses (MOOCs), which provide students with online teaching materials and interactive forums, have seen a rapid rise in recent years (in the US, enrolment rose 100-fold between March 2012 and March 2013; Waldrop, 2013). One-to-one tuition has grown in a similar manner. • This development presents a major challenge to teaching in traditional university settings, in particular with regard to the cost advantages it offers to both students and learning institutes, and may lead to cuts to staff and infrastructure (Grossmann, 2013). • The use of MOOCs in further training is also growing rapidly in the corporate environment (Meister, 2013); as training schedules become more flexible, e.g. training during work hours and outside of work.
Potential future developments	• MOOCS are expected to continue their expansion, with an estimated 120 million students enrolled worldwide in 2020 (Yuan *et al*., 2013), roughly 50 per cent of overall participation in tertiary education (Uvalić-Trumbić, 2011). • The movement towards free knowledge could relegate paid-for offers to the sidelines by 2030, in particular in the area of further peer-to-

[20] European Credit System for Vocational Education and Training

peer training, where knowledge and experience are shared through social networks rather than expert-driven workshops.

- The tendency of Generation Y to favour gamified and experiential approaches could overturn traditional didactic models. This could mean mainstream models of learning-by-doing (in a truly meaningful way). This would entail new ways of validating and accrediting learning. Companies would need to allow Generation Y workers to define their own development needs.
- The use of Artificial Intelligence (AI) in education may further cut costs and increase the quality of MOOCs, providing them with the personal one-to-one element they currently lack (Vanderbilt, 2012). Learning units need to be attractive and adapted to the learners' typical routines. Bite-sized and gamified content delivery will play an important role.
- By 2030, the traditional model of comprehensive education could be replaced by an approach based on micro learning, i.e. by breaking up traditional learning units into more rapid small/short-term learning activities.

Drivers

- Changes in life patterns – education is no longer a fixed period which ends when people are in their 20s.
- Continuing increase in the cost of traditional education
- Rapid technological change leading to continuously increasing demand for life-long learning.
- Digitalisation enabling new forms of learning.

Implications for jobs

- Currently, the UK has the third-highest tuition fees worldwide (OECD, 2013b), pricing many out of the opportunity to study at university. The UK also has a comparably high number of 15-19-year-olds who are not in education, potentially leading to a more low-skilled workforce in the future and hurting innovation capability and job growth.
- Reducing average student debts by reducing the cost of education would increase the disposable income available to labour market entrants and boost consumer spending. A more highly skilled workforce would grow the talent pool, making it easier for businesses to hire the staff they need - helping job creation.
- As the UK workforce ages, retirement ages may increase and technological development is likely to lead to rapid changes in necessary competences and skills. Easy 'up skilling' would help to maintain employees' and businesses' competitive position in the global economy.

- The education and training landscape will change dramatically, giving rise to novel forms of education. ICT intensity will increase considerably. Training providers might find themselves more in the role of 'training the trainers' in peer learning rather than providing content to students. Expensive universities and training providers need to adapt their business models and core services to compete against low cost MOOCs. Life-long learning will open new markets that can be developed by established and new players alike.

Implications for skills

- MOOCs make life-long learning feasible and affordable anywhere, anytime, – therefore opening up non-elitist access to learning with the increased ability to attract students from lower socio-economic levels – leading to a much more qualified workforce. In corporate on-the-job training and up skilling, MOOCs and similar models make it much easier to reach and involve (in particular older) workers.
- Bite-sized learning offers a route to developing skills to precisely fit the task, providing ready-to-use new knowledge. Additionally, with gamified learning tools they might get very attractive and even fun to learn.
- Teamwork, social skills, and presentation fluency, etc., are more conducive to being taught in a traditional environment and resultantly may suffer in an overwhelmingly online learning environment.
- Education and training providers will need to acquire and use radically different skills using online technology, moderating and supervising group learning, etc.
- HR departments will need adequate competence to assess the real value of the many new certificates available in the future in order to be able to rely on job applicant's competences.

3.6 Artificial Intelligence and Robots

Description	Further advancements in the fields of robotics, algorithms and Artificial Intelligence may make it possible to automate processes and services that are presently provided by high-wage experts (e.g. surgery, diagnostics, legal advice).
Recent developments	• Over the past decade, Artificial Intelligence (AI) applications have matured in many areas, most prominently in stock trading (using textual analysis to predict the development of stocks; Mims, 2010), but also in medical diagnosis (lowering costs and improving outcomes; IU, 2013), education (one-to-one teaching of maths; Williams, 2011), and computer games (guiding the actions of computer opponents; Lane, 2013), among others. In general, AI is increasingly used to facilitate capturing, structuring, and analysing Big Data (O'Leary, 2013). • Outside of these specialised fields and when measuring overall intelligence, the latest AIs are considered to have reached the level of a four-year-old human (Galatzer-Levy, 2013). • Today, robots are not only employed in manufacturing (i.e. industrial robotics), but have also found use in health care (supporting or conducting surgery, and more recently, as service robots in hospitals; Hay, 2012) or in agriculture and various other fields with routine tasks. • In warehousing, more and more robots are used to increase the speed of picking, packing, and stowing, particularly for large e-commerce operations and similar businesses (Kellett, 2011). • Robots are increasingly used in the domestic environment, albeit in more minor roles (e.g. 'Roomba' robots for vacuuming).
Potential future developments	• Robots will begin to enter occupations previously thought to be limited to humans, among them nursing (in particular in ageing societies; SD, 2013) or the transportation of passengers and goods in autonomous vehicles (Shankland, 2012). • In heath care, microbots that travel through and 'maintain' the human body, automatically repairing organ damage could be introduced (Earls, 2013). • Many tasks on the stock market are already handled by AI applications. In the future these AI applications could take over the stock and financial markets completely, almost entirely foregoing human input. • AI applications may change education across all levels by providing

	one-to-one tutoring, grading work, etc. (Vanderbilt, 2012). AI might also influence customer services by enabling automated but personalised customer service in call centres, at service terminals and at online/mobile devices. • Other roles of AI would be legal analysis, possibly leading to the abolition of lower courts and the introduction of fully automated minor trials.
Drivers	• Continued technological development, in particular in IT, both with regard to hard- and software • Further expansion of the Internet and availability of real-time information
Implications for jobs	• A greater role for both AI and robotics as described above would bring about a further decoupling of productivity from employment, leading to the loss of medium and high skilled jobs in analysis and management, with the productivity gains benefitting a small set of entities. Some productivity gains may be used to improve service quality, leading to the creation of new jobs created in the area of personal training and assistance. This could even lead to an upheaval in wage structures, where e.g. non-replaceable non-routine social jobs may become much better paid. • In contrast to robots and AI supporting humans in completing tasks, workers may support the former by handling non-routine manual tasks in low-wage jobs (e.g. delivering packages, installing domestic hardware). • The cost advantages offered by AI and robotics in health care could lead to lower health costs and consequently to a lower tax burden, increasing consumption and making businesses more competitive. • Jobs in AI programming and robot manufacturing and maintenance could see strong growth, increasing demand for relevant high-skilled workers.
Implications for skills	• Many jobs will be ‘de-skilled’, i.e. stripped of routine, complex technical tasks; leading to a new focus on interpersonal skills in formerly purely technical and other occupations (in health care, e.g. a shift from medical diagnosis to working with patients). • As personalised, AI-supported training and education reduce the cost and efforts necessary for acquiring skills, more workers could gain additional qualifications, leading to a higher skilled workforce.

3.7 De-Globalisation

Description	Increasing protectionist and nationalist tendencies, due to the persistent global economic crisis, may counteract international cooperation and trade.
Recent developments	• Governments worldwide are increasingly using protectionist measures to support their national companies, with more than 400 measures taken globally since the autumn of 2012 (Evenett, 2013). Rather than using traditional trade barriers, protectionist measures include restricting migration and providing export subsidies and guarantees, or financial aid. As a consequence, the WTO has cut its 2013 global trade forecast (Elliott, 2013). • Increasingly, jobs and manufacturing processes that had been exported to emerging nations are 're-shored' (Economist, 2013), as rapid reaction to market changes and access to talent is becoming more important than lower wages, a development also expected for the UK (Groom, 2013). One study suggests optimistically that 200,000 jobs will be created over the next 10 years as a result of this process (BusinessBirmingham, 2013). • In the financial services sector cross-border lending has fallen sharply and major banks have scaled back their international ventures, also as a response to new regulatory requirements (Davies, 2012). • Nations are retreating from multilateral trade agreements and instead favouring bilateral agreements (Pedraza-Farina, 2013). • Many companies are redesigning their procurement procedures in order to reduce uncertainty, with one-third of US high-tech manufacturers intending to balance global sourcing (IDC, 2012). • In the wake of the NSA scandal, (Roberts and Ackerman, 2013) a regionalisation of computer services is to be expected. • Anti-immigration sentiments are also growing, as are voices that call for reducing the free movement of labour. In the UK, public concern over immigration has reached a three-year high (Jordan, 2013).
Potential future developments	• The current mood towards more protectionism could result in a trade barrier war, with reciprocal retaliations in the form of new trade barriers. Regional trade agreements could take the place of intercontinental multilateral agreements, leading to the rise of several regional trade blocks with little trade between each other by 2030. Intra-regional trade within the EU would absorb much of the negative impact on the UK, as in 2013 8 out of 10 of the UK's significant import

	and export partner countries were within the EU (ONS, 2013f). Another alternative would be a newly built Commonwealth Free Trade Area covering a highly dynamic and growing market (The Foreign Affairs Committee, 2013). However, de-globalisation would mean a dramatic change for many UK goods and services. • Should re-shoring accelerate in the UK, economic growth in the emerging and developing nations could be significantly affected, leading to a recovery of manufacturing in the West by 2030. • De-globalisation could also lead to greater resilience in the global economy, with crises easier to contain and less likely to escalate across continents, leading to more stable, evenly paced economic development. Economic growth will be strongly reduced, globally and nationally.
Drivers	• Sluggish economic recovery increases government willingness to protect national trade at all costs • The complexity of multilateral trade agreements (e.g. the failure of Doha) pushes states towards bilateral agreements
Implications for jobs	• The UK has more to lose than most other countries from a revival of 'regionalism'. A large proportion of jobs depend on exports (17 per cent of the national economic output). Financial and business services, e.g. insurance, finance, or consultancy, would be hard hit by a loss of export markets. Many UK utilities and manufacturing companies are foreign-owned; a withdrawal of capital would mean the loss of many jobs. • Migrants bring a net benefit to the UK economy, should they (be required to) return to their homelands, a net loss of jobs would ensue. • Re-shoring could – in combination with regional sourcing – lower the UK's dependency on imports.
Implications for skills	• Should anti-immigration legislation become reality, many skilled workers may need to be replaced, e.g. in nursing, requiring a vast up skilling effort. • Re-shoring would require large-scale retraining efforts to regain the skills lost in, e.g., manufacturing. Skills necessary in global sectors, like the financial industry, will be demanded at a lower scale. • Anti-immigration sentiment would drain the talent pool, and would also mean the loss of skilled small-scale entrepreneurs who are more likely than others to start businesses in the UK.

3.8 Geographically Alternative Centres of Excellence

Description	As emerging countries develop the infrastructure necessary to push them to the next level of development, a new wave of cities, like Shanghai, Hong Kong or Singapore in the case of the financial industry, are taking the competitive lead in specific production and innovation fields. Supportive government (e.g. subsidies and tax incentives), large working age population, and cheaper production and labour costs encourage foreign investors and an increasing amount of business start-ups.
Recent developments	• The emerging markets are driving global economic growth, i.e. most new growth is located in these countries. Trade surpluses will enable these countries to spend more money on developing regional centres, in particular if the industries in question benefit from large economies of scale. • Governments in emerging nations are more willing to adapt local laws (weakening labour laws or environmental legislation) to develop local centres of excellence, e.g. China's special administrative regions (Ren, 2008). China has also used significant state subsidies to enable private actors to form industry clusters in which a specific future-tech sector dominates (e.g. photovoltaic; ASM, 2011; Weiwei and Rui, 2011). • Recently modernised cities in emerging countries often enjoy state-of-the-art infrastructure superior to that in developed countries, leading to a concentration of services around these cities. • Asian financial capitals, particularly Shanghai, Hong Kong or Singapore are challenging the dominance of today's leading financial centres (e.g. London, New York and Tokyo). Two-thirds of British investment bankers surveyed in 2012 expect that in 2022 the top global finance centre will be in Asia, due to a low tax and bank friendly environment (Jeff, 2012). • New trade corridors are opening between Asia and Africa, Asia and South America and within Asia, which will re-chart global supply chains. As trade volumes shift towards emerging markets, centres of commerce in the emerging markets will replace those in the West (PwC, 2010b). • Many emerging nations are investing heavily in tertiary education clusters, which are likely to improve rapidly in the coming decades and mature into research clusters (PwC, 2010c).

Potential future developments	• In combination with aggressively active governments, emerging market leaders will become a disruptive force in the global competitive landscape (as in, e.g., the destruction of the German Photovoltaic industry). • The new clusters will be much closer to the growth markets (countries with growing populations and/or increasing affluence), giving them an edge over the clusters in the 'old' industrial nations of the West. This could lead to an exodus of talent to these clusters, further weakening the position of the old clusters. • PwC predicts that six of the world's ten largest industry clusters will be located in today's emerging markets by 2040 (PwC, 2010c).
Drivers	• Economic growth predominantly in emerging countries • Ageing workforces in industrial nations, growing talent pools in the emerging markets • Geographical proximity of the new clusters to future growth markets.
Implications for jobs	• Due to increasing global competition, and emerging economies broadly supporting a set of strategic industries through subsidies and a lax tax and regulatory framework, the UK risks losing its competitive advantage in different sectors. A real risk of job losses might exist in tertiary education and future tech research. • The indirect effects of an exodus of key industries could be much higher than the direct loss of jobs, as consumption and the national income suffers.
Implications for skills	• In order to compete with the new centres of excellence, top talent is needed, necessitating easier immigration.

3.9 Disrupted Internet Developments

Description	The 'smooth' development of the future Internet may be blocked as corporatisation and privacy issues dominate the online space. Incidents of cyber crime are rising: targeting internet structures, organisations and individuals.
Recent developments	• The Internet is a huge driver of job creation, contributing more than 20 per cent to economic growth in mature countries from 2007-2011 (McKinsey, 2011b; for the UK, Page, 2012). • In some countries, most notably the US and the UK, Internet service providers (ISP) have introduced bandwidth caps, ostensibly a reaction to growth in the absolute number of users and the amount of content shared, but more likely a way to increase revenue (Masnick, 2013). Similar to plans to end net neutrality (e.g. for the EU; see RT, 2013), these caps have stoked fears of a corporatisation of the Internet. • In many countries, public investment in broadband infrastructure is also lacking (for the UK see Shah, 2013), raising the threat that many regions will be unable to access the bandwidth necessary for expected future uses. • Privacy concerns have also increased. On the one hand, private companies have been shown to violate their customers' trust, most notably Facebook (for an example, see Rosenblatt, 2012), on the other, the recent NSA/GCHQ scandal demonstrated the far-ranging data collection activities of UK and US intelligence services (Ball *et al.*, 2013). • Several governments have proposed to install Internet filters at ISP level (most recently in the UK, to be introduced in 2014). Ostensibly to combat the dissemination of child pornography and violent or extremist content, these filters may be used to block any content desired by the authorities, similar to China's 'great firewall', a fact much criticised (BBC, 2013a). Also, a move from multi-stakeholder Internet governance to top-down regulation is expected to stifle economic growth (Kleinwächter, 2013). • In recent years, cyber crime has grown steadily and become more sophisticated, with e.g. 8 per cent of the UK adult population reporting to have lost money to online computer fraud in 2012 (UoK, 2013; a 2011 report put the overall cost of cyber crime to the UK economy at £27bn; Detica, 2011). Online fraud in social networks mostly focuses on creating 'fake buzzes' (e.g. fake 'likes' on Facebook) to promote

companies or individuals (Finkle, 2013), also reducing trust in Internet functionality.

- Cyber attacks by state and non-state actors have increased in recent years, targeting institutions and businesses, occasionally for grassroots political aims ('hacktivism'), but predominately as industrial and defence espionage and denial-of-service operations (Blitz, 2013).

Potential future developments

- Until 2020, bandwidth usage is expected to grow more than ten-fold (mostly through increased use of mobile devices), raising fears – in view of a lack of investment – of widespread network congestion, in particular in rural areas (Brodkin, 2012). The result would be a two-tier Internet, severely limiting economic prospects in disadvantaged areas. Further, national safeguards and filters could lead to an uneven Internet, in which access depends on the user's location, severely limiting international services.
- Should net neutrality fall, paid-for content would receive priority treatment over all other content, effectively privatise the Internet.
- Cyber attacks and espionage are expected to pose a much greater threat in 2030, up to and including attacks on networked transport infrastructure (NIC, 2012). Increased unemployment, in particular among graduates, is expected to result in an increase in 'hacktivism' (Williams, 2012). Many Internet users fear that by 2020, privacy will have ceased to exist (Kennedy, 2012).
- The NSA/GCHQ scandal could also lead to re-regionalisation efforts to remove online content from UK and US jurisdiction and access of the countries' intelligence agencies, with the result of limited regional networks.

Drivers

- The rise and increasing sophistication of cybercrime
- Lack of widespread public investment in Internet infrastructure
- Rampant and essentially unlimited activities of intelligence agencies
- Continued use of business models which revolve around monetising users' private data

Implications for jobs

- The UK's broadband penetration rate growth could remain comparatively limited (OECD, 2013c), severely reducing future job growth potential in rural areas.
- The UK's financial services industry depends on a stable, secure, and freely accessible high-speed Internet, the developments described above would lead to job losses. In contrast there would be a rise in IT security jobs: efforts to increase cyber security in businesses and organisations would lead to job growth in this area.

- The Internet plays a major role in international trade; any re-regionalisation would severely hurt UK export-related jobs.

Implications for skills

- Basic cyber security knowledge in the workforce would need to be expanded vastly. Currently, the talent for improving online security is not widely available. Here, a national training effort to increase the number of highly skilled workers would be necessary.
- To replace digital processes in all sectors new solutions or old analog approaches might need to be implemented; this might require broad re-skilling for everybody.

3.10 Resource Conflicts or Climate Disasters Threaten Supply

Description	As global resource requirements increase in line with global population growth, disputes surrounding the use of strategic resources may arise. Conservation and efficiency efforts do little to quell fears. Resource supply may become a crucial strategic focus for countries and organisations.
Recent developments	• Natural deposits of many resources are slowly nearing exhaustion, or at least are getting harder and more expensive to exploit. At the same time, consumption continues to increase as the world's population grows and the living standards of more and more people improve (Tamminen, 2013). • Increased political turmoil in resource-exporting nations leads to temporary spikes and shortages in resource prices, most prominently for oil (e.g. during the Arab Spring; Bahgat, 2012). • As supplies become limited (in particular water supplies), access to resources may cause conflicts (water wars; Klare, 2013). Current strategies for dealing with supply bottlenecks include land grabbing (see Brown, 2013), with (predominantly Asian) nations acquiring land or developing resources in Africa, and stockpiling, e.g. of rare earths (Lasley, 2013). • Other options are the exploitation of substitute resources, for instance natural gas obtained through fracking in replacement of oil, which in some instances drove down, and in others, kept stable the price of oil (BBC, 2013b; shale oil could have a similar impact; PwC, 2013c). In the UK, fracking is also being considered for widespread use to increase energy independence (Richards *et al.*, 2013), yet its environmental impact remains a hotly contested issue (Bawden, 2013). • As resources scarcity increases, there is also a trend towards erecting trade barriers (quantitative export restrictions on scarce products), which hinder or hurt international trade (Carbonnier, 2013). • At the same time, the impacts of climate change are becoming more evident, bringing rising sea levels which threaten coastal areas, changes in rainfall patterns which reduce agricultural yields, more extreme weather events which harm infrastructures, and ocean acidification which hurts fishing through biodiversity loss, among others. • To date, the UK has suffered comparatively little from climate change,

but extreme weather events (floods, droughts and water scarcity in general) have made agricultural production more difficult to manage (Carrington, 2013) and the number of floods has increased in recent years.

Potential future developments

- By 2030, population growth, increasing resource use and scarcity, and climate change impacts could bring about a 'perfect storm' and plunge the world into a global crisis (Malvey, 2009).
- In the UK, the risk of flooding in coastal cities is increasing, which in the case of London could cause immense damage (Connor, 2013), necessitating costly upgrades to the Thames barrier.
- Should fossil fuel use continue unchanged, global warming could cross the 'tipping point' with dramatic consequences by 2030 (accelerated warming and sea level rise; Ahmed, 2013).
- Changes in the political climate and policy-making, however, could also lead to a 'zero-carbon' UK by 2030 (Allen *et al.*, 2013).
- Radical legislation could be used to limit the consumption of scarce materials, increasing government influence on the economy (e.g. enforcing stringent recycling or efficiency criteria, introducing resource quotas for businesses, etc.). These hard political choices could result in social and business unrest.
- As resource prices rise, substitutes may become economically attractive (e.g. synthetic fuels), reducing bottlenecks and thus keeping prices/economic growth stable.

Drivers

- Population growth increases resource use, in particular with regard to fuel and food.
- As affluence rises in the emerging countries, consumption grows, increasing resource use.
- Climate change will continue, even if full decarbonisation over the next two decades is achieved.

Implications for jobs

- In the industrial sector, the UK will be – except for gas – at a competitive disadvantage compared to businesses in resource-rich countries, leading to a loss of jobs. But looking at the mining sector, very high resource prices could make mineral extraction in the UK viable again, bringing job growth to the mining industry. Renewable energies are a key industry when it comes to reducing import dependency. The sector promises future growth both in manufacturing and in installation and maintenance services, in particular if a decentralisation of power production is achieved. For example, increased demand is anticipated in the UK offshore wind industry in

engineering, technical, managerial and other skills over the next decade (BIS and DECC, 2013).

- Jobs in especially water-intensive industries such as thermal power generation, pulp, textile, chemicals, or steel production may suffer comparative disadvantages in the UK in the future should severe droughts force companies to halt production.
- Climate change impacts affecting agriculture in the UK are caused in particular by an increase in extreme events and volatility of water availability, while higher temperatures would make it possible to expand growing areas. Ocean acidification and higher water temperatures will lead to smaller fish stocks (Carrington, 2012), hitting UK fisheries and leading to a loss of jobs. Adaptation measures to increase national preparedness for extreme events requires jobs in planning and in construction, e.g. for upgrading of embankments, but also for overall preparedness and well equipped disaster response measures.
- Material efficient production and consumption – realising a paradigm shift in the economy from a linear value chain to a circular one –, where the UK champions the reuse and recycling of already available resources, could generate 50,000 new jobs with a investment of £10bn, boosting the GDP by £3bn according to an Environmental Services Association (2013) report. The jobs will be created in the waste and resources industry, design, manufacturing, retailing and consumption as well as logistics. Energy efficient production will lead to a growth in 'green' jobs across different sectors from manufacturing to construction. Finally, should sharing replace owning as a key social paradigm to reduce consumption, new service jobs will be created.

Implications for skills

- Climate change impacts on the UK may be relatively minor compared to other world regions and might make the UK an attractive target for climate migrants, increasing the talent pool for UK businesses.
- As a 'resource-poor' country, the UK would need to grow its innovation capabilities to find substitutes, re-design products without using critical materials, etc., necessitating a science offensive and vast (re-)training efforts (repair rather than replace).
- Executives would have to constantly re-scale and adapt production to meet company needs through available materials, necessitating highly developed organisational skills.

3.11 Partial Fragmentation of the EU

Description	The United Kingdom may leave the European Union, as may several peripheral countries. This could result in the emergence of a core Eurozone single market plus a detached United Kingdom.
Recent developments	• Great economic disparities continue to exist in the EU (Ciurea and Miu, 2010), leading to major differences in regard to preferable economic policies, e.g. in the regulation of the financial markets (in particular between the UK, France and Germany; for a topical example see Masters, 2013). • The Euro crisis has shown that a two-tier EU is already in existence, as (with just two non-euro countries making contributions) only the Eurozone countries negotiated and underwrote the rescue package for Greece etc. (Barysch, 2010). • Anti-EU sentiment has increased throughout Europe among the general public. Between 2007 and 2013, the share of those having a positive view of the EU dropped by 22 percentage points to 46 per cent (PEW, 2013). Almost all countries now have parties promoting anti-EU policies, most prominently the UK's UKIP. • In the UK, in particular, euro scepticism has always played a major role. The current government has proposed a referendum on whether Britain should leave the EU, which at the moment a majority of Britons might support (Boffey and Helm, 2012).
Potential future developments	• Should the inequalities between rich and poor nations persist, one outcome is a two-tier EU, in which the economically powerful nations collaborate closely, while the weaker nations become far less integrated and do not share the other's common policies. Here, the UK would probably withdraw from the inner circle, leaving it without power in the EU's decision-making, yet still influenced by the results of the latter in regard to common market regulations, etc. (see Ditchley, 2012). • Public anti-EU sentiment, both in net contributing nations (refusal to continue paying into the EU) and recipient nations (refusal to accept a common policy dominated by the donor nations), could lead to a fragmented explosion in which member states leave individually after holding public referenda, a development which the UK would most likely spearhead. • The Euro crisis could also lead to a much stronger political and economic integration, based on the recognition that stronger

European political control and representation offers much better means to solve calamities such as this. This may involve almost all current member states. Should the UK opt out of this development, the consequences would be much more negative than in the other scenarios.

Drivers

- Diverging economic development increasing relative inequality between EU member states.
- Growing euro-scepticism among the general public
- Failure of the European institutions to successfully shape a common policy and provide Europe with a common cause.

Implications for jobs

- In the highly complex post-industrial globalised world, interconnectedness is key to success – leaving the EU would mean a loss of vital connections, hurting UK competitiveness. Only 18 per cent of UK businesses surveyed believe that a withdrawal from the UK could have a positive impact (Vina, 2013). Should the UK lose its current free-trade status with the EU, exports would suffer, leading to a loss of jobs.
- The loss of the current freedom of movement of EU nationals to the UK would mean a considerably smaller talent pool for UK businesses. But also vice-versa, UK nationals would find it harder to obtain a job in continental Europe, and would therefore be more likely to remain in the UK talent pool.
- Relatively tough banking regulations in the EU (compared to those of the UK) could grow jobs in the UK financial sector.

Implications for skills

- There are not enough skilled UK workers to fill the respective vacancies, a loss of unhindered access to Europe's talent would render vast retraining and up skilling efforts necessary. Skills retention would become more important; competition for limited talent would increase.
- It would become harder for Britons to study or train in continental Europe, reducing the number of top national talents.

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