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THE GEOGRAPHY OF THE UK'S CREATIVE AND HIGH-TECH ECONOMIES

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EXECUTIVE SUMMARY

The UK's creative and high-tech economies are major employers. Between them, and without double counting, they account for 4.76 million jobs, or around 16 per cent of the UK workforce (average of 2011–2013). Within this, 2.52 million jobs are in the creative economy, 3.11 million are in the high-tech economy, and 0.87 million are in both.

Between 2011 and 2013, employment in the UK's creative economy (jobs in the creative industries plus creative jobs elsewhere) grew by 4.3 per cent per annum (p.a.) on average, over three times faster than the workforce as a whole (1.2 per cent p.a.).[1] This is also faster than employment growth in the high-tech economy – that is, jobs in the high-tech industries plus Science, Technology, Engineering and Mathematics (STEM) jobs outside the high-tech industries – which grew at 2.1 per cent p.a.

Similarly, employment in the UK's creative industries grew at 5.0 per cent p.a., much faster than the 1.5 per cent p.a. growth of employment in the high-tech industries (which was dragged down by particularly slow growth in non-STEM occupations).

Echoing Nesta's previous research findings using business registry data,[2] we detect strong tendencies for creative and high-tech employment to co-locate. The creative economy is, however, less equally distributed across the UK, with London being more prominent than it is in the UK's high-tech economy. There is some evidence though of a slight catch up since 2011 as London's creative economy workforce has grown more slowly than most parts of the country.

How big are the UK's creative and high-tech economies?

There were 2.52 million jobs in the UK's creative economy (average 2011–2013), representing 8.3 per cent of the workforce. This consisted of 1.65 million jobs in the creative industries (866,000 of which were in creative occupations and 782,000 of which were in other roles) and 876,000 jobs in creative occupations outside of the creative industries (sometimes called 'embedded creatives'). That is, there are slightly more creative jobs outside the UK's creative industries than within.[3]

There were 3.11 million jobs in the high-tech economy (average 2011–2013), around 10.3 per cent of the workforce. This consisted of 2.33 million jobs in high-tech industries (805,000 of which were in STEM occupations and approximately 1.53 million in other roles) and 782,000 STEM jobs outside the high-tech industries. The extent to which STEM jobs are embedded in the wider UK economy is therefore similar in proportional terms to creative jobs.

0.87 million jobs fell within both the creative and high-tech economies (average 2011–2013, 2.8 per cent of the workforce); 0.46 million of these were at the same time both creative and STEM occupations. 0.54 million people worked in industries that we classify as both creative and high-tech. That part of the UK workforce where the creative and high-tech economies meet has been particularly dynamic, growing faster than the workforce as a whole over the 2011–2013 period at 8.0 p.a. on average (with dual creative/high-tech occupations growing at 5.7 per cent p.a. and dual creative/high-tech industry employment growing especially rapidly at 9.6 per cent p.a.). Policymakers should therefore pay particular attention to this segment of the UK's economy.

What is the geographic spread of creative and high–tech employment and how is it changing?

Regions with the highest concentrations of creative economy employment tend also to be regions with high concentrations of high–tech economy employment (concentrations being defined in terms of the level of creative (high–tech) economy employment as a proportion of the area's workforce).

The creative economy is, however, more unequally distributed across the country than is the high–tech economy. In particular, it is even more highly concentrated in London (where it accounts for 15.5 per cent of the workforce) compared with the high–tech economy which employs 10.6 per cent of the workforce in London .

At a sub–regional level the creative and high–tech economies are particularly concentrated in the counties to the north, south and west of London (Berkshire, Oxfordshire, Buckinghamshire, Surrey, Hertfordshire, Cambridgeshire) in Outer London (West and North West) and in Milton Keynes, Edinburgh and Bristol.[4]

There are pockets of concentrated high–tech economy employment without correspondingly high concentrations of creative employment in areas including Aberdeen City & Aberdeenshire, Cheshire, Derby, West Cumbria, Swindon, Halton and Warrington, Bedfordshire, Hampshire and Warwickshire.

Sub–regional concentrations of the creative economy where there is no corresponding concentration of high–tech can be found in Inner London (East and West), and in Outer London (South). Brighton and Hove is also notable for its concentration of creative economy employment. This is not deny the existence of high–tech activity in Inner London, but as our definition is broader encompassing a range of different technological activities it does not pick these out in isolation.

Over the period 2011 to 2013 London's creative economy grew on average by 2.9 per cent p.a., just under three–quarters of the rate of the UK's creative economy as a whole (4.3 per cent p.a.). This is all the more striking given that London's overall workforce grew almost twice as fast as the UK's over this period. With the exception of Scotland, the creative economy grew more rapidly in all areas outside London, particularly the East of England (9.3 per cent p.a.), the West Midlands (8.2 per cent p.a.) and the North East (5.6 per cent p.a.).

Employment in London's high–tech economy grew more quickly than did its creative economy, at 4.5 per cent p.a., more than double the 2.1 per cent p.a. growth achieved in the UK as a whole. With the exception of the South West of England and Northern Ireland, all UK regions saw expansion in their high–tech economies.

1. INTRODUCTION

In recent years, analysts have variously employed terms such as the knowledge economy,[5] information economy,[6] creative economy,[7] and high-tech economy[8] to characterise a trend in advanced developed countries towards economic activities where conceptions of technical know-how, expertise and creativity are considered critical. The two concepts of creative and high-tech industries have had particular longevity – in the UK and beyond – though definitional ambiguities have prevented an understanding of how they compare. This report corrects these ambiguities, clarifies the relationship between creative and high-tech industries and compares their size and recent performance.

In policy circles, it is widely believed that both these industries enjoy faster productivity growth than other sectors and are therefore good for a country's international competiveness and economic growth. They are also viewed as engines of job growth as they employ highly-skilled workers who are less vulnerable to substitution from new technologies.[9] Last, but not least, both sectors are seen as supporting growth in the wider economy, insofar as they create knowledge spillovers, such as those embodied in mobile labour, which drive innovation and productivity growth in other industries. These spillovers, it is argued, constitute a market failure and justify policy intervention. As such, policymakers in an increasing number of countries – developing as well as developed – are prioritising their creative and high-tech industries for policy support (UNESCO, 2013, Edwards and Lawrence, 2010).

The importance of skilled labour and human capital is reflected in an emphasis on talent in the definitions used to understand these industries, as illustrated, for example, by the Department for Culture, Media & Sport (DCMS) definition of the creative industries, and the role assigned to STEM knowledge or skills in many accounts of the high-tech industries. Thus, the DCMS's 1998 Mapping Document, the first national attempt to define the UK's creative industries, defined them as:[10]

> *"those industries which have their origin in individual creativity, skill and talent and which have a potential for wealth and job creation through the generation and exploitation of intellectual property*

and a US Congressional Office of Technology Assessment document describes high-tech firms as those:[11]

> *"engaged in the design, development, and introduction of new products and/or innovative manufacturing processes through the systematic application of scientific and technical knowledge*

In our 2013 study, *A Dynamic Mapping of the UK's Creative Industries*,[12] we noted that concepts like the 'creative industries' and 'creative economy' – indeed 'creativity' itself – although widely used by policymakers, lacked sufficiently clear and rigorous definitions. The report aimed to address this weakness by introducing clear criteria for which occupations should or should not be considered 'creative' for measurement purposes. The report also introduced a methodology for determining which industries should be classified as 'creative' based on their creative intensity (Freeman 2004, 2008a, Bakhshi et al., 2013:12), defined as the proportion of an industry's workforce in creative occupations. It found that creative intensity distinguishes

'creative industries' from other industries which also employ creative talent: although large numbers of individuals are employed in creative occupations in many industries, only a small number of these – the 'creative industries' – have exceptionally high levels of creative intensity.

Concepts like 'high-tech industry', and 'STEM' occupation, it turns out, are also plagued by definitional ambiguities and uncertainties. The wide range of classifications adopted by different studies – even within countries – has given rise to significant differences in estimates of the size, growth and geography of the high-tech industries and also of the demand for, and use made of, STEM occupations and skills in the wider economy.

The idea of using STEM workforce intensity (the proportion of an industry's workforce in STEM occupations) to identify high-tech industries has been independently applied by a number of US researchers. For example, Hecker (2005:58) defines high-tech industries in the US as follows:

> *An industry is considered high tech if employment in technology-oriented occupations accounted for a proportion of that industry's total employment that was at least twice the 4.9 per cent average for all industries.*[13]

In this report, we ground our definition of STEM occupations, the high-tech industries and the wider high-tech economy, in a statistical analysis of STEM intensity which mirrors our use of creative intensity, but which differs from it in significant ways (and in particular, as discussed below, reflecting the fact that STEM intensity turns out to be a weaker discriminator between industries than creative intensity).

In summary, in this report we make the following contributions:

1. We review the classifications of the creative and high-tech economies in the UK context **(Section 2).**
2. We update the baseline estimates of the UK's creative industries and creative economy in Dynamic Mapping for the period 2011–2013 and analyse their growth rates and geographies **(Section 5).**[14]
3. We estimate the number of individuals employed in STEM occupations in the UK and analyse how STEM intensity is distributed across industries. We find that the tendency for a small set of industries to have particularly high proportions of STEM workers in their workforce is less pronounced than is the case for creative occupations in the creative economy **(Section 6).**
4. We combine the STEM intensity analysis with Eurostat's classifications of high-tech industries, based on their level of R&D spend (for manufacturing) and knowledge intensity, measured by the qualifications of their workforce[15] for (services), to generate a classification of high-tech industries, and corresponding estimates of the size, growth and regional geography of high-tech industries and the high-tech economy **(Section 6).**
5. Using our classifications for creative and high-tech industries and economies we compare the make-up of these two parts of the UK economy and describe how they relate to one another in accounting terms **(Section 7).**
6. We analyse the sub-regional geography of the UK's creative and high-tech economies and compare it with how other sectors are distributed **(Section 8).**
7. We conclude by summarising the research findings and discussing the implications for measurement and future research **(Section 9).**

The next section provides some of the UK context on debates surrounding the definition of the creative and high-tech economies.

2 POLICY CONTEXT

2.1 DEFINITIONS OF THE UK'S CREATIVE ECONOMY

The 1998 and 2001 DCMS Mapping Documents[16] proposed that 13 sub-sectors made up the creative industries. These industries appeared to form a reasonably coherent group based on the generation of commercial value by creative talent. The 13 sub-sectors however, contained a notable split between household-facing sub-sectors like music, film and performing arts and business-facing sectors like advertising, design and software, leading to accusations of over-inclusion and boosterism.[17]

There were also many caveats and limitations in the DCMS Mapping Documents concerning gaps, a lack of comparability across sub-sectors, and the reliance on highly aggregated source data. The annual DCMS Creative Industries Economic Estimates, first published in 2002, attempted to address some of these challenges, at least for those sub-sectors identifiable using the official Standard Industrial Classification (SIC) codes, by producing each year the same headline statistics on Gross Value Added (GVA), employment, net exports and the number of creative businesses, based on consistent data sources for each sub-sector. These headline statistics showed the UK's creative industries were growing at twice the rate of other sectors, helping to raise the profile of the sector.[18]

A great many challenges remained in the DCMS statistics as a result of the limitations of the SIC codes, which are set in conjunction with the UN's industrial classification system for the purposes of international consistency and which are reviewed only at roughly ten-year intervals.

Partly because of this – but also due to differing data needs – sector bodies such as UK Music, the British Fashion Council and the Crafts Council started producing their own sector-specific economic statistics, along with equivalent bodies across the devolved nations and the English regions. Inconsistent treatments of sectoral boundaries (what should be included and what should not) led to a plethora of non-comparable estimates. The result was an ever-increasing landscape of sectoral, national and regional statistics that purported to measure similar things but were not strictly comparable.[19]

The position was exacerbated further in December 2011 when the DCMS removed two software-related occupations and industries from its classifications, cutting £25.9 billion from the amount creative industries were estimated to contribute to UK GVA. This decision showed a lack of appreciation for the interconnected relationship between software and creative content. But it also exposed the fact that the DCMS statistics had always been based on a pragmatic selection of occupational and industrial codes, and not on a systematic methodology.

Dynamic Mapping proposed an explicit methodology for determining which occupations and industries should be classified as creative for measurement purposes. It assessed the different characteristics which make an occupation creative, and then used the workforce intensity of employment in creative occupations to identify creative industries.[20] By

showing that a defining characteristic of creative industries was their especially intensive use of creative talent, it provided a statistical basis for treating the different creative industries as a coherent group. Following a public consultation exercise, in January 2014 the DCMS adopted this methodology for its official creative industries economic estimates.[21]

2.2 DEFINITIONS OF THE UK'S HIGH-TECH ECONOMY

Policymakers in the UK have long held the view that the UK's future growth prospects depend on it having a strong high-tech economy. The 2011 HM Treasury/BIS *Plan for Growth* states that:

> *Britain has to earn its way in the modern world. We have to become much more productive so we can be a leading high tech, highly skilled economy. We must build a new model of economic growth – where instead of borrowing from the rest of the world, we invest and we save and we export. Our economy must become more balanced.*[22]

This quote brings out a number of aspects of UK policymakers' interest in high-tech: the idea that it is a future area of opportunity, the association of high-tech with high skills, and the view that the UK economy needs to be more 'balanced'.[23]

However, the rhetoric of 'high-tech' has outpaced improvement in its measurement. Its scope is rarely defined, statistics on its economic importance are lacking and, in contrast to the creative economy, there is no 'official' classification. A review of the use of the term in the UK public policy literature reveals that it has been variously thought of as:

- A set of technologies.
- A group of firms that invest in high levels of R&D activity.
- A key employment destination for Science Technology Engineering and Mathematics (STEM) talent.
- A distinct group of industries.

We discuss these in turn:

A set of technologies

In 2012 David Willetts, the Minister of State of Science and Universities, in a speech on the UK's high-tech future[24] referred to the Government Office for Science's 2010 report identifying future technologies and innovations likely to be important to the UK in the 2020s. These being classified into the following broad categories:[25]

- Biotechnology and Pharmaceuticals.
- Materials and Nanotechnology.
- Digital and Networks.
- Energy and low-carbon technologies.

In a subsequent publication, Willetts outlined 'eight great technologies' where the government was working to ensure that they were properly supported, these being:

1. Robotics and autonomous systems
2. Satellites
3. Advanced materials
4. Regenerative medicine
5. Energy storage
6. Synthetic biology
7. Agri-science
8. Big data[26]

A group of firms that invest in high levels of R&D activity

In 2010, a report by James Dyson set out a plan for making the UK the leading high-tech exporter in Europe.[27] This included a range of policy measures, among which were a number of support proposals for high-tech companies to encourage R&D investment. One of these was that the level of Enterprise Investment Scheme (EIS) tax relief should be raised for angel investors in high-tech companies. High-tech companies being defined on the basis of their level of R&D activities.

An employment destination for STEM talent

There is a long tradition in the UK of assessing whether the UK is producing enough people with STEM skills to meet its future workforce needs, resulting in successive reports by the Government on this subject: DTI (2006),[28] DFES (2006),[29] DIUS (2009)[30] and BIS (2011).[31]

More recently, in 2011 and 2013 the UK Commission for Employment and Skills (UKCES) has undertaken reviews of the supply of and demand for high-level STEM skills in the UK.[32] The 2011 review was undertaken with the explicit aim of recognising that STEM skills support 'research, innovation and high-tech manufacturing'.[33] It concluded that there was a broad match between the proportion of the workforce with high-level STEM skills and the proportion of jobs requiring such skills. However, it also found evidence of skills shortages in some sub-sectors, such as at graduate entry-level in engineering. The 2013 study, which contained projections out to 2020 under different economic growth scenarios, similarly concluded that although there were no STEM skills shortages in the UK workforce as a whole, certain regions and sectors regions suffered from skills gaps that held back growth.[34]

The argument that specific high-tech industries are significant employers of STEM occupations has been made even more strongly in the US, as we discuss in Section 3 in more detail.

A distinct group of industries

An alternative approach has been to directly identify a set of industries as 'high–tech'. For example, KPMG's 2013 analysis of the location and changes in the UK's 'tech economy' defined technology industries by the following SIC codes, allowing their economic contribution to be estimated in the same way that DCMS does with the creative industries:

- Software publishing (SIC 582).
- Computer programming, consultancy and related activities (SIC 620).
- Data processing, hosting and related activities; web portals (SIC 631).
- Manufacture of computer, electronic and optical products (SIC 26).
- Manufacture of electrical equipment (SIC 27).

BIS's (2012) research paper on UK industrial strategy[36] assessed which high–tech sectors would in the future make the largest contribution to UK economic growth and employment. The report referred to high–tech in the context of 'high–medium tech manufacturing', though which industries codes were taken to make up this measure, and their current economic contribution to employment and value added, were not provided.[37]

Having reviewed the UK context for defining the creative and high–tech economies, the next two sections outline the key features of the Dynamic Mapping methodology and the data sources for our analysis. The two subsequent sections present quantitative estimates of the size, growth and geography of the UK's creative and high–tech economies.

3 DYNAMIC MAPPING METHODOLOGY

The Dynamic Mapping methodology as originally applied to classify the creative economy consists of three stages.[38] First, a set of occupations are identified as creative. Second, the workforce intensity of these occupations is calculated for each industry in the economy. Third, based on the distribution of creative intensity across industries, a threshold intensity is identified, above which all industries are determined to be creative for measurement purposes and all those below are not.

Considering these stages in a little more detail:

1. **Choice of occupation** In the first stage, all occupations in the UK workforce – as represented by Standard Occupational Classification (SOC) codes[39] describing the nature of a job – are subjectively assessed on their creativity against five criteria.[40, 41] A set of creative occupations is identified on this basis.
2. **Calculation of intensity** In the second stage, for every industry – as defined by a set of Standard Industrial Classification (SICs) codes – the intensity i.e. the proportion of the industry's workforce employed in the selected occupations in the first stage is calculated. For example, SIC code 5912, the 'Motion Picture, video and television programme post-production activities' industry employed 12,000 people in 2012 (rounded to the nearest 1,000), of whom 8,000 were working in creative occupations. Accordingly, its creative intensity calculated from these rounded figures, is 8,000/12,000 = 67 per cent in that year.
3. **Partitioning the industry according to an intensity threshold** In the third stage, the distribution of creative occupation intensity is examined across all industries and a threshold intensity selected which is used to partition industries into two groups.

In *Dynamic Mapping*, the creative intensity threshold was selected by an intuitive equiprobabilistic criterion. That is, it was selected to be the intensity at which it was, on the best available estimate of the population parameters (based on the latest published DCMS estimates at the time of publication), equally likely that a creative industry would be wrongly rejected as not creative (a false negative) as would a non-creative industry be wrongly selected as being creative (a false positive). Appendix 4 contains further discussion of the issues raised in determining the threshold intensity in this report.

The set of occupations and industries generated by this analysis defines the employment in the 'economy' of interest. In the case of the creative economy, this consists of a combination of three types of employment:

1. **Specialists:** those working in creative occupations in creative industries.
2. **Non-specialists:** those working in a creative industry, but who are not themselves employed in a creative occupation.
3. **Embedded:** those working in creative occupations outside creative industries.

This has previously been described as the 'Creative Trident' (Higgs et al., 2005, Higgs et al., 2008).

In the present study, we ask if the same approach can be used to study the relation between the occupations and industries commonly considered part of the 'high-tech' economy. We begin by considering, in more depth, the appropriate group of occupations, starting from occupations commonly labelled as STEM occupations.

The connection between STEM intensity and high-tech industries has been studied quite extensively in the US. In 2004, the US Bureau of Labor Statistics (BLS) conducted an inter-agency seminar in which participants concluded that the Bureau should explore the whole range of factors contributing to the high-tech nature of an industry, including:

- A high proportion of scientists, engineers, and technicians (science, engineering, and technician occupation intensity).
- A high proportion of R&D employment (R&D employment intensity).
- Production of high-tech products, as specified on a Census Bureau list of advanced-technology products.
- Use of high-tech production methods, including heavy use of high-tech capital goods and services in the production process.

Following this, the BLS (Hecker, 2005) produced a classification of high-tech industries based on their intensity of high-tech employment.[42] High-tech industries were defined as those where the proportion of employment in the industry was at least twice the average (mean) of US industries as a whole. This classification was subsequently used by, among other studies, the Bay Area Council Economic Institute in their 2012 report on high-tech employment and wages in the United States.[43]

Similarly, Echeverri-Carroll and Ayala, in their 2009 study of the effects of high-tech industry agglomerations on wages, classified as high-tech those manufacturing and service industries whose proportion of so-called 'technology orientated workers' was twice the national average or at least 6 per cent of their workforce.[44]

While not using the language of 'high-tech', a much quoted study from the Brookings Institution (Rothwell 2013), uses an approach similar to *Dynamic Mapping*, by using the O*NET database (Occupational Information Network Data Collection Program) which contains information from extensive surveys of workers to classify occupations on the extent of their (in this case) STEM knowledge content.[45]

The report defines STEM occupations according to whether an occupation has a score at least 1.5 standard deviations from the mean for a given set of STEM-related criteria in O*NET. The resulting list of STEM occupations is then used to calculate a STEM intensity to identify industries with a particularly high use of STEM occupations, or, in other words, the high-tech industries.

In this report, we compute creative and STEM intensity for all UK industries at the 4-digit SIC level to identify, and therefore measure the economic contribution of, creative and high-tech industries, and the wider creative and high-tech economies they are part of.

Conceptually, it will help to fix ideas to establish a terminology that lets us discuss similarities and differences between these areas in a coherent way. If the relationship between STEM occupations and high-tech industries were the same as that between creative occupations and creative industries, then we could map ideas developed in the two areas of research as shown in Table 2.1.

TABLE 2.1 CONCEPTUAL SEGMENTATION OF THE CREATIVE AND HIGH-TECH ECONOMIES

Specialist	Non-specialist	Embedded	Industry Total (specialist + non-specialist)	Occupation Total (specialist + embedded)	Economy (Industry + Embedded) OR Occupation + non-specialist
Creative specialist	Non-Creative specialist	Embedded Creatives	Creative Industries	Creative Occupations	Creative Economy
STEM specialist	Non-STEM specialist	Embedded STEM workers	High-tech Industries	STEM Occupations	High-tech Economy

The next section discusses the data sources we use in the analysis, and is followed by two sections that present estimates of employment in the creative and high-tech economies.

4 DATA SOURCES

The source for labour market data we use in this report is the Office for National Statistics' (ONS) Annual Population Survey (APS).[46] The APS consists of the core Labour Force Survey (LFS) described below and a series of booster samples which are undertaken using a shorter questionnaire than the LFS. Currently, the quarterly *Main LFS* dataset contains around 120,000 individuals and the APS dataset contains around 340,000 individuals.[47] The results presented in this report are calculated using the APS weighted to gross up the figures to the population level.

The LFS is a quarterly household survey covering the UK; each year, the four quarters are combined to provide an annual survey. The LFS has the following characteristics:

- It covers both employee jobs and self-employment, which includes sole traders.
- It provides data on both the occupation of a person, and the industry that employs that person.
- It is repeated regularly – the surveys are conducted quarterly, but the data is amalgamated and joined with additional, so-called 'booster' surveys to produce an annual result.

Sections 5 and 6 discuss the creative and high-tech economies in turn. Each section covers the classifications we adopt, and the size, recent growth (since 2011) and the regional UK geography of the sector.

5 THE CREATIVE ECONOMY

5.1 CLASSIFYING THE CREATIVE ECONOMY

In January 2014, the DCMS adopted the Dynamic Mapping approach to identifying creative occupations and industries.[48]

Uncertainties in the data and classifications meant that the DCMS considered it was important to review the inclusion or exclusion of some industries with creative intensities around the threshold level. The final classification of industries therefore also drew on feedback obtained from users of the statistics through a public consultation exercise (most obviously, SIC codes for museums and libraries were included on this basis). The consultation process, which led to the agreement of the final classification, was supported by cross-industry coordination overseen by the government's Creative Industries Council, including Nesta, the Sector Skills Councils (Creative Skillset and Creative and Cultural Skills), DCMS and a number of other industry bodies.

In this report, to be consistent with the resulting official creative industry statistics, we use the DCMS classifications for creative occupations and industries published in the January 2014 statistical release, even though there are some small differences with those in *Dynamic Mapping*. The corresponding 30 occupations and 31 industries are set out respectively in Tables 5.1.1 and 5.1.2 below, along with the creative intensities using 2013 APS data.[49]

TABLE 5.1.1 CREATIVE OCCUPATIONS (SOC2010 CODES)

1	**Advertising and marketing**	
	1132	Marketing and sales directors
	1134	Advertising and public relations directors
	2472	Public relations professionals
	2473	Advertising accounts managers and creative directors
	3543	Marketing associate professionals
2	**Architecture**	
	2431	Architects
	2432	Town Planners
	2435	Chartered architectural technologists
	3121	Architectural technologists and town planning technicians
3	**Crafts**	
	5211	Smiths and forge workers
	5411	Weavers and Knitters
	5441	Glass and ceramics makers, decorators and finishers
	5442	Furniture makers and other craft woodworkers
	5449	Other skilled trades n.e.c.

4	**Design: product, graphic and fashion design**	
	3421	Graphic designers
	3422	Product, clothing and related designers
5	**IT, software and computer services**	
	1136	Information technology and telecommunications directors
	2135	IT business analysts, architects and systems designers
	2136	Programmers and software development professionals
	2137	Web design and development professionals
6	**Film, TV, video, radio and photography**	
	3416	Arts officers, producers and directors
	3417	Photographers, audio-visual and broadcasting equipment operators
7	**Publishing**	
	2471	Journalists, newspaper and periodical editors
	3412	Authors, Writers
8	**Museums, galleries and libraries**	
	2451	Librarians
	2452	Archivists and curators
9	**Music, performing and visual Arts**	
	3411	Artists
	3413	Actors, Entertainers
	3414	Dancers and Choreographers
	3415	Musicians

TABLE 5.1.2 **CREATIVE INDUSTRIES (SIC 2007 CODES)**

			Creative intensity
1	**Advertising and marketing**		
	7021	Public relations and communication activities	60.3
	7311	Advertising agencies	51.6
	7312	Media representation	49.7
2	**Architecture**		
	7111	Architectural activities	64.1
3	**Crafts**		
	3212	Manufacture of jewellery and related articles	56.2
4	**Design: product, graphic and fashion design**		
	7410	Specialised design activities	61.6

5	**Film, TV, video, radio and photography**		
	5911	Motion picture, video and television programme production activities	70.5
	5912	Motion picture, video and television programme post-production activities	63.9
	5913	Motion picture, video and television programme distribution activities	22.9
	5914	Motion picture projection activities	7.8
	6010	Radio broadcasting	63.2
	6020	Television programming and broadcasting activities	52.4
	7420	Photographic activities	79.8
6	**IT software and computer services**		
	5821	Publishing of computer games	28.6
	5829	Other software publishing	39.2
	6201	Computer programming activities	55.1
	6202	Computer consultancy activities	32.0
7	**Publishing**		
	5811	Book publishing	48.2
	5812	Publishing of directories and mailing lists	21.0
	5813	Publishing of newspapers	45.8
	5814	Publishing of journals and periodicals	59.5
	5819	Other publishing activities	37.9
	7430	Translation and interpretation activities	83.9
8	**Museums, galleries and libraries**		
	9101	Library and archive activities	22.6
	9102	Museum activities	21.6
9	**Music performing and visual arts**		
	5920	Sound recording and music publishing activities	55.6
	8552	Cultural education	34.2
	9001	Performing arts	78.5
	9002	Support activities to performing arts	54.1
	9003	Artistic creation	90.2
	9004	Operation of arts facilities	38.6

5.2 THE SIZE OF THE CREATIVE ECONOMY

Based on these classifications, we estimate the overall size of the UK's creative economy, and its three main components: specialist, non-specialist, and embedded employment. Table 5.2.1 gives employment in the UK within these components for 2011 to 2013 and the average of these three years.

TABLE 5.2.1 CREATIVE ECONOMY, 2011-2013

Year	Specialist	Non-specialist	Creative Industries	Embedded	Creative Occupations	Creative Economy
2011	820,000	731,000	1,551,000	856,000	1,675,000	2,407,000
2012	888,000	796,000	1,684,000	866,000	1,754,000	2,550,000
2013	890,000	818,000	1,708,000	907,000	1,798,000	2,616,000
Average	866,000	782,000	1,648,000	876,000	1,742,000	2,524,000
Share of workforce	2.9%	2.6%	5.4%	2.9%	5.8%	8.3%
Share of creative economy	34.3%	31.0%	65.3%	34.7%	65.7%	100.0%

Note: The 2011-2013 average is given for comparison with later tables where greater disaggregation requires averaging over three years to avoid small sample biases.

The table shows that there were 2.6 million jobs in the UK's creative economy in 2013, and just over 2.5 million looking at the 2011-2013 period on average, of which 1.6 million were jobs in the creative industries.

The data can be arranged in a trident format with industries as columns and occupations as rows (Table 5.2.2).[51] This shows that around one-half of creative jobs were outside the creative industries in the wider creative economy.

TABLE 5.2.2 CREATIVE TRIDENT, AVERAGE 2011-2013

	Creative Industries	Non-Creative Industries	All Industries
Creative Occupations	Specialists 866,000	Embedded 876,000	Creatively-occupied jobs 1,742,000
Non-Creative Occupations	Non-Specialists 782,000	Non-Creative 27,719,000	Non creatively-occupied jobs 28,500,000
All Occupations	Working in the Creative Industries 1,648,000	Working outside the Creative Industries 28,595,000	Workforce 30,243,000

It is common practice in presenting data on creative employment to divide these into sectors or segments.[52] Here, we make a higher level distinction between two very broad categories with distinctive types of creative activity which we will call Creative Services and Creative Content.[53] A full list of occupation and industry codes used in this report are given in Appendices 1 and 2 respectively.

TABLE 5.2.3 CREATIVE SEGMENTS (SAME FOR OCCUPATIONS AND INDUSTRIES)

Creative Services	Creative Content
Advertising and marketing	Crafts
Architecture	Film, TV, video, radio and photography
Design: product, graphic and fashion design	Publishing
IT, software and computer services	Museums, galleries and libraries
	Music, performing and visual arts

Table 5.2.4 provides the totals for employment in these two broad categories, and Table 5.2.5 shows what these are as a proportion of total creative economy employment, for ease of comparison.

TABLE 5.2.4. EMPLOYMENT IN CREATIVE CONTENT AND CREATIVE SERVICES, UK, AVERAGE 2011-2013

	Creative Service Industries	Creative Content Industries	Creative Industries	Embedded	Total
Creative Service Occupations	409,000	59,000	469,000	645,000	1,114,000
Creative Content Occupations	27,000	371,000	397,000	231,000	628,000
Creative Occupations Total	436,000	430,000	866,000	876,000	1,742,000
Non-specialist Occupations	455,000	326,000	782,000	n/a	782,000
Total	**891,000**	**756,000**	**1,648,000**	**876,000**	**2,524,000**

TABLE 5.2.5 EMPLOYMENT IN CREATIVE CONTENT AND CREATIVE SERVICES AS A PROPORTION OF TOTAL CREATIVE ECONOMY EMPLOYMENT, UK, AVERAGE 2011-2013

	Creative Service Industries	Creative Content Industries	Creative Industries	Embedded	Total
Creative Service Occupations	16%	2%	19%	26%	44%
Creative Content Occupations	1%	15%	16%	9%	25%
Creative Occupations Total	17%	17%	34%	35%	69%
Non-specialist Occupations	18%	13%	31%	0%	31%
Total	**35%**	**30%**	**65%**	**35%**	**100%**

The creative service industries accounted for 1.2 times as many jobs as the creative content industries in the UK over the 2011-2013 period, while creative services occupations accounted for as many as 1.8 times the creative content occupations.

Interestingly, the small proportions of 'cross-employment' (creative service occupations in creative content industries, and vice versa),[54] suggest that, just as the creative industries are themselves a specialised employer of creative talent, each broad category specialises in a particular type of talent within the creative industries. Tables 5.2.4 and 5.2.5 show that in the main the creative content industries employ creative content workers and the creative service industries employ creative services workers.

KEY FINDINGS

- In 2013, there were around 2.6 million jobs in the UK's creative economy. This consisted of around 1.71 million jobs in the creative industries (890,000 of which were creative jobs) and 907,000 creative jobs outside of the creative industries.
- Within the creative industries, creative content and creative service industries appear to specialise in employing different types of creative talent. This is particularly the case with creative service industries, where only 3 per cent of jobs are in creative content occupations.

5.3 GROWTH OF THE CREATIVE ECONOMY

Unfortunately, the classification changes in the SIC codes with the shift from SIC03 to SIC07, (implemented in the 2008 data), and in the SOC codes from SOC2000 to SOC2010 (implemented in the 2010 data) precluded a longer historical analysis at the time of writing this report (though an approximate series on a SOC2000 basis for the 2004-2010 period is provided in *Dynamic Mapping*).[55] Shortly before the publication the DCMS published a statistical release (DCMS 2015), containing the first backcasting of creative economy employment back to 1997.

TABLE 5.3.1 EMPLOYMENT GROWTH IN THE MAIN CREATIVE ECONOMY COMPONENTS (PERCENTAGE CHANGE ON PREVIOUS YEAR)

	Specialist	Non-specialist	Creative Industries	Embedded	Creative Occupations	Creative Economy	Workforce
Total jobs employment growth							
2011 to 2012	8.4%	8.8%	8.6%	1.2%	4.7%	6.0%	0.7%
2012 to 2013	0.2%	2.8%	1.4%	4.8%	2.5%	2.6%	1.6%
Average	**4.3%**	**5.8%**	**5.0%**	**3.0%**	**3.6%**	**4.3%**	**1.2%**

Note: The average annual growth rate is the arithmetic mean of the growth rate in the two periods.

Table 5.3.1 shows the average annual growth rate over the period 2011-2013. It shows the creative economy grew 3.6 times faster than the UK workforce as a whole over this period.

Workforce share and its growth

Table 5.3.2 presents the evolution of the creative economy in terms of its contribution to the overall workforce.

TABLE 5.3.2 WORKFORCE SHARES, 2011-2013

	Specialist	Non-specialist	Creative Industries	Embedded	Creative Occupations	Creative Economy
2011	2.7%	2.4%	5.2%	2.9%	5.6%	8.0%
2012	2.9%	2.6%	5.6%	2.9%	5.8%	8.5%
2013	2.9%	2.7%	5.6%	3.0%	5.9%	8.5%
Average	**2.9%**	**2.6%**	**5.4%**	**2.9%**	**5.8%**	**8.3%**

KEY FINDINGS

- Employment in the creative economy grew over three times faster than the workforce as a whole between 2011 and 2013, at 4.3 per cent p.a. on average.
- As a result, the creative economy's contribution to the overall workforce increased from 8.0 per cent to 8.5 per cent between 2011 and 2013.

5.4 REGIONAL GEOGRAPHY OF THE UK'S CREATIVE ECONOMY

Table 5.4.1 presents the size of the different components of the creative economy and the workforce as a whole for the UK's regions and Devolved National Administrations (DNAs),[56] reported as the average of 2011 to 2013 to minimise fluctuations related to sample survey biases. These appear in descending order of the size of their creative economies' employment.

TABLE 5.4.1 CREATIVE ECONOMY EMPLOYMENT IN THE REGIONS AND DNAs, UK, AVERAGE 2011-2013

	Specialist	Non-specialist	Creative Industries	Embedded	Creative Occupations	Creative Economy	Workforce
London	261,000	183,000	444,000	168,000	429,000	613,000	3,945,000
South East	148,000	155,000	303,000	164,000	312,000	467,000	4,374,000
Eastern	84,000	81,000	165,000	86,000	170,000	251,000	2,980,000
South West	69,000	59,000	128,000	73,000	143,000	201,000	2,645,000
North West	62,000	64,000	126,000	74,000	135,000	199,000	3,217,000
Scotland	53,000	51,000	105,000	59,000	113,000	164,000	2,554,000
West Midlands	41,000	49,000	91,000	67,000	108,000	157,000	2,481,000
Yorkshire and Humberside	49,000	41,000	90,000	60,000	109,000	150,000	2,511,000
East Midlands	38,000	47,000	85,000	59,000	97,000	144,000	2,187,000
Wales	25,000	23,000	48,000	29,000	54,000	78,000	1,369,000
North East	18,000	18,000	36,000	21,000	39,000	57,000	1,168,000
Northern Ireland	17,000	10,000	27,000	16,000	33,000	43,000	814,000
UK	**866,000**	**782,000**	**1,648,000**	**876,000**	**1,742,000**	**2,524,000**	**30,243,000**

Note: There are a small number of people in the survey sample that count towards the UK totals in this and subsequent tables, but are not allocated to any region.

Figure 5.4.1 shows the regional/DNA distribution of the creative economy workforce, London and the South East account for a very significant share of creative economy employment, as noted previously in Freeman (2010). Together London and the South East of England region account for 43 per cent of employment in the creative economy in the UK.

FIGURE 5.4.1 THE REGIONAL/DNA DISTRIBUTION OF THE CREATIVE ECONOMY WORKFORCE, UK, AVERAGE, 2011-2013

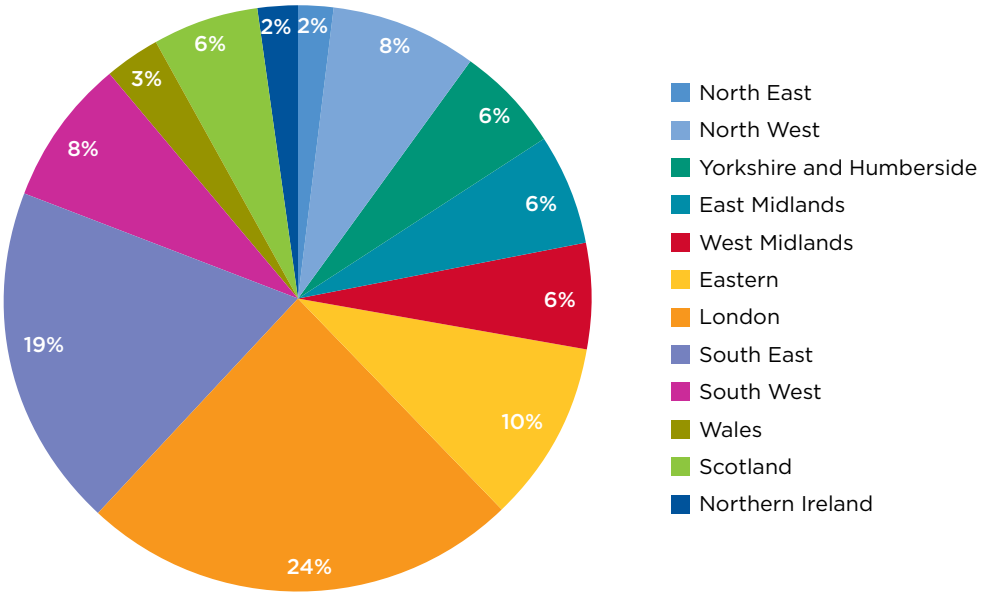


Table 5.4.2 presents the different components of the creative economy as shares of the regional workforce. The particular importance of the creative economy to London's economy is apparent in this table. The creative economy's share of London's workforce – at 15.5 per cent – is almost double the national figure. Creative occupations in creative industries are also a higher proportion of the creative economy than in other regions, at 43 per cent (=6.6/15.5), a point consistent with earlier findings.[57]

TABLE 5.4.2 WORKFORCE SHARES OF THE COMPONENTS OF THE CREATIVE

	Specialist	Non-specialist	Creative Industries	Embedded	Creative Occupations	Creative Economy
London	6.6%	4.6%	11.3%	4.3%	10.9%	15.5%
South East	3.4%	3.5%	6.9%	3.8%	7.1%	10.7%
Eastern	2.8%	2.7%	5.5%	2.9%	5.7%	8.4%
South West	2.6%	2.2%	4.8%	2.8%	5.4%	7.6%
East Midlands	1.8%	2.1%	3.9%	2.7%	4.5%	6.6%

Scotland	2.1%	2.0%	4.1%	2.3%	4.4%	6.4%
West Midlands	1.7%	2.0%	3.7%	2.7%	4.4%	6.3%
North West	1.9%	2.0%	3.9%	2.3%	4.2%	6.2%
Yorkshire and Humberside	1.9%	1.6%	3.6%	2.4%	4.3%	6.0%
Wales	1.8%	1.7%	3.5%	2.1%	4.0%	5.7%
Northern Ireland	2.1%	1.2%	3.3%	2.0%	4.1%	5.3%
North East	1.5%	1.5%	3.1%	1.8%	3.4%	4.9%
UK	**2.9%**	**2.6%**	**5.4%**	**2.9%**	**5.8%**	**8.3%**

WORKFORCE BY REGION AND DNAs, UK, AVERAGE 2011-2013

Creative workforce shares may be helpfully analysed using location quotients (LQs). These are defined for the creative economy as the creative workforce share of the region (CE_R/WF_R) divided by the creative workforce share of the national workforce (CE_{UK}/WF_{UK}). As such, they allow us to compare how the importance of employment in particular occupations or industries in a region compares with their importance in the country as a whole. An LQ>1 means the regional workforce is more concentrated than the national one, an LQ=1 means that the concentration is the same and an LQ<1 means that it is less concentrated.

The table of location quotients is calculated by simply dividing every regional row of Table 5.4.2, by the corresponding UK row yielding Table 5.4.3.

TABLE 5.4.3 LOCATION QUOTIENTS OF THE CREATIVE ECONOMY AND ITS COMPONENTS, UK REGIONS AND DNAs, AVERAGE 2011 -2013

Location quotient	Specialist	Non-specialist	Creative Industries	Embedded	Creative Occupations	Creative Economy
London	2.31	1.80	2.07	1.47	1.89	1.86
South East	1.18	1.37	1.27	1.29	1.24	1.28
Eastern	0.98	1.05	1.02	0.99	0.99	1.01
South West	0.92	0.86	0.89	0.96	0.94	0.91
East Midlands	0.61	0.83	0.72	0.93	0.77	0.79
Scotland	0.73	0.77	0.75	0.80	0.76	0.77
West Midlands	0.58	0.77	0.67	0.93	0.76	0.76
North West	0.67	0.77	0.72	0.79	0.73	0.74

Yorkshire and Humberside	0.68	0.64	0.66	0.82	0.75	0.72
Wales	0.64	0.66	0.65	0.74	0.69	0.68
Northern Ireland	0.73	0.48	0.61	0.68	0.70	0.63
North East	0.54	0.60	0.56	0.63	0.58	0.59

A great deal has been written about the agglomeration economies enjoyed by London's creative industries (e.g. Freeman 2009, Pratt 2011, Chapain et al., 2010). Cities provide the combination of resources that allow the many different types of creative worker to interact with each other, on a face-to-face basis. This helps to explain why many creative industries form very tight clusters.[58] However, agglomeration alone is unlikely to explain why London is so distinctive in comparison to other large connected metropolitan agglomerations such as the West Midlands or the North West of England, each of which have more than half the population of London.[59]

Rather, London's great attractiveness as a location for creative businesses is also likely to be due to its role as a 'world city'. The connectivity of world cities makes them, for example, the preferred location for gateway institutions that manage pre-market selection (that is, where creative content is selected by, for example, galleries, film producers, and publishers before going to market). In this way, world cities are the site of 'world galleries', festivals, and so on, which are not to be found in equivalent density in other large metropolitan areas which, on grounds of size alone, one might expect to be a focus of attraction for creative producers and their employees.[60]

Agglomeration alone is also insufficient to explain the unevenness in the distribution of the creative economy and its components outside the Greater South East of England (the area consisting of London, the South East and the East of England regions), since all the regions listed contain quite major and connected urban concentrations. What explains, for example, the fact that the North East has a creative economy location quotient of only 0.59? We are examining the extent of agglomeration economies and spillovers more widely in new research.

KEY FINDINGS

- London and the South East account for a very significant share of creative employment, together accounting for 43 per cent of employment in the creative economy in the UK.
- Creative specialists (as opposed to support workers in the creative industries) play a particularly prominent role in London's creative economy, accounting for 43 per cent of the creative economy, higher than in any other region.
- The creative economy is especially important to London's economy. It accounts for 15.5 per cent of all jobs, compared with 10.7 per cent in the South East and an 8.3 per cent share of the UK workforce as a whole. Previous research suggests this is likely explained by strong agglomeration effects associated with London's size, but also its status as a world city.

Where is the creative economy growing?

Table 5.4.4 shows the annual average growth rates for employment in different components of the creative economy from 2011 to 2013, by region and DNA in the UK.

TABLE 5.4.4 PERCENTAGE ANNUAL EMPLOYMENT GROWTH IN THE CREATIVE ECONOMY IN THE MAJOR REGIONS/DNAs, UK, AVERAGE 2011-2013

	Specialist	Non-Specialist	Embedded	Creative Occupations	Creative Industries	Creative Economy	Workforce
Eastern	9.0%	14.0%	5.6%	7.2%	11.5%	9.3%	1.5%
West Midlands	12.1%	11.5%	3.9%	6.8%	11.8%	8.2%	1.8%
North East	6.5%	13.3%	-0.9%	2.4%	9.8%	5.6%	0.8%
Yorkshire and Humberside	15.4%	3.5%	-0.5%	6.3%	9.7%	5.5%	1.6%
South East	5.6%	6.1%	2.3%	3.8%	5.8%	4.5%	1.5%
East Midlands	17.8%	8.5%	-5.1%	2.6%	12.4%	4.5%	0.5%
South West	9.6%	1.8%	0.6%	4.8%	5.9%	3.9%	0.9%
North West	4.0%	1.8%	5.7%	4.9%	2.8%	3.9%	0.3%
Wales	8.9%	5.7%	-2.8%	2.4%	7.4%	3.3%	1.7%
Northern Ireland	-10.0%	1.0%	23.5%	3.7%	-6.2%	3.1%	0.3%
London	-1.9%	5.7%	8.2%	1.8%	1.0%	2.9%	2.0%
Scotland	-0.6%	-1.1%	-1.3%	-1.0%	-0.8%	-1.0%	0.2%
UK	**4.3%**	**5.8%**	**3.0%**	**3.6%**	**5.0%**	**4.3%**	**1.2%**

These tables show that the fastest growing parts of the UK's creative economy over this period have been the East of England, the West Midlands and the North East of England. With the exception of Scotland, which has experienced a negative growth rate on average in its creative economy over this period, London has been the slowest growing region.

KEY FINDINGS

- Since 2011 London's creative economy workforce has been growing more slowly than most of the rest of the UK. The creative economy has been growing particularly rapidly in the East of England, West Midlands and North East of England.

Having analysed the size, growth and regional geography of the creative economy we present equivalent results for the high-tech economy.

6 THE HIGH-TECH ECONOMY

In this section, we define the high-tech economy in terms of a set of high-tech industries and STEM occupations embedded in the wider economy, and from this derive estimates of its size, growth since 2011 and regional geography.

6.1 DEFINING THE HIGH-TECH ECONOMY

In our approach we propose a baseline classification for STEM occupations based on a review of pre-existing treatments of STEM work. We compare the industries selected as STEM-intensive – or 'high-tech' – at different intensity thresholds with a classification of high-tech industries produced by the EU's statistical agency, Eurostat, based on R&D and knowledge intensity, and use this analysis to derive a classification that we use in this report.

6.1.1 Definition of STEM occupations in the literature

As discussed in Section 3, the concept of STEM has its origins in concerns that the qualifications of the workforce, and in particular, the supply of STEM-qualified graduates, do not match the needs of industry. There have been perennial complaints that the UK economy is not producing enough high-quality STEM graduates. There has, however, been remarkably little attempt to build a consensus on what constitutes a STEM occupation.

For this report we reviewed the detailed STEM occupation classifications employed in the studies listed in Table 6.1.1.1.

TABLE 6.1.1.1 **LIST OF AUTHORITIES FOR STEM OCCUPATIONAL CLASSIFICATIONS CONSIDERED IN THIS REPORT**

Abbreviation	Source	Origin	Brief description
Hecker	Hecker (2005),[61] Bureau of Labor Statistics (BLS)	US	Article for Monthly Labor Review on the classification of the high-tech economy, based on the intensity of STEM occupations as selected by the authors.
DIUS	DIUS (2009)[62]	UK	Report on demand for STEM skills by the UK Department for Innovation, Universities and Skills (DIUS).
BLS	BLS (2010)[63]	US	Recommendations by the Bureau of Labor Statistics (BLS) to the Office of Management and Budget (OMB) giving a standard set of domains and types of STEM labour for interagency use in US government.

RAE	Greenwood et al., (2011)[64]	UK	Report prepared by the Institute of Education on the market value of STEM occupations produced for the Royal Academy of Engineering.
Brookings	Rothwell (2013)[65]	US	Independent report on 'the hidden STEM economy' prepared for the Brookings Institution.

Note: In cases where the classifications are given in terms of the North American codes of the NAICS system, we have converted them to the nearest SOC2010 equivalents.[66]

According to the broadest classification we consider, that of the BLS (2010), it turns out that there are over four million STEM jobs in the UK. The narrowest, derived from Hecker, yields less than half this number, as shown in Table 6.1.1.2. The full list of occupations treated as STEM according to different accounts is given in Appendix 1, Table A1-4.

TABLE 6.1.1.2 OCCUPATIONAL EMPLOYMENT TOTALS (1000s) ACCORDING TO DIFFERENT DEFINITIONS OF STEM OCCUPATIONS, WORKFORCE JOBS, UK, AVERAGE 2011-2013

	BLS	Brookings	RAE	DIUS	Hecker (BLS)	Workforce
STEM Employment	4,552,000	4,436,000	3,030,000	2,474,000	2,088,000	30,243,000

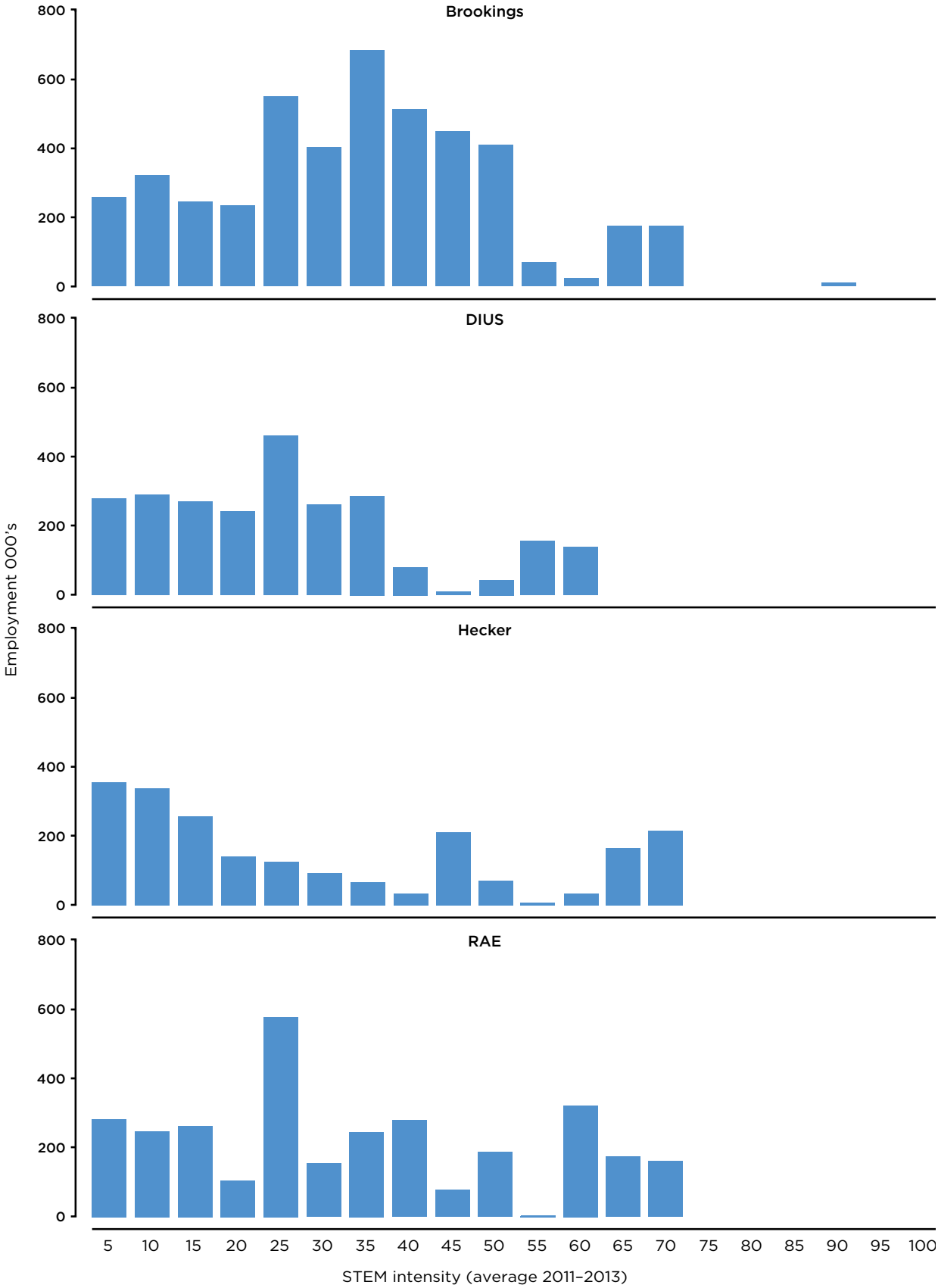
This table confirms that the considerable variation in how STEM occupations are classified has a significant effect on the number of jobs that are estimated to be in STEM occupations.

In the next section we undertake an analysis of STEM intensity according to these different STEM classifications, to determine whether a distinct set of high-tech industries can be identified that have an especially high percentage of STEM workers in their workforces.

6.1.2 How the distribution of STEM intensity is affected by different definitions of STEM occupations

To examine STEM intensity as a means of selecting a group of high-tech industries, we first construct the frequency distributions shown in Figure 6.1.2.1 for the set of STEM classifications given in Table 6.1.1.2. Each chart shows the distribution of STEM intensity for different classifications.

FIGURE 6.1.2.1 FREQUENCY DISTRIBUTION OF EMPLOYMENT BY STEM INTENSITY, ACCORDING TO VARIOUS CLASSIFICATIONS OF STEM OCCUPATIONS (AVERAGE OF 2011-2013)



Note: The tables underlying these charts may be found in Appendix 3

It is apparent from the chart that regardless of which of the four classifications of STEM occupations is used there is no one distinct set of industries where these occupations are uniquely unusually concentrated. This means that, unlike the case of creative intensity, we cannot use STEM intensity on its own with these definitions to identify the high-tech industries – that is, the employment of STEM occupations in the UK economy is much less specialised than is the case with creative workers.

How can we proceed? The distributions of STEM intensity above suggest that the discriminatory power of STEM intensity is perhaps greater for the narrower classifications of Hecker and RAE.

A theoretical justification for a narrower classification would be that STEM occupations constitute, in some way, one of the means by which scientific 'knowledge' finds its way into the processes and outputs of an enterprise or activity. Formally, we might think of them as:

> *roles explicitly involved in the development of new knowledge from the domains of science and engineering or in the rigorous application of existing science and engineering knowledge and processes to new circumstances.*

The application of existing science and engineering knowledge and processes is necessary, but not sufficient according to this view, for an occupation to be a STEM occupation – though we accept this is a question of judgment. Routine application of engineering processes to standardised product or process should not be sufficient to be considered a STEM occupation. For this reason, occupations with high administrative or manual components – such as laboratory technicians or air-conditioning technicians are outside the scope of STEM occupations in our treatment.

Similar to creative occupations, STEM occupations involve weighing up alternatives and making decisions and choices that can significantly alter the outcome of the work. The routine following of a STEM-developed process, such as on a production line or in the installation of network cabling in an office does not in this conception make the role "STEM". For this reason, we do not classify as STEM many technician occupations, even when they are in a STEM field. Implementing someone else's STEM decision or checklist does not in itself, we argue, make the occupation itself STEM.

How does this view of STEM occupations compare with our treatment of creative work? We think STEM and creative occupations differ in at least two ways:

- **Uniqueness** Creative occupations are focussed on adding value through uniqueness – the market rewards those creators who can tap into the wants and needs of users, including businesses, with a product or service that is unique, even if only for a short time. Success in the fields of science and engineering knowledge is also initially measured through the novelty of the contribution, but subsequent to this the replicability of a result must always be established.
- **Domain** One of the criteria for creative occupations is that the output of the occupation is typically considered to be a creative service or product whatever the industry setting. In the case of STEM, we suggest, the range of output domains is much broader – from construction (material sciences), manufacturing (robotics), to agriculture (pesticides research and chemical engineering) and financial services (big data modelling).

By reviewing the set of STEM classifications used to generate the distributions in Figure 6.1.1 and applying the principles above, we propose a pragmatic set of STEM occupations, shown in Table 6.1.2.1 (described as 'baseline' to acknowledge the reality that classifying individual occupations as STEM or not STEM – or indeed creative or non-creative – is inherently fuzzy).

TABLE 6.1.2.1 **BASELINE STEM OCCUPATIONS**

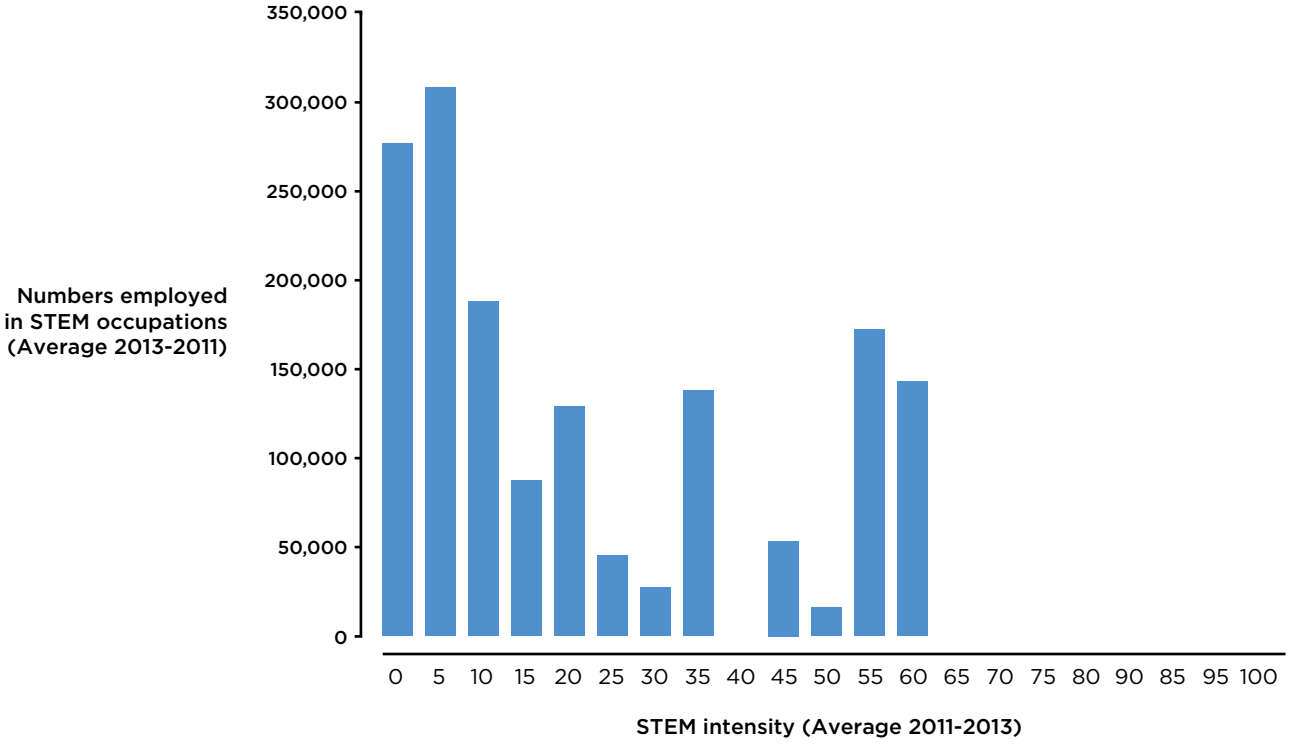
Subgroup	Code	Description
Engineering		
	2121	Civil engineers
	2122	Mechanical engineers
	2123	Electrical engineers
	2124	Electronics engineers
	2126	Design and Development engineers
	2127	Production and process engineers
	2129	Engineering professionals n.e.c.
	2434	Chartered surveyors
IT		
	1136	Information technology and telecommunications directors
	2133	IT specialist managers
	2135	IT business analysts, architects and systems designers
	2136	Programmers and software development professionals
	2137	Web design and development professionals
	2139	Information technology and telecommunications professionals
Science		
	2111	Chemical scientists
	2112	Biological scientists and biochemists
	2113	Physical scientists
	2119	Natural and social science professionals n.e.c..
	2141	Conservation professionals
	2142	Environment professionals
	2150	Research and development managers
	2425	Actuaries, economists and statisticians (includes mathematicians)

This selection is very close in spirit to that of Hecker (2005), with the major difference that we exclude a number of technician roles that Hecker includes.

6.1.3 Determining the STEM intensity threshold and identifying the high-tech industries

Figure 6.1.3.1 shows the frequency distribution of industry STEM intensities using our baseline STEM occupations. Although not bimodal, it suggests that – when combined with other indicators – STEM intensity is nonetheless a useful statistic for classifying a group of industries as high-tech.

FIGURE 6.1.3.1 **FREQUENCY DISTRIBUTION OF INDUSTRIES BY INTENSITY OF STEM BASELINE EMPLOYMENT, UK, AVERAGE 2011-2013**



To identify these other indicators we begin with an alternative approach to defining the high-tech industries which incorporates criteria that are independent of occupational intensity, or at least are not directly dependent on it.

This is the approach taken by Eurostat, which separately considers high-tech manufacturing and high-tech knowledge-intensive services. The group of industries selected is based on the NACE revision 1 classification, and is given in Table 6.1.3.1 (NACE is the EU's statistical classification of economic activities).[67, 68] The Eurostat high-tech manufacturing classification is a NACE translation of the OECD's classification of high-tech manufacturing.[69]

TABLE 6.1.3.1 HIGH-TECH INDUSTRIES AS DEFINED BY EUROSTAT IN NACE 1.1

High-tech Manufacturing (R&D intensity)	
24.4	Manufacture of pharmaceuticals, medicinal chemicals and botanical
30	Manufacture of office machinery and computers
32	Manufacture of radio, television and communication equipment and apparatus
33	Manufacture of medical, precision and optical instruments, watches and clocks
35.3	Manufacture of aircraft and spacecraft
High-tech Services (knowledge intensity)	
64	Post and telecommunications
72	Computer and related activities
73	Research and development.

Source: Eurostat, Aggregations of manufacturing and services based on NACE Rev 1.1

NACE industry classifications are generally equivalent to the previous version of the UK Standard Industry codes (SIC92 and SIC03), so we translate the NACE codes to these and then map them on to SIC07 classifications.[70]

The following two tables show the industry classifications that are the most appropriate fit to the 2-digit NACE specified above – along with average employment over 2011 to 2013 and the STEM intensity calculated the same period.

TABLE 6.1.3.2 STEM INTENSITY OF HIGH-TECH KNOWLEDGE-INTENSIVE INDUSTRIES (BASED ON EUROSTAT DEFINITION), UK, AVERAGE 2011-2013

Industry classification in SIC07		2-digit NACE 1.1 code	Average Employed	STEM Intensity
9511	Repair of computers and peripheral equipment	72	31,902	32.6%
7220	Research and experimental development on social sciences and humanities	73	11,506	18.6%
7219	Other research and experimental development on natural sciences and engineering	73	83,594	47.9%
7211	Research and experimental development on biotechnology	73	13,020	53.2%
6312	Web portals	72	469	37.5%
6311	Data processing, hosting and related activities	72	15,740	22.0%
6209	Other information technology and computer service activities	72	31,092	45.3%
6202	Computer consultancy activities	72	287,209	59.8%
6190	Other telecommunications activities	64	29,314	23.4%
6130	Satellite telecommunications activities	64	3,596	24.6%
6120	Wireless telecommunications activities	64	84,544	27.4%
6110	Wired telecommunications activities	64	53,024	27.2%
5829	Other software publishing	72	18,988	50.3%
5821	Publishing of computer games	72	2,157	21.1%
5819	Other publishing activities	72	35,858	10.1%
5320	Other postal and courier activities	64	102,141	1.6%
5310	Postal activities under universal service obligation	64	207,279	0.7%
6201	Computer programming activities	72	233,447	60.8%

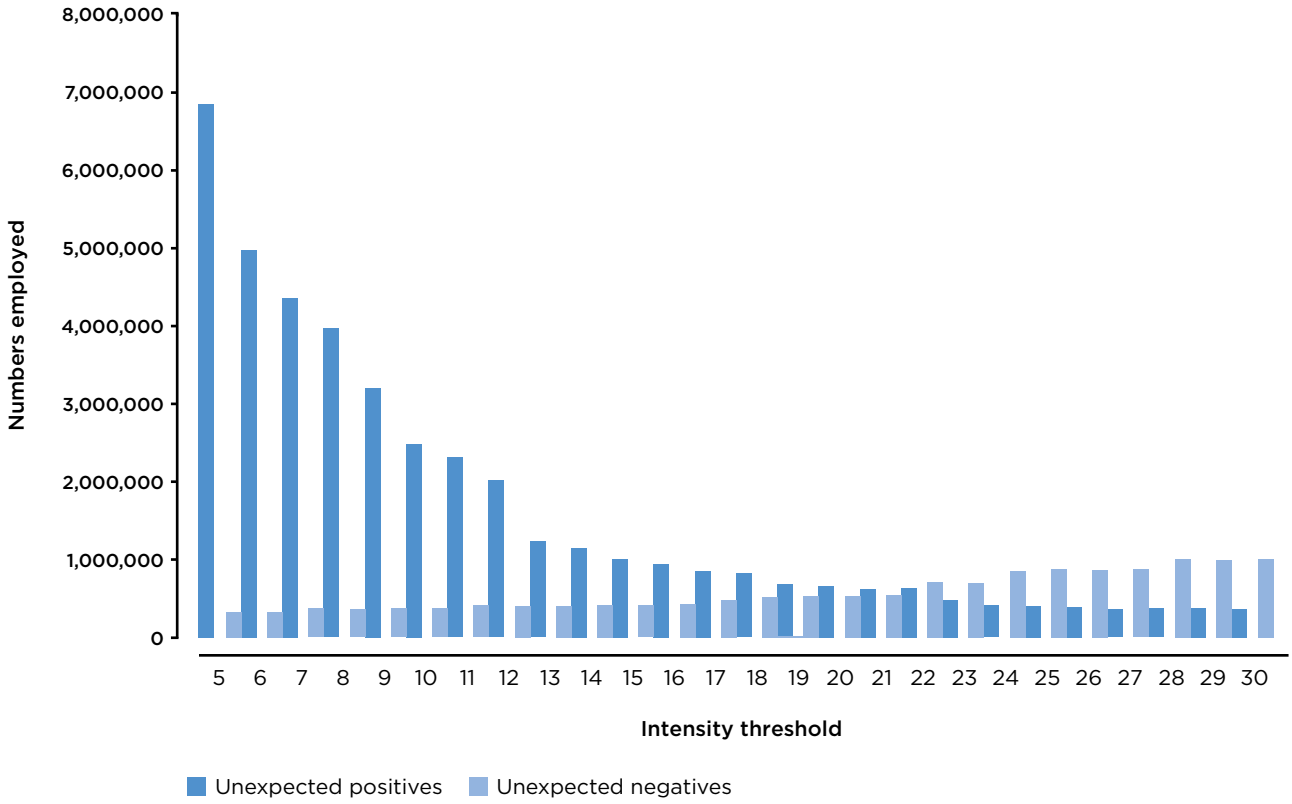
TABLE 6.1.3.3 STEM INTENSITY OF R&D-INTENSIVE INDUSTRIES (BASED ON EUROSTAT DEFINITION), UK, AVERAGE 2011-2013

Industry classification in SIC07		2-digit NACE 1.1 code	Average Employed	STEM Intensity
2620	Manufacture of computers and peripheral equipment	24	47,313	34.8%
2660	Manufacture of irradiation, electromedical and electrotherapeutic equipment	32	11,082	20.9%
2630	Manufacture of communication equipment	32	21,752	21.2%
3030	Manufacture of air and spacecraft and related machinery	35	126,816	23.1%
2110	Manufacture of basic pharmaceutical products	24	44,198	21.4%
2120	Manufacture of pharmaceutical preparations	24	65,787	21.0%
2651	Manufacture of instruments and appliances for measuring, testing and navigation	32	44,428	16.4%
2652	Manufacture of watches and clocks	32	3,181	17.8%
2670	Manufacture of optical instruments and photographic equipment	33	8,205	24.3%
2611	Manufacture of electronic components	24	39,584	17.8%
2640	Manufacture of consumer electronics	32	7,652	15.1%
3316	Repair and maintenance of aircraft and spacecraft	35	24,985	15.2%
3250	Manufacture of medical and dental instruments and supplies	35	51,728	6.8%
2612	Manufacture of loaded electronic boards	24	4,324	2.1%

As shown in Tables 6.1.3.2 and 6.1.3.3, a significant proportion – though by no means all – of the industries classified as high-tech in the Eurostat classification have high proportions of STEM employment relative to industries as a whole. In other words, STEM intensity appears to work relatively well in selecting those industries that are, on the grounds of their science and technology R&D spend or investment in other forms of knowledge, considered to be high-tech according to the Eurostat classification.

However, STEM intensity also selects a number of industries that are less R&D or knowledge-intensive. One way to view the different options is to consider the effect of varying the intensity threshold on the selection of STEM-intensive (high-tech) industries. This is shown in Figure 6.1.3.2. We use the term 'unanticipated negatives' to denote those industries that are identified as high-tech under the Eurostat classification but have a STEM intensity below the threshold STEM intensity, so would not be classified as high-tech using that threshold. 'Unanticipated positives' denotes those industries that are identified as high-tech as their STEM intensity is greater than the threshold, but are not classified as high-tech according to the Eurostat classification.

FIGURE 6.1.3.2 SCENARIOS: UNANTICIPATED NEGATIVES AND UNANTICIPATED POSITIVES FOR DIFFERENT STEM THRESHOLDS, UK, AVERAGE 2011-2013



We adopt the following pragmatic procedure for selecting the threshold where we trade off the objective of minimising employment in the group of 'unanticipated positives' with the aim of capturing as many of the Eurostat high-tech industries as possible.

From Figure 6.1.3.2, it can be seen that as the STEM intensity threshold increases (i.e. the high-tech industry definition becomes more restrictive) the absolute number of people employed in industries that would be counted as high-tech under this definition (but which are not high-tech in the Eurostat definition) starts to fall off in discontinuous jumps until around the 15 per cent level where the effect of a higher rate of STEM intensity becomes more gradual, i.e. from this point onwards there are a set of smaller industries with STEM intensities clustered in the 15 per cent plus range.

If a lower STEM threshold of, say, 10 per cent was therefore adopted, we would be including significant numbers of jobs (over two million) in industries that are not considered as high-tech by Eurostat.

A 15 per cent threshold – as can be seen from Table 6.1.3.2 and 6.1.3.3 – would also mean that all but five of the industries in the Eurostat classification would be included (in contrast, a further six industries would drop out if a 20 per cent threshold intensity was instead used).[71] On this basis, we adopt a threshold of 15 per cent as the intensity threshold for our baseline high-tech industry classification.

As with the treatment of creative industries (and described in detail in *Dynamic Mapping*), following the application of the threshold intensity we remove those industry codes for which the APS sample size is too small to be statistically reliable (a threshold of 4,000 was used for this). This results in a baseline high-tech industrial classification, shown in the Table 6.1.3.4 below.

TABLE 6.1.3.4 **HIGH-TECH INDUSTRIES (EMPLOYMENT AND STEM INTENSITY)**

SIC07		Average intensity percentage (2011-2013)	Average employment (2011-2013)
610	Extraction of crude petroleum	26.73	16,820
910	Support activities for petroleum and natural gas extraction	22.99	62,370
1820	Reproduction of recorded media	22.33	7,317
1920	Manufacture of refined petroleum products	19.79	29,777
2013	Manufacture of other inorganic basic chemicals	17.59	15,517
2059	Manufacture of other chemical products n.e.c.	17.29	8,797
2110	Manufacture of basic pharmaceutical products	21.41	44,198
2120	Manufacture of pharmaceutical preparations	21.04	65,787
2452	Casting of steel	21.51	5,210
2611	Manufacture of electronic components	17.85	39,584
2620	Manufacture of computers and peripheral equipment	34.83	47,313
2630	Manufacture of communication equipment	21.16	21,752
2640	Manufacture of consumer electronics	15.08	7,652
2651	Manufacture of instruments and appliances for measuring, testing and navigation	16.37	44,428
2660	Manufacture of irradiation, electromedical and electrotherapeutic equipment	20.89	11,082
2670	Manufacture of optical instruments and photographic equipment	24.29	8,205
2752	Manufacture of non-electric domestic appliances	22.49	4,924
2811	Manufacture of engines and turbines, except aircraft, vehicle and cycle engines	15.14	28,511
2894	Manufacture of machinery for textile, apparel and leather production	15.07	5,073
3030	Manufacture of air and spacecraft and related machinery	23.10	126,816

3316	Repair and maintenance of aircraft and spacecraft	15.23	24,985
3511	Production of electricity	22.03	67,345
4221	Construction of utility projects for fluids	16.73	16,540
4222	Construction of utility projects for electricity and telecommunications	16.41	4299
4299	Construction of other civil engineering projects n.e.c.	18.74	146,532
4920	Freight rail transport	15.45	7,558
4950	Transport via pipeline	19.67	5,738
5829	Other software publishing	50.35	18,988
6110	Wired telecommunications activities	27.20	53,024
6120	Wireless telecommunications activities	27.36	84,544
6190	Other telecommunications activities	23.43	29,314
6201	Computer programming activities	60.79	233,447
6202	Computer consultancy activities	59.85	287,209
6203	Computer facilities management activities	37.00	9,140
6209	Other information technology and computer service activities	45.31	31,092
6311	Data processing, hosting and related activities	22.00	15,740
6520	Reinsurance	15.49	13,170
6629	Other activities auxiliary to insurance and pension funding	25.79	11,966
7112	Engineering activities and related technical consultancy	37.61	354,048
7120	Technical testing and analysis	16.96	48,399
7211	Research and experimental development on biotechnology	53.24	13,020
7219	Other research and experimental development on natural sciences and engineering	47.91	83,594
7220	Research and experimental development on social sciences and humanities	18.61	11,506
7490	Other professional, scientific and technical activities n.e.c.	23.85	73,316
9104	Botanical and zoological gardens and nature reserve activities	20.11	12,387
9511	Repair of computers and peripheral equipment	32.63	31,902
9512	Repair of communication equipment	16.09	7,520

Having defined the UK's high-tech economy in terms of a given set of occupations (Table 6.1.2.1) and industries (Table 6.1.3.4), we can quantify its size, and growth and describe its regional geography.

6.2 THE SIZE OF THE HIGH-TECH ECONOMY

The preceding analysis suggests that whilst there are essential features of the high-tech economy that differ from the creative economy – in particular, that STEM workers have a less pronounced tendency to be employed in a specialised set of industries – there is nonetheless a strong analogy, because STEM occupations play a distinctive role in the production process.

The overall numbers of high-tech jobs in the UK are given in Table 6.2.1. The table shows that the UK's high-tech economy accounted for 3.2 million jobs in 2013, of which 2.4 million were in the high-tech industries. Around 50 per cent of STEM jobs were outside the high-tech industries in the wider high-tech economy, a strikingly similar degree of embeddedness to creative jobs.

TABLE 6.2.1 THE HIGH-TECH ECONOMY OF THE UK, 2011-2013

	STEM Specialist	High-tech Non-specialist	High-tech Industries	Embedded STEM	STEM Occupations	High-tech Economy
2011	785,000	1,522,000	2,307,000	750,000	1,535,000	3,057,000
2012	806,000	1,501,000	2,307,000	790,000	1,596,000	3,097,000
2013	825,000	1,552,000	2,377,000	806,000	1,631,000	3,182,000
Average	805,000	1,525,000	2,330,000	782,000	1,587,000	3,112,000
Share of workforce	2.7%	5.0%	7.7%	2.6%	5.2%	10.3%
Share of High-tech Economy	25.9%	49.0%	74.9%	25.1%	51.0%	100.0%

This, like the creative economy, can be displayed in the same trident format as Table 5.2.2, and is given in Table 6.2.2.

TABLE 6.2.2 **HIGH-TECH TRIDENT AVERAGE 2011-2013**

	High-tech Industries	Non- High-tech Industries	All Industries
STEM Occupations	Specialists 805,000	Embedded 782,000	STEM occupations 1,587,000
Non-STEM Occupations	Non-Specialists 1,525,000	Non-STEM 27,131,000	Non-STEM occupations 28,656,000
All Occupations	Working in the High Tech Industries 2,330,000	Working outside the High Tech industries 27,913,000	Workforce 30,243,000

KEY FINDINGS

- There were 3.2 million jobs in the UK's high-tech economy in 2013 (around 10 per cent of the workforce). This consists of 2.4 million jobs in high-tech industries (825,000 of which were in STEM occupations and 1.6 million in other roles) and 806,000 jobs in STEM occupations outside of the high-tech industries.
- The proportion of STEM jobs outside high-tech industries, at around half, is approximately the same as for creative jobs outside creative industries.

6.3 GROWTH OF THE HIGH-TECH ECONOMY

Table 6.3.1 shows the growth in employment within the various components of the UK's high-tech economy over time.

TABLE 6.3.1 EMPLOYMENT GROWTH IN THE MAIN HIGH-TECH ECONOMY COMPONENTS (PERCENTAGE CHANGE ON PREVIOUS YEAR)

	STEM Specialist	Non-specialist	High-tech Industries	Embedded STEM	STEM Occupations	High-tech Economy	Workforce
Total employment growth							
2011 to 2012	2.6%	-1.4%	0.0%	5.4%	4.0%	1.3%	0.7%
2012 to 2013	2.4%	3.4%	3.0%	1.9%	2.2%	2.8%	1.6%
Average growth rate	**2.5%**	**1.0%**	**1.5%**	**3.7%**	**3.1%**	**2.1%**	**1.2%**

The table shows that the high-tech economy grew by 2.1 per cent p.a. on average between 2011 and 2013, higher than the average rate of growth of the UK workforce (1.2 per cent p.a.). This growth was driven by STEM jobs (2.5 per cent p.a. in high-tech industries and 3.7 per cent p.a. outside), with growth in non-STEM roles in the high-tech industries being slower at 1 per cent p.a.

KEY FINDINGS

- High-tech industry employment grew on average by 1.5 per cent p.a. over the 2011-2013 period, a little faster than the rate of the workforce (1.2 per cent p.a.), reflecting a faster growth in specialist STEM roles at 2.5 per cent p.a. and a slower growth rate in non-specialist roles (1.0 per cent p.a.).
- Employment of STEM occupations outside the high-tech industries grew on average by 3.7 per cent p.a. over this period.
- As a consequence, the UK's high-tech economy expanded by 2.1 per cent a year on average between 2011 and 2013, higher than the workforce as a whole (but weaker than the 4.3 per cent p.a. growth in the creative economy).

6.4 REGIONAL GEOGRAPHY OF THE UK'S HIGH-TECH ECONOMY

Table 6.4.1 presents the size of the different components of the high-tech economy and the workforce as a whole for the UK's regions and devolved national administrations, reported as the average of 2011 to 2013 to iron out year-on-year fluctuations. These are placed in descending order of the size of their high-tech economies' workforce. Figure 6.4.1 presents these numbers as contributions to the UK's high-tech economy workforce.

TABLE 6.4.1 HIGH-TECH ECONOMY EMPLOYMENT IN THE REGIONS AND DNAs, UK, AVERAGE 2011-2013

Region	STEM Specialist	Non-specialist	High-tech Industries	Embedded STEM	STEM Occupations	High-tech Economy	Workforce
South East	162,000	266,000	429,000	132,000	294,000	560,000	4,374,000
London	122,000	167,000	290,000	129,000	252,000	419,000	3,945,000
Eastern	94,000	154,000	248,000	86,000	180,000	334,000	2,980,000
North West	78,000	168,000	245,000	73,000	150,000	318,000	3,217,000
Scotland	70,000	150,000	220,000	58,000	128,000	278,000	2,554,000
South West	76,000	124,000	200,000	62,000	138,000	262,000	2,645,000
West Midlands	52,000	117,000	169,000	58,000	110,000	226,000	2,481,000
Yorkshire & Humberside	47,000	105,000	152,000	64,000	111,000	216,000	2,511,000
East Midlands	46,000	118,000	164,000	49,000	95,000	213,000	2,187,000
Wales	22,000	67,000	90,000	30,000	52,000	119,000	1,369,000
North East	23,000	59,000	82,000	24,000	47,000	106,000	1,168,000
Northern Ireland	13,000	28,000	42,000	18,000	32,000	60,000	814,000
UK	**805,000**	**1,525,000**	**2,330,000**	**782,000**	**1,587,000**	**3,112,000**	**30,243,000**

Note: There are a small number of people in the survey sample that count towards the UK totals in this and subsequent tables, but are not allocated to any region.

FIGURE 6.4.1 THE REGIONAL/DNA DISTRIBUTION OF THE HIGH-TECH ECONOMY WORKFORCE, UK, AVERAGE, 2011-2013

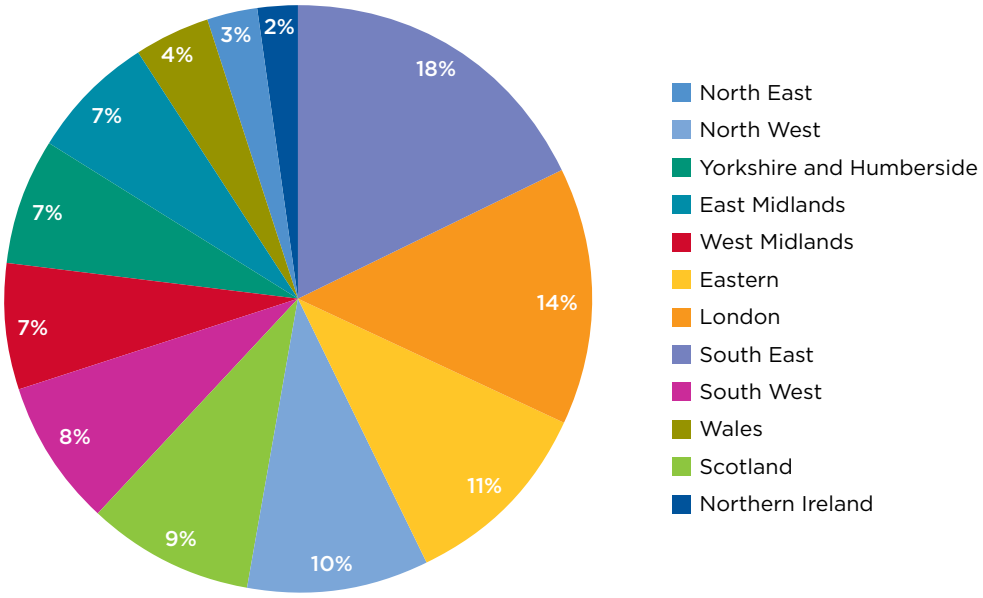


Figure 6.4.1 shows that London and the South East account for a very significant share of UK high-tech employment, though at 31 per cent this is less pronounced than in the case of the creative economy (43 per cent). Table 6.4.2 gives the regional workforce shares for all the components of the UK's high-tech economy. With a workforce share of 10.6 per cent, London has a smaller proportion of high-tech employment than the South East, and has a proportion equivalent to that of Scotland – strikingly different from the creative economy, where the difference between London and Scotland's creative economy workforce share is nine percentage points (Table 5.4.2).

Table 6.4.3 gives the corresponding location quotients (which as before normalise the various workforce shares for the region/DNA's overall share in the UK workforce) and for convenience gives the creative economy equivalents. This confirms the general finding that the distribution of high-tech economy jobs is more even than in the case of the creative economy, with location quotients ranging from 0.72 to 1.24 compared with those for regional creative economy which range from 0.59 to 1.86.

TABLE 6.4.2 GEOGRAPHICAL DISTRIBUTION OF THE COMPONENTS OF THE HIGH-TECH WORKFORCE SHARE BY UK REGIONS AND DNAs, AVERAGE 2011-2013

Region	STEM Specialist	Non-specialist	High-tech Industries	Embedded STEM	STEM Occupations	High-tech Economy
South East	3.7%	6.1%	9.8%	3.0%	6.7%	12.8%
Eastern	3.1%	5.2%	8.3%	2.9%	6.0%	11.2%
Scotland	2.7%	5.9%	8.6%	2.3%	5.0%	10.9%
London	3.1%	4.2%	7.3%	3.3%	6.4%	10.6%
South West	2.9%	4.7%	7.6%	2.3%	5.2%	9.9%
North West	2.4%	5.2%	7.6%	2.3%	4.7%	9.9%
East Midlands	2.1%	5.4%	7.5%	2.2%	4.4%	9.8%
West Midlands	2.1%	4.7%	6.8%	2.3%	4.4%	9.1%
North East	1.9%	5.1%	7.0%	2.1%	4.0%	9.1%
Wales	1.6%	4.9%	6.5%	2.2%	3.8%	8.7%
Yorkshire & Humberside	1.9%	4.2%	6.1%	2.5%	4.4%	8.6%
Northern Ireland	1.6%	3.5%	5.1%	2.3%	3.9%	7.4%
UK	**2.7%**	**5.0%**	**7.7%**	**2.6%**	**5.2%**	**10.3%**

TABLE 6.4.3 LOCATION QUOTIENTS FOR THE HIGH-TECH ECONOMY AND ITS COMPONENTS, UK REGIONS AND DNAs, AVERAGE 2011-2013

Region	STEM Specialist	Non-specialist	High-tech Industries Total	Embedded STEM	STEM Occupations	High-tech Economy	Creative Economy
South East	1.39	1.21	1.27	1.17	1.28	1.24	1.28
Eastern	1.18	1.03	1.08	1.11	1.15	1.09	1.01
Scotland	1.03	1.16	1.12	0.87	0.95	1.06	0.77
London	1.17	0.84	0.95	1.27	1.22	1.03	1.86
South West	1.08	0.93	0.98	0.90	0.99	0.96	0.91
North West	0.90	1.03	0.99	0.87	0.89	0.96	0.74
East Midlands	0.80	1.07	0.98	0.87	0.83	0.95	0.79
West Midlands	0.79	0.93	0.88	0.90	0.84	0.89	0.76
North East	0.73	1.01	0.91	0.80	0.76	0.88	0.59
Wales	0.61	0.98	0.85	0.84	0.72	0.85	0.68
Yorkshire & Humberside	0.71	0.83	0.79	0.98	0.84	0.84	0.72
Northern Ireland	0.62	0.69	0.67	0.87	0.74	0.72	0.63

TABLE 6.4.4 SUMMARY OF CREATIVE AND HIGH-TECH LOCATION QUOTIENTS OF UK REGIONS/DNAs

		Regions/DNAs whose workforce's share of creative economy employment	
		is less than that of the workforce overall (Creative economy LQ < 1)	**is greater than that of the workforce overall** (Creative economy LQ > 1)
Regions/DNAs whose workforce's share of high-tech economy employment:	**is greater than that of the workforce overall** (High-tech economy LQ > 1)	Scotland	London, South East and East of England
	is less than that of the workforce overall (High-tech economy LQ > 1)	South West, North West, East Midlands, North East, West Midlands, Wales, Yorkshire and the Humber	

Table 6.4.4 shows that the UK regions/DNAs with relatively high workforce shares in the high-tech economy also tend to have higher workforce shares in the creative economy (the rank correlation for the LQs is 0.85). This echoes a finding in Chapain et al., (2010) that there are strong patterns of geographical co-location between high-tech and creative firms (such as the co-location of advertising, software, computer games, and electronic publishing with high-tech manufacturing) in the UK. The regions which have LQs above 1 in both the high-tech and creative economies are the three neighbouring regions that constitute the greater South East of England.

KEY FINDINGS

- The South East of England and London account for 31 per cent of employment in the high-tech economy in the UK. However, as a share of the workforce in London, the high-tech economy accounts for fewer jobs than does the creative economy (10.6 per cent of the workforce compared to 15.5 per cent).
- The high-tech economy is in fact an important employer in all the regions and DNAs in the UK, not just the South of England. In other words, the high-tech economy is more evenly distributed compared with the creative economy, even though London, the South East and the East of England are significant regions in both cases.

Where is the high-tech economy growing?

Table 6.4.5 shows the average annual growth rate between 2011 and 2013 in employment across the regions and DNAs for each component of the UK's high-tech economy.

TABLE 6.4.5 ANNUAL GROWTH IN EMPLOYMENT IN THE HIGH-TECH ECONOMY BY REGIONS AND DNAs, AVERAGE 2011-2013

Region	STEM Specialist	Non-specialist	Embedded STEM	STEM Occupations	High-tech Industries	High-tech Economy	Workforce
Scotland	10.7%	3.2%	3.6%	7.4%	5.5%	5.1%	0.2%
Yorkshire & Humberside	6.5%	-0.6%	13.4%	10.3%	1.5%	4.6%	1.6%
London	0.2%	7.3%	5.3%	2.7%	4.2%	4.5%	2.0%
West Midlands	2.9%	5.3%	-0.3%	1.2%	4.6%	3.3%	1.8%
Wales	-3.2%	2.7%	6.4%	2.0%	1.1%	2.4%	1.7%
North East	4.1%	1.3%	2.5%	3.3%	2.1%	2.2%	0.8%
East Midlands	24.7%	-3.4%	-1.2%	9.3%	2.9%	1.9%	0.5%
Eastern	4.9%	-1.0%	2.9%	3.9%	1.1%	1.6%	1.5%
South East	-2.8%	1.9%	4.1%	0.2%	0.1%	1.0%	1.5%
North West	0.6%	-2.5%	8.4%	4.2%	-1.6%	0.5%	0.3%
South West	-0.8%	-0.7%	-2.4%	-1.5%	-0.8%	-1.1%	0.9%
Northern Ireland	0.2%	-9.5%	-5.5%	-3.2%	-6.5%	-6.2%	0.3%
UK Average	**2.5%**	**1.0%**	**3.7%**	**3.1%**	**1.5%**	**2.1%**	**1.2%**

KEY FINDINGS

- The regions with the fastest growing high-tech economy over the 2011-2013 period have (in order) been Scotland, Yorkshire and Humberside, London and the West Midlands.
- The number of STEM jobs embedded in the wider economy fell in Northern Ireland, the South West of England and the East and West Midlands, over the period.

7 THE CREATIVE AND HIGH-TECH ECONOMIES COMPARED

How in an accounting sense do the creative and high-tech economies relate? To what extent do they intersect given the presence of occupational and industrial codes common to both of them? Are there any particular geographical patterns to activities which are both creative and high-tech?

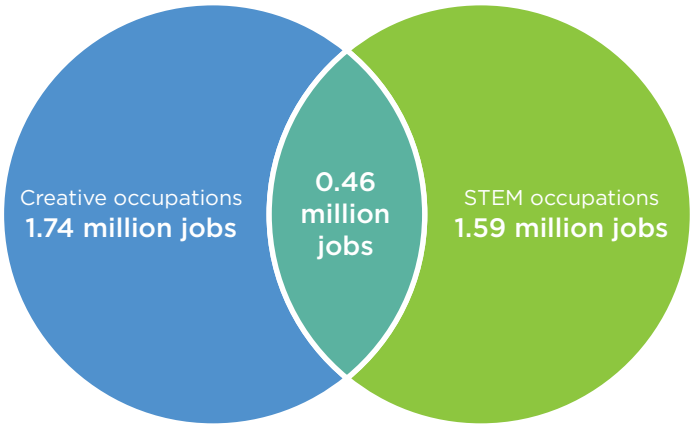
Table A1.3 (Appendix 1), summarises the relationship between creative and STEM occupations in our analysis. Of the 22 STEM and 30 creative occupations, there are four common SOC codes (Information technology and telecommunications directors (1136); IT business analysts, architects and systems designers (2135); Programmers and software development professional (2136), and Web design and development professionals (2137)).

Table A2.3 (Appendix 2) summarises the relationship between the creative and high-tech industries. Three of the 31 creative industry codes are also classified as high-tech in our definition (Other software publishing (5829), Computer programming activities (6201) and Computer consultancy activities (6202)).

The coinciding occupations and industries are all Information and Communication Technologies (ICT) related occupations and industries. Arguably, this reflects the fact that ICTs are an example of what economic historians call a general purpose technology, playing a role analogous to electricity in the late 19th century – transforming the nature of all production in the economy.[74] Instead of just separating out ICT industries, therefore, it makes sense also to acknowledge that both high-tech and creative industries make extended and universal use of ICT (even if that may be in different and distinctive ways).[75]

Figure 7.1 plots the relationship in accounting terms between STEM and creative occupations, as we have classified them, on a Venn diagram. It shows that there were around 0.46 million jobs that were both STEM and creative (average 2011-2013). Although these are ICT jobs it should be noted that this number is significantly smaller than broader treatments of ICT work e.g., that used by e-Skills UK in its 2013 statistical release on the UK's Information Economy which estimates that there are over one million people employed in ICT occupations in the UK.[76]

FIGURE 7.1 **EMPLOYMENT OF CREATIVE AND STEM OCCUPATIONS, UK, AVERAGE 2011-2013**



Tables 7.1 and 7.2 give the UK breakdown by region/DNA of the number and workforce share of jobs in creative and STEM occupations.

TABLE 7.1 NUMBERS EMPLOYED IN CREATIVE AND STEM OCCUPATIONS BY UK REGIONS AND DNAs, AVERAGE 2011-2013

Region	Both Creative and STEM Occupations	Only Creative	Only STEM	Neither Creative Nor STEM	Workforce	CO+STEM	Creative Occupations Total	STEM Occupations Total
South East	95,000	217,000	199,000	3,863,000	4,374,000	511,000	312,000	294,000
London	91,000	338,000	161,000	3,355,000	3,945,000	590,000	429,000	252,000
Eastern	51,000	119,000	129,000	2,681,000	2,980,000	299,000	170,000	180,000
South West	39,000	103,000	98,000	2,403,000	2,645,000	241,000	143,000	138,000
North West	38,000	97,000	112,000	2,970,000	3,217,000	247,000	135,000	150,000
Yorkshire & Humberside	31,000	78,000	80,000	2,322,000	2,511,000	189,000	109,000	111,000
Scotland	30,000	83,000	98,000	2,343,000	2,554,000	211,000	113,000	128,000
West Midlands	29,000	79,000	81,000	2,292,000	2,481,000	189,000	108,000	110,000
East Midlands	24,000	73,000	71,000	2,018,000	2,187,000	169,000	97,000	95,000
Wales	14,000	40,000	38,000	1,277,000	1,369,000	92,000	54,000	52,000
North East	11,000	28,000	36,000	1,093,000	1,168,000	75,000	39,000	47,000
Northern Ireland	9,000	24,000	23,000	758,000	814,000	56,000	33,000	32,000
UK	**462,000**	**1,281,000**	**1,126,000**	**27,375,000**	**30,243,000**	**2,868,000**	**1,742,000**	**1,587,000**

Note: There are a small number of people in the survey sample that count towards the UK totals in this and subsequent tables, but are not allocated to any region.

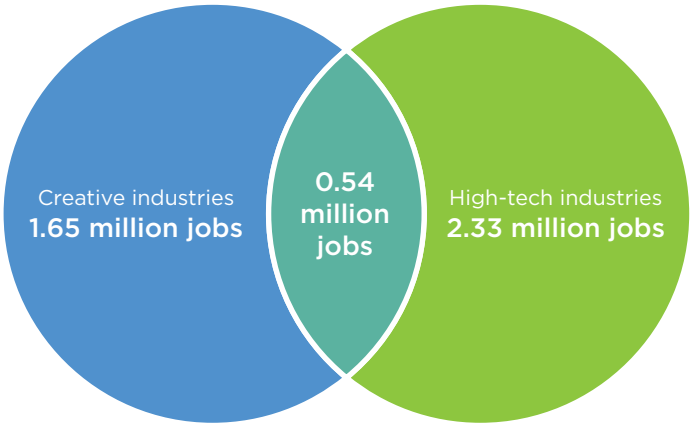
TABLE 7.2 PERCENTAGE OF WORKFORCE EMPLOYED WITHIN CREATIVE AND STEM OCCUPATIONS, BY REGION AND DNAs, AVERAGE 2011-2013

Region	Both Creative and STEM Occupations	Only Creative	Only STEM	CO+STEM	Creative Occupations Total	STEM Occupations Total
London	2.3%	8.6%	4.1%	14.7%	10.9%	6.4%
South East	2.1%	5.0%	4.6%	11.5%	7.1%	6.7%
Eastern	1.7%	4.0%	4.4%	9.9%	5.7%	6.0%
South West	1.5%	3.9%	3.7%	9.0%	5.4%	5.2%
North West	1.2%	3.0%	3.5%	7.6%	4.2%	4.7%
Yorkshire & Humberside	1.2%	3.1%	3.2%	7.4%	4.3%	4.4%
Scotland	1.2%	3.3%	3.8%	8.2%	4.4%	5.0%
East Midlands	1.1%	3.4%	3.3%	7.7%	4.5%	4.4%
West Midlands	1.1%	3.2%	3.3%	7.5%	4.4%	4.4%
Northern Ireland	1.1%	3.0%	2.8%	6.8%	4.1%	3.9%
Wales	1.0%	3.0%	2.8%	6.6%	4.0%	3.8%
North East	0.9%	2.4%	3.1%	6.4%	3.4%	4.0%
UK	1.5%	4.3%	3.7%	9.4%	5.8%	5.2%

Jobs that are both creative and STEM are particularly prevalent in London and the South East, accounting for 2.3 per cent and 2.1 per cent of their overall workforces, respectively. Along with the East of England, these are the only regions where the proportion of employment is higher than the UK level of 1.5 per cent.

As shown in Figure 7.2 the number of jobs in industries that are both creative and high-tech is around 0.54 million. These are jobs in the three ICT-related industries mentioned earlier.

FIGURE 7.2 EMPLOYMENT IN CREATIVE AND HIGH-TECH INDUSTRIES, AVERAGE 2011-2013



Tables 7.3 and 7.4 below give the UK breakdown by region/DNA of the number and workforce share of jobs in creative and high–tech industries.

TABLE 7.3 NUMBER OF EMPLOYEES IN CREATIVE AND HIGH-TECH INDUSTRIES BY UK REGIONS AND DNAs, AVERAGE 2011-2013

Region	High-tech and Creative Industries	Only Creative	Only High-tech	Neither Creative nor High-tech	Workforce	Creative and High-tech	Creative Total	High-tech Total
South East	125,000	178,000	304,000	3,767,000	4,374,000	607,000	303,000	429,000
London	105,000	340,000	185,000	3,316,000	3,945,000	630,000	444,000	290,000
Eastern	61,000	104,000	187,000	2,628,000	2,980,000	352,000	165,000	248,000
North West	46,000	79,000	199,000	2,893,000	3,217,000	324,000	126,000	245,000
South West	44,000	84,000	156,000	2,360,000	2,645,000	284,000	128,000	200,000
West Midlands	36,000	55,000	133,000	2,257,000	2,481,000	224,000	91,000	169,000
East Midlands	31,000	54,000	133,000	1,968,000	2,187,000	218,000	85,000	164,000
Scotland	31,000	73,000	188,000	2,261,000	2,554,000	293,000	105,000	220,000
Yorkshire & Humberside	27,000	63,000	125,000	2,296,000	2,511,000	215,000	90,000	152,000
Wales	13,000	36,000	77,000	1,244,000	1,369,000	125,000	48,000	90,000
North East	11,000	25,000	71,000	1,061,000	1,168,000	107,000	36,000	82,000
Northern Ireland	8,000	19,000	34,000	753,000	814,000	61,000	27,000	42,000
UK	**539,000**	**1,109,000**	**1,791,000**	**26,803,000**	**30,243,000**	**3,439,000**	**1,648,000**	**2,330,000**

Note: There are a small number of people that count towards the UK totals in this and subsequent tables, but are not allocated to any region.

TABLE 7.4 PERCENTAGE OF WORKFORCE EMPLOYED IN CREATIVE AND HIGH-TECH INDUSTRIES BY UK REGIONS AND DNAs, AVERAGE 2011-2013

Region	Percentage of workforce employed in both creative and high-tech industries	Percentage of workforce only employed in creative industries	Percentage of workforce only employed in high-tech industries	Percentage of workforce employed in creative or high-tech industries	Percentage of workforce employed in creative industries	Percentage of workforce employed in high-tech industries
South East	2.8%	4.1%	6.9%	13.9%	6.9%	9.8%
London	2.7%	8.6%	4.7%	16.0%	11.3%	7.3%
Eastern	2.1%	3.5%	6.3%	11.8%	5.5%	8.3%
South West	1.7%	3.2%	5.9%	10.7%	4.8%	7.6%
North West	1.4%	2.5%	6.2%	10.1%	3.9%	7.6%
East Midlands	1.4%	2.5%	6.1%	10.0%	3.9%	7.5%
West Midlands	1.4%	2.2%	5.4%	9.0%	3.7%	6.8%
Scotland	1.2%	2.9%	7.4%	11.5%	4.1%	8.6%
Yorkshire & Humberside	1.1%	2.5%	5.0%	8.6%	3.6%	6.1%
North East	1.0%	2.1%	6.0%	9.1%	3.1%	7.0%
Wales	0.9%	2.6%	5.6%	9.2%	3.5%	6.5%
Northern Ireland	0.9%	2.4%	4.2%	7.5%	3.3%	5.1%
UK	**1.8%**	**3.7%**	**5.9%**	**11.4%**	**5.4%**	**7.7%**

Echoing the result for STEM occupations, this table shows that those industries that are classified as both creative and high-tech (the three ICT-related industries) are again particularly important employers in London (2.7 per cent) and the South East (2.8 per cent) and the East of England (2.1 per cent) compared with the rest of the country.

Figure 7.3 brings together Figures 7.1 and 7.2 at the UK level to show the intersection between the creative and high-tech economies (average 2011-2013). It shows that there were 0.87 million jobs in this segment.

FIGURE 7.3 EMPLOYMENT IN THE CREATIVE AND HIGH-TECH ECONOMIES, UK, AVERAGE 2011-2013

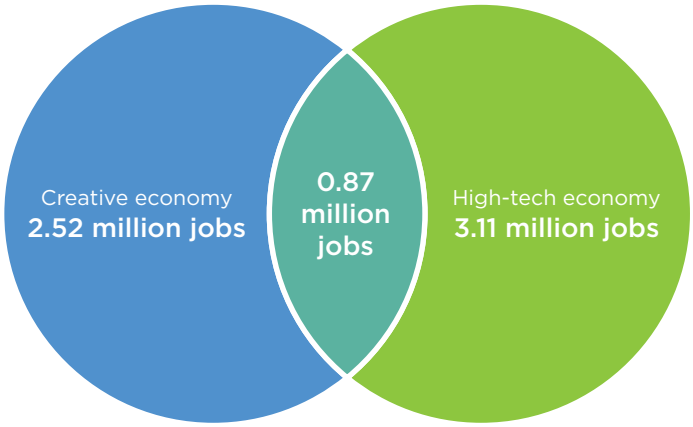


Table 7.5 further shows how these jobs split into specialist employment, non-specialist workers and embedded roles.

TABLE 7.5 INTERSECTION OF THE HIGH-TECH AND CREATIVE ECONOMIES, UK, AVERAGE 2011-2013

		High-tech economy			
Creative Economy		STEM specialist	High-tech non-specialist	Embedded	Total
	Creative specialist	203,000	24,000	22,000	250,000
	Creative non-specialist	120,000	189,000	20,000	328,000
	Embedded	70,000	58,000	166,000	294,000
	Total	**393,000**	**271,000**	**208,000**	**873,000**

Note: Numbers may not sum due to rounding

The table confirms that of the 0.87 million jobs that are located in both the creative and the high-tech economies, 0.46 million were in occupations that are both creative and STEM (the shaded areas in the table above). The cells outlined in bold are the 0.54 million jobs in industries that are both creative and high-tech.

Table 7.5 also shows that there were 20,000 STEM jobs (that were not in creative occupations) that were non-specialist jobs in creative industries that are not high-tech, and 58,000 creative jobs (that were not in STEM occupations) that were non-specialist jobs in high-tech industries that are not creative.

Growth in high-tech and creative employment

TABLE 7.6 ANNUAL GROWTH RATES OF THE UK'S CREATIVE AND HIGH-TECH ECONOMIES AND THEIR COMPONENTS, AVERAGE 2011-2013

Average annual growth	Specialist	Non-specialist	High-tech (Creative) Industries	Embedded	STEM (Creative) Occupations	High-tech (Creative) Economy	Workforce
High-tech	2.5%	1.0%	1.5%	3.7%	3.1%	2.1%	1.2%
Creative	4.3%	5.8%	5.0%	3.0%	3.6%	4.3%	1.2%

Table 7.6 re-emphasises the finding from earlier sections that the UK's creative economy has been growing over three times faster than the workforce as a whole at 4.3 per cent p.a. on average between 2011 and 2013, compared with a 2.1 per cent p.a. growth rate in the high-tech economy.

TABLE 7.7 AVERAGE ANNUAL GROWTH RATES OF THE INTERSECTION OF THE CREATIVE AND HIGH-TECH ECONOMIES (2011-2013)

	Creative and high-tech economy	Creative and high-tech industries	Creative and high-tech occupations	Workforce
Average annual growth 2011-2013	8.0%	9.6%	5.7%	1.2%

Table 7.7 reveals that the part of the UK workforce which straddles both the creative and high-tech economies (industries) has been particularly dynamic over this period, growing at 8.0 per cent (9.6 per cent) p.a.

KEY FINDINGS

- A core set of four ICT occupations account for the overlap between the 22 STEM and 30 creative occupations in our classifications. These are Information technology and telecommunications directors (1136); IT business analysts, architects and systems designers (2135); Programmers and software development professional (2136), and Web design and development professionals (2137).
- The number of jobs that are both creative and STEM is around 0.46 million. They account for 2.3 per cent, 2.1 per cent and 1.7 per cent of the London, South East and East of England workforces respectively, the only regions where the workforce share is higher than the national level of 1.5 per cent.

- Three of the 31 creative industry codes are also classified as high-tech in our definition: Other software publishing (5829), Computer programming activities (6201) and Computer consultancy activities (6202). Between them they account for 0.54 million jobs, although not all are in creative occupations.
- They account for 2.8 per cent, 2.7 per cent and 2.1 per cent of the South East, London and East of England workforces respectively, the only regions where the workforce share is higher than the national level of 1.8 per cent.
- 0.87 million people work in the intersection of the high-tech and creative economies i.e. either work in an occupation or industry that is in both the high-tech and creative economy.
- The part of the workforce which straddles both the creative and high–tech economies (industries) has been particularly dynamic over this period, growing at 8.0 per cent (9.6 per cent) p.a.

The next section examines the geography of the creative and high-tech economies at a sub-regional level.

8 SUB-REGIONAL GEOGRAPHY OF THE UK'S CREATIVE AND HIGH-TECH ECONOMIES

To understand the geography of the creative and high-tech economies, and to formulate supportive policies, it is necessary to analyse it at a sub-regional level. Analysis at a higher degree of spatial resolution allows concentrations of particular economic activity to be more accurately identified. Regions and DNAs can contain greater variations in economic characteristics within them (e.g. urban vs rural) than between them, so comparisons between regions/DNAs can potentially be misleading. Concentrations of creative and high-tech activity may also occur at small spatial scales, the visual effects industry cluster in London's Soho, for example, so it is desirable to analyse the data at the smallest possible scale for which official data are available.[77]

There are, however, limitations to analysing the Annual Population Survey (APS), or indeed any survey, for small units of geography: the sample sizes become smaller so that inferences on the characteristics of individual localities become less robust. The statistical authorities also impose restrictions on reporting numbers due to them being potentially disclosive of survey participants' identities.

In this report, we adopt the sub-regional geography of the European Union's NUTS (Nomenclature of Territorial Units of Statistics) classification.[78] This is the geographic system used by the European Union and has the benefit of allowing international comparisons.[79] There are three spatial levels in the NUTS system: NUTS1 is the largest geography and corresponds to UK regions, NUTS2 is the second largest geography corresponding to counties or groups of counties, and NUTS3 is the geography with the smallest spatial scale. NUTS3 units can be aggregated to create NUTS2 and NUTS1 geographies and correspond to a mixture of UK counties and unitary authorities/urban areas. As the APS is based on place of residence, this means, however, that in some cases respondents will be working in an area different from where they live i.e. employment allocated to a given NUTS3 geography may be located elsewhere.

In the following set of maps we plot the location quotients i.e. the proportion of the area's workforce in a given activity relative to the share of that activity in the UK workforce as a whole.[80] This is undertaken for the creative economy and its components, followed by the high-tech economy. Areas that are more darkly shaded in the maps are those where there is a higher proportion of employment in creative and high-tech activity relative to the national level (i.e. those with a higher location quotient). As Northern Ireland is not coded at the NUTS3 level within the APS it is plotted at the NUTS1 level i.e. as Northern Ireland. This means concentrations of high-tech or creative activity at lower levels of spatial resolution in Northern Ireland will not be identified.

8.1 The sub-regional geography of the UK's creative economy and its components

Figure 8.1.1 shows that creative specialists (i.e. people in creative occupations working in creative industries) are a particularly high proportion of employment relative to their proportion in the UK workforce in West Inner London, East Inner London, West and North West Outer London, South Outer London and Brighton & Hove. They are also particularly prevalent in the counties to the west (Berkshire, Oxfordshire, and Buckinghamshire), north (Hertfordshire and Cambridgeshire) and south (Surrey) of London, and in Bristol, Edinburgh and Glasgow.

FIGURE 8.1.1 GEOGRAPHICAL DISTRIBUTION OF EMPLOYMENT OF CREATIVE SPECIALISTS IN THE CREATIVE INDUSTRIES, UK, AVERAGE 2011-2013 (LOCATION QUOTIENTS)

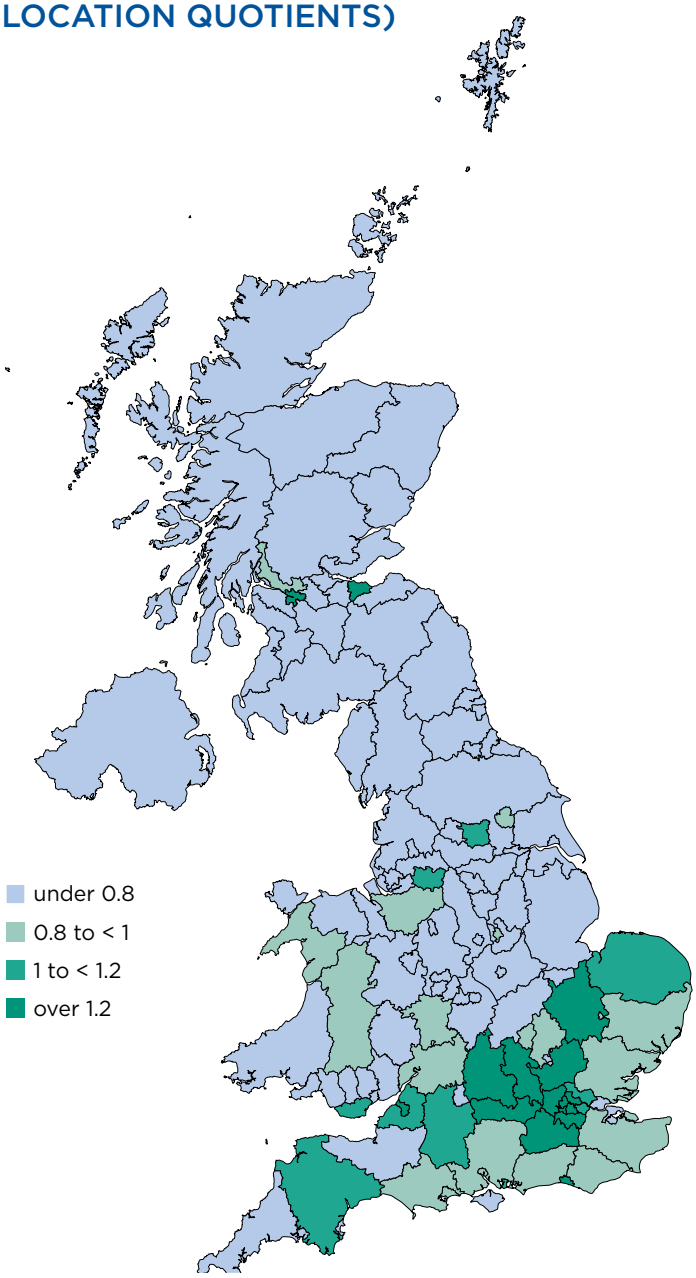
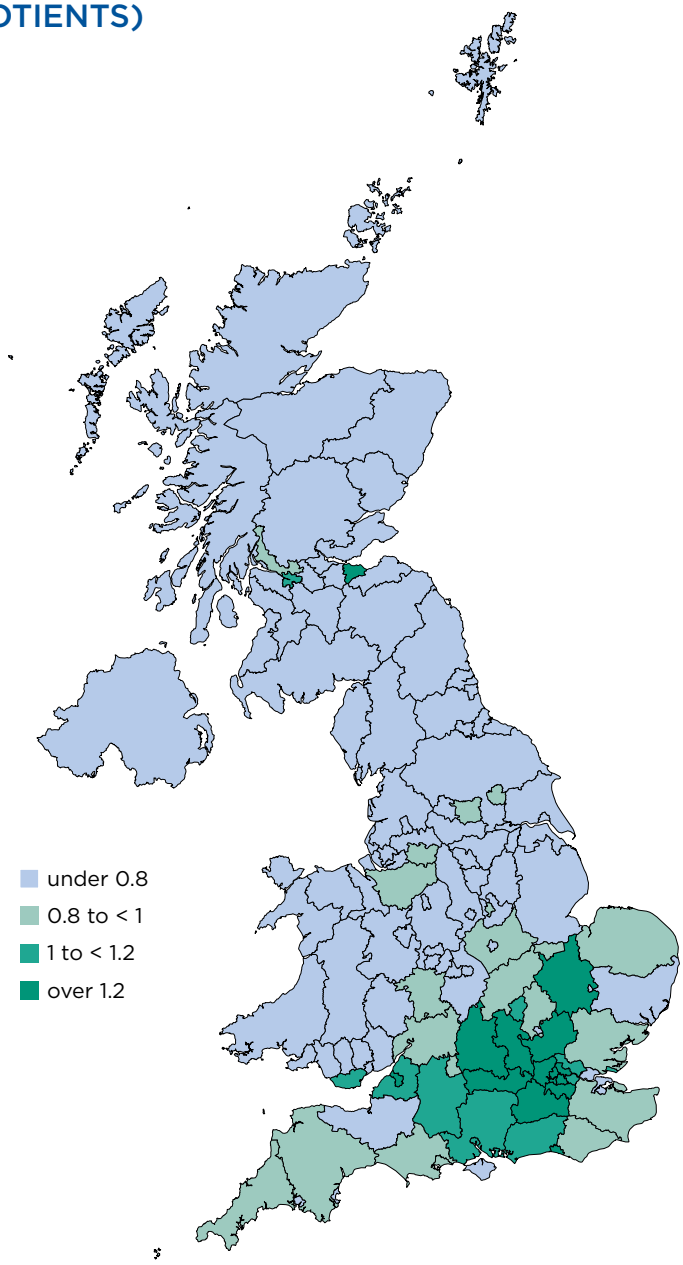
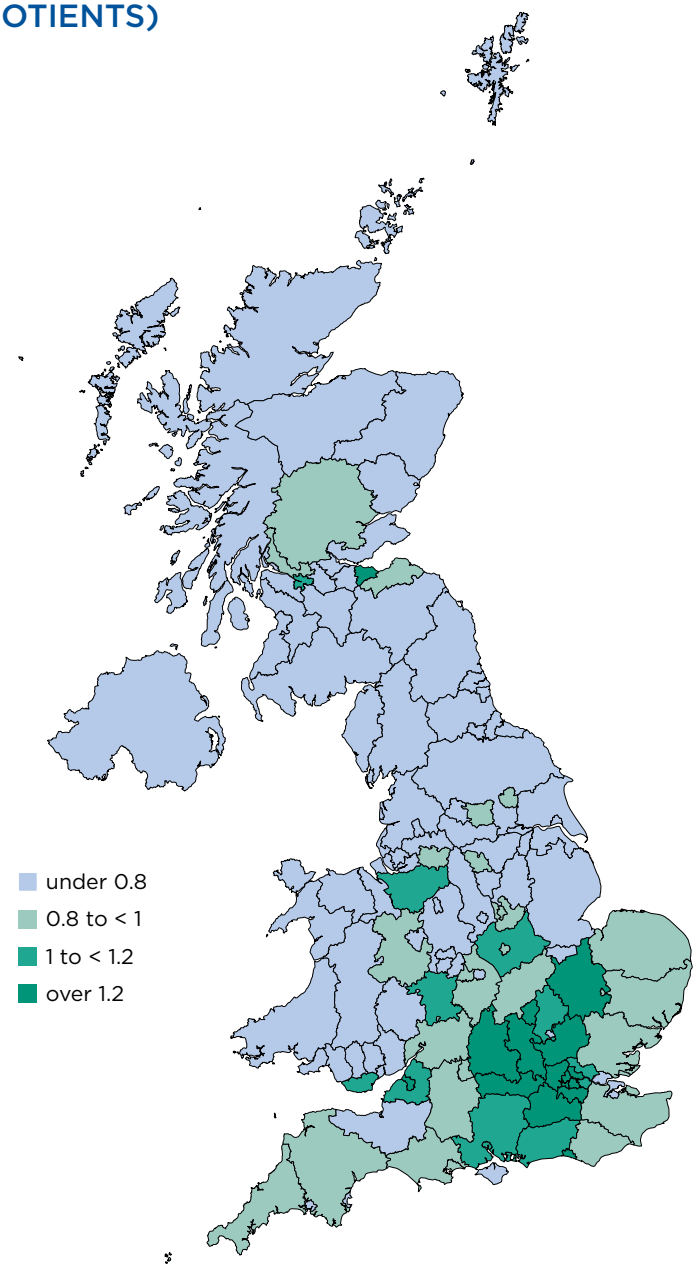


FIGURE 8.1.2 GEOGRAPHICAL DISTRIBUTION OF EMPLOYMENT IN THE CREATIVE INDUSTRIES, UK, AVERAGE 2011-2013 (LOCATION QUOTIENTS)



The creative industries account for a particularly high workforce share in East Inner London, West Inner London and Brighton & Hove. They are also a significant proportion of the workforce in West and North West Outer London, South Outer London,[84] to London's west (Berkshire, Oxfordshire, Buckinghamshire) the immediate north (Hertfordshire and Cambridgeshire) and south (Surrey), and in Bristol and Edinburgh.

FIGURE 8.1.3 GEOGRAPHICAL DISTRIBUTION OF EMPLOYMENT IN THE CREATIVE ECONOMY, UK, AVERAGE 2011-2013 (LOCATION QUOTIENTS)



The wider creative economy is a particularly significant employer as a proportion of the workforce in East Inner London, West Inner London, Surrey, Brighton & Hove and Outer London (West and North West, and South). It is also concentrated to the west (Berkshire, Oxfordshire, Buckinghamshire, Milton Keynes), the north (Hertfordshire and Cambridgeshire) and in Edinburgh and Bristol.

8.2 The sub-regional geography of the UK's high-tech economy and its components

FIGURE 8.2.1 GEOGRAPHICAL DISTRIBUTION OF EMPLOYMENT IN STEM OCCUPATIONS IN THE HIGH-TECH INDUSTRIES, UK, AVERAGE 2011-2013 (LOCATION QUOTIENTS)

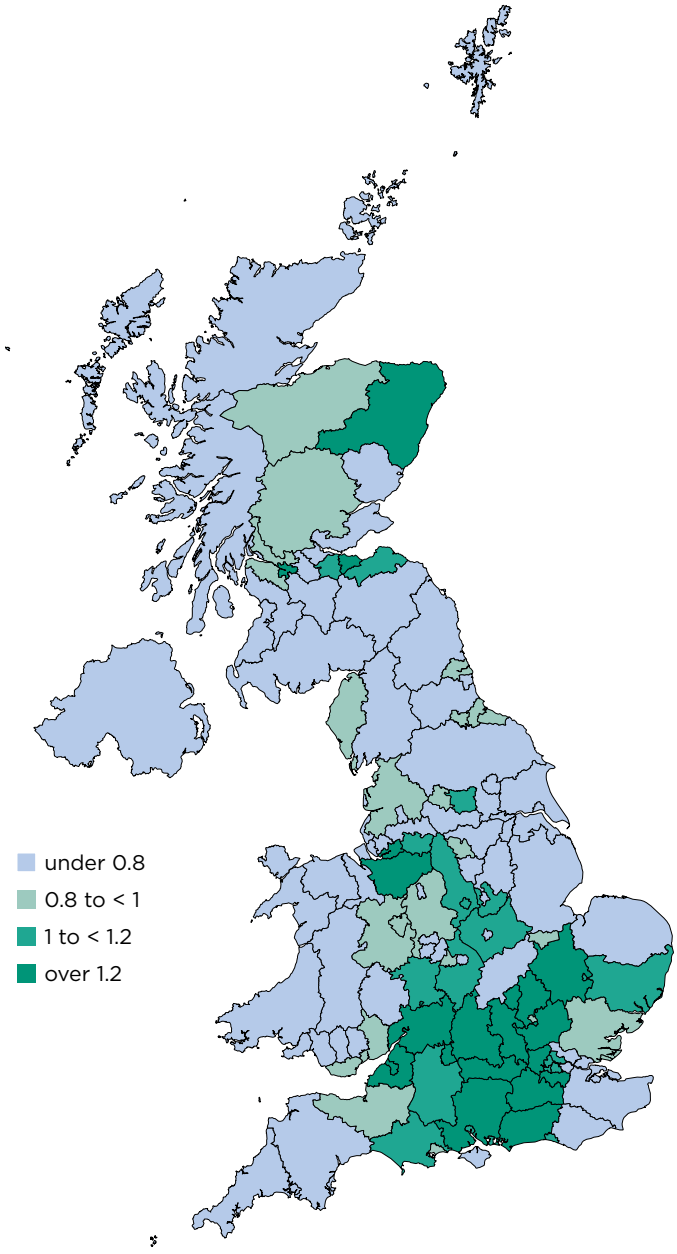
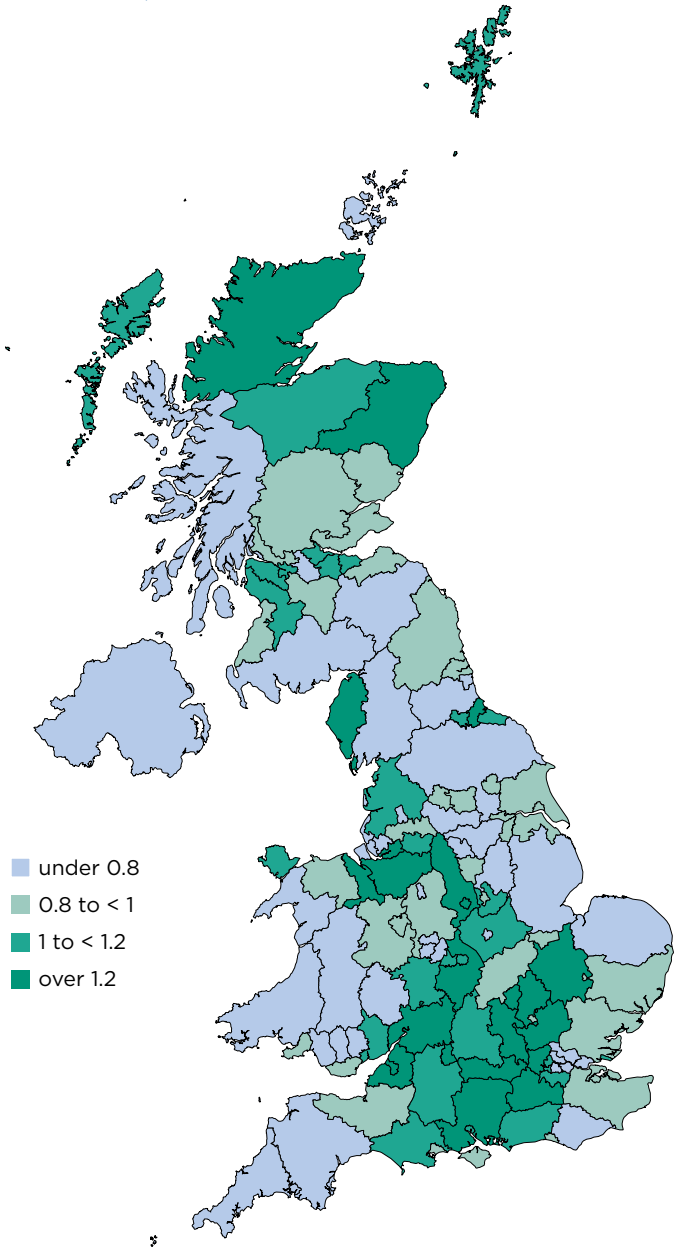


Figure 8.2.1 shows that STEM occupations in high-tech industries account for a particularly high share of employment relative to their share of the UK workforce in Berkshire (largest towns: Reading and Slough) and in Cambridgeshire. They also account for a high proportion of the workforce in the counties to the north, west and south west of London, Outer London (West and North West) and Cheshire, Gloucestershire, North and North East Somerset, Aberdeen City & Aberdeenshire, Halton and Warrington and Bedfordshire. Urban areas with a particularly high proportion of STEM occupations working in high-tech industries in the workforce include: Glasgow, Bristol, Milton Keynes, Swindon, and Edinburgh.

FIGURE 8.2.2 GEOGRAPHICAL DISTRIBUTION OF EMPLOYMENT IN THE HIGH-TECH INDUSTRIES, UK, AVERAGE 2011-2013 (LOCATION QUOTIENTS)

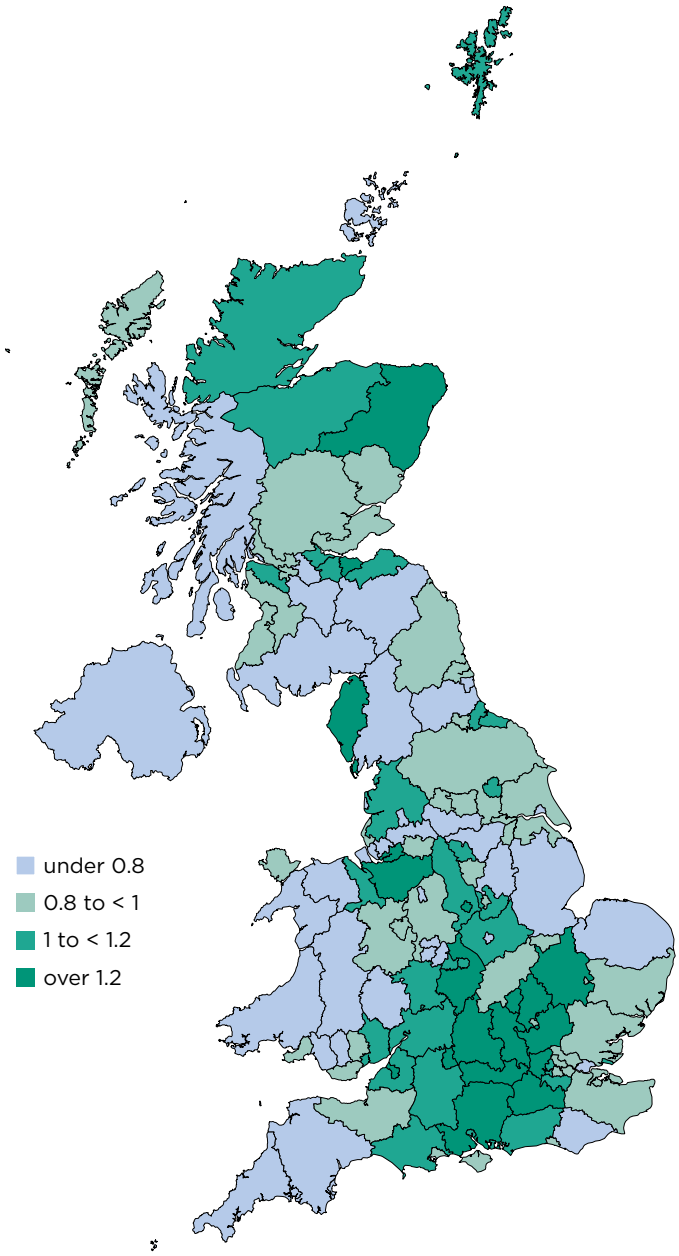


Employment in high-tech industries as a proportion of areas' workforces is more evenly distributed, being also relatively prominent in West Cumbria, Flintshire and Wrexham, Derby, South and West Derbyshire, Caithness and Sutherland, Portsmouth, Hartlepool and Stockton-on-Tees, and Warwickshire.

Some of the agglomerations are likely to relate to the supply chains and employment of specific large-scale employers: for instance, Rolls Royce plc employs its largest concentration of aeronautic engineers in the UK in Derby.[85] In West Cumbria, there are two major employers in the form of the Sellafield Nuclear site (the largest nuclear site in Europe[86]) and BAE systems' submarine operations in Barrow-in-Furness.[87] Aberdeen City and Aberdeenshire – the area with the highest LQ – is the centre of the UK's North Sea oil industry. The pattern of concentrations

of high-tech activity also relate to the transport links along the M4 corridor and the close links with Heathrow airport which have stimulated technology in this area with a number of prominent software companies locating nearby, for example Microsoft and Oracle which have their UK headquarters in Reading.

FIGURE 8.2.3 GEOGRAPHICAL DISTRIBUTION OF EMPLOYMENT IN THE HIGH-TECH ECONOMY, UK, AVERAGE 2011-2013 (LOCATION QUOTIENTS)



The high-tech economy represents a particularly high proportion of the workforce in Aberdeen City & Aberdeenshire, the counties to the north, west and south west of London, and in Cheshire, Warwickshire, Halton and Warrington and West Cumbria. Urban areas with a particularly high proportion of high-tech economy employment include: Milton Keynes, Derby, Swindon, Edinburgh, Outer London (West and North West) and Bristol.

The lower intensity threshold (15 per cent as opposed to 30 per cent in the case of the creative industries) for being in a high-tech industry has the consequence that non-specialist/support workers account for a larger proportion of the workforce than in the case of the creative industries, so the change in geographical distributions when comparing STEM employment in the high-tech industries with high-tech industry employment may, depending on the industries involved, be larger than in the case of the creative industries. This helps to explain the more marked differences between the high-tech economy and high-tech industries maps compared with the differences between the creative economy and creative industries maps.

8.3 How the sub-regional distributions of the creative and high-tech economies compare

Tables 8.3.1 and 8.3.2 show the location quotients for the high-tech and creative economies and their components sorted by the 20 NUTS3 areas with the largest creative and high-tech economy location quotients respectively.

TABLE 8.3.1 LOCATION QUOTIENTS FOR THE CREATIVE ECONOMY AND ITS COMPONENTS SORTED BY THE TOP 20 AREAS WITH THE HIGHEST CREATIVE ECONOMY LOCATION QUOTIENTS, UK, AVERAGE 2011-2013

NUTS3 Area	Creative specialists	Creative industry	Creative economy
Inner London – East	3.4	2.8	2.5
Inner London – West	3.3	2.6	2.5
Surrey	1.5	1.7	1.7
Brighton and Hove	2.2	1.8	1.7
Outer London - West and North West	1.9	1.9	1.7
Oxfordshire	1.7	1.7	1.7
Buckinghamshire CC	1.5	1.7	1.7
Berkshire	1.2	1.6	1.6
Outer London – South	1.6	1.7	1.6
Edinburgh	1.6	1.4	1.3
Hertfordshire	1.3	1.4	1.3
Bristol	1.6	1.4	1.3
Milton Keynes	1.0	1.1	1.3
Cambridgeshire CC	1.3	1.2	1.2
Hampshire CC	1.0	1.1	1.2
West Sussex	0.9	1.0	1.1

Worcestershire	0.9	1.0	1.1
Portsmouth	1.1	1.0	1.1
Cardiff and Vale of Glamorgan	1.1	1.1	1.1
North and North East Somerset	1.1	1.0	1.1

TABLE 8.3.2 LOCATION QUOTIENTS FOR THE HIGH-TECH ECONOMY AND ITS COMPONENTS SORTED BY THE TOP 20 AREAS WITH THE HIGHEST HIGH-TECH ECONOMY LOCATION QUOTIENTS, UK, AVERAGE 2011-2013

NUTS3 Area*	STEM specialists	High-tech industry	High-tech economy
Aberdeen City and Aberdeenshire	2.0	2.3	1.9
Berkshire	2.2	2.0	1.9
Cambridgeshire CC	2.2	1.7	1.7
Buckinghamshire CC	1.7	1.6	1.5
Derby	1.2	1.7	1.4
West Cumbria	1.0	1.7	1.4
Surrey	2.0	1.5	1.4
Oxfordshire	1.7	1.2	1.4
Milton Keynes	1.6	1.4	1.4
Hampshire CC	1.3	1.4	1.4
Cheshire CC	1.3	1.4	1.4
Hertfordshire	1.7	1.4	1.3
Halton and Warrington	1.3	1.4	1.3
Edinburgh	1.7	1.2	1.3
Swindon	1.7	1.4	1.3
Bedfordshire CC	1.3	1.3	1.3
Bristol	1.7	1.2	1.2
Outer London - West and North West	1.5	1.2	1.2
Warwickshire	1.1	1.2	1.2
Flintshire and Wrexham	0.6	1.3	1.2

*areas that also appear in the creative economy table are highlighted in blue

It is immediately apparent from these tables that the creative economy is especially highly concentrated in Inner London in a way that the high-tech economy is not (in fact, Inner London does not even feature in the top 20 location quotients for high-tech).

We might reasonably speculate that this pattern is explained by the fact that high-tech manufacturing industries are in the main more capital-intensive than creative industries, and therefore require more space to operate than is economical in central London. This is less likely to be the case for many digital media and software businesses which are at the nexus of the high-tech and creative economies, such as those that have amassed in Tech City.[88] Indeed, it has been argued that such firms are increasingly locating in city centres due to their attractiveness of those locations to the talent they employ, the need to draw on the range of different skills that cities offer, and technological developments, such as cheap cloud storage, which is allowing companies to operate with smaller footprints.[89] If we examine the LQs of the intersection of the high-tech and creative economy then the LQ for Inner London East becomes much higher at 1.5, which is consistent with this (although this is not the highest LQ in London). A recent study (KPMG Data Monitor, 2013) using Annual Business Register and Employment Survey (BRES) data, at a lower spatial of resolution (the London borough level) also did not find the tech-cluster in the Old Street area to be that pronounced relative to others in London.[90] That study explained this as being due to the London boroughs of Hackney and Islington, having substantial and diverse economies containing many multinational companies, particularly in the financial services, advertising and market research industries. In the case of that study it also considered that the BRES data was likely to under-record start-up activity as it is based on VAT registrations that will omit smaller companies. In the case of the current study the use of APS data, which is based on where workers reside, may also be making it harder to distinguish the existence of the East London tech cluster.

Another location that one might expect to appear in the above list, but which is absent is Manchester (the relevant NUTS3 geographies in this case being Greater Manchester – North, and Greater Manchester – South). These employ a large number of people in the creative economy, with both areas in the top quartile of NUTS3 areas in employment terms. Their absence is partly explained by the fact that London is so prominent in the creative economy thus having a substantive effect on the proportion of those employed in the creative economy in the UK. If London is excluded from the calculation of location quotients, then the LQs of some of the Manchester areas become larger i.e. there is a high proportion of creative employment relative to the rest of the UK, but this is partly hidden by the amount of creative employment in London.

As many as 15 of the 20 areas with the highest location quotients for the creative economy are in London and the South East/East of England area, with the equivalent number for the high-tech economy being ten.

11 of the areas make both top-20 lists: Berkshire, Cambridgeshire, Oxfordshire, Buckinghamshire, Milton Keynes, Surrey, Hertfordshire, Hampshire, and Outer London (West and North-West), and outside the South East of England, Edinburgh and Bristol.

Table 8.3.3 provides further detail on the specialisation profile of different areas, showing areas with high-tech or creative economy LQs greater than 1.2 in one or both of the categories.

TABLE 8.3.3 AREAS WITH CONCENTRATIONS OF EMPLOYMENT IN THE CREATIVE AND HIGH-TECH ECONOMY, UK, AVERAGE 2011-2013

NUTS3	High-tech only	Creative only	Creative and High-tech (Creative LQ, High-tech LQ)
Surrey			1.68 , 1.43
Oxfordshire			1.66 , 1.40
Outer London - West and North West			1.66 , 1.21
Buckinghamshire CC			1.65 , 1.49
Berkshire			1.57 , 1.87
Hertfordshire			1.32 , 1.33
Edinburgh			1.32 , 1.31
Bristol			1.27 , 1.24
Cambridgeshire CC			1.25 , 1.66
Milton Keynes			1.25 , 1.38
Inner London - East		2.49	
Inner London - West		2.45	
Brighton and Hove		1.67	
Outer London - South		1.55	
Aberdeen City & Aberdeenshire	1.88		
Derby	1.45		
West Cumbria	1.44		
Hampshire CC	1.37		
Cheshire CC	1.35		
Halton and Warrington	1.31		
Swindon	1.29		
Bedfordshire CC	1.29		
Warwickshire	1.21		

From this we can see a number of areas where there are particularly high concentrations of creative and high–tech employment as a proportion of an area's workforce relative to their respective shares of the UK workforce:

Of high-tech and creative activity: Berkshire, Cambridgeshire, Oxfordshire, Buckinghamshire, Surrey, Hertfordshire, Milton Keynes and Edinburgh, Bristol, West and North West Outer London.

Of high-tech only: Aberdeen City & Aberdeenshire, Derby, West Cumbria, Hampshire, Cheshire, Halton and Warrington, Swindon, Bedfordshire and Warwickshire.

Of creative only: East Inner London and West Inner London, South Outer London, and Brighton & Hove.

How geographically dispersed are the creative industries compared to the high-tech industries?

To analyse how geographically distributed high-tech and creative industries are in the UK compared with other sectors, Table 8.3.4 shows how they compare across three measures of the dispersion with the location quotients for the broad industrial groups used by the ONS.[91]

This confirms that employment in sectors like construction, distribution, transport, hotels and restaurants and government, health and education, where demand is broad-based on a geographical basis are evenly distributed across the country. In other sectors like agriculture, which are strongly driven by proximity to specific natural resources, industries are highly spatially concentrated. All three dispersion measures present a consistent story. Namely that:

- The high-tech industries are more evenly distributed across the UK than the creative industries.
- Financial and insurance industries (see also Figure 8.3.5) are even more highly concentrated than the creative industries, being especially important employers in central London and in areas like Edinburgh, Essex and Southend on Sea. The LQ for the financial and insurance industries in West Inner London is 3.18, the highest LQ of any sector anywhere outside of agriculture.

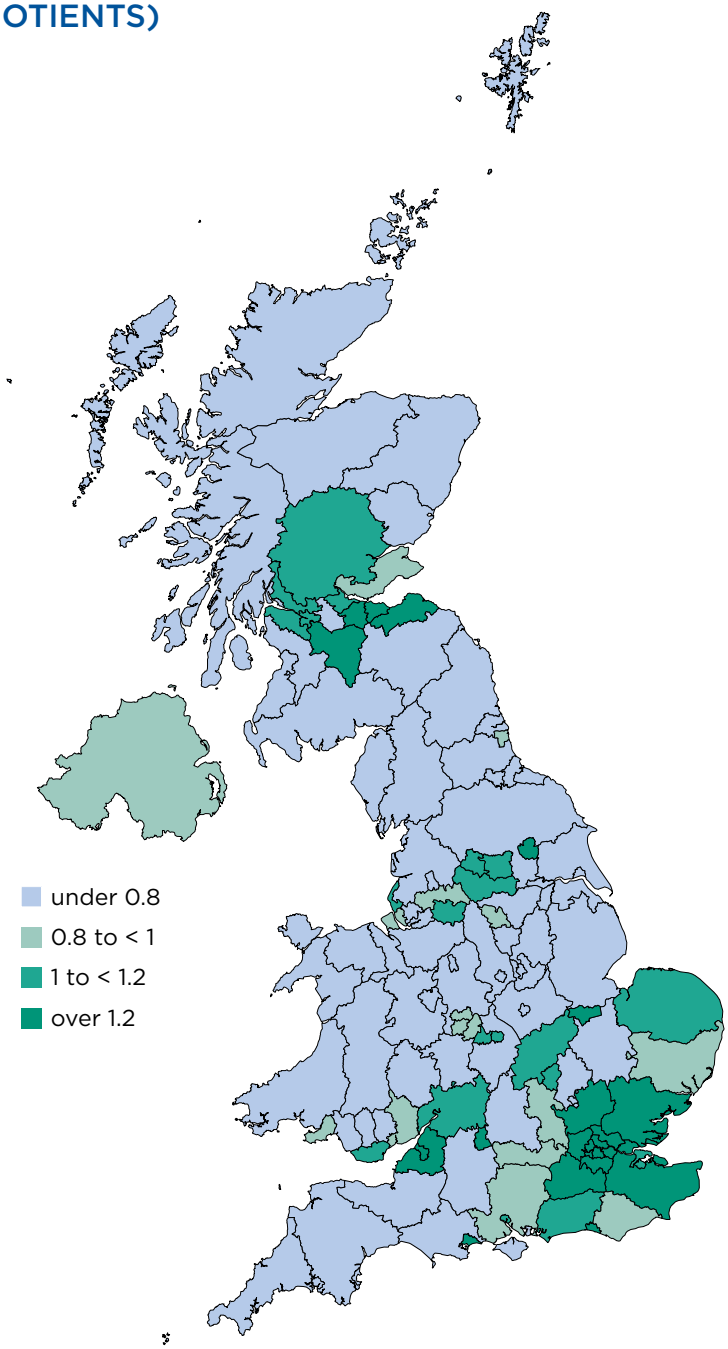
TABLE 8.3.4 MEASURES OF THE DISPERSION AT THE NUTS3 OF LOCATION QUOTIENTS BY DIFFERENT INDUSTRY GROUPS, UK, AVERAGE 2011-2013

Industry	Range	Standard deviation	Gini coefficient
Agriculture	9.04	1.81	0.60
Finance and insurance	3.14	0.51	0.32
Creative (as defined in the report)	2.47	0.41	0.24
Information and communication	2.31	0.44	0.28
Real estate	2.19	0.37	0.21
Production	1.86	0.34	0.17
High-tech (as defined in the report)	1.80	0.30	0.17
Professional and support	1.47	0.22	0.13
Construction	0.94	0.17	0.09
Arts and other	0.83	0.17	0.10
Distribution, transport, hotels and restaurants	0.67	0.12	0.06
Government, health and education	0.56	0.10	0.06

Source: APS 2011-2013

Note: The Arts and other sector. Although this category includes a number of Arts related activities (e.g. performing arts employment) it also includes employment relating to sporting activities, membership organisations and personal services e.g. washing and (dry-)cleaning of textile and fur products. The measure is therefore not comparable to the creative industries figure.

FIGURE 8.3.5 GEOGRAPHICAL DISTRIBUTION OF EMPLOYMENT IN THE FINANCE AND INSURANCE INDUSTRIES (LOCATION QUOTIENTS)



KEY FINDINGS

- The creative economy is an especially important employer in Inner London and in the counties surrounding London. While the creative industries are relatively geographically concentrated across the UK compared with many other sectors, they are less concentrated than sectors like financial and insurance services, and agriculture.
- The high-tech economy, although found in many of the same areas as the UK's creative economy, is more evenly distributed around the country. This partly reflects the fact that it contains a number of industries that are centred outside London and the South East.
- The colocation of the creative and high-tech economies and its concentration in the South East of England is not wholly explained by the ICT-related occupations and industries that commonly make them up. It also reflects a tendency for creative activities and high-tech activities more generally to collocate (echoing the earlier finding by Chapain et al, 2010).
- In the European NUTS3 sub-regional geography:

  1. Counties identified as being those where the creative and high-tech economies account for a particularly high proportion of jobs are:
     - High-tech and creative: Berkshire, Cambridgeshire, Oxfordshire, Buckinghamshire, Hertfordshire and Surrey.
     - High-tech only: Aberdeenshire & Aberdeen City, Cheshire, Hampshire, West Cumbria and Bedfordshire and Warwickshire.
  2. Unitary authorities/Urban areas identified as being where the creative and high-tech economies both account for a particularly high proportion of jobs are:
     - High-tech and creative: Bristol, Edinburgh, Outer London (West and North West) and Milton Keynes.
     - High-tech only: Derby, Swindon, Halton and Warrington.
     - Creative only: Inner London, South Outer London and Brighton & Hove.

9 CONCLUSIONS AND NEXT STEPS

CONCLUSIONS

Size of the creative and high-tech economies

- **Creative** There were 2.6 million jobs in the UK's creative economy in 2013. This consisted of 1.71 million jobs in the creative industries (890,000 in creative occupations and 818,000 working in other roles) and 907,000 jobs in creative occupations outside of the creative industries.
- **High-tech** There were 3.2 million jobs in the UK's high-tech economy in 2013. This consisted of around 2.4 million jobs in high-tech industries (825,000 in STEM (Science, Technology, Engineering and Mathematics) occupations and approximately 1.6 million in other roles) and 806,000 jobs in STEM occupations outside of the high-tech industries.

Growth of the creative and high-tech economies

- **Creative** Employment in the creative economy on average grew at 4.3 per cent p.a. 3.6 times faster than the workforce as a whole (1.2 per cent p.a.) between 2011 and 2013. Employment in creative industries grew faster still, at over four times the rate of the workforce. This was driven by strong growth in both creative occupations employed in creative industries (4.3 per cent p.a.) and in those employed in other occupations in creative industries (5.8 per cent p.a.).
- **High-tech** At 2.1 per cent p.a., employment in the high-tech economy also grew faster than the workforce as a whole between 2011 and 2013. High-tech industry employment grew on average by 1.5 per cent p.a., more slowly than the rate of growth in STEM occupations of 3.1 per cent p.a. (Within this the rate of growth of STEM occupations outside the high-tech industries (3.7 per cent p.a.) was faster than that for those employed in high-tech industries (2.5 per cent p.a.)).

The intersection of the creative and high-tech economies

The figures below are the average of 2011-2013 data

- There were on average 0.46 million jobs in dual creative-STEM occupations in 2011-2013, accounting for 2.3 per cent of London's workforce, 2.1 per cent of the workforce in the South-East, and 1.7 per cent of the workforce in the East of England respectively. These were the only regions where the proportion of employment was higher than the level in the UK as a whole of 1.5 per cent.
- There were 0.54 million jobs in industries that were both creative and high-tech. They accounted for 2.8 per cent of the workforce in the South East of England, 2.7 per cent of the workforce in London and 2.1 per cent of the workforce in the East of England.
- 0.87 million jobs fell within both the high-tech and creative economies.
- This part of the workforce has been particularly fast-growing, at 8.0 per cent p.a. on average over the period 2011-2013. Within this, those ICT-related industries that can be considered as both creative and high-tech were particularly dynamic, growing at 9.6 per cent p.a.

Regional geography of the creative and high-tech economies

The high-tech and creative economies are disproportionately important employers in the Greater South East of England (London, East of England and South East) relative to the share that these sectors are of the UK workforce. The significance of London is even more pronounced in the case of the UK's creative economy than it is in the high-tech economy.

Interestingly, in recent years the creative economy employment has – Scotland's aside – been growing faster in regions outside London than it has in the capital itself.

Creative

- London and the South East of England account for 43 per cent of employment in the UK's creative economy.
- The creative economy employs 15.5 per cent of London's workforce, 10.7 per cent of the South East's workforce, and 8.4 per cent of the East of England workforce. Previous research suggests that the prominence of London is likely explained by strong agglomeration effects associated with London's size and with its status as a world city.
- The creative economy has been growing most rapidly in areas outside London between 2011-2013, particularly in the East of England, West Midlands, North East, and Yorkshire and the Humberside. Scotland is the only area where the creative economy has shrunk.

High-tech

- The South East of England and London account for 31 per cent of employment in the UK's high-tech economy.
- The high-tech economy employs 12.8 per cent of the South East's workforce and 11.2 per cent of the East of England's workforce. In contrast to the creative economy, this measure of the importance of high-tech to London's workforce is slightly behind Scotland, at 10.6 per cent compared with 10.9 per cent respectively.
- The regions/DNAs with the fastest growing employment in the high-tech economy over the 2011-2013 periods are: Scotland, Yorkshire and Humberside, London and the West Midlands.

Sub-regional geography of the high-tech and creative economy

In the European NUTS3 sub-regional geography:

- Counties identified as being those where the high-tech and creative economies are particularly important employers as a proportion of the geographies' workforce are:
  - High-tech and creative: Berkshire, Cambridgeshire, Oxfordshire, Buckinghamshire, Hertfordshire and Surrey.
  - High-tech only: Aberdeenshire & Aberdeen City, Cheshire, Hampshire, West Cumbria, Bedfordshire and Warwickshire
- Unitary authorities/Urban areas identified as being where the high-tech and creative economies are particularly important employers as a proportion of the geographies' workforce are:
  - High-tech and creative: Bristol, Edinburgh, Outer London (West and North West) and Milton Keynes.
  - High-tech only: Derby, Swindon and Halton & Warrington.
  - Creative only: Inner London (East and West), South Outer London, Brighton & Hove.

DISCUSSION AND NEXT STEPS

- The creative and high-tech industries have captured the imagination of policymakers in describing segments of the economy which are believed to display high levels of job creation, innovation and economic growth. However, **conceptual ambiguities and the insufficient regard to transparent classifications that has beset these areas have hindered the design and evaluation of effective policies.** Policymakers have been seemingly happy to use the terms 'industries' and 'economy' interchangeably, and employ inconsistent classifications that have made it impossible to track progress across key parts of the economy and over time.
- The definitional uncertainties are great, meaning that sensitivity analysis is critical,[92] but in the baseline classifications adopted in this report employment in both the creative and high-tech economies since 2010 has been rapid, and much faster than in the UK workforce as a whole. Classification changes from SOC2000 to SOC2010 in the occupational codes precluded a historical analysis going back further in time during the writing of this report. **The Office for National Statistics should give greater attention to how longer time-series for industrial and occupational analysis can be constructed when classification systems change** (ideally this would include back coding a sample of individual survey responses using revised codes).
- The APS data we have employed in this study has enabled us to reveal the size, growth and geography of the UK's creative and high-tech economies. In further research we **are using the data to investigate the extent of possible knowledge spillovers from creative/high-tech activities on those working in other fields.**[93] Insofar as knowledge spillovers are associated with sub-optimally low levels of investment in knowledge – that is, they give rise to a market or systems failure – this may justify some form of policy intervention.
- Despite its large sample size, the APS is however a sample survey which limits its use at microspatial units of geography. The Household Census in principle provides a solution to this problem, but in practice is of limited use for our analysis. First, because the data is only available for 200 industry sectors at a mixture of 2-, 3- and 4-digit levels (this compares with the SIC07 standard of 617 codes available at 4 digits, of which 603 are used in the APS), which places major constraints on the ability of researchers to identify creative and high-tech industries in the Census data. Second, we cannot undertake regional analysis on Census data as the ONS has not released 4-digit occupational data within the 3-digit industry employment tables released at regional or sub-regional level. **These restrictions severely limit the use of Census data for industrial policy analysis (a marked contrast with the US where the Household Census has been used in a multitude of influential studies of occupation and industry dynamics), and should be addressed by the ONS in its future work on the Census.**

10 GLOSSARY

Creative Economy
Those employed in creative industries (either in creative occupations or other roles) and those employed in creative occupations outside the creative industries.

Creative Industries
Industries defined as creative under the Department for Culture Media and Sport (DCMS) definitions. These are set out in Appendix 2 (Table A2.1).

Creative Non-specialist
Someone employed in the creative industries in an occupation which is not creative on the definition below.

Creative Occupations
Occupations defined as being creative under the set of SOC codes in the Department for Culture Media and Sport definition set out in Appendix 1 (Table A1.1).

Creative Specialist
Someone employed in a creative industry in a creative occupation.

Crosswalk
A mapping between a set of occupational (or industrial classifications) done on a different basis e.g. SIC2007 and SIC2003.

DM, Dynamic Mapping
The report which introduced the Dynamic Mapping approach. Bakhshi, H., Freeman, A. and Higgs, P. (2013) 'A Dynamic Mapping of the UK's Creative Industries.' London: Nesta.

Embedded Creative
Someone employed in a creative occupation outside of the creative industries.

Embedded STEM worker
Someone employed in a STEM occupation outside of the high-tech industries. STEM occupations being defined below.

High-tech Economy
Those employed in high-tech industries (either in STEM occupations or other roles) and those employed in STEM occupations outside of the high-tech industries.

High-tech Industries
Industries which have a STEM occupation intensity in excess of a threshold of 15 per cent, subject to passing the 4,000 employment robustness test (in our baseline classification). Set out in Appendix 2 (Table A2.2.).

High-tech Non-specialist
Someone employed in a high-tech industry who is not in a STEM occupation.

Microspatial Clustering
Small-scale clusters that form at spatial levels that may be below existing standardised geographies, for example a block of streets.

The Standard Industrial Classification (SIC)
This is a means of classifying businesses according to the type of economic activity that they are engaged in. The latest version of SIC codes in the UK is SIC 2007, which superseded SIC 2003.

The Standard Occupational Classification (SOC)
This is a means of classifying the occupation of a person according to the work they do and the skill level required.

STEM occupation
An occupation that involves the use of Science, Technology, Engineering and Mathematics (STEM). The STEM occupational definition used in this report are set out in Appendix 1 (Table A1.2).

STEM Specialist
Someone who is working in a STEM occupation in a high-tech industry.

Creative/STEM intensity
The proportion of industry employment that is in the set of occupations considered as creative or STEM.

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APPENDICES

1. APPENDIX OF SOC TABLES

TABLE A1.1 SOC2010 CREATIVE OCCUPATIONS AND THEIR SEGMENTS

Creative Services Occupations		
1	**Advertising and marketing**	
	1132	Marketing and sales directors
	1134	Advertising and Public Relations managers
	2472	Public relations professionals
	2473	Advertising accounts managers and creative directors
	3543	Marketing associate professionals
2	**Architecture**	
	2431	Architects
	2432	Town Planners
	2435	Chartered architectural technologists
	3121	Architectural technologists and Town Planning technicians
3	**Design: product, graphic and fashion design**	
	3421	Graphic Designers
	3422	Product, Clothing and related designers
4	**IT, software and computer services**	
	1136	Information technology and telecommunications directors
	2135	IT business analysts, architects and systems designers
	2136	Programmers and software development professionals
	2137	Web design and development professionals
Content production		
5	**Crafts**	
	5211	Smiths and forge workers
	5411	Weavers and Knitters
	5441	Glass and ceramics makers, decorators and finishers
	5442	Furniture makers and other craft woodworkers
	5449	Other skilled trades n.e.c.

6	**Film, TV, video, radio and photography**	
	3416	Arts officers, producers and directors
	3417	Photographers, audio-visual and broadcasting equipment operators
7	**Publishing**	
	2471	Journalists, newspaper and periodical editors
	3412	Authors, Writers
8	**Museums, galleries and libraries**	
	2451	Librarians
	2452	Archivists and curators
9	**Music, performing and visual arts**	
	3411	Artists
	3413	Actors, Entertainers
	3414	Dancers and Choreographers
	3415	Musicians

TABLE A1.2 **SOC2010 STEM OCCUPATIONS**

Code	Description
Engineering Occupations	
2121	Civil engineers
2122	Mechanical engineers
2123	Electrical engineers
2124	Electronics engineers
2126	Design and Development engineers
2127	Production and process engineers
2129	Engineering professionals n.e.c.
2434	Chartered surveyors
IT Occupations	
1136	Information technology and telecommunications directors
2133	IT specialist managers
2135	IT business analysts, architects and systems designers
2136	Programmers and software development professionals
2137	Web design and development professionals
2139	Information technology and telecommunications professionals
Science Occupations	
2111	Chemical scientists
2112	Biological scientists and biochemists
2113	Physical scientists

2119	Natural and social science professionals n.e.c.	
2141	Conservation professionals	
2142	Environment professionals	
2150	Research and development managers	
2425	Actuaries, economists and statisticians (includes mathematicians)	

TABLE A1.3 **RELATIONSHIP BETWEEN CREATIVE AND STEM OCCUPATIONS**

Code	Description	STEM also?
	CREATIVE OCCUPATIONS	
Creative Services Occupations		
1 Advertising and marketing		
1132	Marketing and sales directors	No
1134	Advertising and Public Relations managers	No
2472	Public relations professionals	No
2473	Advertising accounts managers and creative directors	No
3543	Marketing associate professionals	No
2 Architecture		
2431	Architects	No
2432	Town Planners	No
2435	Chartered architectural technologists	No
3121	Architectural technologists and Town Planning technicians	No
3 Design: product, graphic and fashion design		
3421	Graphic Designers	No
3422	Product, Clothing and related designers	No
4 IT, software and computer services		
1136	Information technology and telecommunications directors	Yes
2135	IT business analysts, architects and systems designers	Yes
2136	Programmers and software development professionals	Yes
2137	Web design and development professionals	Yes
Content production		
5 Crafts		
5211	Smiths and forge workers	No
5411	Weavers and Knitters	No
5441	Glass and ceramics makers, decorators and finishers	No
5442	Furniture makers and other craft woodworkers	No
5449	Other skilled trades n.e.c.	No

6	**Film, TV, video, radio and photography**		
	3416	Arts officers, producers and directors	No
	3417	Photographers, audio-visual and broadcasting equipment operators	No
7	**Publishing**		
	2471	Journalists, newspaper and periodical editors	No
	3412	Authors, Writers	No
8	**Museums, galleries and libraries**		
	2451	Librarians	No
	2452	Archivists and curators	No
9	**Music, performing and visual arts**		
	3411	Artists	No
	3413	Actors, Entertainers	No
	3414	Dancers and Choreographers	No
	3415	Musicians	No
STEM Occupations outside the Creative Occupation definition (18 in total)			
	2119	Natural and social science professionals n.e.c.	Yes
	2141	Conservation professionals	Yes
	2142	Environment professionals	Yes
	2150	Research and development managers	Yes
	2425	Actuaries, economists and statisticians (includes mathematicians)	Yes
	2111	Chemical scientists	Yes
	2112	Biological scientists and biochemists	Yes
	2113	Physical scientists	Yes
	2121	Civil engineers	Yes
	2122	Mechanical engineers	Yes
	2123	Electrical engineers	Yes
	2124	Electronics engineers	Yes
	2126	Design and Development engineers	Yes
	2127	Production and process engineers	Yes
	2129	Engineering professionals n.e.c.	Yes
	2434	Chartered surveyors	Yes
	2139	Information technology and telecommunications professionals	Yes
	2133	IT specialist managers	Yes

TABLE A1.4 SOC2010 CODES CORRESPONDING TO STEM OCCUPATIONS FOR VARIOUS CLASSIFICATIONS

Please note that the original Hecker, BLS and Brookings definitions are defined using the much richer US occupation classification schemes – these have been mapped as closely as possible to the equivalent UK SOC2010 classification scheme. As this is neither an exact nor standardised process – other analysts may come up with different mappings.

Code	Description	Hecker	BLS	Brookings	RAE	DIUS
1122	Production managers and directors in construction			Yes		Yes
1123	Production managers and directors in mining and energy			Yes		Yes
1136	Information technology and telecommunications directors	Yes	Yes		Yes	Yes
1181	Health services and public health managers		Yes			Yes
1211	Managers and proprietors in agriculture and horticulture			Yes		Yes
2111	Chemical scientists	Yes	Yes	Yes	Yes	Yes
2112	Biological scientists and biochemists	Yes	Yes	Yes	Yes	Yes
2113	Physical scientists	Yes	Yes	Yes	Yes	Yes
2114	Social and humanities scientists		Yes	Yes		
2121	Civil engineers	Yes	Yes	Yes	Yes	Yes
2122	Mechanical engineers	Yes	Yes	Yes	Yes	Yes
2123	Electrical engineers	Yes	Yes	Yes	Yes	Yes
2124	Electronics engineers	Yes	Yes	Yes	Yes	Yes
2126	Design and Development engineers	Yes	Yes	Yes	Yes	Yes
2127	Production and process engineers	Yes	Yes	Yes	Yes	Yes
2129	Engineering professionals n.e.c.	Yes	Yes	Yes	Yes	Yes
2133	IT specialist managers	Yes	Yes			
2135	IT business analysts, architects and systems designers	Yes			Yes	Yes
2136	Programmers and software development professionals	Yes			Yes	Yes
2137	Web design and development professionals	Yes			Yes	Yes
2139	Information technology and telecommunications professionals	Yes	Yes		Yes	Yes
2141	Conservation professionals	Yes	Yes	Yes		Yes
2150	Research and development managers	Yes	Yes	Yes	Yes	Yes
2211	Medical practitioners		Yes	Yes	Yes	Yes
2212	Psychologists		Yes		Yes	Yes
2213	Pharmacists		Yes	Yes	Yes	Yes
2214	Ophthalmic opticians		Yes	Yes	Yes	Yes
2215	Dental practitioners		Yes	Yes	Yes	Yes

2216	Veterinarians		Yes	Yes	Yes	Yes
2217	Medical radiographers		Yes	Yes	Yes	Yes
2218	Podiatrists		Yes	Yes	Yes	Yes
2219	Health professionals n.e.c.		Yes		Yes	
2221	Physiotherapists		Yes	Yes	Yes	Yes
2223	Speech and language therapists		Yes		Yes	Yes
2231	Nurses		Yes			
2311	Higher education teaching professionals		Yes	Yes		
2312	Further education teaching professionals			Yes		
2423	Management consultants and business analysts		Yes	Yes		Yes
2425	Actuaries, economists and statisticians	Yes	Yes			
2431	Architects		Yes	Yes	Yes	
2432	Town Planners		Yes			
2433	Quantity surveyors			Yes		
2434	Chartered surveyors	Yes	Yes	Yes		
3111	Laboratory technicians	Yes	Yes	Yes	Yes	Yes
3112	Electrical and electronics technicians	Yes	Yes	Yes	Yes	Yes
3113	Engineering technicians	Yes	Yes	Yes	Yes	Yes
3114	Building and civil engineering technicians	Yes	Yes	Yes	Yes	Yes
3115	Quality assurance technicians	Yes	Yes	Yes		Yes
3116	Planning, process and production technicians			Yes		
3122	Draughtspersons	Yes	Yes	Yes		
3132	IT user support technicians	Yes			Yes	
3213	Paramedics		Yes		Yes	
3216	Dispensing opticians		Yes		Yes	Yes
3217	Pharmaceutical technicians		Yes		Yes	Yes
3218	Medical and dental technicians		Yes	Yes	Yes	Yes
3219	Health associate professionals n.e.c		Yes	Yes		
3319	Protective service associate professionals n.e.c.			Yes		
3422	Product, Clothing and related designers			Yes		
3443	Fitness instructors		Yes			
3512	Aircraft pilots and flight engineers			Yes		
3513	Ship and hovercraft officers			Yes		
3539	Business and related associate professionals n.e.c.	Yes	Yes			
3542	Business sales executives		Yes	Yes		
3545	Sales accounts and business development managers		Yes			

3550	Conservation and environmental associate professionals	Yes	Yes	Yes		
3567	Health and safety officers		Yes	Yes		
4112	National government administrative occupations			Yes		
4131	Records clerks and assistants		Yes			
5119	Agricultural and fishing trades n.e.c.			Yes		
5222	Tool makers, tool fitters and markers-out			Yes	Yes	
5224	Precision instrument makers and repairers			Yes	Yes	
5231	Vehicle technicians, mechanics and electricians			Yes	Yes	
5235	Aircraft maintenance and related trades			Yes		
5241	Electricians and electrical fitters			Yes	Yes	
5242	Telecommunications engineers	Yes	Yes	Yes	Yes	
5245	IT engineers	Yes		Yes	Yes	
5249	Electrical and electronic trades n.e.c.			Yes	Yes	
5314	Plumbers and heating and ventilating engineers			Yes	Yes	
5319	Construction and building trades n.e.c.			Yes		
5442	Furniture makers and other craft woodworkers			Yes		
5449	Other skilled trades n.e.c			Yes		
6131	Veterinary nurses		Yes			
6132	Pest control officers			Yes		
6141	Nursing auxiliaries and assistants		Yes	Yes		
6143	Dental nurses		Yes			
6148	Undertakers, mortuary and crematorium assistants			Yes		
7114	Pharmacy and other dispensing assistants		Yes			
8119	Process operatives n.e.c.			Yes		
8124	Energy plant operatives			Yes		
8126	Water and sewerage plant operatives			Yes		
8129	Plant and machine operatives n.e.c.			Yes		

2. APPENDIX OF SIC TABLES

TABLE A2.1 SIC07 CREATIVE INDUSTRIES AND THEIR SEGMENTS

Creative services industries		
1	**Advertising and marketing**	
	7021	Public relations and communication activities
	7311	Advertising agencies
	7312	Media representation
2	**Architecture**	
	7111	Architectural activities
3	**Design: product, graphic and fashion design**	
	7410	Specialised design activities
4	**IT, software and computer services**	
	5821	Publishing of computer games
	5829	Other software publishing
	6201	Computer programming activities
	6202	Computer consultancy activities
Content production industries		
5	**Crafts**	
	3212	Manufacture of jewellery and related articles
6	**Film, TV, video, radio and photography**	
	5911	Motion picture, video and television programme production activities
	5912	Motion picture, video and television programme post-production activities
	5913	Motion picture, video and television programme distribution activities
	5914	Motion picture projection activities
	6010	Radio broadcasting
	6020	Television programming and broadcasting activities
	7420	Photographic activities
7	**Publishing**	
	5811	Book publishing
	5812	Publishing of directories and mailing lists
	5813	Publishing of newspapers
	5814	Publishing of journals and periodicals
	5819	Other publishing activities
	7430	Translation and interpretation activities

8	**Museums, galleries and libraries**	
	9101	Library and archive activities
	9102	Museum activities
9	**Music, performing and visual arts**	
	5920	Sound recording and music publishing activities
	8552	Cultural education
	9001	Performing arts
	9002	Support activities to performing arts
	9003	Artistic creation
	9004	Operation of arts facilities

TABLE A2.2 SIC07 **HIGH-TECH INDUSTRIES**

SIC07 code	High-Tech industries	Average intensity % (2011-2013)	Average employment (2011-2013
610	Extraction of crude petroleum	26.73	16,820
910	Support activities for petroleum and natural gas extraction	22.99	62,370
1820	Reproduction of recorded media	22.33	7,317
1920	Manufacture of refined petroleum products	19.79	29,777
2013	Manufacture of other inorganic basic chemicals	17.59	15,517
2059	Manufacture of other chemical products n.e.c.	17.29	8,797
2110	Manufacture of basic pharmaceutical products	21.41	44,198
2120	Manufacture of pharmaceutical preparations	21.04	65,787
2452	Casting of steel	21.51	5,210
2611	Manufacture of electronic components	17.85	39,584
2620	Manufacture of computers and peripheral equipment	34.83	47,313
2630	Manufacture of communication equipment	21.16	21,752
2640	Manufacture of consumer electronics	15.08	7,652
2651	Manufacture of instruments and appliances for measuring, testing and navigation	16.37	44,428
2660	Manufacture of irradiation, electromedical and electrotherapeutic equipment	20.89	11,082
2670	Manufacture of optical instruments and photographic equipment	24.29	8,205

2752	Manufacture of non-electric domestic appliances	22.49	4,924
2811	Manufacture of engines and turbines, except aircraft, vehicle and cycle engines	15.14	28,511
2894	Manufacture of machinery for textile, apparel and leather production	15.07	5,073
3030	Manufacture of air and spacecraft and related machinery	23.10	126,816
3316	Repair and maintenance of aircraft and spacecraft	15.23	24,985
3511	Production of electricity	22.03	67,345
4221	Construction of utility projects for fluids	16.73	16,540
4222	Construction of utility projects for electricity and telecommunications	16.41	16,567
4299	Construction of other civil engineering projects n.e.c.	18.74	146,532
4920	Freight rail transport	15.45	7,558
4950	Transport via pipeline	19.67	5,738
5829	Other software publishing	50.35	18,988
6110	Wired telecommunications activities	27.20	53,024
6120	Wireless telecommunications activities	27.36	84,544
6190	Other telecommunications activities	23.43	29,314
6201	Computer programming activities	60.79	233,447
6202	Computer consultancy activities	59.85	287,209
6203	Computer facilities management activities	37.00	9,140
6209	Other information technology and computer service activities	45.31	31,092
6311	Data processing, hosting and related activities	22.00	15,740
6520	Reinsurance	15.49	13,170
6629	Other activities auxiliary to insurance and pension funding	25.79	11,966
7112	Engineering activities and related technical consultancy	37.61	354,048
7120	Technical testing and analysis	16.96	48,399
7211	Research and experimental development on biotechnology	53.24	13,020

7219	Other research and experimental development on natural sciences and engineering	47.91	83,594
7220	Research and experimental development on social sciences and humanities	18.61	11,506
7490	Other professional, scientific and technical activities n.e.c.	23.85	73,316
9104	Botanical and zoological gardens and nature reserve activities	20.11	12,387
9511	Repair of computers and peripheral equipment	32.63	31,902
9512	Repair of communication equipment	16.09	7,520

TABLE A2.3 **HIGH-TECH AND CREATIVE INDUSTRY CODES COMPARED (SIC07)**

Segment and Code			
Creative services industries			**High-tech also?**
1	**Advertising and marketing**		
	7021	Public relations and communication activities	
	7311	Advertising agencies	
	7312	Media representation	
2	**Architecture**		
	7111	Architectural activities	
3	**Design: product, graphic and fashion design**		
	7410	Specialised design activities	
4	**IT, software and computer services**		
	5821	Publishing of computer games	
	5829	Other software publishing	Yes
	6201	Computer programming activities	Yes
	6202	Computer consultancy activities	Yes
Content production industries			
5	**Crafts**		
	3212	Manufacture of jewellery and related articles	
6	**Film, TV, video, radio and photography**		
	5911	Motion picture, video and television programme production activities	
	5912	Motion picture, video and television programme post-production activities	
	5913	Motion picture, video and television programme distribution activities	

	5914	Motion picture projection activities	
	6010	Radio broadcasting	
	6020	Television programming and broadcasting activities	
	7420	Photographic activities	
7	**Publishing**		
	5811	Book publishing	
	5812	Publishing of directories and mailing lists	
	5813	Publishing of newspapers	
	5814	Publishing of journals and periodicals	
	5819	Other publishing activities	
	7430	Translation and interpretation activities	
8	**Museums, galleries and libraries**		
	9101	Library and archive activities	
	9102	Museum activities	
9	**Music, performing and visual arts**		
	5920	Sound recording and music publishing activities	
	8552	Cultural education	
	9001	Performing arts	
	9002	Support activities to performing arts	
	9003	Artistic creation	
	9004	Operation of arts facilities	
High-Tech Industries Outside the Creative Industries definition			
	610	Extraction of crude petroleum	Yes
	910	Support activities for petroleum and natural gas extraction	Yes
	1820	Reproduction of recorded media	Yes
	1920	Manufacture of refined petroleum products	Yes
	2013	Manufacture of other inorganic basic chemicals	Yes
	2059	Manufacture of other chemical products n.e.c.	Yes
	2110	Manufacture of basic pharmaceutical products	Yes
	2120	Manufacture of pharmaceutical preparations	Yes
	2452	Casting of steel	Yes
	2611	Manufacture of electronic components	Yes
	2620	Manufacture of computers and peripheral equipment	Yes
	2630	Manufacture of communication equipment	Yes
	2640	Manufacture of consumer electronics	Yes
	2651	Manufacture of instruments and appliances for measuring, testing and navigation	Yes

2660	Manufacture of irradiation, electromedical and electrotherapeutic equipment	Yes
2670	Manufacture of optical instruments and photographic equipment	Yes
2752	Manufacture of non-electric domestic appliances	Yes
2811	Manufacture of engines and turbines, except aircraft, vehicle and cycle engines	Yes
2894	Manufacture of machinery for textile, apparel and leather production	Yes
3030	Manufacture of air and spacecraft and related machinery	Yes
3316	Repair and maintenance of aircraft and spacecraft	Yes
3511	Production of electricity	Yes
4221	Construction of utility projects for fluids	Yes
4222	Construction of utility projects for electricity and telecommunications	Yes
4299	Construction of other civil engineering projects n.e.c.	Yes
4920	Freight rail transport	Yes
4950	Transport via pipeline	Yes
6110	Wired telecommunications activities	Yes
6120	Wireless telecommunications activities	Yes
6190	Other telecommunications activities	Yes
6203	Computer facilities management activities	Yes
6209	Other information technology and computer service activities	Yes
6311	Data processing, hosting and related activities	Yes
6520	Reinsurance	Yes
6629	Other activities auxiliary to insurance and pension funding	Yes
7112	Engineering activities and related technical consultancy	Yes
7120	Technical testing and analysis	Yes
7211	Research and experimental development on biotechnology	Yes
7219	Other research and experimental development on natural sciences and engineering	Yes
7220	Research and experimental development on social sciences and humanities	Yes
7490	Other professional, scientific and technical activities n.e.c.	Yes
9104	Botanical and zoological gardens and nature reserve activities	Yes
9511	Repair of computers and peripheral equipment	Yes
9512	Repair of communication equipment	Yes

3. APPENDIX ON EMPLOYMENT INTENSITY DISTRIBUTIONS

TABLE A3.1 INTENSITY DISTRIBUTION OF EMPLOYMENT CORRESPONDING TO THE OCCUPATION CLASSIFICATIONS CONSIDERED IN THIS REPORT (AVERAGE OF 2011 TO 2013)

Intensity	Brookings	DIUS	Hecker	RAE
0<5	253,000	275,000	355,000	281,000
5-10	318,000	286,000	340,000	243,000
10-15	240,000	265,000	259,000	259,000
15-20	232,000	234,000	140,000	101,000
20-25	542,000	454,000	126,000	573,000
25-30	395,000	256,000	92,000	150,000
30-35	675,000	282,000	66,000	244,000
35-40	508,000	77,000	33,000	274,000
40-45	441,000	8,000	205,000	75,000
45-50	405,000	40,000	68,000	183,000
50-55	65,000	158,000	5,000	-
55-60	18,000	138,000	28,000	318,000
60-65	171,000	-	160,000	170,000
65-70	170,000	-	210,000	156,000
70-75	-	-	-	2,000
75-80	-	-	-	-
80-85	-	-	-	-
85-90	3,000	-	-	-
90-95	-	-	-	-
95-100	-	-	-	-

Note: The figure in the leftmost column gives a range of intensities or share of employment within industries. The figures in the remaining columns specify how much STEM employment is to be found in industries whose intensity falls in the given range of frequencies.

– = sample too small to disclose

4. APPENDIX ON USING INTENSITY AS A DISCRIMINATOR BETWEEN INDUSTRIES

When intensity (or any other continuous indicator) is used to separate industries into two groups A and B, it is implicitly assumed that the industries in each group form a distinct statistical distribution. The intensity of any given industry is then a function of the group to which it belongs, together with other factors which are not entirely known. If the two groups have widely-differing means, and small standard deviations compared to the differences between the two means, and if both parameters are known, this offers an intuitive method of determining which group any given industry belongs to. Suppose that group A has a low average intensity, $\mu(A)$ and group B a high average intensity, $\mu(B)$. A 'threshold' frequency f^* can then be set, with $\mu(A) < f^* < \mu(B)$ such that any industry with an intensity less than f* will be assigned to group A, and any industry with an intensity greater than f* will be assigned to group B.

Difficulties arise if the distribution of intensities within the two groups is not known and in particular if $\mu(A)$ and $\mu(B)$ and the associated standard deviations are not known. In the case of the creative industries, the frequency distribution of employment as a function of intensity seems more clearly bimodal, and estimates of the population parameters of the creative and non-creative industries can be established, as was done in *Dynamic Mapping* by establishing a 'most likely' threshold between the two modes, so that statistical estimates of the population parameters, and the equiprobable separation between them, are established at the same time.

When studying the relation between STEM occupations and high-tech industries, this method cannot be used because the distributions are less clearly bimodal. In this situation, we must make use of additional information to inform industry classifications.

5. APPENDIX ON INDUSTRIES WITH A STEM INTENSITY OF MORE THAN 15 PER CENT(WITH MORE THAN 4000 EMPLOYEES) THAT DO NOT FALL WITHIN THE EUROSTAT HIGH-TECH DEFINITION

TABLE A5.1 NON-EHT INDUSTRIES WITH HIGH STEM INTENSITY

SIC07 code	Industry name	Workforce Employment Average (2011-2013)	STEM intensity Average (2011-2013
7112	Engineering activities and related technical consultancy	354,048	37.6
4299	Construction of other civil engineering projects n.e.c.	146,532	18.7
7490	Other professional, scientific and technical activities n.e.c.	73,316	23.8
3511	Production of electricity	67,345	22.0
910	Support activities for petroleum and natural gas extraction	62,370	23.0
7120	Technical testing and analysis	48,399	17.0
1920	Manufacture of refined petroleum products	29,777	19.8
2811	Manufacture of engines and turbines, except aircraft, vehicle and cycle engines	28,511	15.1
610	Extraction of crude petroleum	16,820	26.7
4222	Construction of utility projects for electricity and telecommunications	16,567	16.4
4221	Construction of utility projects for fluids	16,540	16.7
2013	Manufacture of other inorganic basic chemic	15,517	17.6
6520	Reinsurance	13,170	15.5
9104	Botanical and zoological gardens and nature reserve activities	12,387	20.1
6629	Other activities auxiliary to insurance and pension funding	11,966	25.8
6203	Computer facilities management activities	9,140	37.0
2059	Manufacture of other chemical products n.e.c.	8,797	17.3
4920	Freight rail transport	7,558	15.4
9512	Repair of communication equipment	7,520	16.1
1820	Reproduction of recorded media	7,317	22.3

4950	Transport via pipeline	5,738	19.7
2452	Casting of steel	5,210	21.5
2894	Manufacture of machinery for textile, apparel and leather production	5,073	15.1
2752	Manufacture of non-electric domestic appliances	4,924	22.5

ENDNOTES

1. This is on the basis of employment in both first and second jobs. That is, an individual who holds down two separate jobs in the creative industries is counted twice.
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3. Higgs, P., Cunningham, S. and Bakhshi, H. (2008) 'Beyond the Creative Industries: Mapping the UK's Creative Economy.' London: NESTA.
4. A concentration being defined here as an area where the proportion of the workforce employed in the creative (high-tech) economy is more than 1.2 times the proportion that the creative (high-tech) economy constitutes of the UK workforce.
5. Brinkley, I. (2006) 'Defining the knowledge economy.' London: The Work Foundation.
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7. Bakhshi, H., Freeman, A. and Higgs, P. (2013), 'A Dynamic Mapping of the UK's Creative Industries.' London: Nesta.
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10. DCMS (1998) 'Creative Industries Mapping document.' London: DCMS.
11. U.S. Congress, Office of Technology Assessment (1982) 'Technology, Innovation, and Regional Economic Development.' Washington DC: U.S. Government Printing Office.
12. This report (Bakhshi, Freeman, and Higgs 2013) is frequently mentioned, and so for ease of reading we refer to it henceforth as 'Dynamic Mapping'.
13. Hecker, D. (2005) High-technology employment: a NAICS -based update. 'Bureau of Labor Statistics, Monthly Labour Review.' Washington DC: Bureau of Labor Statistics.
14. Since the publication of 'Dynamic Mapping' the DCMS has adopted the methodology in the production of the official DCMS creative industries economic estimates. There are, however, some small differences in the assessment of which occupations are creative, and in the case of libraries and museums, for example, the DCMS has included industrial codes whose creative intensity is below the 'threshold' adopted in the 'Dynamic Mapping'. For consistency with the published official statistics we use the DCMS classifications in this report. See DCMS (2015) for the latest official creative employment estimates.
15. R&D intensity in manufacturing is measured by the ratio of an industry's R&D expenditure to value added, and knowledge intensity in services is measured by its share of tertiary educated persons at NACE 2-digit level. Only services labelled 'high-tech' by Eurostat are considered in our analysis.
16. DCMS (1998 and 2001) 'Creative Industries Mapping Documents.' London: DCMS.
17. Garnham, N. (2005) From cultural to creative industries. 'International Journal of Cultural Policy.'
18. Smith, C. (1998) 'Creative Britain.' London: Faber & Faber.
19. Bakhshi, H., Hargreaves, I. and Mateos-Garcia, J. (2013) 'A Manifesto for the Creative Economy.' London: Nesta.
20. Previous studies that have emphasised the importance of understanding the occupation-industry mix of economies include Currid and Stolarick (2010) The Occupation-Industry Mismatch: New Trajectories for Regional Cluster Analysis and Implications for Economic Development. 'Urban Studies.' 47(2); and Mellander, Stolarick and King (2011) 'What You Do, Not Who You Work For: A Comparison on the Occupational Industry Structures of the US, Canada and Sweden.' Martin Prosperity Institute Working Paper, University of Toronto.
21. DCMS (2014) 'Creative Industries Economic Estimates'. London: DCMS.
22. HM Treasury and BIS (2011) 'The plan for growth.' London: HM Treasury and BIS. p3.
23. Westlake, S. (2013) Rebalancing Act: Rationales and Policies for Sectoral Economic Rebalancing. 'Oxford Review of Economic Policy.'
24. Speech by Rt Hon David Willets MP (2012) 'Our High-tech future'.
25. Government Office for Science (2012) 'Technology and Innovation Futures: UK Growth Opportunities for the 2020s.' London: Government Office for Science.
26. Rt Hon David Willets MP (2013) 'Eight Great Technologies.' Speech at Policy Exchange.
27. Dyson, J. (2010) 'Ingenious Britain. Making the UK the leading High-tech exporter in Europe.'
28. DTI (2006) 'Science, Engineering and Technology skills in the UK.' London: DTI.
29. DFES (2006) 'The Supply And Demand for Science, Technology, Engineering And Mathematics Skills In The UK Economy.' London: DFES.
30. DIUS (2009) 'The Demand for Science, Technology, Engineering and Mathematics (STEM) Skills.' London: DIUS.
31. BIS (2011) 'STEM graduates in non-STEM jobs'. London: BIS.
32. UKCES (2011) 'The Supply of and demand for High-Level STEM skills.' See also UKCES (2013) 'Supply of and demand for High-Level STEM skills.'
33. UKCES (2011), op. cit., p4.
34. UKCES (2013), op. cit. http://www.ukces.org.uk/publications/er77-high-level-stem-skills-supply-and-demand
35. KPMG and Tech Monitor UK (2013) 'Understanding tech clusters and tracking the UK tech sector's outlook for employment and growth.'
36. BIS (2012) 'BIS industrial strategy: UK Sector analysis.' London: BIS.
37. BIS (2012) 'BIS industrial strategy: UK Sector analysis.' p9, Box 2. London: BIS.
38. Bakhshi, H., Freeman, A. and Higgs, P. (2013) 'A Dynamic Mapping of the UK's Creative Industries.' London: Nesta.
39. See ONS (2010) 'Standard Occupational Classification 2010.' Newport: ONS.
40. These are whether the occupation: 1. Involves a novel process, 2. Is mechanisation resistant 3. Is non-repetitive or performs a non-uniform function 4. Involves a 'creative' contribution to the value chain irrespective of context and 5. Involves interpretation, and not mere transformation. Different occupational codes at the four-digit level are assessed against these criteria, based on the detailed list of sub-occupations (the 'coding index') published by the ONS (ONS, 2010).

41. In a forthcoming report we use machine learning-based techniques to identify 'creative occupations' from the official codes. Almost all of the occupations scored as creative in 'Dynamic Mapping' also turn out to be creative using this approach, although a relatively large number of occupations not classified as creative in 'Dynamic Mapping' also turn out to be creative.
42. Hecker, D. (2005) High-technology employment: a NAICS-based update. 'Monthly Labour Review.' U.S. Bureau of Labour Statistics.
43. Bay Area Council Economic Institute Report (2012) 'Technology Works: High-Tech Employment and Wages in the United States.' San Francisco CA: Bay Area Council Economic Institute.
44. Echeverri-Carroll, E. and Ayala, S. (2009) Wage differentials and the spatial concentration of high-technology industries. 'Papers in Regional Science.' Vol. 88, Issue 3, pp.623-641. Note other studies in this area include Markusen, A., Chapple, K., Schrock, G., Yamamoto, D. and Yu, P. (2001) 'Gauging Metropolitan "High-Tech" and "I-Tech" Activity.' which uses a different threshold of three times the national average.
45. Rothwell, J. (2013) 'The hidden STEM economy.' Washington DC: Brooking Institution Metropolitan Program. The O*Net data is part of an ongoing project funded by the Department of Labor's Employment and Training Administration to provide detailed information about every occupation in the US economy.
46. We had originally hoped that the analysis could be expanded to include data from the 2011 Household Census as this also provides occupational and industry data and, in principle, covers the whole population so is not subject to sampling biases. In practice, however, the UK Census has no benefit for our research over the APS/LFS. First, because the Census utilises only 200 industry classifications at a mixture of 2-, 3- and 4-digit level of detail out of the SIC07 standard of 617 codes available at 4 digits of which 603 are used in the APS. In the Census only 21 4-digit industry codes used, and mostly relate to public and government activities. As a result, the ability to discriminate creative from other industries is significantly reduced from 30 industries under the APS to just 15 industries in the Census. Second, we cannot undertake regional analysis on census data as there appears to be no 4-digit occupation within the 3-digit industry employment tables released at the regional or sub-regional level. And third, because the Census is conducted only once every ten years it is unsuitable for time series analysis for anything other than long-term trends.
47. ONS (2011) 'Labour Force Survey. User Guide, Volume 1.' p7. Newport: ONS.
48. DCMS (2014a) 'Creative Industries Economic Estimates.' London: DCMS.
49. Note that these differ from those published in DCMS (2014a) which are based on 2011 and 2012 averages.
50. For consistency with the published DCMS statistics, all estimates of creative and high-tech employment in this report include the total of main and second jobs.
51. The equivalent table in the previous 'Dynamic Mapping' report is Table 10.2.
52. DCMS (2014a)'Creative Industries Economics Estimates, January.' London: DCMS.
53. The rationale for segmentation, given in Cunningham (2014) arises from work on Australian Census data at the most detailed level of industry and occupation classifications that are possible. CCI found correlations in their characteristics sufficient to allow them to be gathered into these two distinct sub-categories. In the UK context a similar distinction was also made in Nesta's (2006) 'Creating Growth' report, Appendix 3 – A refined model of the creative industries pp53-55.
54. See also Bakhshi, H., Freeman, A. and Higgs, P. (2013) 'A Dynamic Mapping of the UK's Creative Industries.' London: Nesta. Table 2.4, p13.
55. Ibid, p54.
56. The geography analysed in this sub-section is the European NUTS1 geography, which corresponds to Government Office Regions (GORs) in England and to the devolved administrations elsewhere in the UK. Location is measured on place of residence as opposed to place of work, so in some cases people may be working in one region and living in another, for example London and the South East of England. For more information see: http://www.ons.gov.uk/ons/guide-method/geography/beginner-s-guide/eurostat/relationship-of-nuts-to-uk-administrative-geographies.html
57. Freeman, A. (2009) 'London's creative workforce: 2009 update.' London: Greater London Authority.
58. Freeman, A. (2009) uses the term microspatial clustering. This work, based on IDBR data, calculated an index of geographical concentration at the level of the ONS's Medium Super-Output areas – approximately the size of electoral wards. Chapain et al., (2010) describe the 'dartboard effect' of microspatial clusters peppered across the UK that are hidden in the analysis of agglomeration economies at higher levels of aggregation.
59. The combined population of Manchester and Merseyside was 4.6 million according to mid-year estimates released by ONS on 17 May 2011. The population of the West Midlands was 5.6 million on March 27 2011, census day (http://www.ons.gov.uk/ons/rel/mro/news-release/census-shows-increase-in-population-of-the-west-midlands/censuswestmidlandnr0712.html). The population living within the Greater London Authority area was 7,825,200 on census day. A better comparison may be afforded by the population of the Greater London Functional Urban Region (Freeman and Cheshire 2006:5) of which the best available estimate is 12,255,000. This is still less than three times the population of Manchester and Merseyside and barely double that of the West Midlands.
60. For a discussion of the role of culture in world cities see BOP (2014) 'World Cities Culture Report'. London: BOP Consulting.
61. Hecker, D. (2005) High-technology employment: a NAICS -based update. 'Bureau of Labor Statistics, Monthly Labour Review.' Washington DC: Bureau of Labor Statistics.
62. DIUS (2009) 'The Demand for Science, Technology, Engineering and Mathematics (STEM) Skills'. London: DIUS.
63. BLS (2010) 'Options for defining STEM (Science, Technology, Engineering, and Mathematics) occupations under the 2010 Standard Occupational Classification (SOC) system: SOC Policy Committee recommendation to the Office of Management and Budget (OMB).' Washington DC: Bureau of Labor Statistics.
64. Greenwood, C., Harrison, M. and Vignoles, A. (2011) 'The labour market value of STEM qualifications and occupations.' Report prepared by the Institute of Education for the Royal Academy of Engineering.
65. Rothwell, J. (2013) 'The hidden STEM economy.' Washington DC: Brookings Institution Metropolitan Program.
66. These codes were mapped to the UK equivalent using a combination of techniques. Approximately half of the occupation codes were able to be mapped using a two-step process using the US SOC to ISCO 08 (International Standard Classification of Occupations 2008) cross walk as the first step and then using the ONS-supplied ISCO to UK SOC2010 crosswalk file as the second step. The balance of occupation codes were mapped using a manual process of matching the main job description for each occupation and identifying the most equivalent occupation title in the ONS's coding index of UK occupations.
67. Eurostat 'Aggregations of manufacturing and services based on NACE Rev 1.1.'
68. High-tech in manufacturing is defined using the intensity of expenditure in R&D and knowledge intensity is defined using the industries' employment share of tertiary educated people. It should be noted that most are 2-digit codes, as a result of which all the underlying 4-digit codes are included in our initial Eurostat High-Tech list.
69. OECD Directorate for Science, Technology and Industry (2011) 'ISIC rev.3 Technology intensity definition.' Paris: OECD.
70. Each 2-digit or 3-digit NACE industry was expanded to the SIC03 industry at the 4-digit level of detail. The UK industry coding index was then used to map the SIC03 industry activities to the most relevant SIC07 industry.

71. Industries with intensities above 15 per cent that were not classified within the Eurostat definition and have over 4,000 employees are included in Appendix 5.
72. In order to be included the industry had, in addition to passing the intensity test, had to have a workforce sample size that was greater than 4,000 for the average of 2011-2013.
73. Chapain et al., (2010) 'Creative clusters and innovation.' NESTA.
74. Helpman, E. and Trajtenberg, M. (1996) 'Diffusion of General Purpose Technologies.' Cambridge MA: NBER Working Paper No. 5773; Rincon, Vecchi and Venturini (2013) 'ICT as a General Purpose Technology: Spillovers, Absorptive Capacity and Productivity Performance.' NIESR discussion paper 416. London: NIESR.
75. In ongoing research we are exploring the use workforce intensity of ICT occupations to identify Information Economy industries.
76. e-skills UK, Intellect and BCS (2013) 'Information Economy Economic estimates 2013.' London: e-skills UK, Intellect and BCS.
77. In other research we have used data sourced from public online sources, as opposed to official survey data, to map the location of the video games industry at the hyperlocal level (Mateos-Garcia, Bakhshi and Lenel, 2014).
78. http://epp.eurostat.ec.europa.eu/portal/page/portal/nuts_nomenclature/introduction
79. In new research we are applying the 'Dynamic Mapping' approach to EU and North American countries.
80. The location quotients are calculated based on employment figures for main and second jobs in UK NUTS3 areas 2003 geographies (mapped using the 2006 geographies available from the Eurostat website).
81. West Inner London is made up of City of London, Camden, Hammersmith and Fulham, Kensington and Chelsea, Wandsworth and Westminster.
82. East Inner London is made up of Hackney, Haringey, Islington, Lambeth, Lewisham, Newham, Southwark and Tower Hamlets.
83. West and North West Outer London is made up of Barnet, Brent, Ealing, Harrow, Hillingdon, Hounslow and Richmond upon Thames.
84. South Outer London is made up of Bromley, Croydon, Kingston upon Thames, Merton and Sutton.
85. Source Rolls Royce website.
86. Source Sellafield website
87. Midlands Aerospace Alliance 'Mobilising the Midlands aerospace cluster.' Coventry: Midlands Aerospace Alliance.
88. Nathan, M. and Vandore, E. (2014) Here Be Startups: Exploring a young digital cluster in Inner East London. Forthcoming in 'Environment and Planning.'
89. Florida, R. (2012) The Joys of Urban Tech. 'The Wall Street Journal.' 31 August 2012.
90. KPMG and Tech Monitor UK (2013) 'Understanding tech clusters and tracking the UK tech sector's outlook for employment and growth.' p9.
91. The range is the difference between the largest and the smallest LQ for an industry grouping across the NUTS3 geographies. Standard deviation is a measure of dispersion which is based on the square of deviations from the mean. The Gini coefficient is a measure of equality among the LQs, which is bounded between 0 (all LQs are the same) and 1 (Complete inequality, only one NUTS3 area has a positive LQ).
92. Bakhshi, H., Freeman,A. and Higgs, P. (2013) 'A Dynamic Mapping of the UK's Creative Industries.' London: Nesta.
93. Bakhshi, H., Lee, N. and Mateos-Garcia, J. (2013) represents an attempt to do this using earlier classifications for creative occupations and industries.

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