THE CAMBRIDGE BIOSCIENCE IMPACT ASSESSMENT STUDY

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Institute of Public Health,
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The Aims and Scope of the Study

1. Although the importance of the Bioscience sector to the Cambridge economy is widely recognised there is very little up to-date research that shows the size of the economic impact that it is making and how this has been changing;
2. This is unfortunate because in these times of austerity continued research funding cannot be taken for granted and the sector has to demonstrate in a robust manner its impact on the growth of Cambridge, the wider region and the nation as a whole;
3. Moreover, it is important to identify the actions required by those involved in industry, academia and government to maximise the local and national economic contribution that Cambridge biosciences can make;
4. To identify the economic impact of the Cambridge Bioscience sector is challenging and requires a robust conceptual framework that identifies the diverse and complex interactions that exist between individuals, companies, universities and government and which occur across different geographies;
5. The complexity suggests that it is best to begin by developing a broad conceptual framework and modelling approach and undertake some baseline cross-sectional research. It is with this that this study has been concerned;
6. The study has not been concerned with quantifying the health related benefits of Cambridge bioscience;
7. The research approach has adopted both a qualitative and quantitative element. The quantitative research has involved economic modelling using various tools that are discussed in Annex 5. Besides the quantitative modelling it has also been necessary to survey and interview key stakeholders in the Cambridge Bioscience cluster (described in Annex 1);
8. The research has considered; a) the factors driving the growth of the bioscience cluster in Cambridge and how it may develop in the future, b) the competitiveness of the Cambridge Bioscience cluster relative to elsewhere and the factors that give it a competitive edge (the more unique the Cambridge offer the more likely the economic benefits it produces contribute to national growth) and c) the constraints on the growth and development of the cluster and the actions that might help to overcome them.

The Cambridge Bioscience Cluster.

1) Today the Cambridge bioscience cluster is responsible for some 13,800 jobs spread geographically between 18 parks (or sub-clusters) within a radius of approximately 10 miles of Cambridge, with outliers in Ely, Newmarket, Huntingdon-Godmanchester and Royston. Estimates suggest there may be as many as 185 firms, institutes or other organizations involved in the biotechnology, life sciences, medical technology and pharmaceuticals within the cluster **(Page 17)**.

2) Considered as a whole**,** the cluster involves a close synergy between four main components

that make up the regional innovation system, namely university-industry-government and charitable funding foundations. There are close links between research staff in medical and related Departments in the University and local bioscience companies, either in the form of collaboration, funding, an employment route for University graduates, or as vehicles for the commercialization of University-based research; while much of the research in those University departments is funded by public bodies such as the Medical Research Council and in the research institutes by major charitable bodies, such as the Wellcome Trust. The Cambridge Bioscience cluster is benefiting from the presence and convergence in Cambridge of biotechnology, information technology and nanotechnology **(Page 18).**

3) The University is a source of basic and applied research, which can be commercialized with the help of the University's Enterprise Unit. At the same time the University supplies highly qualified graduates and scientists that make up a large skilled local labour pool available to local bioscience, medical science and pharmaceutical companies;

4) Externally originating public funds support the primary health care sector in the city-region, which in turn has strong links to, and interactions with the University, whilst also supporting relevant research within the University. Local companies both compete and collaborate in bioscience, drug development and related medical fields, in some cases via strategic alliances with similar firms elsewhere (including overseas);

5) A small but significant venture and private equity market has developed locally, to provide finance for new and expanding companies. In some cases, venture finance also originates outside the region, in London or even overseas. The synergies between these different components that together make up the Cambridge bioscience cluster are not only mutually reinforcing, but act to stimulate innovation, enterprise and growth **(Page 20).**

6) Patents are often used as an indicator of innovation, though not unproblematic in how they may be interpreted. OECD data on patenting is available for Cambridgeshire, effectively the Cambridge cluster. The most striking feature is the rapid growth in life sciences in Cambridgeshire from the early 1990s onwards led by biotechnology and pharmaceuticals. Since the mid-2000s the overall level of patenting has levelled off somewhat, mainly in biotechnology. Patenting in pharmaceuticals and medical technology has remained more or less steady and now accounts for most of the cluster's patent activity **(Page 20).**

7) Five main regional innovation systems dominate UK patenting activity – Cambridgeshire, Inner London (West), Oxfordshire, Hertfordshire, Inner London (East), and Greater Manchester (South). These areas account for more than a fifth of national patenting, across all fields. Cambridge clearly stands out as the main centre of innovation in the UK. These same five clusters or regional innovation systems also dominate patenting in the life sciences, and again Cambridge leads, although by a smaller margin **(Page 21).**

8) Of further interest is how the Cambridgeshire cluster (and other UK bioscience centres) compares with international counterparts, in particular in the USA and Germany. In the USA, five sub-regional centres or clusters dominate life science patenting activity, namely San Diego, Boston, San Jose, Rayleigh-Durham-Chapel Hill, and Seattle. In terms of sheer number of patents Boston and San Jose are in a league of their own, with between 13 and 15

times as many patents as Cambridgeshire and 9 times as many as Munich or Berlin, the major centres in Germany. But the US areas are geographically more extensive, and have much larger populations than the UK or German clusters. Standardising by the size of each area's working–age population reveals that patenting rate gaps are noticeably smaller, although San Diego and Boston still emerge as being more innovative. However, Cambridgeshire and Oxfordshire are not far behind, and are well ahead of the German centres **(Page 22).**

9) The volume of research funding flowing into the knowledge based institutions has also been gaining in strength. Some indication of this is the volume of research funding in the University of Cambridge. Of the £371.1 million of research funds secured in 2013/2014, some 60% was in the areas of Clinical Medicine and Biological Sciences. The share attributed to this sector has increased significantly over the last ten years with the University Planning department indicating that since 2006-07 more than half of the awards (by value) to the University have been to Clinical Medicine and Biological Sciences. Some 46% of the funding in the sector is now from UK Charities **(Page 24).**

10) Companies surveyed on the Babraham Campus as part of this study were asked why they located in the Cambridge cluster. The three most important factors were the presence of local networks and contacts, the availability of suitable premises and the quality of the labour force **(Page 26).**

11) The companies were also asked to consider how the Cambridge Bioscience cluster compared to other locations in the United Kingdom with which they were familiar. The Cambridge Bioscience cluster scored highly on all of the key proximity attributes identified in the international research literature as being important influences on the relative competitiveness of a bioscience cluster. The presence of local contacts and networks stood out, as well as proximity to research institutions to obtain intellectual property and the presence of similar companies for collaborations and technology-spillovers. The scores suggest a very significant competitive advantage to the Cambridge cluster compared to elsewhere in the United Kingdom **(Page 26).**

12) Interviews with venture capitalists and others that provided funding for the cluster indicated that what impressed them about the Cambridge cluster was the depth of the knowledge base, the extensive networking and interactions that were taking place between the knowledge based institutions, companies and other relevant organisations and the way in which the 'soft infrastructure' needed to promote interaction and exchange had grown and developed in recent years. Particularly impressive was the manner in which different technologies and knowledge bases were coming together to find common applications **(Page 28).**

13) Moreover, it was apparent to those involved in the provision of finance that there was a very conducive and cooperative attitude and approach to Intellectual Property from the major Knowledge Based Institutions, many of whom had committed substantial human resource to help to promote the knowledge exchange and enterprise that underpins successful clusters.

14) The investment by the knowledge based institutions in basic research and also in the provision of world class teaching was widely recognised and admired. It was also clear that the geography of Cambridge facilitated interaction across what is becoming known as the

London, Stansted and Cambridge Corridor linking the core Cambridge establishments with GSK and the Stevenage Catalyst and the substantial Bioscience base focusing around the new Crick Institute at Kings Cross and elsewhere in London **(Page 29).**

15) The overall view was that the Cambridge Bioscience cluster was increasingly consolidating its position as probably the best bioscience cluster in Europe. The scope for extensive growth in life sciences in the Corridor is very strong indeed.

The impact of the Cambridge Bioscience cluster on the wider economy

Indicator	Contribution to the Cambridge economy 2013 (% of total in brackets).
Direct employment	13,800 jobs (7.6% of total)
Direct gross value added (GVA)	£907m (11.4% of total)
Total employment (including indirect and induced effects)	25,300
Total GVA (including indirect and induced effects)	£1.54 bn

1) In 2013, the Bioscience sector is estimated to have been responsible for 13,800 jobs in Cambridge (7.6% of total employment) and created £907m in gross value added (GVA); 11.4% of the total; while across Great Britain (GB) as a whole it accounted for 2.0% of employment and just under 2.4% of GVA. The majority of employment and three quarters of GVA in Bioscience is in Research and Experimental Development, with Pharmaceuticals accounting for much of the remainder. The Cambridge economy has a relatively high density of Bioscience employment; the share of total employment in Cambridge (at 7.6%) is 2.5 times higher than GB average, and higher than in any other area of GB. Taking account of knock-on effects to businesses and workers (indirect and induced), the Cambridge Bioscience sector generated a total of 25,300 jobs and £1.54bn in GVA for the UK economy in 2013. The indirect and induced effects each amount to just under 6,000 employees and over £310m in real GVA. Most of the indirect impacts are in Financial and Business services whilst Commerce Services, including Distribution and Accommodation and Food Services, makes up a large proportion of the induced effect **(Pages 30-32).**

2) The majority of the employment generated by the Cambridge Bioscience sector is in high-skilled jobs, although a substantial number of medium- and low-skilled jobs are created by the indirect and induced effects **(Page 34).**

Projections for the future of Cambridge Bioscience

1) Out of three scenarios presented for future growth of Cambridge Bioscience, the central projection, based on historical trends, projects an increase of 10,800 jobs and £1.14bn in GVA from the 2013 level by 2030. This compares to an increase of less than 2,000 jobs in the low projection and 21,000 jobs in the high projection. Reaching the £2bn increase in GVA projected by the high projection is subject to measures to improve productivity and accommodate a larger workforce **(Page 48).**

2) If future employment growth was to follow its historical trend, by 2030, 11,000 additional jobs would be generated. To put this in context, the Office of National Statistics (ONS) projects that population in the area will increase by 33,000 over the same period. In the short term, growth in the number of households is expected to outpace population growth as a result of declining household size, putting more pressure on the housing market in Cambridge which has experienced substantial increases in prices **(Page 48).**

Key constraints and the policy agenda

1) As the Cambridge Bioscience sector has grown it has placed increasing demands on the built environment of the Cambridge economy. **Housing and transport related infrastructure has come under increasing pressure (Page 49);**

2) **The rising cost of living has clear implications for affordability and the real incomes of those on relatively lower incomes.** Those interviewed as part of this study considered that the downsides at the present time revolved around the fragility of core infrastructure particularly as it related to connectivity and housing to accommodate the people. The impact of the high cost of living in Cambridge and problems with travelling around the cluster was highlighted in the findings of the business survey undertaken as part of this study. Companies pointed to **the cost of housing, commuting problems for their employees and the lack of quality and choice in the housing market (Page 50).**

3) Companies also identify problems **with obtaining affordable and relatively low cost floorspace together with securing finance. Laboratory and incubator space was also perceived to be a constraining influence and, perhaps surprisingly, good mobile telecommunications reception (Page 51).** Grade A floorspace is in very short supply and there are particular constraints on incubator floorspace **(Page 51).**

4) The ability of local infrastructure to accommodate the people and businesses required to grow the Cambridge Bioscience is clearly a major issue that has to be addressed if further growth potential is to be realised. However, during the course of the research a number of other issues were highlighted by those who participated in the study. Key issues related to the need to maintain an adequate **flow of research funding from Government including that for the NHS and the charitable sector and** the importance of ensuring the continued availability **of finance at the relevant stages of the commercialisation process.** Whilst it was recognised that seed-corn funding was less of a problem at the present time there are still major issues around businesses accessing funds as they seek to scale up to the market. A further factor identified was the importance of **speeding-up the adopting of new drugs by the NHS as a continuing issue in the translation process (Page 53)**.

Next steps

1) The evidence presented in this study highlights the important economic contribution that Cambridge Bioscience is making to the growth of Greater Cambridge. The strength of the Cambridge bioscience cluster confirms that it is rapidly becoming the most prominent cluster of its kind in Europe and this reinforces the belief that it is making a significant addition to the growth of the United Kingdom economy as a whole **(Page 53);**

2) However, the continued growth and success of the cluster cannot be taken for granted. There are a number of areas where action is required if the momentum is to be maintained and the cluster is to realise its undoubted economic potential. Cambridge City Council, South Cambridgeshire Council, Cambridgeshire County Council and other key stakeholders including the University of Cambridge are struggling to find the resources that are required to expand the basic infrastructure required to allow all of its technology based clusters to grow and prosper;

3) The City Deal is a central element in obtaining the funding required to tackle key infrastructure and housing issues. It is a powerful and effective alliance of the relevant partners including the Local Enterprise Partnership. Much good work has been done by those involved to make it happen but the reality is that more resources and coordinated action will be required in the years ahead;

4) The specific needs of the Cambridge Bioscience cluster will only be met by coordinating the actions and resources of the key stakeholders we present in this report and which we believe underpin the workings of the Cambridge Bioscience cluster **(Page 54)**. We would emphasise the importance of aligning and sharing agendas to ensure that a truly strategic approach is adopted that continues to build and sustain the research and teaching excellence of the knowledge base that attracts the people and ideas that influence the continued success of the cluster. The relevant boundaries of interest have to be shared across the innovation network to ensure that ideas are translated into commercial application. A central component in building the required capacity is to continue to build an evidence base that can help to inform policy. In this respect it is important to monitoring, assess and benchmark the ongoing economic impact of the cluster on the local and national economy.

1. The aims and scope of the study

Review objectives

1.1 One of the most successful parts of the ‘Cambridge Phenomenon’ (the development of technology based companies around a world leading university) has been the development of the biosciences. The biosciences have attracted major charitable and public sector funding in recent years that has included the Cambridge Biomedical Research Centre (£220m NHS funding for research over 10 years), the MRC Laboratory of Molecular Biology (now based in a new £212m building on the Addenbrooke’s Campus which opened in 2013), the Wellcome Trust funded Sanger Centre (based at Hinxton Hall and which now employs 800 people) and the Cancer Research UK Cambridge Institute (now based in a new £50m building on the Addenbrooke’s Campus).

1.2 Associated with these centres of basic scientific research has been the development of industrial links. These have included the location of biotech companies to the area around Cambridge, for example the recently announced move of Astra-Zeneca’s global headquarters to the Addenbrooke’s site including the relocation of 2,000 scientists from its other locations. The MRC Laboratory of Molecular Biology claims to have generated over £330m of commercial income through technology transfer[1].

1.3 Although the impact of the Bioscience sector to the Cambridge economy is widely recognised there is very little up to-date research that shows the size of the economic impact that it is making and how this has been changing through time. This is unfortunate because in these times of austerity continued funding cannot be taken for granted and the sector has to demonstrate in a robust manner its impact on the growth of Cambridge, the wider region and the nation as a whole.

1.4 Moreover, the visible success of Cambridge University and NHS based scientific endeavour in attracting research funds and inward investment from industry raises a number of questions of more general interest for which the Cambridge bioscience sector might be used as a case study. These include the contribution of Cambridge bioscience science to the local economy and the benefits and possible costs of its recent growth. It is important to assess the actions required by those involved in industry, academia and government to maximise the local and national economic contribution that Cambridge bioscience sciences can make.

1.5 Identifying the economic impact of the Cambridge Bioscience sector on the local economy and eventually the United Kingdom as a whole is challenging. If it is to be addressed effectively it has to be underpinned by a robust conceptual framework that

[1] http://www2.mrc-lmb.cam.ac.uk/about-lmb/

identifies the diverse and complex interactions that exist between individuals, companies, universities and government. These occur across different geographies and evolve through time. This complexity suggests that it is best to begin by developing a broad conceptual framework and modelling approach and undertake some baseline cross-sectional research. It is with this that this study has been concerned. It should be made clear at the outset that this study is not concerned with quantifying the health related benefits of Cambridge bioscience.[2] The intention has been to put in place a modelling framework that can be developed and improved as more research is undertaken.

Methodology

1.6 This research methodology used in this study has adopted both a qualitative and quantitative element. The quantitative work has involved economic modelling using various tools to quantify the impact of the Cambridge bioscience sector on the growth of the Cambridge economy. The tools used include: Cambridge Econometrics' (CE) Local Economy Forecasting Model (LEFM) ; CE's Multisectoral Dynamic Model (MDM-E3 of the UK and regions; and analyses of various sources of data including ONS' input-output and other economic and demographic data. Annex 5 describes the methodology in more detail and its limitations.

1.7 Besides the quantitative modelling work it has also been necessary to undertake more qualitative analysis. This has involved a survey of businesses on the Babraham Research Campus and interviews with stakeholders in the Cambridge Bioscience sector including companies in the Cambridgeshire study area. Annex 1 describes the approach in more detail and its limitations. The interviews with the stakeholders sought to understand more about what has driven the growth of the bioscience cluster in Cambridge and the factors that are likely to influence its future growth. They also probed the geography of the cluster and how it relates to other places and in particular that of the London Cambridge Stansted Life Science Corridor that is now being actively promoted.[3]

The discussions also probed the competitiveness of the Cambridge Bioscience cluster relative to elsewhere in the United Kingdom and elsewhere in the world and the factors that appear to give it a competitive edge. The more unique the Cambridge offer then the more likely the economic benefits it produces contribute to national as well as local economic growth in the United Kingdom. A further area of interest was to establish the constraints that might hinder the growth and development of the Cambridge Bioscience cluster and what actions might help to overcome them.

[2]. Insight into how the health related benefits can be assessed, albeit in the American context, is shown in 'Exceptional Returns; The Economic value of America's Investment in Medical Research. http://www.laskerfoundation.org/media/pdf/exceptional.pdf

[3] http://lscc.co/sectors-2/life-sciences/

2. The Cambridge Bioscience cluster.

Introduction

2.1 Ever since it's early emergence in the early-1970s, the Cambridge high-tech economy has attracted widespread attention and attempts to characterise its development. It has been variously labelled as 'Silicon Fen', the 'Cambridge Phenomenon', and the 'Cambridge Cluster'. The latter term is particularly apt since the notion of a 'cluster' has itself become a key analytical and policy category in contemporary business and technology studies.

2.2 The concept of the 'cluster' has its origins in the work of Alfred Marshall, the Cambridge economist[4], who writing in the 1890s noted how many of the industries that had spearheaded Britain's rise to economic supremacy over the course of the nineteenth century were highly localized in particular places across the country. He argued that local specialisation conferred certain key advantages that fuelled the growth and success of these 'industrial districts', namely the attraction of workers skilled in the industries concerned, the growth of dedicated intermediate suppliers and supporting trades, and the diffusion of knowledge and know-how amongst the firms in the district (what he called an industrial atmosphere, or 'something in the air'). Some ninety years later Michael Porter[5], the Harvard business economist revived and extended Marshall's idea of the 'industrial district', and, by linking it explicitly to firm competitiveness, promoted the notion of the 'cluster', which has since become an indispensable component in the local economic policy making toolkit the world over. Porter defines a cluster as:

> 'Geographic concentrations of interconnected companies, specialised suppliers, service providers, firms in related industries, and associated institutions (for example, universities, standards agencies, and trade associations), in particular fields that compete but also cooperate (Porter, 1998, pp. 197-198).'

2.3 According to his model, this geographical concentration of related, competing and cooperating firms creates a series of advantages that fuel the cluster's growth and success, in three broad ways. First, by increasing the productivity of constituent firms or industries; second, by increasing their capacity for innovation and thus for productivity growth; and third by stimulating new business formation that supports innovation and expands the cluster. Many cluster advantages rest on external economies or spillovers across firms and industries of various sorts.

2.4 A cluster may thus be defined as a system of interconnected firms and institutions whose value as a whole is greater than the sum of its parts (1998, p. 213). So defined, it emerges that the dynamics of a cluster can be strongly self-reinforcing and cumulative,

[4] Marshall, A (1890). Principles of Economics, London: McMillan.
[5] Porter, M.E (1990).The Competitive Advantage of Nations, London, Macmillan.

whereby once a critical mass is reached, external localisation economies can lead to expansion through new firm formation (entrepreneurship), new knowledge creation and spillovers (innovation), and possible branching into related and complementary activities. Much depends on the type of specialization, and the types of knowledge, skill and expertise involved.

2.5 There is a considerable difference, for example, between a product-base cluster, say, shoe production (as in Felgueiras in Portugal, mentioned by Porter), and a technology based one, say, computing software (as in Silicon Valley, California). The latter, in principle, offers far more scope for branching into related, applied and complementary activities than the former. Arguably, this distinction has been important in the case of Cambridge. From the very start, the basis of the Cambridge cluster has been more one of technology than a specialised product. In the initial years the early development centred on scientific instruments and computing. Over time, a series of related and complementary technologies have developed from those beginnings, and the range of technological specialisms has expanded accordingly. In effect there are now several 'sub-clusters' in the Cambridge Cluster (see Figure 2.1), perhaps all linked directly or indirectly by some degree of reliance on applied computing. The concept of 'converging technologies' in the Cambridge technology cluster is aptly demonstrated in Figure 2.2.

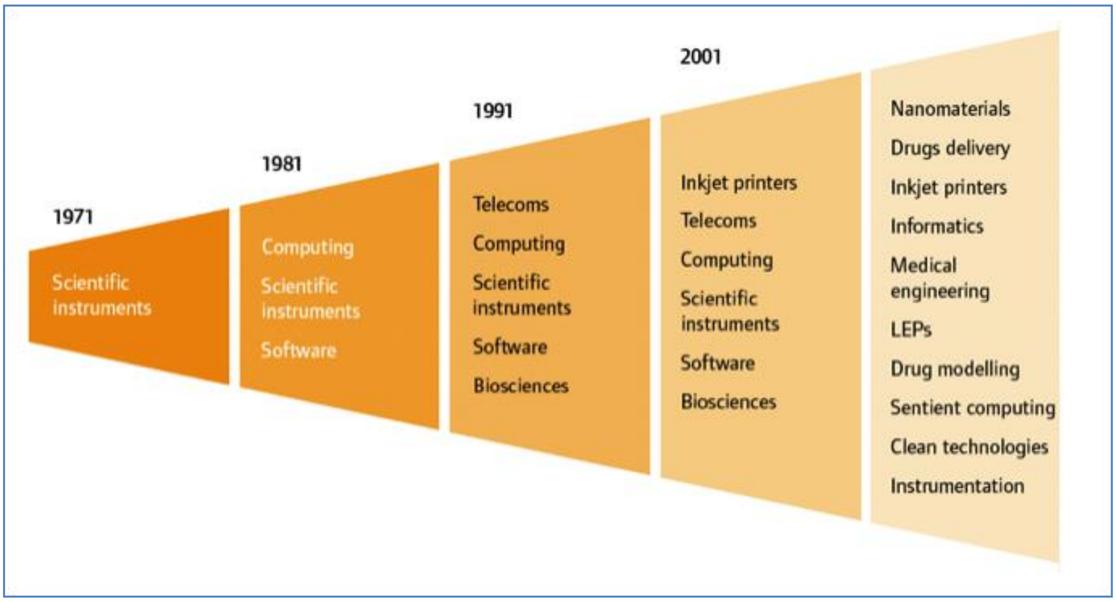
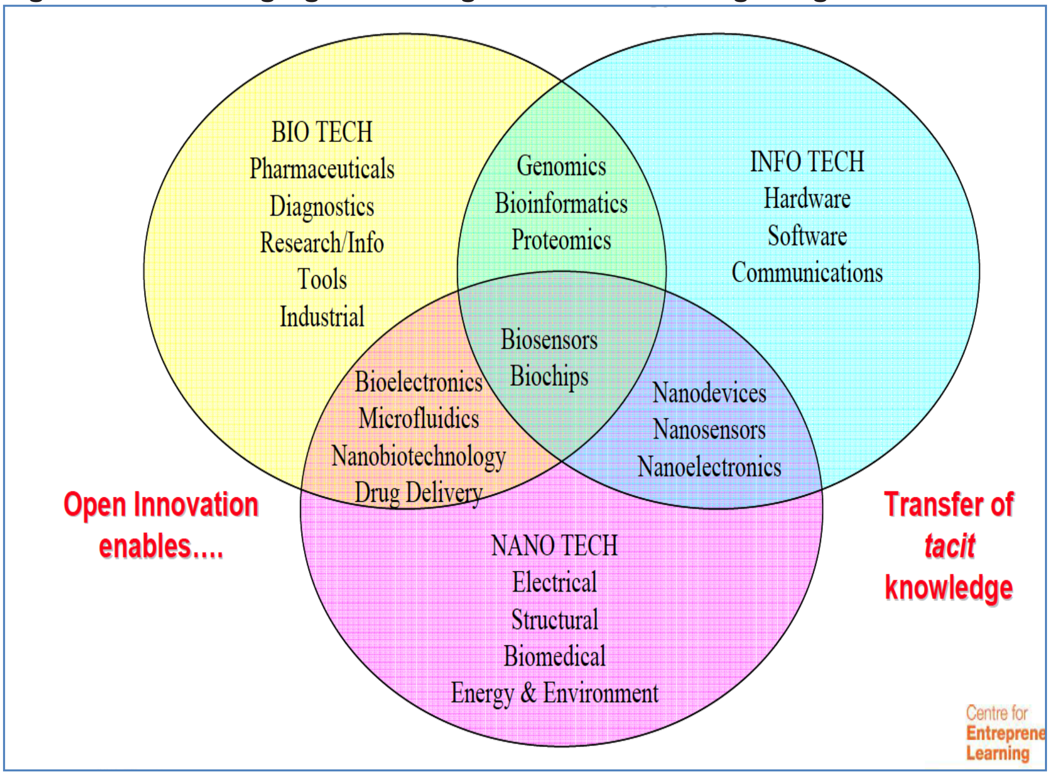


Figure 2.1: The Evolution of the Cambridge 'High-Tech' Cluster

2011

Source: PACEC, Greater Cambridge Partnership

Figure 2.2: Converging Technologies in the Cambridge 'High-Tech' Cluster



Source: Alan Barrell. The Cambridge Phenomenon-Fulfilling the Potential (2005)

2.6 Given the importance of technological and scientific knowledge in the Cambridge Cluster, it can also be thought of a (sub) regional innovation system. This notion has received considerable attention in the academic and policy communities. Whilst similar in some respects to a cluster, the idea of a regional innovation system is intended to capture the centrality of knowledge production within and between a localized system of firms, institutions and associated organizations. Regional innovation systems are geographical expressions of what has been called the 'triple helix'. The concept of the 'triple helix' (Ettkowitz, 1993[6]; Etkowitz and Leyesdorf[7], 1995) refers to the university-industry-government system of interaction and knowledge production. The thesis is that the potential for innovation and economic development in today's 'knowledge society' lies in a more prominent role for the university and in the hybridization of elements from university, industry and government (public sector organizations and institutions) to generate new formats and platforms for the production, transfer and application of knowledge.

2.7 In the case of Cambridge, it has been repeatedly argued that the University – its science departments and institutes – have played a formative role in the emergence and especially the development of the cluster. The spin out of commercialisable ideas and inventions from research scientists within the University has been and continues to be a key

[6] Etzkowitz, H. 1993. Technology transfer: The second academic revolution. Technology Access Report 6, 7

[7] Etzkowitz, H. and Leydesdorff, L. (1995). The Triple Helix: University Industry-Government Relations: A Laboratory for Knowledge -Based Economic Development. EASST Review 1414 -19.

source of the knowledge production and innovation system on which the cluster is based. Some of that research is publicly funded (by Government or research councils), some by charitable and related organizations. The University also provides a steady supply of science graduates, many of whom find employment in the firms and institutes that make up the cluster. Over the years a synergy has developed between University-based science research and the technological and scientific base of the cluster. A key feature of the innovation system that is the Cambridge cluster is its focus primarily on 'analytical' knowledge, which can be distinguished from 'synthetic' knowledge and 'symbolic' knowledge (Table 2.1).

Table 2.1: Differentiated Knowledge Bases

Analytical (science based)	Synthetic (engineering based)	Symbolic (artistic based)
Developing new knowledge about natural systems by applying scientific laws and techniques	Applying or combining (in novel ways) existing knowledge; knowhow	Creating meaning, aesthetic qualities, affect; know-how critical
Scientific knowledge, models	Problem solving; inductive, custom production	Creative process
Collaboration with and between research units Strongly codified knowledge; content, abstract	Interactive learning with customers and suppliers Partially codified knowledge, strong tacitness	Learning by doing in studio, project teams Strong semiotic knowledge content, some forms highly context specific
EG. Drug development	E.g. Mechanical engineering	E.g. Advertising

Source: Asheim and Gertler, (2005)[8]

The Cambridge Bioscience Cluster and Innovation System

The Size and Scale of the Cluster

2.8 The origins and development of the biosciences cluster in Cambridge can be linked to a series of major breakthrough scientific discoveries, beginning with Crick and Watson's discovery of the double helix model of DNA in the 1950s.

2.9 Insight into how major scientific ideas shaped the development of Bioscience is provided in 'The Cambridge Phenomenon; 50 Years of Innovation and Enterprise' by Kate Kirk and Charles Cotton[9]. Their genealogy timeline traces the science of Genomics beginning in 1953 with Francis Crick and James Watson discovering the structure of DNA followed by the first genome sequencing by Fred Sanger in 1977. The next major step was the development of a new approach to DNA sequencing in 1997 through the pioneering work of Shankar Balasubramanian and David Klenerman. Balasubramanian then went on

[8] Asheim, B and Gertler, M (2005). The Geography of Innovation. The Oxford handbook of innovation,

[9]Kirk, K and Cotton, C (2015). The Cambridge Phenomenon; 50 Years of Innovation and Enterprise. Third Millennium Publishing.

with John Berriman to found Solexa which by 2006 under the leadership of John West had developed the capability to produce fast, low cost gene sequencing. This company was acquired by Illumina in 2006 (for $650 million). The ability to sequence at ever lower cost has continued to the present day with interviewees stating it is now possible to sequence a human genome for £700.

2.10 Moving alongside genomics has been the development of Monoclonal Antibodies beginning in 1975 with the work of George Kohler and Cesar Milstein. The next big step forward was the invention by Greg Winter in 1986 of the first humanised monoclonal antibody. Professor Winter kindly agreed to be interviewed as part of this research.

2.11 In 1989 Greg Winter and David Chiswell established Cambridge Antibody Technology (CAT). By 2006 CAT had developed Humira, the first human monoclonal antibody drug. CAT was bought by AstraZeneca in 2006 which then went on to buy the US company Medimmune in 2007 (for $15 billion) which it merged with CAT 'combining Medimmune's manufacturing capacity and drug development pipeline with CAT's antibody libraries and expertise in drug discovery[10]'. This brought together Medimmune's formidable manufacturing capability with CAT's antibody libraries and expertise (Kirk and Cotton, pg 106). Jane Osborn who is Vice President of Research at Medimmune also kindly agreed to be interviewed during the present research.

2.12 Today the Cambridge bioscience cluster, as defined here directly employs some 13,800. It is spread geographically between 18 parks (or sub-clusters) within a radius of approximately 10 miles of Cambridge (see Figure 2.3), with outliers in Ely, Newmarket, Huntingdon-Godmanchester, and Royston. The Map shown in Figure 2.3 is difficult to read and is better viewed at: http://www.obn.org.uk/wp-content/uploads/2014/05/Cambridge-Biopharma-Cluster-Map_2013.pdf where there is a zoom facility. Estimates by OBN suggest there may be as many as 185 firms, institutes or other organizations involved in the biotechnology, life sciences, medical technology and pharmaceuticals within the cluster, with the most significant sub-clusters and centres (in terms of numbers of firms or organizations) being the Cambridge Science Park (27), the Cambridge Biomedical Campus (14), and the Babraham Research Campus (40).[11]

2.13 The parks and centres that make up the Cambridge cluster vary in composition and specialisation. Some are composed overwhelmingly of private sector firms (for example, the Cambridge Science Park). Others include or are based around one or more institutes (such as the Wellcome Trust Genome Campus), others (such as the Babraham Research Campus), have a more mixed composition, while the Cambridge Biomedical Campus, centred on Addenbrookes Hospital (Cambridge University Hospitals NHS Foundation Trust), is highly dependent on public sector and medical charity funding.

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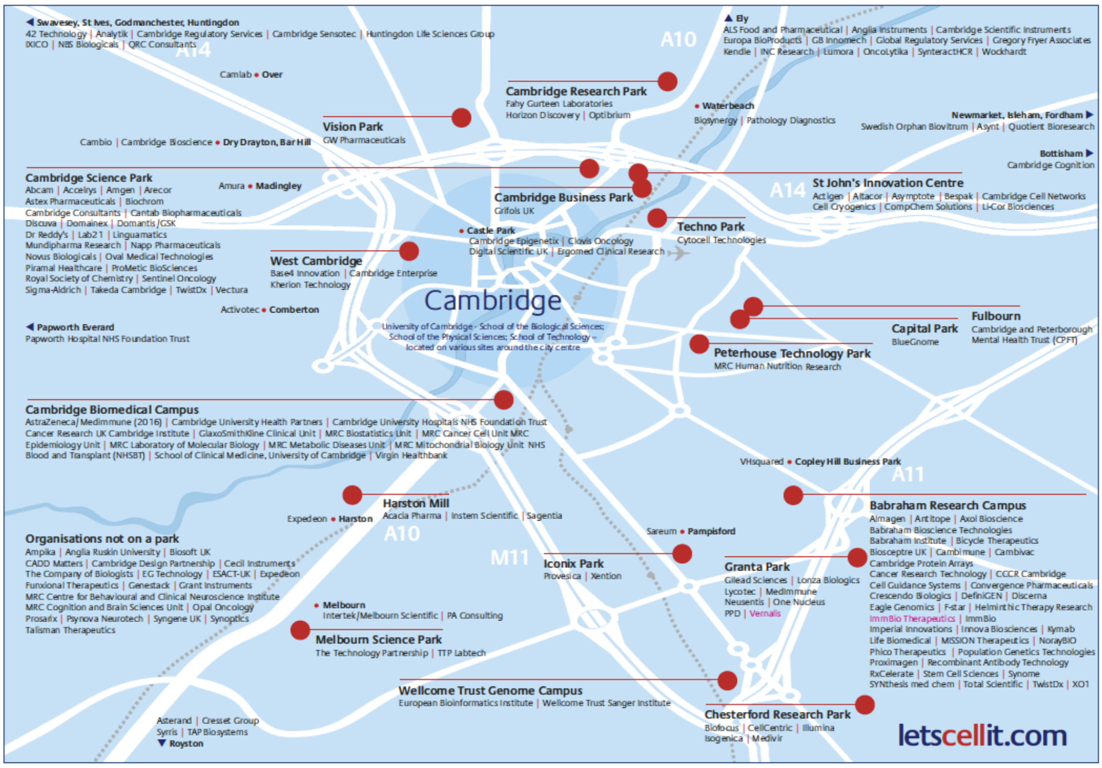
[11] The OBN is the membership organization supporting and bringing together the UK's emerging life sciences companies, corporate partners and investors (see www.obn.org).

2.14 Considered as a whole, the cluster conforms closely to the archetypical Porterian cluster-cum regional innovation system models. It involves a close synergy between the three main components that make up the 'triple helix' of a regional innovation system, namely university-industry-government. There are close links between research staff in medical and related Departments in the University and local bioscience companies, either in the form of collaboration, funding, an employment route for University graduates, or as vehicles for the commercialization of University-based research; while much of the research in those University departments is funded by public bodies such as the Medical Research Council. In fact a fourth element should be added to the Cambridge regional innovation system, namely the funding and institutes provided by major charitable bodes, such as the Wellcome Trust: the reality is one of a 'quadruple helix'.

2.15 In Porterian terms, the cluster involves the mutually reinforcing interaction between several components (Figure 2.4). The University is a source of basic and applied research, which can be commercialized with the help of the University's Enterprise Unit. At the same time the University supplies highly qualified graduates and scientists that make up a large skilled local labour pool available to local bioscience, medical science and pharmaceutical companies. Externally originating public funds support the primary health care sector in the city-region (mainly Addenbrooke's hospital, which in it turn has strong links to and interactions with the University), whilst also supporting relevant research within University. Local companies both compete and collaborate in bioscience, drug development and related medical fields, in some cases via strategic alliances with similar firms elsewhere (including overseas). Meanwhile, a small but significant venture and private equity market has developed locally, to provide finance for new and expanding companies. In some cases, venture finance also originates outside the region, in London or even overseas. This study benefitted greatly from interviews with some of those actively involved at the present time in providing finance including Kate Bingham (SVLSA), Regina Hodits (Wellington Partners) and Andy Sandham (Synconapartners).

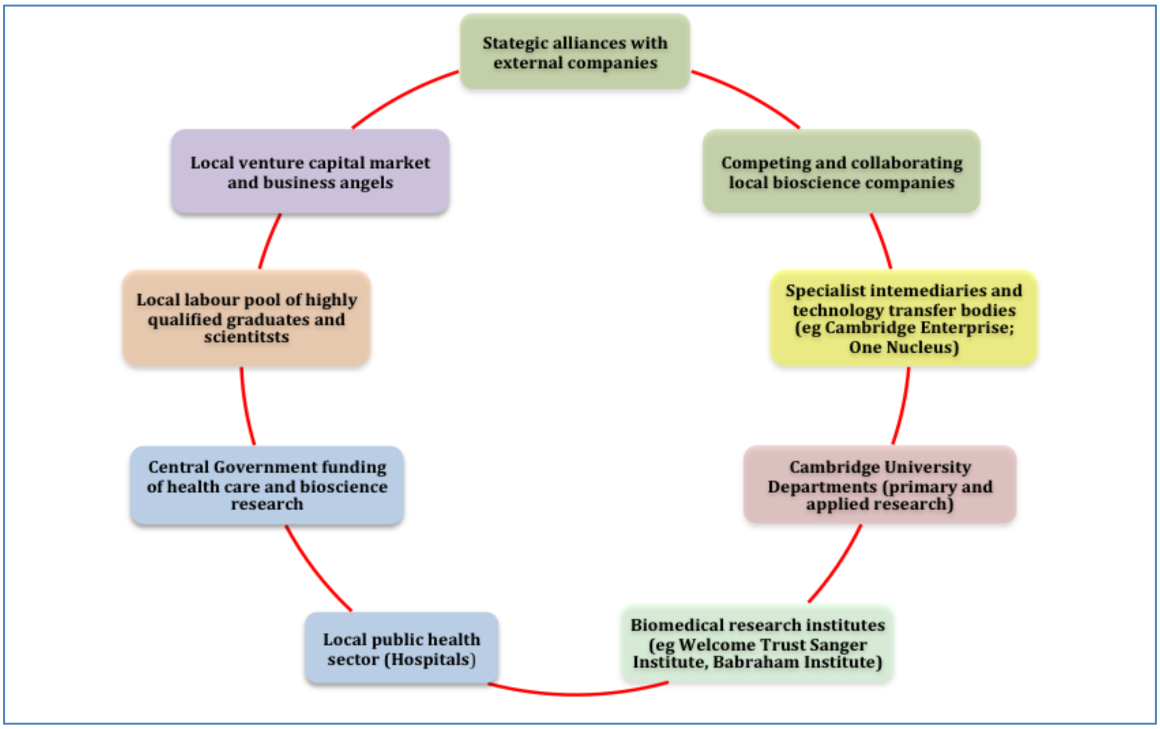
2.16 The synergies between these different components that together make up the Cambridge bioscience cluster are not only mutually reinforcing, but act to stimulate innovation, enterprise and growth. In this sense the cluster is a prime example of place-based circular and cumulative causation.

Figure 2.3: The Cambridge Bioscience-Pharma Cluster (as at 2013).



Source: ttp://www.obn.org.uk/wp-content/uploads/2014/05/Cambridge-Biopharma-Cluster-Map_2013.pdf.
Note: This map is based on the OBN membership companies

Figure 2.4: Main Components of the Cambridge Bioscience Cluster



Source: Authors

2.17 Indeed, the cluster is essentially a knowledge-intensive and knowledge-driven network of both core and applied medical-related science. There are several indicators of the scale and importance of this focus on knowledge production and innovation. The most commonly used is that of patents.

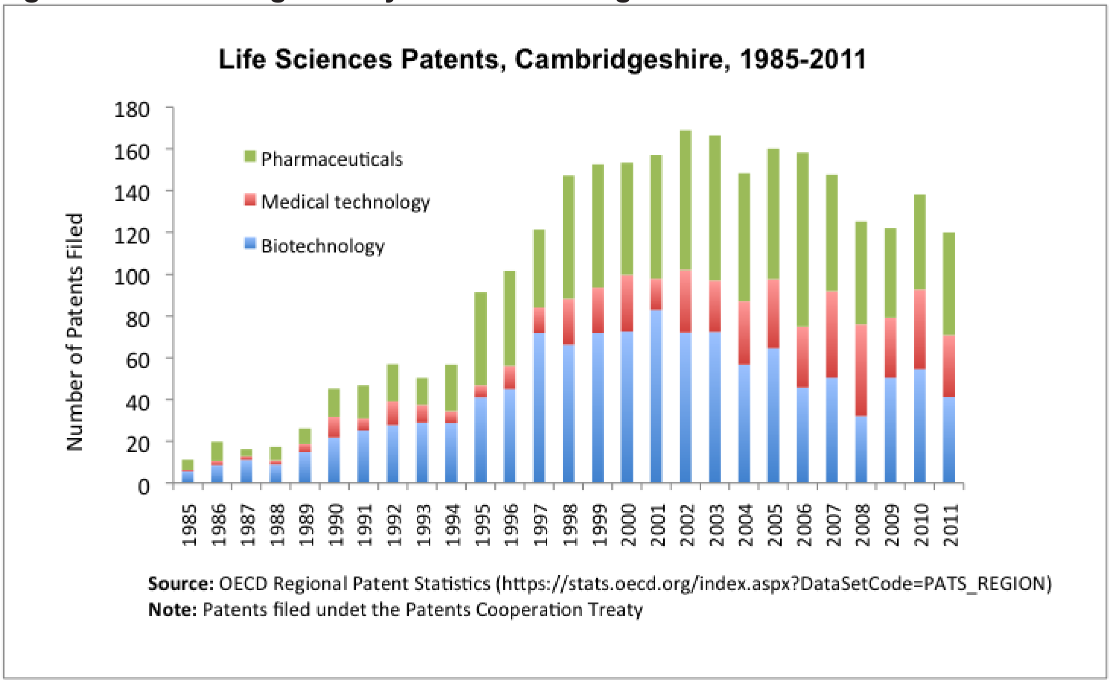
Patenting Activity in the Cluster

2.18 Although patents are often used as an indicator of innovation, they are not unproblematic, since not all firms patent their ‘inventions’, and even if they do a considerable time may elapse before the invention is commercialized, and some inventions may never come to market. Further, there is some evidence that in the medical field, licensing is often a preferred alternative to patenting. However, licensing data are difficult to obtain, whereas information on patenting activity is much more readily available.

2.19 The OCED collects life science patenting data for regions at various scales, the smallest for the UK being counties and unitary authority areas. Thus, while information is not available for the city of Cambridge and its immediately surrounding area, data are available for Cambridgeshire. Since most of the life science research and development activity in Cambridgeshire is based within a 15 mile radius of the city (see Figure 2.3), the data effectively refer to the Cambridge cluster.

2.20 The evolution of life science patenting activity in Cambridgeshire is shown in Figure 2.5 for the three main life sciences sectors for which data are collected, and for the period (1985-2011) for which reliable statistics are available. The most striking feature is the rapid growth in life sciences patenting activity from the early-1990s onwards. This growth was led by biotechnology and pharmaceuticals. Secondly, since the mid-2000s, the overall level of patenting appears to have levelled off somewhat and more recently has fallen back a little. This appears to have been mainly due to biotechnology. While the sector has experienced a decline in patenting activity, patenting in pharmaceuticals and medical technology has remained more or less steady. As a consequence of these different trends, the latter two sectors now account for most of the cluster’s patent activity. Allowing for any possible changes in the definitional coverage of the three sectors, it is clear that the past thirty years have seen significant shifts in the sectoral composition of innovation in Cambridgeshire’s life science economy. The apparent loss of some momentum in overall patenting activity evident in Figure 2.5 should not necessarily be taken to indicate a slowing down of the dynamism of the Cambridge biosciences cluster, however, since, as mentioned above, it could be that licensing has become a more frequently used alternative to patents. This is an issue that would repay more detailed investigation.

Figure 2.5: Patenting Activity in the Cambridgeshire Life Sciences Cluster



Source: As in figure 2.5

2.21 Another way of looking at the significance of Cambridge's life sciences cluster is in relation to similar activity elsewhere. Five main regional innovation systems dominate UK patenting activity – Cambridgeshire, Inner London (West), Oxfordshire, Hertfordshire, Inner London (East), and Greater Manchester (South). These areas account for more than a fifth of national patenting, across all fields. Cambridgeshire clearly stands out as the main centre of innovation in the UK (Table 2.2). These same five clusters or regional innovation systems also dominate patenting in the life sciences, and again Cambridgeshire leads, although by a smaller margin (Table 2.3).

Table 2.2: Patent Activity in Cambridgeshire and other UK Regions, 2011

	Total	ICT	Biotech	Pharma	Med Tech	Total Life Science
Cambridgeshire	402.1	206.4	43.6	49.8	30.0	123.4
Inner London (West)	349.1	130.6	46.0	36.0	19.0	101.0
Oxfordshire	288.9	92.1	41.3	36.0	19.0	96.3
Hertfordshire	143.0	41.7	22.9	30.6	15.3	68.8
Inner London (East)	138.0	49.5	13.4	14.3	17.5	45.2
Greater Manchester (South)	110.7	36.4	6.6	5.2	2.0	13.8
Buckinghamshire	92.3	29.6	6.8	13.8	6.7	27.3
Edinburgh	73.1	37.6	13.3	5.3	13.6	32.2
Cheshire (East)	62.3	10.0	3.9	9.8	22.1	35.8
Tyneside	54.4	6.9	2.4	4.4	0.0	6.8
Outer London (South)	46.2	20.0	0.8	4.5	4.5	9.8
Cardiff	42.2	10.0	4.8	7.8	7.1	19.7
Birmingham	42.0	10.5	10.0	5.4	1.3	16.7

Source: As in Figure 2.5.

2.22 And while Cambridgeshire leads life science patenting in absolute and relative terms, as a cluster it is internally less dominated by this activity than some other centres, such as Hertfordshire and Cheshire (East), reflecting the very strong presence of ICT in the Cambridge cluster (Table 2.3).

Table 2.3: Shares of Life Science Patenting: Cambridgeshire and other UK Regions, 2011

Percent	Life Sciences as share of Local Total Patents
Cambridgeshire	30.6
Inner London (West)	28.9
Oxfordshire	33.3
Hertfordshire	48.1
Inner London (East)	32.7
Greater Manchester (South)	12.4
Buckinghamshire	29.6
Edinburgh	44.0
Cheshire (East)	57.5

Source: As in Figure 2.5.

2.23 Of further interest is how the Cambridgeshire cluster (and other UK bioscience centres) compares with international counterparts, in particular in the USA and Germany (see Table 2.4). In the USA, five sub-regional centres or clusters dominate life science patenting activity, namely San Diego, Boston, San Jose, Rayleigh-Durham-Chapel Hill, and Seattle. In terms of sheer number of patents Boston and San Jose are in a league of their own, with between 13 and 15 times as many patents as Cambridgeshire and 9 times as many as Munich or Berlin, the major centres in Germany. But the US areas are geographically more extensive, and have much larger populations than the UK clusters or German clusters. Standardising by the size of each area's working–age population reveals that patenting rate gaps are noticeably smaller, although San Diego and Boston still emerge as being more innovative. However, Cambridgeshire and Oxfordshire are not far behind, and are well ahead of the German centres.

Cambridgeshire and other Major UK Bioscience Clusters in International Perspective, 2011

	Total Life Science Patents	Patents per 10,000 working age population
Cambridgeshire, UK	123.4	2.95
Inner London (West), UK	101.2	1.20
Oxfordshire, UK	96.3	2.21
Hertfordshire, UK	45.2	0.61
Inner London (East), UK	68.8	0.30
San Diego, USA	761.2	3.50
Boston USA	1850.0	3.24
San Jose-San Francisco, USA	1636.1	2.41
Rayleigh-Durham-Chapel Hill, USA	273.2	1.22
Seattle-Bellvue-Everett, USA	236.4	0.71
Berlin, Germany	176.3	0.80
Munich, Germany	190.3	0.96

The quality of the research being undertaken in the cluster

2.24 The extent of the overall research activity in the cluster depends on the quality of its life science knowledge base and its ability to attract research funding from the public, private and voluntary sectors. The durability of the activity will reflect the quality of the research output. Funding may be sufficient to maintain the existing stock of direct activity in some form of steady state but the evidence suggests that in successful clusters it is far more likely that there will be a significant increase in the amount of funding and thus increased activity as momentum builds. There are a number of possible ways in which this could occur.

2.25 The research activity will generate new ideas and knowledge that may be patented. Companies will seek to exploit new market opportunities that may arise as a result and this may be reflected in increased numbers of academic spin-outs and higher levels of technology licensing. Networking between companies in the Cambridge cluster will enable new ideas and commercial opportunities to be exploited, thus further powering further momentum.

2.26 The concentration of knowledge based institutions in the Cambridge cluster is quite astounding and continues to grow and evolve at a rapid pace generating knowledge that fuels the innovation process. Of central importance to the Cambridge Biomedical Campus is the MRC Laboratory of Molecular Biology[12] housed in a £230 million new facility that opened in 2013. With some 32,000 sq metres of floor space, over 400 scientists and support staff it is involved in a number of key research areas that include the biology of immunity and cancer, molecular origins of neurodegenerative diseases, synthetic biology and in vitro evolution and intercellular signalling and membrane trafficking.

2.27 There are a number of ways in which the quality of the research output can be assessed. Interviews with key stakeholders highlighted the strength of the Cambridge offer. The results of the recent Research Excellence Framework exercise are also most revealing (Table 2.5). A number of the Units of Assessment used in that exercise are of relevance for the present exercise. The key metric is the proportion of research orientated staff in the respective institution securing a 4* rating (quality that is world leading in terms of originality, significance and rigour) and 3* (quality that is internationally excellent in terms of originality, significance and rigour but which falls short of the highest standard of excellence). Table 2.5 presents the results. The impressive performance of the Cambridge offer is clear across all of the relevant units of assessment.

[12] http://cambridge-biomedical.com/laboratory-of-molecular-biology/

Table 2.5. The Results of the Research Excellence Framework 2015; Cambridge Universities Units of Assessment A1, A2, A4, A5 and A6.

	FT Cat A staff sub	CamAv 4*	REF av 4*	Cam av 3*	REF Av 3*
Clinical Medicine (A1)	192.05	58	39	29	44
Public Health, Health Services and Primary Care (A2)	57.07	50	39	43	41
Psychology, Psychiatry and Neuroscien (A4)	75.95	58	38	35	40
Biological Sciences (A5)	189.63	52	38	35	40
Agricult, Veterinary and Food Science (A6)	39.60	40	35	40	41

Source: HEFCE. Research Excellence Framework 2014: The results. Ref 01.2014. December 2014.

2.28 The volume of research funding flowing into the knowledge based institutions has also been gaining in strength. Some indication of this can be gained by considering research funding in the University of Cambridge (Table 2.6). Of the £371.1 million of research funds secured in 2013/2014, some £222 million (60%) was in the areas of Clinical Medicine and Biological Sciences.

The share attributed to this sector in the University of Cambridge has increased significantly over the last ten years with the University Planning department indicating that since 2006-07 more than half of the awards (by value) to the University have been to Clinical Medicine and Biological Sciences. In 2015/16 it is predicted that associated expenditure in Clinical Medicine will be higher than the Physical Sciences and Technology combined. Some 46% of the funding in the sector is now from UK Charities.

Table 2.6. Research Funding to the University of Cambridge (£m), 2003/4, 2007/8, 2008/9, 2013/13 and Clinical Medicine and Biological Science in 2013/14

	3/4 All Cam Uni	7/8 All Cam Uni	8/9 All Cam Uni	13/14 All Cam Uni	13/14 Clin Med, Biol Science
UK Res Coun	66.4	112.3	123.3 (46.0)	119. (32.2)	**53.7 24%**
UK Charit	52.2	68.5	71.6 (27)	112.8 (30.4)	**102.7 46.3%**
UK industry and Comrce	20.5	18.4	14.6 (5.0)	15.8 (4.3)	**1.3 0.6 %**
UK Govern bodies	12.3	9.9	9.5 (4.0)	5.8 (1.6)	**1.1 0.5 %**
UK Health and hospital auth	1.9	3.5	8.4 (3.0)	28.2 (7.6)	**27.8 12.5%**
Eurp Commission	10.4	14.2	19.0 (7.0)	52.0 (14.0)	**22.4 10.1 %**
Ovseas	10.6	16.0	19.3 (7.0)	36.3 (9.8)	**12.9 5.8 %**
Other	1.8	1.1	1.2 (-)	0.9 (0.2)	**0.1 -%**
Total	176.3	243.0	266.9 (100)	371.1 (100)	**222.0 100%**

Source: Planning and Resource Allocation Office; University of Cambridge.

The views of the companies on the Babraham Research Park

2.29 To help understand more about the factors that led bioscience companies to choose a location within the Cambridge Bioscience cluster, a questionnaire was piloted on the companies that are currently located on the Babraham Research Park. Some twenty two companies (around one third on the Campus total) agreed to take part. The researchers are very grateful for the generous and extensive support that was provided by Derek Jones, Chief Executive of Babraham Bioscience Technologies. Besides providing valuable insight into a range of issues of relevance to understanding their location decision, the companies also identified factors that were constraining their operations, including difficulties with recruitment. They also provided valuable insight into their future plans for expansion. It's not possible to establish precisely how representative the views of the companies are of the total stock of companies in the Cambridge Bioscience cluster which will require more extensive research. However, the findings provide some important insights.

2.30 Of the companies that responded 46% were completely new start-ups, 4.5% the result of a merger with an existing company but the majority were the result of a spin-out from a research institute (university) 27%, a spin-out from an existing company 18% or a spin-out from a research consultancy-4.5%. Some 50% of the companies only operated from the one site but a further 32% operated from multiple sites in more than one country and 18% operated from multiple sites in the United Kingdom. Over 90% undertook research and development at the Babraham site and for nearly 73% it was their corporate headquarters. Some 18% operated their marketing functions from the site also.

2.31 Before they had chosen their present location over four fifths had been looking elsewhere in the Cambridge Bioscience cluster. And a further 9% had not considered anywhere else but their existing location. A further 32% had considered locations elsewhere in the United Kingdom outside of Cambridge.

2.32 A key area of interest was to understand the factors that had influenced the company to locate where they had. The companies were asked to assess relative importance on a scale of one to five (one was not important and five was very important). Table 2.7 shows the results. The three most important factors that scored around a four where the presence of local networks and contacts (4.05), the availability of suitable premises (4.05) and the quality of the labour force (3.95). Other factors rated quite highly were proximity to research institutions to recruit labour, the availability of affordable/ low cost premises, convenience to your existing employees (3.68), and location to founders / directors' home (3.50), proximity to colleagues working in the area (3.50) and proximity to research institutes to use the facilities (3.50).

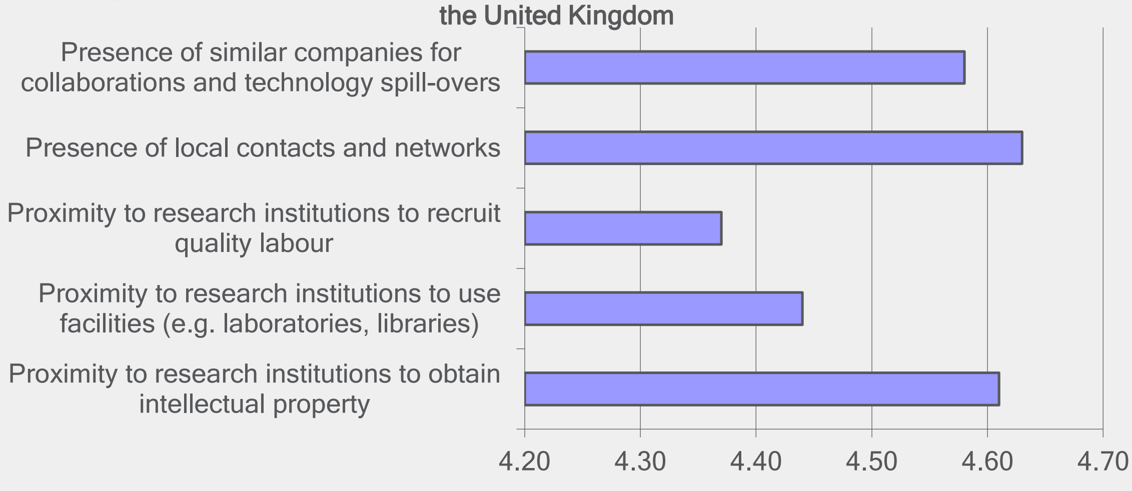
Table 2.7. Key influences on location	Rating Average
Presence of local contacts and networks	4.05
Availability of suitable premises (e.g. purpose built for your company's needs)	4.05
Quality and availability of the local labour force	3.95
Proximity to research institutions to recruit quality labour	3.77
Availability of affordable/low cost premises	3.71
Convenience to your existing employees	3.68
Image/'right address'	3.59
Availability of parking for employees, customers and suppliers	3.52
Proximity to research institutions to use facilities (e.g. laboratories, libraries)	3.50
Proximity to colleagues working in the area	3.50
Location of the founders/directors' home	3.50
Good communications infrastructure (e.g. broadband, mobile telecommunications reception)	3.30
Good transport links (e.g. roads, rail and airports)	3.05
Proximity to customers and clients for your products/services	3.00
Proximity to research institutions to obtain intellectual property	2.91
Presence of similar companies for collaborations and technology spill-overs	2.91
Capacity of utilities: power, water, sewerage, waste disposal	2.71
Quality of residential environment, social facilities and cultural amenities	2.62

Availability of specialised finance (e.g. angel & venture capital)	2.57
Proximity to key suppliers and sub-contractors	2.33
Proximity to research institutions to train existing employees	2.27
Availability of specialised business support services (e.g. accounting, legal)	2.18
Outcome of a merger or acquisition involving another company (if applicable)	2.10
Supportive national regulatory framework - standards, laws and regulations	1.86
Availability of premises for manufacturing	1.79
Availability of area targeted government assistance/local economic incentives (e.g. regional grants)	1.76
Favourable local taxation policies (e.g. UK Local Business Rates)	1.67
Supportive land-use planning policies and procedures	1.48

Source: Survey of Babraham Businesses

2.33 The companies were also asked to consider how the Cambridge Bioscience cluster compared to other locations in the United Kingdom with which they were familiar. Again the ranking scale was one to five where one was much worse and five was much better. Figure 2.6 shows that the Cambridge Bioscience cluster scored relatively highly on all of the key proximity attributes identified in the international research literature as being important influences on the relative competitiveness of a bioscience cluster. The presence of local contacts and networks stood out as well as proximity to research institutions to obtain intellectual property and the presence of similar companies for collaborations and technology-spillovers. The scores suggest a very significant competitive advantage to the Cambridge cluster compared to elsewhere in the United Kingdom.

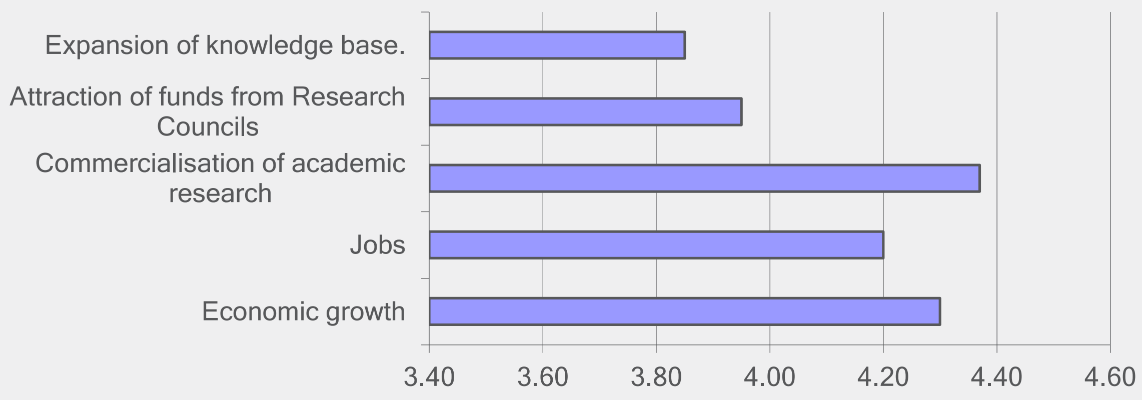
Figure 2.6. Comparision of Cambridge Biscience cluster withe other locations in the United Kingdom



Source: Babraham Business survey

2.34 The companies were also asked for their views on the impact of the Cambridge Bioscience cluster on the wider local economy. As Figure 2.7 shows on a rating scale of one to five where one is no effect and five is major the companies were clear about the benefits of the cluster in commercialising the academic base and thus promoting economic growth and jobs.

Figure 2.7. Company views on the contribution that the Cambridge Bioscience cluster has made to the economy of the Cambridge sub-region.



Source: Company Survey.

The views of the venture capitalists and other funders

2.35 Our interviews with those involved in various parts of the Cambridge Bioscience cluster helped to build a picture of its underlying strength in delivering leading edge ideas and increasingly translating them into commercial application. It was suggested by some of those we interviewed that one way of gauging the relative strength of the Cambridge position was to speak to the venture capitalists that dealt with the organisations and companies in the cluster but also, importantly, with those in other clusters particularly elsewhere in the United Kingdom, Europe and the USA. We were fortunate to be able to have discussions with funders that included Kate Bingham (SVLSA), Regina Hodits (Wellington Partners) and Andy Sandham (Synconapartners).

2.36 Those spoken to emphasised that what impressed them about the Cambridge cluster was the depth of the knowledge base, the extensive networking and interactions that were taking place between the knowledge based institutions, companies and other relevant organisations and way in which the 'soft infrastructure' needed to promote interaction and exchange had grown and developed in recent years. Particularly impressive was the manner in which different technologies and knowledge bases were coming together to find common application.

2.37 Moreover, it was apparent to those involved in the provision of finance that there was a very conducive and cooperative attitude and approach to Intellectual Property from the major Knowledge Based Institutions, many of whom had committed substantial human resource to help to promote the knowledge exchange and enterprise that underpins successful clusters.

2.38 The investment by the knowledge based institutions in basic research and also in the provision of world class teaching was also widely recognised and admired. It was also clear that the geography of the Cambridge facilitated interaction across what was is becoming known as the Cambridge, Stansted and London Corridor linking the core Cambridge establishments with the GSK and the Stevenage Catalyst and the substantial Bioscience base focusing around the new Crick Institute at Kings Cross and elsewhere in London.

2.39 The overall view was that the Cambridge Bioscience cluster was consolidating its position as probably the best bioscience cluster in Europe. When the synergies and scope for development in the Corridor are also considered the potential for future growth is very strong indeed.

2.40 However, those interviewed considered that the key downsides at the present time revolved around the fragility of core infrastructure particularly as it relates to transport connectivity and the housing required to accommodate the people that underpin the strength and vitality of the cluster.

3. The impact of the Bioscience cluster on the Cambridge economy.

• In 2013, the Bioscience sector is estimated to have employed 13,756 people in Cambridge (7.6% of total employment) and created £906.7m in Gross Value Added (GVA); 11.4% of the total; while across Great Britain as a whole it accounted for 2% of employment and just under 2.4% of GVA.
• The vast majority of employment and three quarters of GVA in Bioscience is in Research & experimental development, with Pharmaceuticals accounting for much of the remainder.
• The Cambridge economy has a relatively high density of Bioscience employment; the share of total employment in Cambridge (at 7.6%) is 2.5 times higher than the UK average, and higher than in any other area of the UK.
• The Cambridge Bioscience sector generated 25,257 jobs and £1.54bn in GVA for the UK economy in 2013. The indirect and induced effects amounts to just under 6,000 employees and over £310m each in real GVA. Most of the indirect impacts are in financial & business services whereas commerce services including distribution and accommodation & food services makes up a large proportion of the induced effect.
• The majority of the employment generated by the Cambridge Bioscience sector is in high-skilled jobs, although a substantial number of medium-and low-skilled jobs are created by the indirect and induced effects.

Introduction

3.1 The economic impact of the bioscience sciences cluster occurs in a number of different ways. There are the direct economic impacts that arise from the research activity itself and the associated research jobs and income. There are also direct economic impacts created in the bioscience sector from the commercial exploitation of the knowledge base. Some of these may be located in the Cambridge cluster when academic spin-outs are created or companies move into the local economy to exploit the commercial opportunities offered. In other cases commercial exploitation will occur in other regions or countries around the world as companies acquire licenses to exploit the knowledge.

3.2 The direct economic activity associated with Cambridge bioscience also creates business opportunities for the companies who service the knowledge based institutes and bioscience companies in the cluster. These are usually referred to as indirect effects.

3.3 The people who work in the Cambridge bioscience sector and the organisations that service them spend their incomes on local goods and services and this, in turn, generates more jobs and activity in the local and sub-regional economy. These induced effects can be very significant, particularly as new migrants move into the region to work in the bioscience cluster, but it should also be emphasised that unless there is a corresponding increase in infrastructure to accommodate the increased population then expansion may be inhibited by the effects of congestion and, for example, inflated local house prices.

3.4 These direct, indirect, induced economic effects generate gross value added and employment in the Cambridge sub-regional economy. This is additional activity to the sub-regional economy and perhaps national economy unless it displaces existing activity. Displacement effects can occur in a number of different ways. If the research undertaken in the Cambridge sub-region represents the transfer of a R&D laboratory that is currently located elsewhere in the United Kingdom then this could lead to some displacement although the scale of the effect will depend on a number of factors including the relative advantages of the new location in facilitating growth.

There are a wide range of sectors that could be included as part of Bioscience.

3.5 There is a rich existing literature evaluating Bioscience, both in the UK and overseas. Based on a review of these studies, 23 different NACE[13] codes have been identified as relevant to the Bioscience sector (see Annex 2). For the quantitative work in this study, we have chosen a definition as presented in Table 3.1. We make use of Cambridge Econometrics' detailed local area and sectoral databases and models by mapping these six NACE codes to Cambridge Econometrics' 45 industries using employment data from the Business Register and Employment Survey (BRES), which is available in much richer sectoral detail. The proportion of each detailed BRES sector that is related to Bioscience, as determined by the project team, is then applied as a weighting factor which we used to estimate the level of gross value added[14] (GVA) and employment attributable to Bioscience.

Table 3.1. The subsectors of Bioscience

NACE Rev. 2 code	Sector description	CE Industry	Weighting factor
2059	Manufacture of other chemical products n.e.c.	Chemicals etc	15%
2110	Manufacture of basic pharmaceutical products	Pharmaceuticals	75%
2120	Manufacture of pharmaceutical preparations		75%
2651	Manufacture of instruments and appliances for measuring, testing and navigation	Electronics	20%
7211	Research and experimental development on biotechnology	Other professional services	100%
7219	Other research and experimental development on natural sciences and engineering		100%

3.6 The definition outlined above focuses on only the core sectors, excluding agriculture and distribution sectors, as we have taken the view that they are part of the supply chain to the core Bioscience sector. These sectors are captured in the estimates of the indirect effects of Bioscience later in this chapter.

[13] NACE (Nomenclature of Economic Activity) is a European statistical classification used to classify economic activities.
[14] Gross value added is a measure of economic activity in the economy, capturing the additional value created at each stage of production from raw material through to final good/service

Taking this narrow definition has clear positives, in that the sectors that are included are all likely to be core bioscience activities, and there is little risk of including in this definition activities that are not directly related to the sector. However, it is also likely that we are missing some of the high value added activity in other sectors that form part of the wider sector, but around which there is much more uncertainty as to the proportion that is bioscience-related.

The City of Cambridge and areas within commuting distance house some of the largest Bioscience clusters in the UK.

3.7 The Cambridge and South Cambridgeshire local authorities together form the Cambridge city-region definition adopted in this study. Most of the research and development in Bioscience and pharmaceuticals clusters are contained within this area, as discussed in Chapter 2. A wider definition might include East Cambridgeshire and Fenland, which are predominantly rural, and Huntingdonshire and Peterborough, where the economy is dominated by consumer service sectors, particularly retail and distribution. However, there is a relatively low concentration of Bioscience activity in these regions, and on that basis they have been excluded from the study. As a result of this assumption, a number of Bioscience firms are excluded from the analysis, such as Huntingdon Life Sciences in Huntingdon and ALS Food & Pharmaceutical in Ely; however, these firms likely make up a very small proportion of the sector in wider Cambridgeshire as a whole.

What is the contribution of the Bioscience sector to Cambridge?

The Cambridge Bioscience sector accounted for 7.6% of total employment in Cambridge in 2013.

3.8 In 2013, the Bioscience sector[15] directly employed 13,800 people in the Cambridge city-region (7.6% of total employment) and created £907m in GVA (11.4% of total), while across Great Britain (GB) as a whole it accounted for 2.0% of employment and under 2.4% of GVA. The productivity of these sectors is higher in Cambridge than the GB average, including in Bioscience as a whole (see Table 3.2).

Table 3.2. Snapshot of the Bioscience sector in Cambridge

Sector	GVA (£2011m), 2013	GVA growth (% pa), 1981-2013	Employment, 2013	Employment growth (% pa), 1981-2013	Productivity (thousand pounds per employee), 2013	Productivity growth (% pa), 1981-2013
CAMBRIDGE						
Bioscience	**907**	**4.9**	**13756**	**3.5**	**66**	**1.4**
Chemicals	2	2.0	16	-0.8	101	1.5
Pharmaceuticals	214	9.7	669	3.3	319	6.2
Medical Devices and Equipment	10	4.7	115	-0.7	89	5.4
Research and Experimental	681	4.2	12956	3.6	53	0.6

[15] Bioscience is split into four broad categories: Chemicals, Pharmaceuticals, Medical devices and Equipment and Research and Experimental development.

Sector	GVA (£2011m), 2013	GVA growth (% pa), 1981-2013	Employment, 2013	Employment growth (% pa), 1981-2013	Productivity (thousand pounds per employee), 2013	Productivity growth (% pa), 1981-2013
Development						
GREAT BRITAIN						
Bioscience	**381237**	**3.6**	**681509**	**1.6**	**56**	**1.9**
Chemicals	170	1.8	1953	-2.9	87	4.9
Pharmaceuticals	8522	3.6	32566	-2.6	262	6.3
Medical devices and Equipment	785	1.6	11403	-2.9	69	4.6
Research and Experimental Development	28646	3.7	635588	2.4	45	1.2

Source(s): Business Register Employment Survey (ONS), CE calculations

Most of the employment in Bioscience is in Research and Experimental Development.

3.9 In 2013, almost all employment and three quarters of GVA in bioscience was attributed to Research and Experimental Development, with Pharmaceuticals responsible for much of the remainder (see Figure 3.1 and 3.2). However, productivity is highest in the manufacturing sectors (Chemicals, Pharmaceuticals and Medical devices and Equipment) and lowest in Research and Experimental development. This can be attributed to the nature of general and drugs and biotechnology R&D development in particular in which GVA consists primarily of wages and very little profit, in contrast to substantially higher profits in commercialised sectors. In addition to the direct impact of the Cambridge Bioscience sector outlined above, the sector will also have further impacts on the local, regional and national economy through the economic activity that it creates in its supply chains (the indirect impact) and by the spending of additional wages from the direct and indirect effects, which generates jobs and economic activity in the consumer services sectors (the induced impact). The indirect and induced effects across the whole of the UK economy each amount to just under 6,000 employees and over £310m in real GVA in 2013 (Figure 3.3), which implies an employment multiplier (a measure of the total impact divided by the direct impact) of 1.8 and a GVA multiplier of 1.69. Each hundred Bioscience jobs result in 80 new jobs being created in other sectors and for every £100 in value added generated by Bioscience there is another £69 generated elsewhere in the economy.

Figure 3.1. Sector breakdown of GVA in Bioscience in Cambridge in 2013

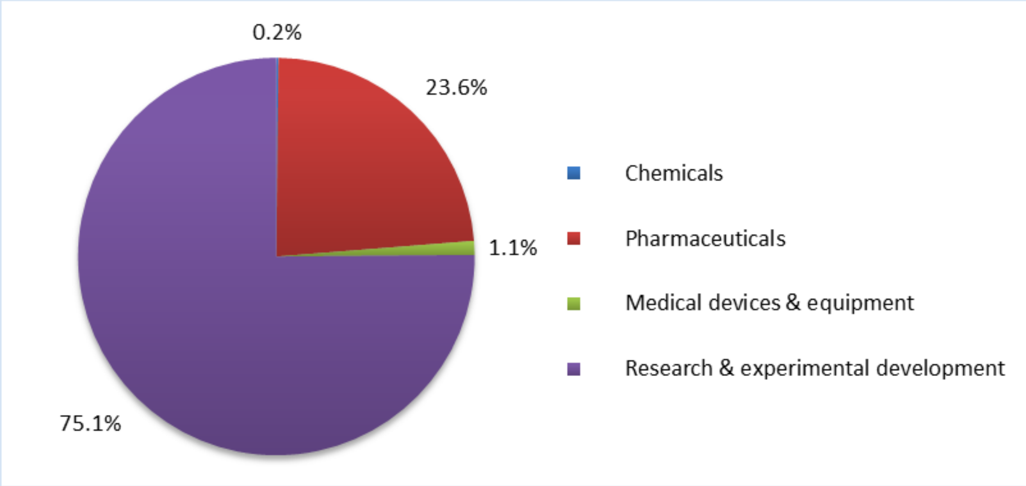
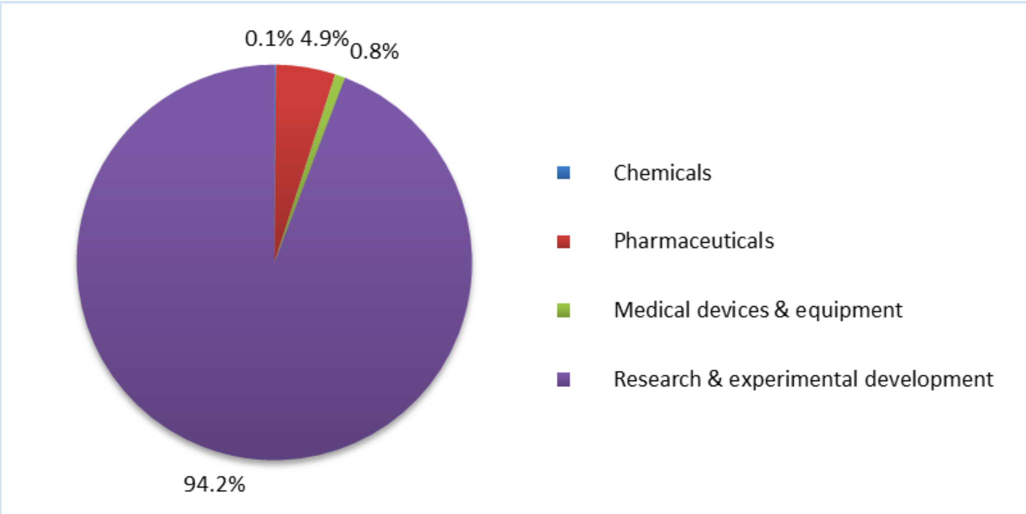


Figure 3.2. Sector breakdown of employment in Bioscience in Cambridge in 2013



What is the footprint of the Cambridge Bioscience sector?

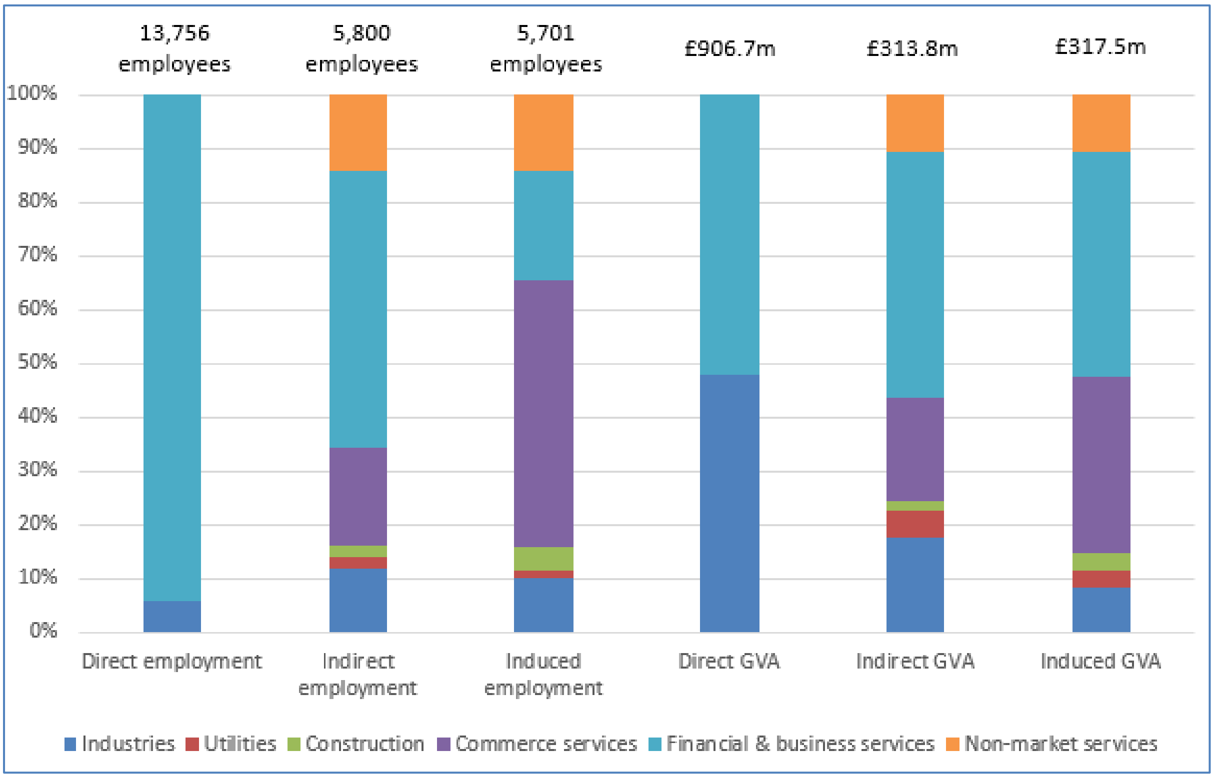
Taking account of knock-on effects to businesses and workers, it is estimated that the Cambridge Bioscience sector generated 25,300 jobs and £1.54bn in GVA in 2013.

3.10 As discussed above, the direct effect is largest in Pharmaceuticals and Research and Experimental Development (which are part of the broad sectors of Manufacturing and Financial and Business Services respectively). These sectors also dominate the indirect effect[16]), as much of the intermediate demand generated by Bioscience is from within these sectors (e.g. Pharmaceuticals firms demand inputs from Research and Experimental Development and other Pharmaceuticals firms). Bioscience also generates supply chain activity in Information and Communication for computer software and programming used in analysing research results and Government services (particularly education; university

[16] Industries include Agriculture, Mining & quarrying and Manufacturing. Commerce services include Distribution, Transport & storage, Accommodation & food services and Information & communication. Non-market services include Government services and Other services.

graduates, research facilities and expertise) and Public Administration (Business Support Services).

Figure 3.3. Breakdown of the economic impacts of the Bioscience sector in 2013



3.11 The largest contribution to the induced effects is from consumer service sectors. Distribution and Accommodation and Food Services contribute the most to employment, although less in terms of GVA due to low productivity. In particular, Distribution, dominated by retail trade, makes up over 25% of induced employment and 15% of induced GVA.

3.12 When taking into account leakage from the local economy, less than half of the total additional jobs (3,000 jobs) and GVA (£148m) are created in the region. Recalculating the induced effect for Cambridge on its own is beyond the scope of the existing modelling tool; however, it is reasonable to assume that it will be similarly proportioned to the national total. Financial and Business Services, Government Services, Distribution and Accommodation and Food Services are likely to make up more of the indirect and induced effects because a very high percentage of these sectors are sourced from within the local economy.

3.13 The increase in GVA and employment is likely to accompany and generate investment i.e. buying assets and building facilities. These large-scale capital expenditures such as the building of the Biomedical Campus serve the functioning of the sector but do not contribute to the final output and therefore need to be captured separately from the impacts described above. For example, investments in the construction sector totalling £700m can create 19,000 jobs (11,000 of which are in construction) and £709m in GVA (£300m of which is in construction) by the time it is circulated through the UK economy, suggesting an employment multiplier of 1.7 and a GVA multiplier of 2.4.

The occupational mix differs substantially between the three impacts; from high-skilled jobs dominating direct and indirect jobs to low-skilled jobs dominating the induced effects.

3.14 The economic importance of Bioscience in Cambridge includes its potential to create high-skilled jobs for both the local residents, commuters and migrants (both domestic and international), as well as medium- and low-skilled jobs. The majority of the jobs created, including direct, indirect and induced effects, are high-skilled, the rest being made up by relatively similar proportions of medium- and low-skilled jobs (Figure 3.4).

Figure 3.4. Total employment effect by skill requirement, 2013

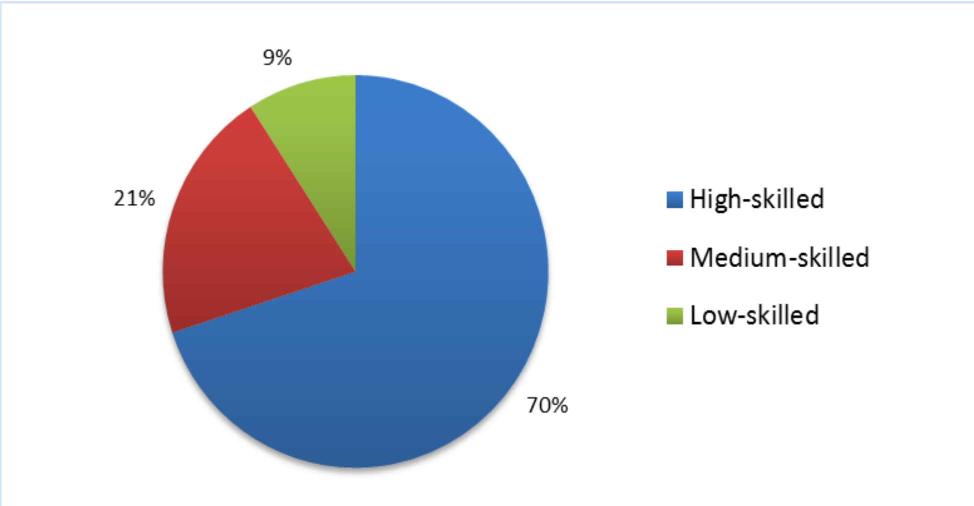
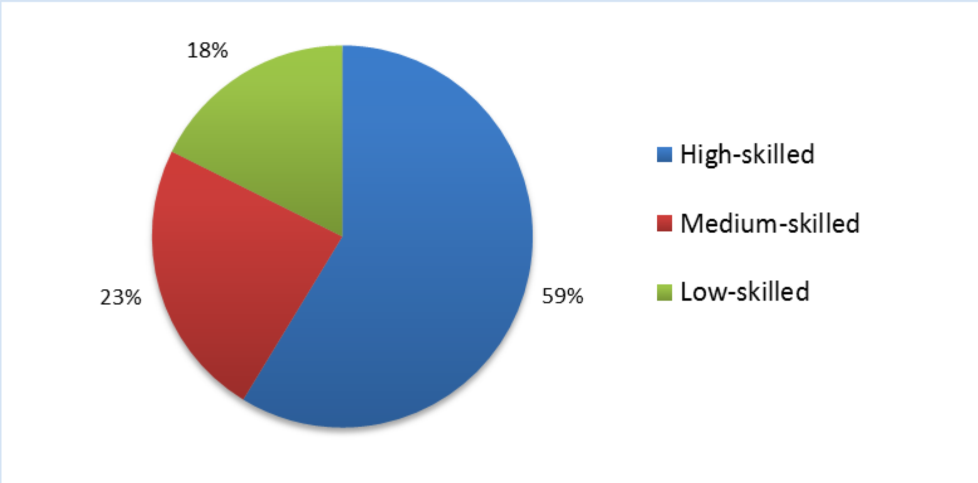
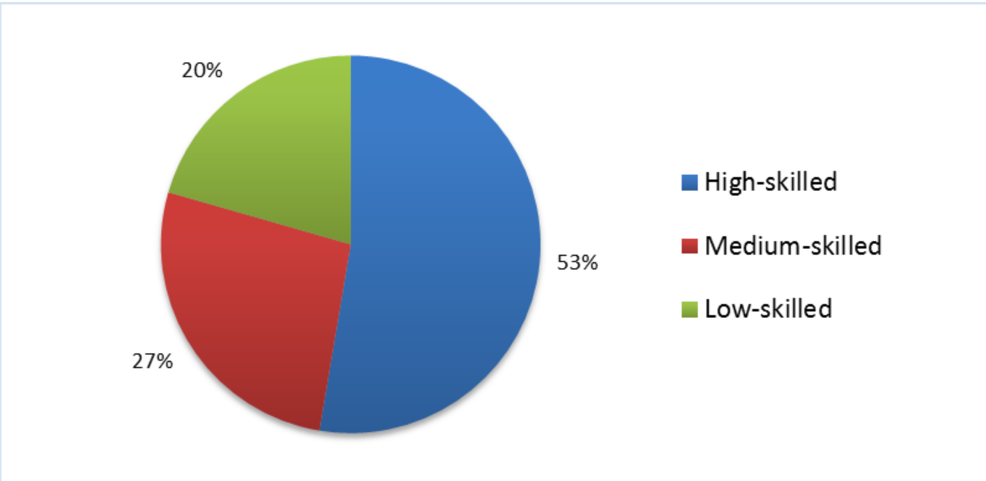


Figure 3.5 Direct employment by skill requirement, 2013



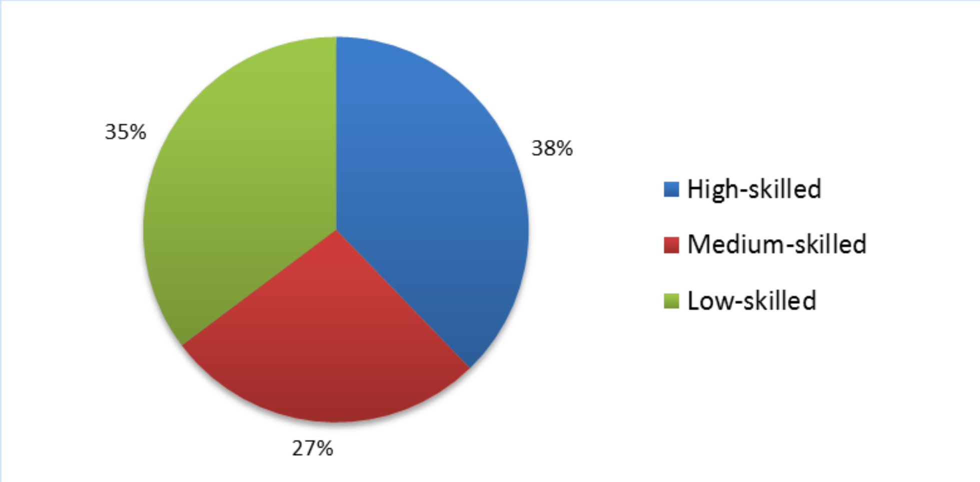
3.15 The research-oriented nature of Bioscience in Cambridge is also reflected in the occupational mix of direct employment: Nearly three quarters of employees are high-skilled, 21% are medium-skilled and only 9% are low-skilled (Figure 3.5). The high-skilled workers include not only resident graduates but also those migrating from other parts of the country (or internationally) to Cambridge due to the strong employment prospects.

Figure 3.6. Indirect employment by skill requirement, 2013



3.16 Of the jobs indirectly generated by Bioscience, 53% are high-skilled and 20% are low-skilled (see Figure 3.6). The induced economic impact has more of an even balance between three levels of skill requirement with 38% of induced employment in Managerial and Professional posts and 35% in Sales and Customer Service, Machinery Operatives and Elementary Occupations (see Figure 3.7).

Figure 3.7. Induced employment by skill requirement, 2013



How has Cambridge Bioscience developed to its current state?

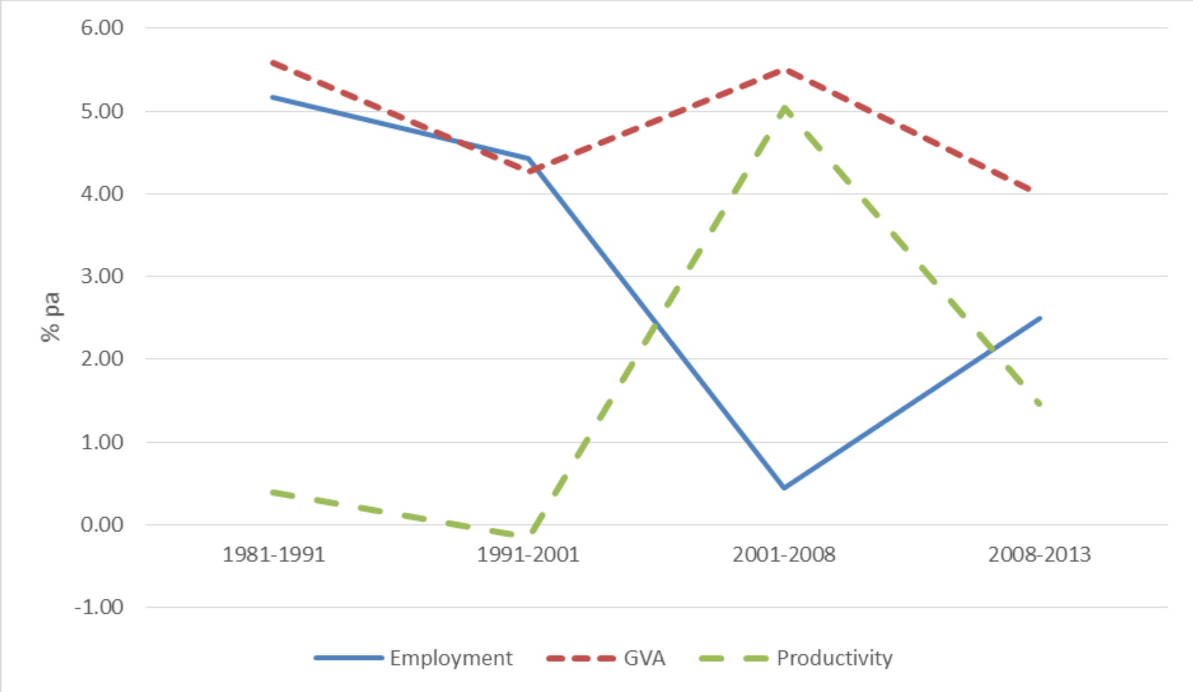
The sector experienced strong output and employment growth in the past, outperforming other sectors and contributing an increasing proportion to growth of the Cambridge economy.

3.17 In 2013, the Cambridge economy produced £7.9bn in Gross Value Added (GVA) and employed 180,000 people. Accounting for approximately 0.6% of the economy in Great Britain, the city-region is a strategic economic centre thanks to its world-class university, close proximity to London and a thriving and specialised business population. Over the 1981-2013 period, GVA and employment in Cambridge grew by 3.3% and 1.6% per annum (p.a.) respectively, around one percentage point faster than the trend across Great Britain as a whole.

3.18 The Cambridge Bioscience sector has steadily expanded (in terms of output) since 1981, bucking the trend in the wider Cambridge economy as well as the national trend for the sector. However, the drivers of that growth have varied over time, reflecting the wider trends of the economy through various business cycles.

3.19 In the period from 1981-1991, increases in GVA were driven almost exclusively by employment growth, a trend that continued through the 1990s, despite the recession in the first half of the decade. During the 1990s, while total employment in Cambridge was broadly static, in the Bioscience sector it increased by more than 4% pa (see Figure 3.8).

Figure 3.8. Decomposition of the growth of Cambridge Bioscience, 1981-2013



3.20 This trend shifted, however, in the early 2000s. As the role of technology, both within Biosciences but also across the wider economy, increased, productivity gains were substantial (5% pa in the Cambridge Bioscience sector), while employment gains were much more modest. In the period including the recession and slow recovery, the sector has continued to see strong output growth (of 4% pa), driven by a combination of both stronger employment and productivity growth (albeit slower than seen before the recession).

3.21 Splitting the regional economy into Bioscience, high-tech sectors (defined as those sectors identified as part of the 'Cambridge Phenomenon', but excluding Bioscience[17]) and other sectors, it is apparent that growth in Bioscience has been much faster than the rest of the economy throughout the whole period (see Figure 3.9 and 3.10). Growth rates in employment in Bioscience and high-tech sectors were broadly similar until 2006 when high-tech employment fell, as a precursor to the UK recession, and then held constant throughout that period. This is in sharp contrast to Bioscience, which saw employment continue to grow until 2009. GVA growth has differed throughout the period from 1981, with GVA consistently growing more rapidly in high-tech sectors. Strong GVA growth despite a decline in employment implies that productivity growth in high-tech sectors was much faster than in Bioscience and was the driving factor behind GVA growth in the 2000s. In 2013, the Bioscience sector and high-tech sectors (excluding Bioscience) accounted for 7.6% and 20.1% of total employment in Cambridge, respectively; 11.4% of total GVA was in Bioscience while high-tech sectors contributed 32.4%.

[17] See Annex 2 for further details.

Figure 3.9. GVA growth in Cambridge, 1981-2013

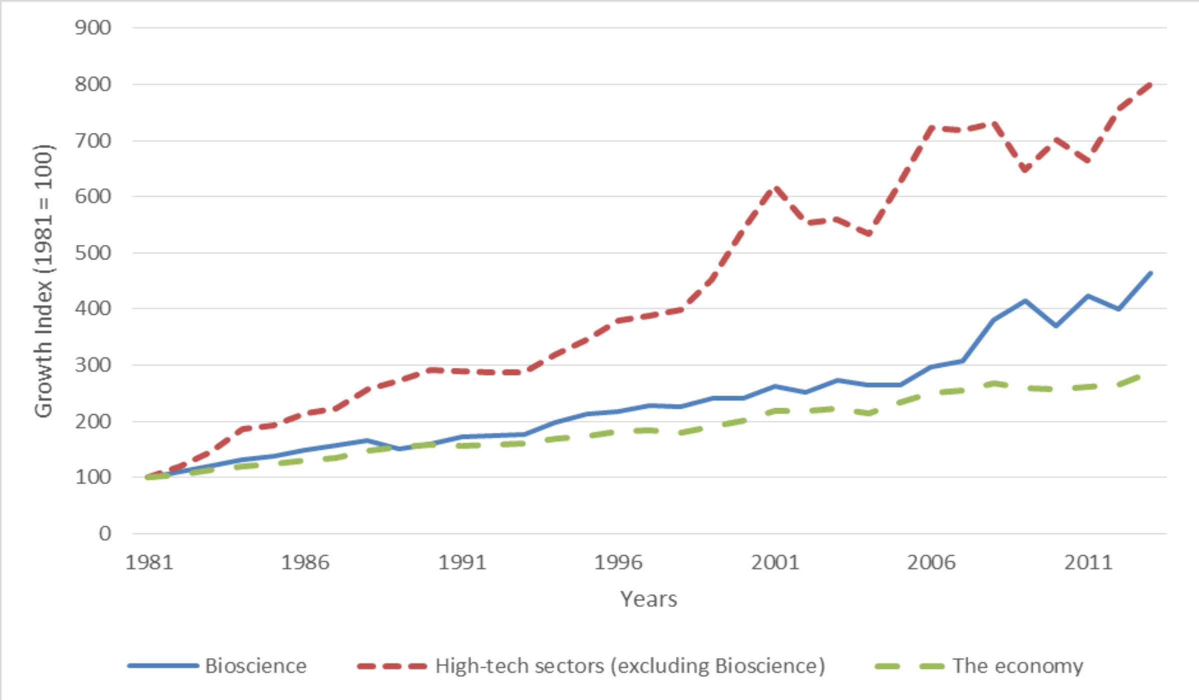
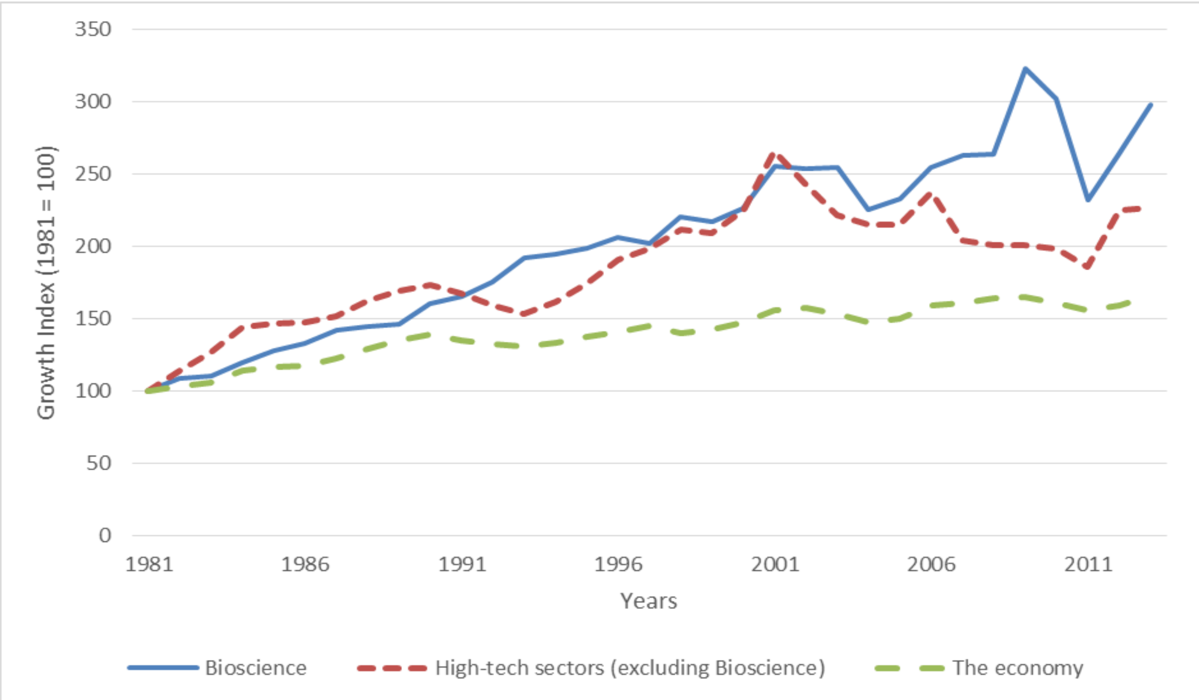
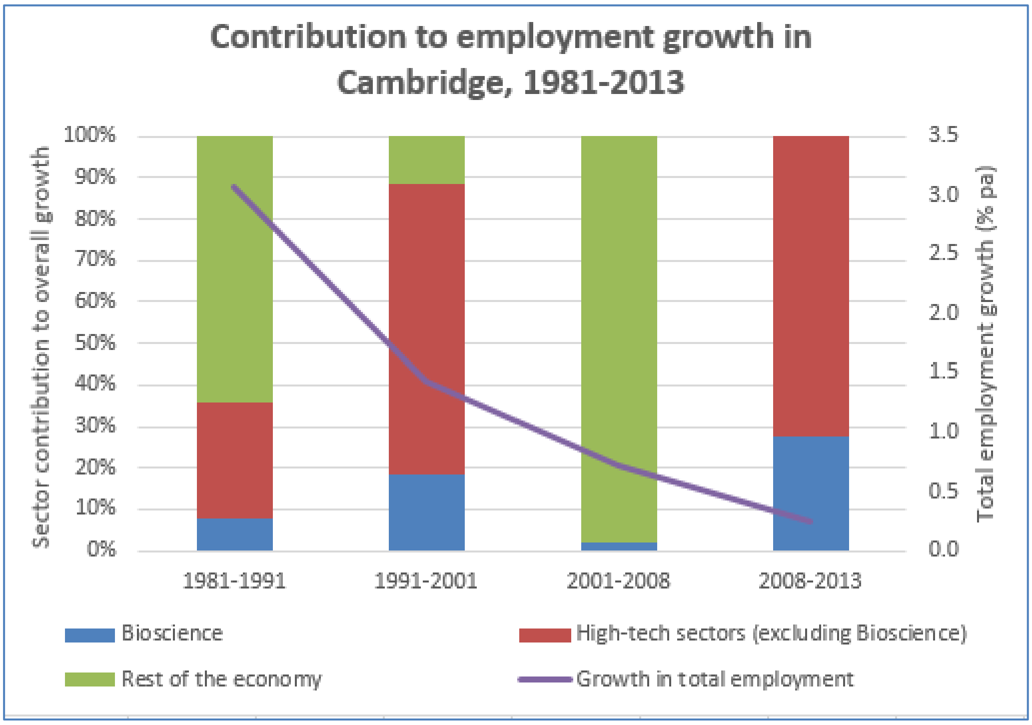


Figure 3.10. Employment growth in Cambridge, 1981-2013



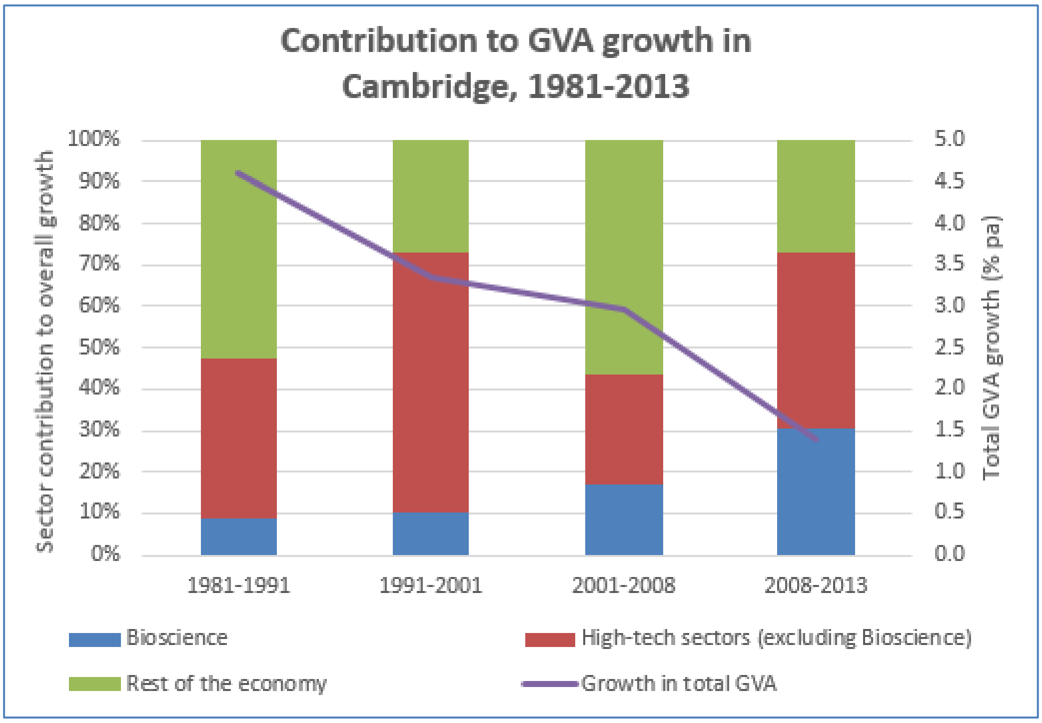
3.22 By virtue of growing more rapidly than the wider economy, the Bioscience sector has been making a positive and increasingly substantial contribution to growth in GVA and employment in Cambridge (see Figure 3.11 and 3.12); even as overall growth has slowed. High-tech sectors contributed a much larger proportion to growth in Cambridge than Bioscience over 1991-2001, partly because of its established size. However, the contribution of Bioscience has been increasing, particularly in terms of contribution to GVA growth, even as overall growth in the city has been slowing. Over the most recent period 2008-13 (including the UK recession and slow recovery), almost a third of growth in GVA was attributable to Bioscience.

Figure 3.11 Contribution to GVA growth in Cambridge, 1981-2013



3.23 There have been more fluctuations in the contribution to employment growth but Bioscience is the only sector that has maintained a positive contribution throughout the whole period. Employment fell in high-tech sectors over 2001-08 and in the rest of the economy over 2008-13, reflecting in part national trends (such as the recession and slow recovery in recent years). At its peak, the contribution of Bioscience to growth in employment was just under 30% over 2008-13 (Figure 3.12).

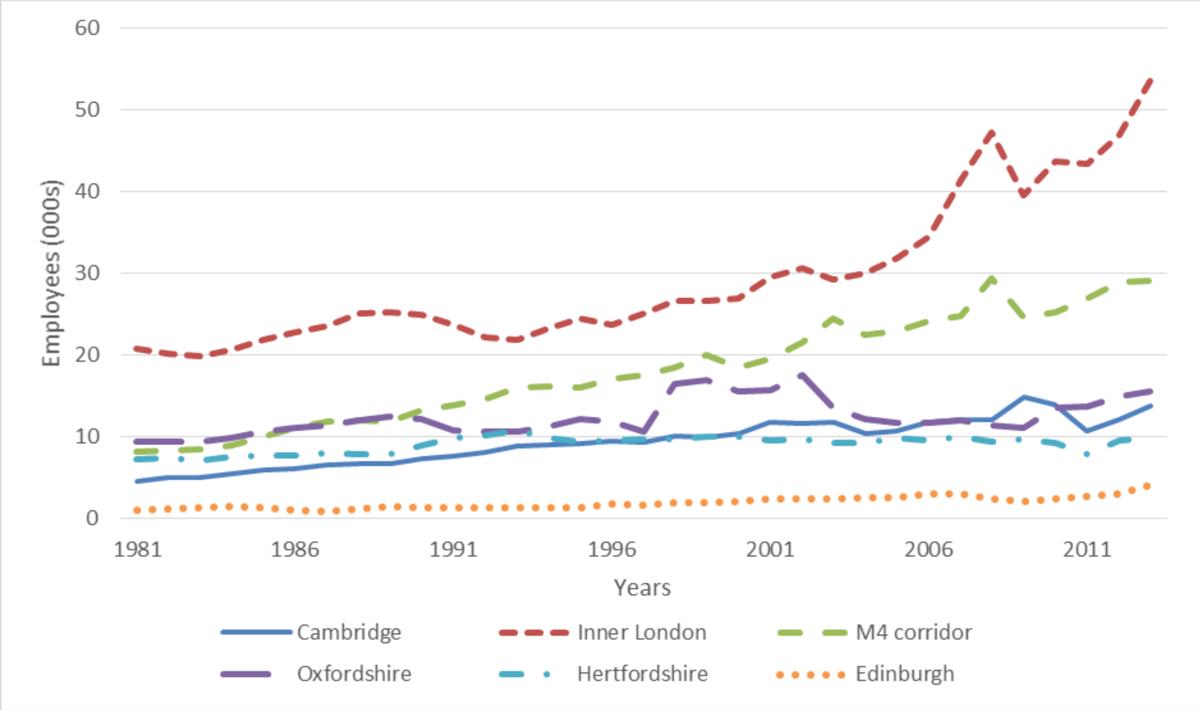
Figure 3.12. Contribution to employment growth in Cambridge, 1981-2013



Cambridge Bioscience is the most specialised cluster among competing UK regions.

3.24 Cambridge's Bioscience sector can be compared with that in competitor regions including Oxfordshire, Inner London, the M4 corridor and Hertfordshire (see Annex 2). Over the last decade, the growth rate of employment in Bioscience in Cambridge was slower than that of Inner London (where the sector is four times as large) and the M4 corridor, and ahead of Oxfordshire and Hertfordshire which are of a similar size (see Figure 3.13 and 3.14).

Figure 3.13 Growth of employment in Bioscience by region, 1981-2013



3.25 Figure 3.15 shows the extent of specialisation in Bioscience in a number of key UK clusters. The area of the spheres shows total employment in a given cluster, while the horizontal axis relates to aggregate growth in employment over 2003-13, and the vertical axis measures relative specialisation in Bioscience. Cambridge is the fourth-largest cluster in employment terms, but the most specialised.

3.26 Bioscience's share of total employment in Cambridge is 3.5 times that of the whole of Great Britain. This statistic, known as the location quotient (LQ), is a measure of specialisation. Cambridge is the most specialised cluster in Great Britain (see Figure 3.15). While employment growth over 2003-13 was more rapid in some other clusters (Inner London, Edinburgh and the M4 corridor), it grew faster than in the similarly-sized clusters in Oxfordshire and Hertfordshire.

Figure 3.14 Employment in Bioscience by region

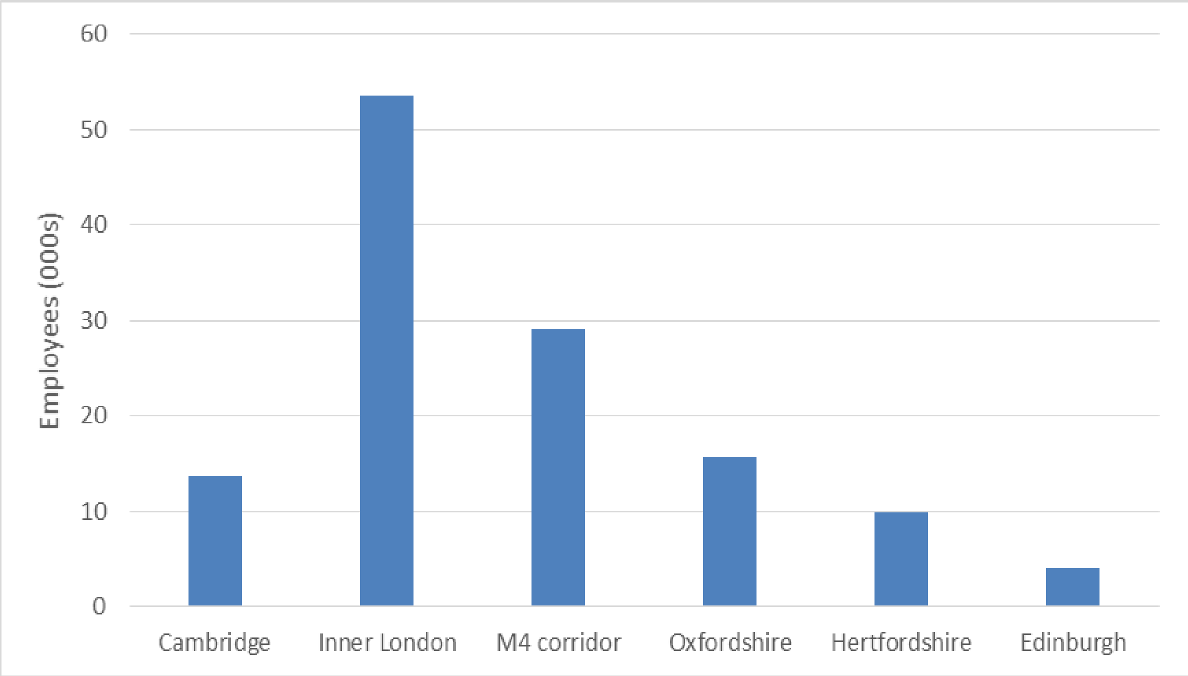
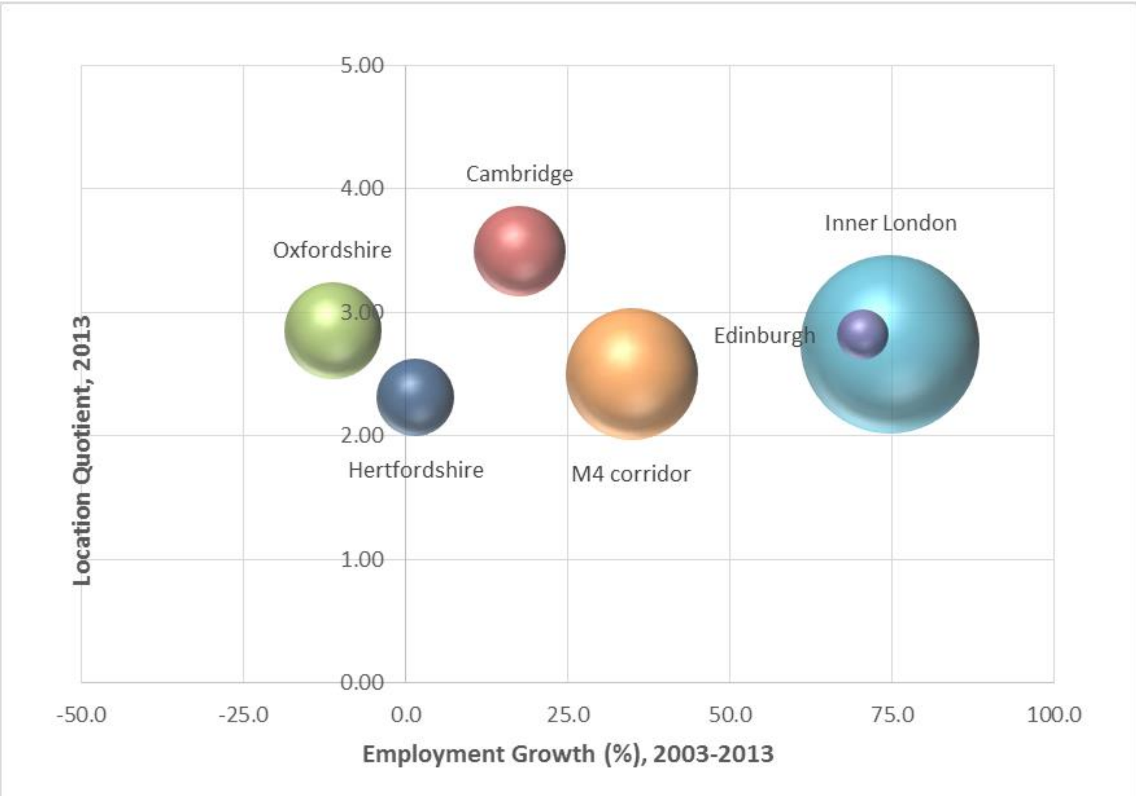


Figure 3.15 Degree of specialisation, growth and size of the Bioscience sector

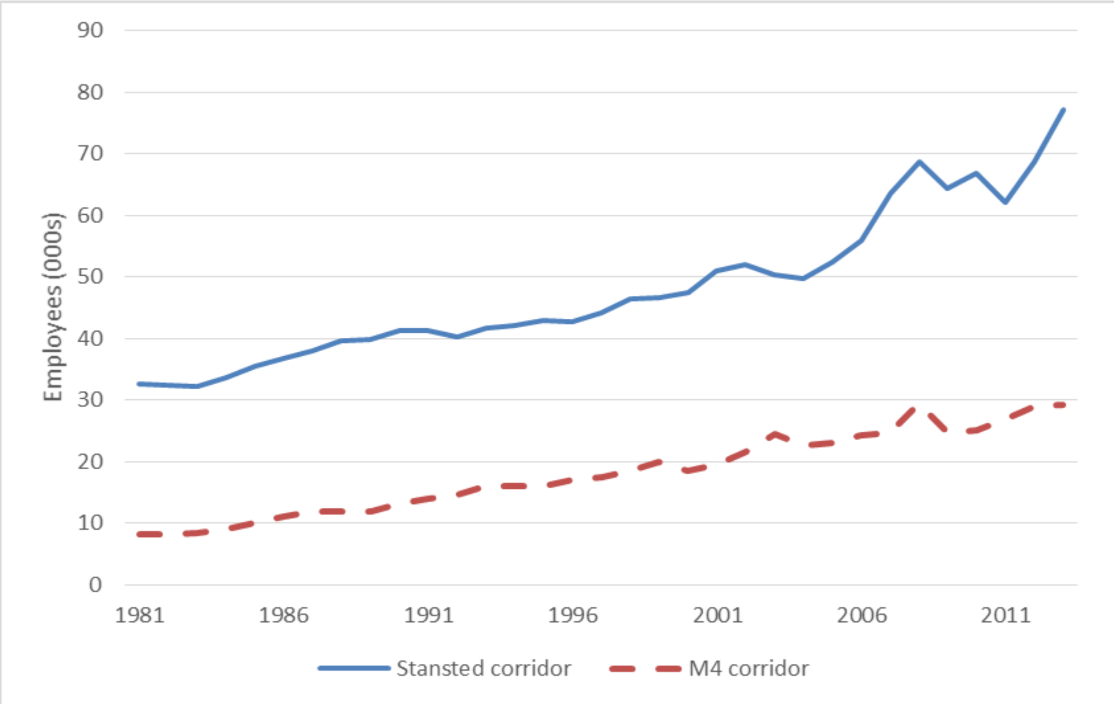


3.27 The largest bioscience clusters create two distinct corridors: the Stansted corridor (East Inner London-Stansted-Hertfordshire-Cambridge) and the M4 corridor (West Inner London-M4 corridor region)[18]. Grouping clusters into these corridors provides a broad

[18] See Annex for a map of the corridors.

perspective of the Bioscience sector in regions that are closely linked and share similar characteristics. Historically, the Bioscience sector in the Stansted corridor, a wider area, has been considerably larger (see Figure 3.16). Both GVA and employment have increased much faster in the Stansted corridor in the 2000s and GVA also grew more rapidly here in the rest of the period.

Figure 3.16 Employment in Bioscience in the Stansted and M4 corridor



4. The potential for future growth, key constraints and the policy agenda.

Extending the past into the future?

- In the short term, household growth is expected to outpace population growth as a result of declining household size, putting more pressure on the housing market in Cambridge which has experienced substantial increases in prices.
- Out of three possible scenarios for growth of Cambridge Bioscience, the central projection based on historical trend forecasts an increase of 10,800 jobs and £1.14bn in GVA from the 2013 level by 2030. This compares to an increase of less than 2,000 jobs in the low projection and 21,000 jobs in the high projection.
- Reaching the £2bn increase in GVA target set by the high projection is subject to measures to improve productivity or accommodate a larger workforce.
  - Under the central projection for employment, each job shifted from R&D to Pharmaceuticals by 2030 will add £337,000 in GVA and increase productivity in Bioscience from £83,000 to £111,000 per employee, compared to the central projection without any change in the sector composition.
  - If employment growth is to follow its historical trend, by 2030, there will be an increase of 51,000 in the population and an additional 20,000 households in Cambridge, 17,000 more people than in the baseline forecast.

4.1 There is very strong evidence from a number of different sources that the cluster will experience strong growth in the future. Thus, the company survey indicated that some 85% of the companies responding wanted to expand their operations and 43% to acquire larger premises.

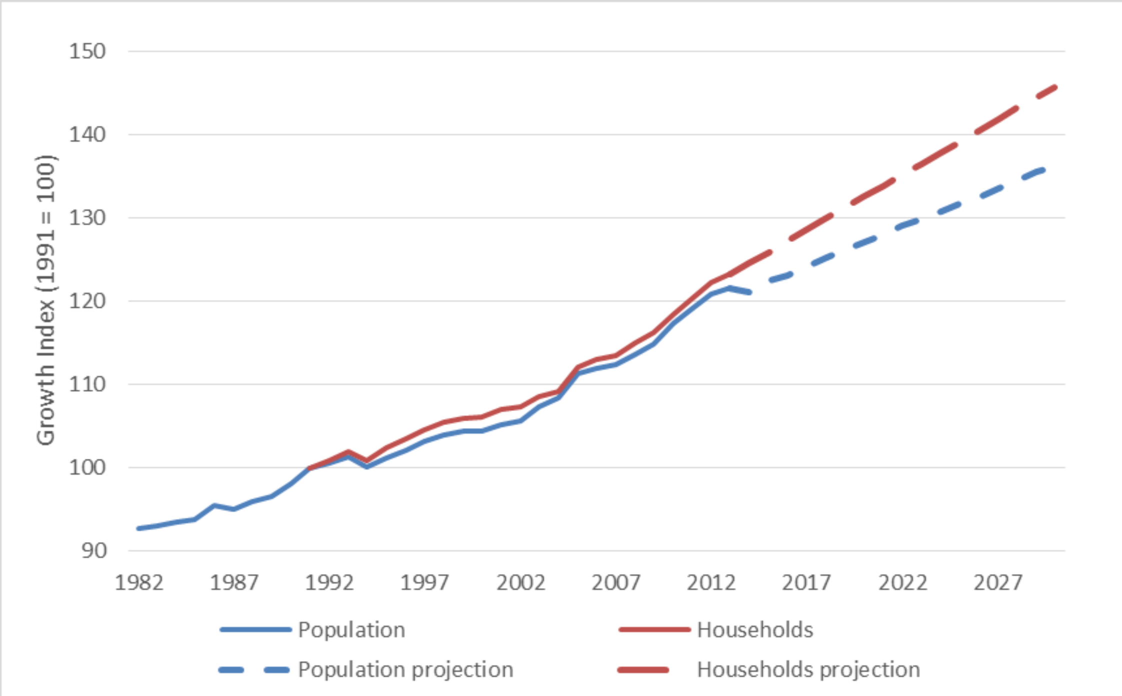
Strong growth in population and households observed in the past is expected to continue while the average household size declines.

4.2 In recent times, the demographics of Cambridge have remained relatively balanced; population and the number of households[19] have been growing at a similar rate (see Figure 4.1). However, over the next few years it is expected that the number of households will grow much faster, as a result of declining household sizes as young professionals continue to move into the region. This growth in the number of households is likely to be accompanied by increased demand for housing, exacerbating the ongoing trend for residential property

[19] A household is a person or group of people sharing a single abode; thus a household is a measure of demand for housing units.

prices to grow substantially faster than earnings. Nominal house prices in Cambridge City have more than tripled over 1996-2012, and continued rapid increases in household numbers will drive these higher still.

Figure 4.1. Growth of population and households in Cambridge, 1981-2030



The Cambridge Bioscience sector is projected to double in size by 2030.

4.3 We have compared future growth in GVA and employment in a number of scenarios to assess the prospects of the sector (see Table 4.1). These include a central projection based on historical trend, CE's baseline (low) projection and a high projection[20]. (Figure 4.2).

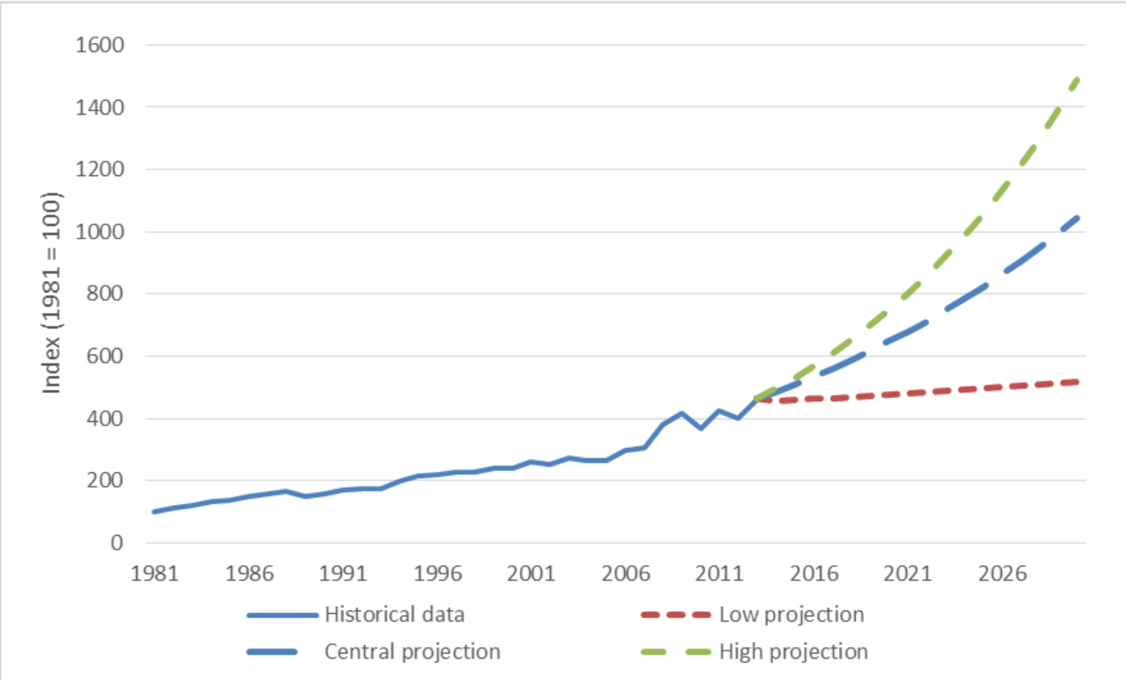
Table 4.1 Future jobs and population growth.

	2013 (thousands)	Change 1991-2013 (thousands)	Change 2013-30 (thousands)
Population	278	+49	+33
Households	109	+21	+20
Jobs Whole economy, low projection	180	+33	+24
Jobs Bioscience, low projection	14	+6	+2
Jobs Bioscience, central projection	14	+6	+11
Jobs Bioscience, high projection	14	+6	+21

[20] See Annex 5 for further details

4.4 In comparison to CE's baseline projection, the central scenario projects an increase of 10,800 jobs and £1.14bn in GVA from the 2013 level by 2030 (Figure 4.2). However, given the scale of recent investment in the Bioscience sector in Cambridge, there is the potential for more rapid growth than presented in the central forecasts. The high projections are therefore designed as an aspirational illustration of future growth rather than a forecast. Under this scenario, for Bioscience to employ 35,000 people by 2030, equivalent to a gain of 21,240 jobs, the number of jobs would need to grow by around 5.7% pa. If GVA growth continues to be driven by employment growth as discussed earlier in the report, this growth in employment could results in a £2bn increase in GVA by 2030 (a growth rate of 7.1% pa).

Figure 4.2 Projected growth of GVA in the Cambridge Bioscience sector by 2030



The high scenario for GVA growth can be achieved by improving productivity or expanding the workforce.

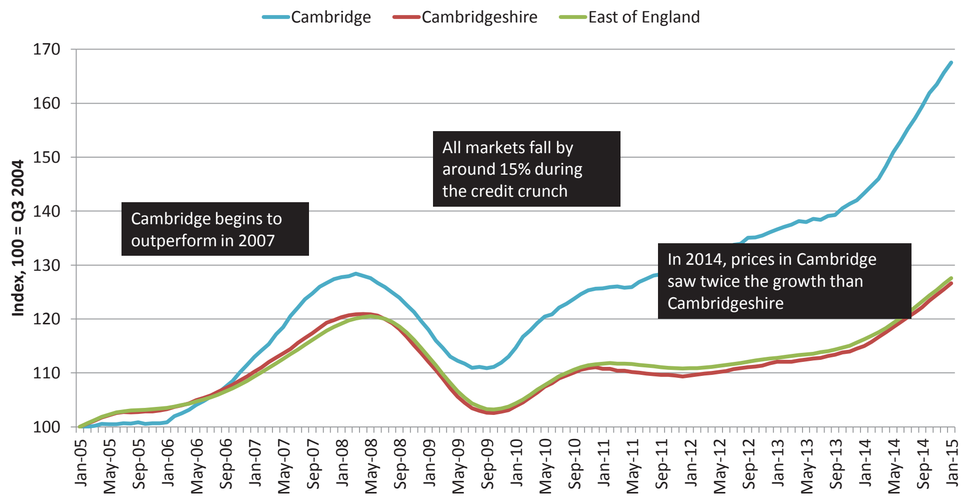
4.5 The aspirational high growth scenario could be achieved by improving productivity or increasing the size of the Bioscience workforce. There is uncertainty over the extent to which a larger workforce could be drawn from the resident population or from commuters from surrounding areas. As Table 4.1 shows, in the central projection (in which future Bioscience jobs grow at the same pace as the historical trend) by 2030, 11,000 additional jobs would be generated; to put this in context, the ONS projects that population in the area will increase by 33,000 over the same period. The high projection would generate 24,000 jobs implying an even greater need to draw in workers with the necessary skills to serve and enhance productivity in the sector.

The constraints on realising the potential of the Cambridge Bioscience cluster

Housing, transport and the skill base

4.6 As the Cambridge Bioscience sector has grown it has placed increasing demands on the built environment of the Cambridge economy. The desire for much of the activity to be located in either Central Cambridge or South Cambridgeshire has put particular pressure on housing and roads in these areas. Rapid growth in the demand for housing and a relatively constrained supply response has led to significant house price inflation in recent years. The rising cost of living has clear implications for affordability and the real incomes of those on relatively lower incomes.

Figure 4.3. House price growth in Cambridge outpaces surrounding locations



Source: Savills using Land Registry, 12 month rolling average index

4.7 Recent research published by Savills in their Spring 2015 Cambridge Residential study using data from the Land Registry illustrates the nature of the problem. As Figure (4.3) makes clear, over the last ten years house prices in Cambridge have increased by nearly 70% compared with the Cambridgeshire and East of England averages. Growth has been particularly strong over the last year (2014) at around 17%. The supply of housing is beginning to respond with more having been added in 2013/14 than in other cities in England[21] and more coming particularly on the Southern City fringe. However, it is unlikely that the supply will keep up with the demand from new workers coming for the jobs that are being created as identified in this chapter. The Savills report highlights that the second

[21] Savills World Research. Spotlight Cambridge Residential Spring 2015. http://www.savills.co.uk/research_articles/186866/187634-0

phase of the Northstowe development at Cambridge is subject to plans announced by HM Treasury on 2nd December 2014 whereby the Homes and Community Agency (HCA) will have an important role at each stage of the residential development process. This will be the largest new town planned for the UK since Milton Keynes.

4.8 The Savills analysis is also reinforced in a recent report from Bidwells[22]. In their Spring 2015 residential commentary they confirm that house prices in Cambridge have risen faster than in any other British town or city over the last seven years. The result of surging demand on a relatively limited supply in core areas has been that median house prices are now some ten to eleven times higher than medium earnings (the equivalent in England is 7).

Attracting people and the skills agenda

4.9 The impact of congestion and the rising cost of living on the quality of life of those who live in Cambridge is illustrated in the findings from the recent Quality of Life Survey of Cambridge Employees undertaken by the RAND Corporation for Cambridge Ahead[23]. The Survey considered quality of life around the six main strands of housing, transport, education, health, leisure and safety and security. Some 27,000 employees (around 29% of the City working population) were surveyed in December 2014 and responses were obtained from 4,861.

4.10 On the more positive side Cambridge is perceived as a highly desirable place in which to live because of its abundant employment opportunities and relative safety. Most people were satisfied with local hospitals and fairly satisfied with local GP provision although there were lower scores for mental health facilities and community health centres. The main negative aspects were housing with 76% of respondents disagreeing with the view that housing was affordable and 76% disagreeing that there was enough social housing. More than half felt that they were struggling to get on the property ladder. A very high number of respondents were dissatisfied with the level of traffic and the provision of parking. There was high dissatisfaction with the bus service in general.

4.11 The impact of the high cost of living in Cambridge and problems with travelling around the cluster was highlighted in the findings of the business survey undertaken for this study. Figure (4.4) shows that when companies in the survey were asked to identify how important were a range of possible constraints on their ability to recruit labour on a scale of one to five with five being the most important they overwhelmingly highlighted the cost of housing, commuting problems for their employees, the lack of quality and choice in the housing market and inevitably, in the face of these factors, competition from other companies.

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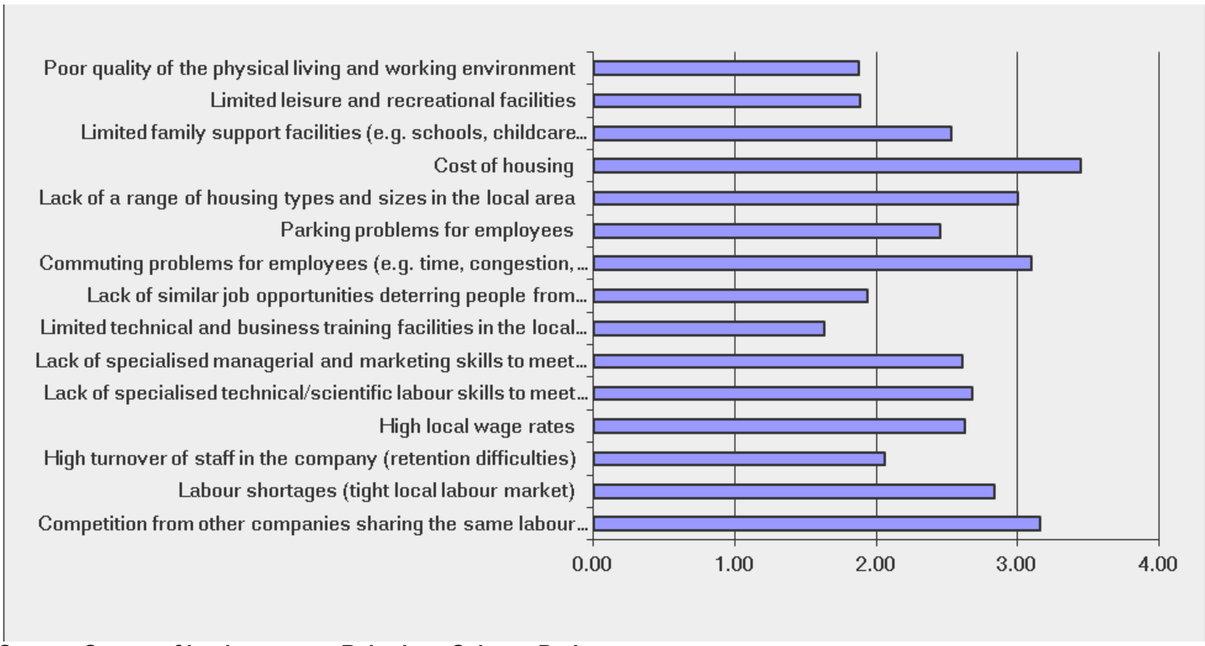
[22] Bidwells Residential Commentary, Spring 2015. http://www.bidwells.co.uk/research/residential-commentary-spring-2015
[23] Cambridge Ahead Survey on Quality of Life. RAND Corporation. http://www.rand.org/randeurope/research/projects/cambridge-ahead.html

Figure 4.4. Importance of constraints to recruiting employees.



Source: Survey of businesses on Babraham Science Park.

Office and commercial floorspace

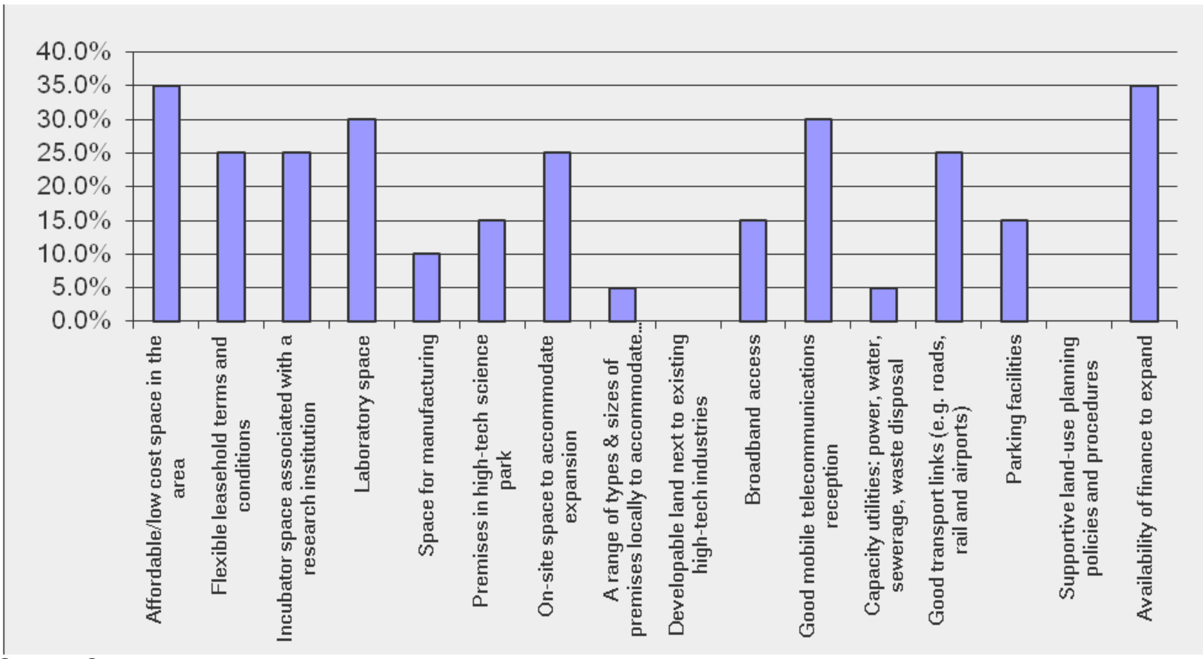
4.12 The survey of companies also asked them to identify the factors that they believed to be major constraints on the growth of their company. Figure 4.5 shows the findings. Affordable and relatively low cost floorspace together with obtaining finance were the most highly cited. Laboratory and incubator space was also perceived to be a constraining influence and, perhaps surprisingly, good mobile telecommunications reception.

4.13 There are also now major issues emerging in relation to the provision of commercial and business floorspace to accommodate the growth of the Bioscience cluster and other technology and non-technology based activity in Cambridge. As a recent report by Bidwells highlights[24]; 'The R&D sector is driving one of the largest expansions of business floorspace in the UK' (Cambridgeshire Business Space, Spring 2015, Bidwells). The Bidwells research indicates that some 950,000 sq ft of office and laboratory activity was recorded with more forecast for 2015. There was also strong growth in the industrial market. Bidwells estimate that the current stock of office and R&D activity in the Cambridge area itself is around 8 million sq ft with significant growth forecast over the next three years including 600,000 sq ft for Astra Zeneca on the Biomedical Campus. Office rentals are now at £34 per sq foot, the highest rental level of any UK city outside London. Industrial rentals are now at £10 per sq ft. Some 350,000 sq ft of speculative office build is commencing in 2015 with a further 150,000 under consideration. Grade A[25] floorspace is in very short supply and there are particular

[24] Bidwells. Business Space Data Book. Spring 2015. http://www.bidwells.co.uk/research/business-space-data-spring-2015/
[25] Grade A floorspace is modern with high quality finishes; flexible layout; large floor plates; spacious, well decorated lobbies and circulation areas; effective central air-conditioning; good lift services zoned for passengers and goods deliveries; professional management; parking facilities normally available.

constraints on incubator floorspace.

Figure 4.5. Factors identified as major constraints on the growth of the company



Source: Company survey.

4.14 As the Bidwell report comments:

> 'The strength of the Cambridge market has begin to impact on other markets in Cambridgeshire, with overall activity in the county up by almost 50% on the previous year's levels of take-up in the office market and 35% in the industrial sector. Rents on secondary space in Cambridge have risen by more than 50% over the past three years, and these effects are expected to spread to surrounding locations.'

Building the innovation system, facilitating technology transfer and financing business development

4.15 The ability of local infrastructure to accommodate the people and businesses required to grow the Cambridge Bioscience is clearly a major issue that has to be addressed if further growth potential is to be realised. However, during the course of the research a number of other issues were highlighted by those who participated in the study. How these concerns might be addressed has not been the subject of this research but it is important to highlight them. Key issues were:

5) The need to maintain an adequate flow of research funding from Government including that for the NHS and the charitable sector;

6) Ensuring the continued availability of finance at the relevant stages of the

commercialisation process. Whilst it was recognised that seed-corn funding was less of a problem at the present time there are still major issues around businesses accessing funds as they seek to scale up to the market;

7) The importance of speeding-up the adoption of new drugs by the NHS as a continuing issue in the translation process.

The policy agenda

4.16 The evidence presented in this study highlights the important economic contribution that Cambridge Bioscience is making to the growth of Greater Cambridge. The strength of the Cambridge bioscience cluster confirms the view held by many that it is rapidly becoming the most prominent cluster of its kind in Europe and is making a significant contribution to the growth of the United Kingdom economy as a whole.

4.17 However, the continued growth and success of the cluster cannot be taken for granted and the previous section has highlighted a number of areas where action is required if the momentum is to be maintained and the cluster is to realise its undoubted economic potential. The Cambridge City Council, South Cambridgeshire Council and Cambridgeshire County Council and other key stakeholders including the University of Cambridge are struggling to find the resources that are required to expand the basic infrastructure to allow its technology based clusters to grow and prosper. They have recently been successful in securing a City Deal from HM Government to help meet the challenge. The City Deal[26] is a central element in obtaining the funding required to tackle key infrastructure and housing issues. It is a powerful and effective alliance of the relevant partners including the Local Enterprise Partnership. Much good work has been done by those involved to make it happen but the reality is that more resources and coordinated action will be required in the years ahead.

4.18 At the national level it is as yet unclear how central government intends to help local authorities to secure the resources required to deliver on their local growth agendas. The recent HM Treasury paper 'Fixing the Foundations: Creating a More Prosperous Nation'[27] provides some insight as to how HM Government may advance the City Growth model to give local areas in England more of the resources that they need to realise their growth potential. One obvious direction of travel is to develop further the Tax Incremental Financing models[28] that have been so popular in the United States. The specific needs of the Cambridge Bioscience cluster will be met by coordinating the actions and resources of the key stakeholders in the quadruple helix model we presented in Section Two and which we believe characterises the workings of the Cambridge Bioscience cluster. We would emphasise the importance of aligning and sharing agendas to ensure that a truly strategic

[26] https://www.gov.uk/government/news/government-formalises-the-first-wave-of-city-deals--2

[27] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/443898/Productivity_Plan_web.pdf

[28] https://en.wikipedia.org/wiki/Tax_increment_financing

approach is adopted that continues to build and sustain the research and teaching excellence of the knowledge base that attracts the people and ideas that underpin the continued success of the cluster. The relevant boundaries of interest have to be shared across the innovation network to ensure that ideas are translated into commercial application. A discussion of the key features of the innovation system required is provided in Baxter et al.[29] A central component in building the required capacity is to continue to build an evidence base that can inform policy. We would emphasise the importance of monitoring, benchmarking and assessing the ongoing economic impact of the cluster on the local and national economy.

[29] http://www.landecon.cam.ac.uk/pdf-files/cv/pete-tyler/copy_of_PRI_ENTERPRISING_REPORT1.pdf

Annexes

This research approach adopted in the research had both a qualitative and quantitative element. The qualitative research involved obtaining information from a number of people who were involved in the Cambridge bioscience sector either as a business or a key stakeholder in a knowledge based institution, the financial sector or in the provision of public or private service delivery.

A business survey was undertaken of all businesses that were based on the Babraham Science Park. A Survey Monkey based questionnaire was emailed to these businesses and one third of them responded. Babraham was selected because it was considered to be typical of the bioscience sector in the sub-region and we were assisted by the CEO of the Babraham Science Park. Clearly the purpose of the research was to test the basic approach. A key limitation is that ideally it would be better to interview more companies to build statistical reliability. A more extensive programme of research could usefully extend the survey tool to bioscience businesses across the sub-region.

Interviews with key stakeholders followed a structured set of questions that probed the main areas of research enquiry. The focus was on understanding what is driving the growth of the bioscience cluster in Cambridge, its geography and how it develops in the future. The discussions also probed the competitiveness of the Cambridge Bioscience cluster relative to elsewhere and the factors that give it a competitive edge. The more unique the Cambridge offer the more likely the economic benefits it produces contribute to national as well as local economic growth in the United Kingdom. A further area of interest was to establish the constraints on the growth and development of the cluster and what actions might help to overcome them.

The people interviewed were identified through cross-reference as being leading experts/ facilitators and practioners in the field. As with the business survey the emphasis was on distilling key messages and testing survey tools. A key limitation is that it would be desirable to conduct more interviews to build statistical reliability. Future research might usefully extend the number of interviewees although it is not obvious that this would change the key findings significantly.

The quantitative work has involved economic modelling using various tools to quantify the impact of the Cambridge bioscience sector on the growth of the Cambridge economy. The tools used include: Cambridge Econometrics' (CE) Local Economy Forecasting Model (LEFM)[30]; CE's Multisectoral Dynamic Model (MDM-E3)[31] of the UK and regions; and analyses of various sources of data including ONS' input-output and other economic and demographic data. Annex 5 provides further detail on the modelling work and its limitations.

30 http://www.camecon.com/SubNational/SubNationalUK/ModellingCapability/LEFM/LEFMOverview.aspx

31 http://www.camecon.com/MacroSectoral/MacroSectoraluk/ModellingCapability/MDM-E3UKMultisectoralDynamicModel.aspx

Annex 1 Key interviewees

The study team would like to thank a number of people who agreed to be invited as part of this study and also those companies who participated in the survey.

Kate Bingham, Managing Partner, SV Life Sciences

Matthew Bullock, Master of St Edmund's College, Cambridge

Dr Andy Cosh, Assistant Director, Centre for Business research (CBR), Judge Business School, University of Cambridge

Anne Dobree, Head of Seed Funds, Cambridge Enterprise, University

Ms Harriet Fear, Onenucleus

Reginna Hodits, Wellington Partners

Derek Jones, Chief Executive of Babraham Bioscience Technologies

Professor Nick Morrell, BHF Professor of Cardiopulmonary Medicine. Research Director, National Pulmonary Hypertension Service, Papworth Hospital. Genetics

Steven Lang, Director of Commercial Research, Savills, London

Ms Karen Livingstone, Director of Partnerships and Industry Engagement for the Eastern Academic Health Science Network

Dr Jane Osbourn, Vice President Research, Medimmune

Dr Tony Raven, CEO, Cambridge Enterprise, University of Cambridge.

Rob Sadler, Savills, Cambridge

Andy Sandham, Partner, Syncona Partners LLP. Jon Sussex, Chief Economist at the Rand Group. Rand Europe.

Ian Thomas, Head of Life Sciences, Cambridge Enterprise, University of Cambridge.

Professor Dame Jean Thomas, Master of St Catharine's College, Cambridge.

Jane Paterson-Todd (Cambridge Ahead)

Andy Walsh, Cambridge Enterprise, University of Cambridge.

Eric Karran. Director of Research Strategy at Alzheimer's Research UK

Jeanette Walker, Project Director of the Cambridge Biomedical Campus

Professor Sir Greg Winter, Master, Trinity College, Cambridge.

Annex 2 Defining the Cambridge Bioscience sector and its comparators

NACE is a statistical classification used to classify economic activities. The original list of 23 NACE codes relevant to bioscience was drawn from a number of similar studies as in Table A1 below. Out of these sectors, the manufacture of chemicals, pharmaceuticals, medical devices and the research and development activities are directly related to bioscience.

Other sectors generally falling into one of the three industries trade, IT services and health are considered part of the supply chain. For example, an IT consultancy provides computer programming and consultancy services for analysing data in a biotechnology research project but does not carry out the research itself so it is a supplier to the bioscience sector. In another case, after the research is successful and turned into viable applications, these are used in healthcare ('Hospital activities' and 'General medical practice activities') and can be purchased at pharmacies ('Retail sale of medical and orthopaedic goods in specialised stores'); these sectors therefore are users of the bioscience sector's output.

In the estimates of *direct* Bioscience activity, we include only sectors that are the most relevant and significant to the sector; the study also estimates the *indirect* effects, that is, the supply chain (inputs to and outputs of the sector from/to other parts of the economy).

Table A1. The Bioscience sector and its supply chain

NACE Rev. 2 code	Sector description	CE Industry
2059	Manufacture of other chemical products n.e.c.	Chemicals etc
2110	Manufacture of basic pharmaceutical products	Pharmaceuticals
2120	Manufacture of pharmaceutical preparations	
2651	Manufacture of instruments and appliances for measuring, testing and navigation	Electronics
3250	Manufacture of medical and dental instruments and supplies	Other manufacturing & repair
4646	Wholesale of pharmaceutical goods	Wholesale trade
4669	Wholesale of other machinery and equipment	
4773	Dispensing chemist in specialised stores	Retail trade
4774	Retail sale of medical and orthopaedic goods in specialised stores	
6201	Computer programming activities	IT services
6202	Computer consultancy activities	
6209	Other information technology and computer service activities	
7022	Business and other management consultancy activities	Head offices & management consulting
7112	Engineering activities and related technical consultancy	Architecture & engineering services
7120	Technical testing and analysis	
7211	Research and experimental development on biotechnology	Other professional services
7219	Other research and experimental development on natural sciences and engineering	

NACE Rev. 2 code	Sector description	CE Industry
7490	Other professional, scientific and technical activities n.e.c.	
8610	Hospital activities	Health
8621	General medical practice activities	
8622	Specialist medical practice activities	
8623	Dental practice activities	
8690	*Other human health activities*	

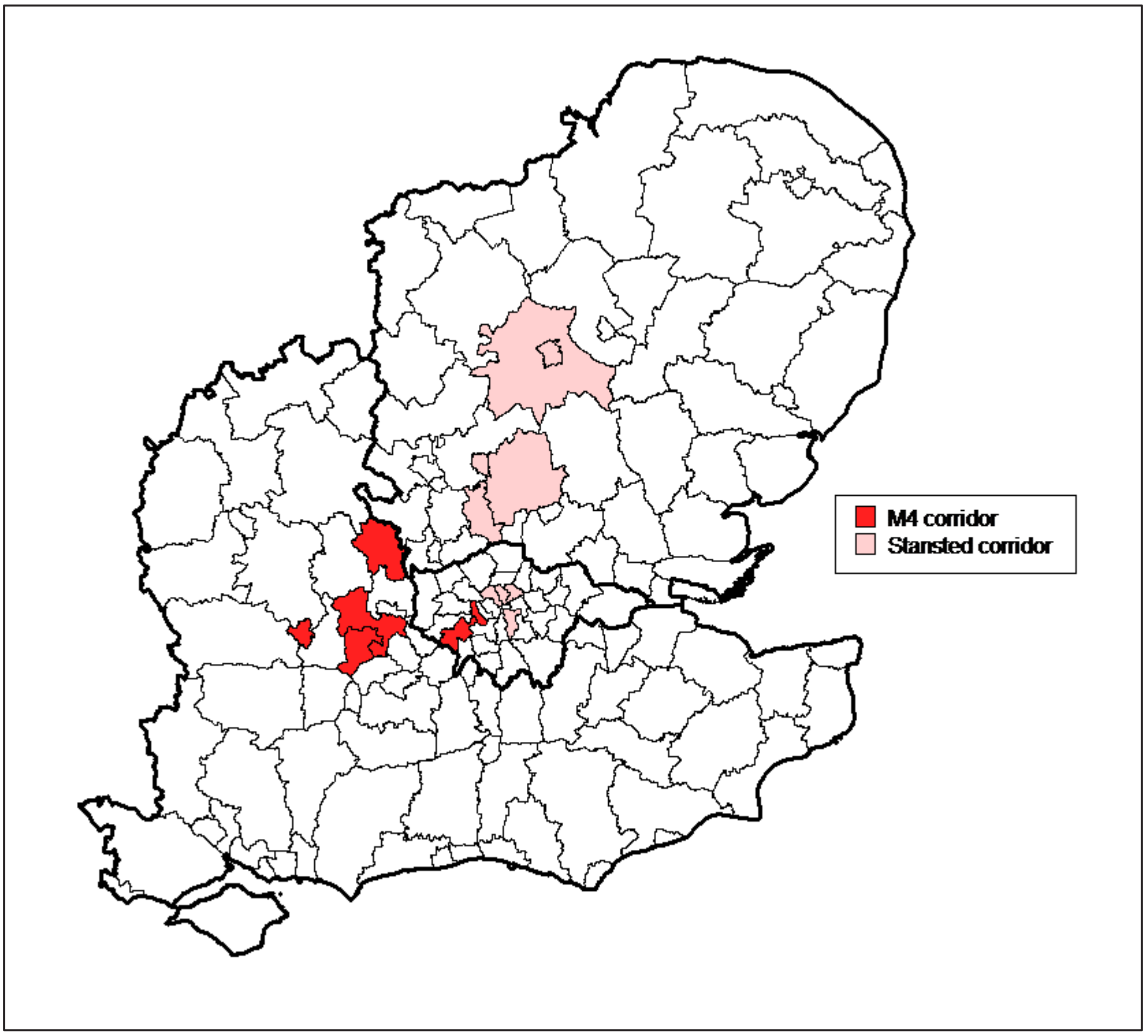
To select regions to make comparisons with Cambridge, we carried out an analysis of the location quotient of all local authorities in England, Wales and Scotland. The location quotient measures the degree of specialisation of a sector in a region and is the ratio of the sector's share of regional employment and the sector's share of national employment. We have identified five regions consisting of the best performing local authorities (described in Table A2) after ranking the location quotient values.

Table A2. Competitor regions and geographical coverage

Competitor region	List of local authorities	Major bioscience research institutes and businesses in the region
Oxfordshire	Oxford, South Oxfordshire and Vale of White Horse	Oxford University, John Radcliffe Hospital, the Medical Research Council (MRC) Radiobiology Institute, Wellcome Trust Human Genetics Centre, Oxford Science Park, Diageo Laboratory, Oxford Genetics Knowledge Park, Diamond Synchrotron
Edinburgh	Midlothian and East Lothian	Edinburgh Science Triangle (including University of Edinburgh)
Inner London	Camden, Islington, Hackney and Southwark	London Bioscience Innovation Centre (including several research institutes and universities across London)
M4 corridor	Bracknell Forest, Chiltern, Richmond upon Thames, Hammersmith & Fulham, Reading and Windsor & Maidenhead	University of Reading (member of the Bophirima Skills Consortium), Pfizer, Abbott Laboratories, TEI Biosciences
Hertfordshire	East Hertfordshire, Stevenage and Welwyn Hatfield	University of Hertfordshire, Stevenage Bioscience Catalyst (including GlaxoSmithKline), Bio Park, Eisai Pharmaceuticals

These regions highlight two main corridors: the Stansted corridor (combining Cambridge and Inner London) and the M4 corridor (see Figure A1 Corridor map).

Figure A1. Corridor map



Annex 3 Cambridge Phenomenon (High-tech) sectors

The list of sectors considered as ‘high-tech’ (see Table A3 below) is based on a simplified and updated version of R L But chart’s definition in 1987.

Table A1 High-tech sectors

NACE Rev. 2 code	Sector description	CE Industry
2016	Manufacture of plastics in primary forms	Chemicals etc
2017	Manufacture of synthetic rubber in primary forms	
2110	Manufacture of basic pharmaceutical products	Pharmaceuticals
2120	Manufacture of pharmaceutical preparations	
2611	Manufacture of electronic components	Electronics
2612	Manufacture of loaded electronic boards	
2620	Manufacture of computers and peripheral equipment	
2630	Manufacture of communication equipment	
2651	Manufacture of instruments and appliances for measuring, testing and navigation	
2660	Manufacture of irradiation, electro medical and electrotherapeutic equipment	
2670	Manufacture of optical instruments and photographic equipment	
2711	Manufacture of electric motors, generators and transformers	Electrical equipment
2712	Manufacture of electricity distribution and control apparatus	
2731	Manufacture of fibre optic cables	
2733	Manufacture of wiring devices	
2740	Manufacture of electric lighting equipment	
2790	Manufacture of other electrical equipment	
2823	Manufacture of office machinery and equipment (except computers and peripheral equipment)	Machinery etc
2829	Manufacture of other general-purpose machinery n.e.c.	
2899	Manufacture of other special-purpose machinery n.e.c.	
3030	Manufacture of air and spacecraft and related machinery	Other transport & equipment
3250	Manufacture of medical and dental instruments and supplies	Other manufacturing & repair
3299	Other manufacturing n.e.c.	
3312	Repair of machinery	
3313	Repair of electronic and optical equipment	
3314	Repair of electrical equipment	
3316	Repair and maintenance of aircraft and spacecraft	
5811	Book publishing	Media
5812	Publishing of directories and mailing lists	
5813	Publishing of newspapers	
5814	Publishing of journals and periodicals	
5819	Other publishing activities	
5821	Publishing of computer games	
5829	Other software publishing	
5920	Sound recording and music publishing activities	
6010	Radio broadcasting	

NACE Rev. 2 code	Sector description	CE Industry
6020	Television programming and broadcasting activities	
6110	Wired telecommunications activities	
6120	Wireless telecommunications activities	
6130	Satellite telecommunications activities	
6190	Other telecommunications activities	
6201	Computer programming activities	IT services
6202	Computer consultancy activities	
6203	Computer facilities management activities	
6209	Other information technology and computer service activities	
6311	Data processing, hosting and related activities	
6312	Web portals	
7211	Research and experimental development on biotechnology	Other professional services
7219	Other research and experimental development on natural sciences and engineering	
7220	Research and experimental development on social sciences and humanities	

Annex 4 Direct, indirect and induced effects

The Multiplier tool is developed by Cambridge Econometrics (CE) based on the multiplier effect theory which suggests that output and employment in one sector (the direct effect) creates additional output and employment in its supply chain (the indirect effect) as well as other parts of the economy in which workers spend their wages and salaries (induced effect).

Employment in the subsectors of Bioscience was converted into direct output using ratios calculated by CE from the UK Input-Output Table. Coefficients used in the tool to quantify backward linkages between sectors were also calculated from the Input-Output Table by dividing intermediate demand by gross output to get the breakdown of inputs to one unit of output.

Using the direct output data and the Type I and Type II Leontief Inverse Matrices, the tool calculates the economic impacts of Bioscience on gross output, GVA and employment in all sectors of the economy. The tool calculates three types of effects for each of these variables: the direct effect, the Type I affect and the Type II effect. The direct effect, as discussed above, measures the size of the sector. The Type I affect includes the direct and indirect effects; in addition, the Type II effect includes the induced effect. The ratio between the Type II effect and the direct effect is known as the expenditure multiplier.

Annex 5. The Economic Projections Used in the Analysis

Examining the projections for the Cambridge economy, it can be seen that the growth in Biosciences is expected to moderate in future[32]. This reflects the trend expected to be seen more widely across the UK. The low projection presented here is from CE's Local Area Database, and they represent the extrapolation of local trends constrained to national forecasts for the economy. In the case of Bioscience, the sector is dominated by the R&D activities (as set out above). These map within CE's 45 sectors as part of 'Professional Services'; the projections are therefore dominated by those estimated for Professional Services (of which Biosciences is only a small part).

In the historical data, the shares of CE's 45 sectors which are used are estimated based upon the more detailed BRES data (which is available only for a very limited number of recent years). These shares are then held constant through the projections; so while, in Cambridge, we might expect to see Bioscience as an increasingly large share of Professional Services, the modelling methodology does take account of this. Both GVA and employment in Bioscience are expected to grow at a slower pace than witnessed historically.

Given that Bioscience is a very small and distinct part of Professional Services, projections based on data for the broad sector are unlikely to capture the full potential of Bioscience; for high-tech sectors this is a less pronounced issue because they cover a wider range and a larger proportion of relevant NACE codes. Projected growth in Bioscience is also likely to be slower than expected as the model did not take into account the impacts of recent events such as AstraZeneca's decision to move to the Biomedical Campus with its 2,000 employees.

The three projection scenarios were derived as follows:

8) Low projection: CE's baseline projection from the Local Area Database
9) Central projection: An extrapolation of the 2013 employment and GVA levels into the future, using historical trends (the compound annual growth rates over 1981-2013)
10) High projection: A projection aiming to reach an employment level of 35,000 by 2030, assuming productivity continues to grow at the historical trends (annual rate over 1981-2013)

CE's economic projections (the low projection) are consistent with ONS' baseline projection of households and population.

There are a number of limitations to using the three scenarios set out above. Primary amongst them is the inherent uncertainty around the likelihood of any single scenario coming to pass; we assign no probabilities to any outcome, and do not present 'fan charts' of the likely range of outcomes (as these are not measured in the analysis). Broadly, the central projection can be seen as the 'most likely' of the three scenarios to come to pass, with the low and high projections showing, without modelling a severe economic crisis or unheralded boom, what a more negative or positive outcome might look like. The assumptions made in

[32] The projections presented in this study are from CE's Local Area Database, and run to 2030.

each of the three scenarios are set out above; however other alternative scenarios might be equally valid for consideration; the intent of choosing three discrete scenarios is to show the range of outcomes that might be realised in the Cambridge Bioscience sector.

These scenarios also primarily concern themselves with a Bioscience sector which looks similar to that which already exists in Cambridge. Expanding areas which are currently underserved in the cluster (e.g. a relative move away from R&D and towards Pharmaceuticals) could increase productivity of the Bioscience workforce as a whole, and have different implications for policy and worker requirements to the current (or expanded) status quo. More broadly, scenarios are trend-based. They are, therefore, not policy-based forecasts of what is expected to happen. Many social and economic factors influence the economy and population, including policies adopted by both central and local government, and these are not explicitly modelled in the scenarios.