OECD Local Economic and Employment Development (LEED) Papers 2021/01

Local entrepreneurship ecosystems and emerging industries: Case study of Cambridgeshire and Peterborough, United Kingdom

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https://dx.doi.org/10.1787/044ffc1d-en

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Local Entrepreneurship Ecosystems and Emerging Industries

Case Study of Cambridgeshire and Peterborough, United Kingdom

This paper examines how local-level policies can strengthen entrepreneurship and innovation in the region of Cambridgeshire and Peterborough in the United Kingdom. It investigates the quality of the local entrepreneurship ecosystem for generating innovative start-ups and scale-ups and the regional conditions for generating positive industry transitions by supporting the strategic sectors of life sciences, information technologies, agri-tech and advanced manufacturing. Key areas of focus are on skills development, entrepreneurship development and knowledge exchange for local economic development. A number of policy recommendations are offered based on the analysis together with international inspiring policy practice examples.

JEL codes: J24, L52, L53, R58

Keywords: Entrepreneurship, skills, knowledge exchange, industry transition, regional policy

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This paper was authorised for publication by Lamia Kamal-Chaoui, Director, Centre for Entrepreneurship, SMEs, Regions and Cities, OECD.

Foreword

This report examines the local entrepreneurship ecosystem of the Cambridgeshire and Peterborough region in the United Kingdom and the capacity of the regional economy to boost productivity and develop new industrial pathways. It forms part of the OECD's work stream on Local Entrepreneurship Ecosystems and Emerging Industries.

The work stream examines conditions for entrepreneurship and industrial transition to higher-productivity and higher value-added specialisations in case study regions. It emphasises the various dimensions of local entrepreneurship ecosystems that affect innovative start-ups and scale-ups – finance, talent, culture etc. – and how to overcome bottlenecks and weak links as well as how to promote new industry path development by strengthening regional skills and knowledge exchange for innovation. It focuses on how policy can facilitate entrepreneurship and industrial transition to support regional and national economic growth.

Cambridgeshire and Peterborough is a fascinating case study area for a number of reasons. It hosts a world-leading high-technology cluster in Cambridge, based on the University of Cambridge, major international inward investor companies in research and knowledge-intensive activities and a rapid rate of company and university spin-offs. Further investment in infrastructure and skills is needed to continue its recent rapid growth. At the same time, other parts of the region are less well developed and less well connected to the cluster. There are key needs to strengthen skills and business innovation in these sub-regions, as well as to better connect them to the cluster. Furthermore, Cambridgeshire and Peterborough has new and pioneering governance arrangements in the form of a Combined Authority for local government and a directly-elected mayor, as is more common in the largest United Kingdom cities. Working with national government and regional stakeholders from the private, non-profit and public sectors, the Combined Authority can define and pursue a forward-looking agenda for supporting the Cambridge cluster and promoting development across the whole region.

During the period in which this analysis took place, the COVID-19 pandemic erupted, causing severe disruption to the economy. While this report does not go into detail on the impact of COVID-19, it does set out a medium- to long-term vision on how policy can strengthen entrepreneurship and innovation in Cambridgeshire and Peterborough. Improving the conditions for entrepreneurship and innovation as recommended in this report is the best way to secure a strong recovery from the crisis and greater resilience to future shocks.

Acknowledgements

This report was prepared by the Centre for Entrepreneurship, SMEs, Regions and Cities (CFE) of the Organisation for Economic Co-operation and Development (OECD), led by Lamia Kamal-Chaoui, Director, at the request of the UK Department for Business, Energy and Industrial Strategy (BEIS) and the Department for Education (DfE). It forms part of the work of the Local Employment and Economic Development (LEED) Committee on Local Entrepreneurship Ecosystems and Emerging Industries.

The project was led by Jonathan Potter, Head of the Entrepreneurship Policy and Analysis Unit, CFE, OECD. The report was drafted by a team involving Helen Lawton Smith (Birkbeck, University of London – focus on the regional economy), Erik Stam (University of Utrecht, the Netherlands – focus on the entrepreneurship ecosystem), Andrea Filippetti (National Research Council, Italy – focus on skills development), and Markus Grillitsch (Lund University, Sweden – focus on knowledge exchange and industrial path development). Project development and report editing was by Jonathan Potter (OECD). We thank Anna Teselli and Pierpaolo Angelini (Fondazione Giuseppe Di Vittorio) for their insights on international cases on skills development.

Key national government partners in the project co-ordination were David Campbell, Rosa Fernandez and Andrew Paterson (BEIS) and Robert Haynes and Richard Garrett (DfE). Key local partners in the project included Neil Cuttell and Amos Akinwale (Cambridgeshire and Peterborough Combined Authority).

Many individuals and organisations in the region provided important information for the report. A wide range of stakeholders participated in meetings with the OECD review panel during an OECD study mission to Cambridgeshire and Peterborough in September 2019. This included a brainstorming seminar at St Catharine's College with the following participants: Alan Barrell, Matthew Bullock, David Campbell, Georgio Caselli, Simon Coward, Neil Cuttell, Andy Cosh, Pawel Dobrzanski, Ben Gardiner, Niamh Matthews, Rick Parisi, Derek Sharp, John Stenhouse, Simon Thorpe, and Peter Tyler. Comments on the report were provided by CPCA, BEIS and DfE.

A summary report was discussed at a stakeholder workshop in March 2020.

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Acronyms and abbreviations

ARU	Anglia Ruskin University
BA	Bachelor of Arts
BEIS	Department for Business, Energy and Industrial Strategy
BIA	Programme for User-driven Research-based Innovation (Norway)
BVCA	British Private Equity and Venture Capital Association
CFE	OECD Centre for Entrepreneurship, SMEs, Regions and Cities
CPCA	Cambridgeshire and Peterborough Combined Authority
CPIER	Cambridgeshire and Peterborough Independent Economic Review
CRUK	Cancer Research UK
DfE	Department for Education
EQF	European Qualifications Framework
ESF	European Social Fund
ESFA	Education and Skills Funding Agency
EU	European Union
FT	Full time
GB	Great Britain
GBP	British Pound
GCP	Greater Cambridge Partnership
GVA	Gross Value Added
HEI	Higher Education Institution
ICT	Information and Communications Technology
IDBR	Inter-Departmental Business Register
IFTS	Istruzione e Formazione Tecnica Superiore
IoT	Internet of Things
JADS	Jheronimus Academy of Data Science (Netherlands)
LEP	Local Enterprise Partnership

LGF	Local Growth Fund
MA	Master of Arts
NEET	Not in education, employment or training
NUTS	Nomenclature of Territorial Units for Statistics
NVQ	National Vocational Qualification
OBE	Order of the British Empire
OCC	Oxford to Cambridge Corridor
OECD	Organisation for Economic Co-operation and Development
OEM	Original Equipment Manufacturers
ONS	Office of National Statistics
PhD	Doctor of Philosophy
R&D	Research and Development
RTD	Research and Technological Development
S3	Smart Specialisation Strategy
SBIR	Small Business Innovation Research Programme (USA)
SBRI	Small Business Research Initiative (UK)
SIA	Science and Innovation Audit
SIP	Strategic Innovation Programmes (Sweden)
Soc2010	Standard Occupational Classification 2010 version
SME	Small and Medium Sized Enterprise
STEM	Science Technology Engineering and Mathematics
UDI	Challenge Driven Innovation Programme (Sweden)
UK	United Kingdom
USA	United States of America
USD	US Dollar

Executive Summary

Cambridgeshire and Peterborough is in the East of England. It has a population of approximately 900 000 people spread across the cities of Cambridge and Peterborough and a range of smaller and dispersed settlements in rural areas. The region is relatively prosperous and its labour market is tight. Indeed, Cambridge hosts one of the world's leading high-tech innovation clusters. However, productivity is slightly below the England average and population growth is not as high as some neighbouring areas. Key challenges are maintaining and strengthening the Cambridge cluster and stimulating broader-based development and coherence across the region as a whole.

Key findings

The region hosts a diverse economy

In many respects there are three distinct sub-regional economies in Cambridgeshire and Peterborough – Cambridge, Peterborough, and the rural Fens – although there are important connections between them that can be further built up.

The City of Cambridge and its immediate surroundings are the most prosperous part of the region. Cambridge hosts a high-tech cluster with some 4 700 knowledge-intensive firms and over 60 000 employees. The cluster's success is underpinned by world-leading research and teaching at the University of Cambridge, a dense network of other research, education and training establishments, research operations of major multinational companies, strong networks and social capital, and an exceptional performance in the generation of high-tech scale-up enterprises. The cluster has experienced rapid growth in recent decades but is also experiencing constraints in infrastructure and access to talent.

Whilst in close proximity, the labour markets and industrial bases of Peterborough and The Fens are significantly different to Cambridge and each other. Skills and productivity are lower in these two areas than in Cambridge. The Fens suffers from poor connectivity to economic centres and relatively low educational attainment and labour market participation. Peterborough, on the other hand, had *new town* status for much of the twentieth century, successfully absorbing population growth from London and the surrounding region, and has a relative strength in advanced manufacturing.

Local strategic documents have identified four key strategic sectors with growth potential for the region; three – life sciences, ICT and agri-tech – which are concentrated in the Cambridge area – and one – advanced manufacturing and materials – which is more evenly spread across the region but has a relative

specialisation in Peterborough. The skills demand intelligence carried out by the Skills Advisory Panel[1] (SAP) in the local Skills Strategy also focuses on these strategic growth sectors.

Policy devolution provides opportunities for tailored policies

The region has gained significant devolved policy powers over skills, innovation and entrepreneurship matters, in particular through the creation in 2017 of the Cambridgeshire and Peterborough Mayoral Combined Authority (CPCA). This has local government responsibilities for economic strategy development and investing in priority projects in co-operation with central government. A Business Board has been created as a private-public sector partnership focused on the key business sectors of the region to advise the CPCA in steering the Local Growth Fund allocation from central government. In addition, the CPCA Skills Committee has created the Employment and Skills Board, which acts as the Skills Advisory Panel **(**SAP**)** for Cambridgeshire and Peterborough. Two key strategy documents have recently been developed by the CPCA – the Local Industrial Strategy and the Skills Strategy, which both identify how to meet local challenges and align well with the analysis in this report.

The local entrepreneurship ecosystem is of high quality, with some weak links

The Cambridgeshire and Peterborough area has generated large numbers of scale-up companies in recent decades, with the Cambridge cluster generating as many as 18 “unicorns” (firms reaching a valuation of at least USD 1 billion), one of the highest regional concentrations globally. This is one indication of a very high-quality entrepreneurship ecosystem. To explore further, this study developed a quantitative entrepreneurship ecosystem index which enables comparison of the Cambridgeshire and Peterborough region combined with the neighbouring counties of Norfolk and Suffolk (i.e. covering all of East Anglia) with other UK regions and other top-performing entrepreneurship ecosystems in Europe. The index is based on indicators of the quality of local institutions and local access to resources for entrepreneurship. This wider area is assessed as having the sixth strongest entrepreneurship ecosystem quality of 41 UK regions. It also compares well with other top-performing entrepreneurship ecosystems in Europe. The supply of entrepreneurial finance, for example, is one of the best developed in Europe. There is also important policy support, for example with CPCA’s Growth Hub “Signpost 2 Grow” referring start-ups and scale-ups to many sources of public and private business advice and support. However, the index also points to weak links, which are in the areas of physical infrastructure, access to talent and availability of intermediary services. A qualitative assessment based on stakeholder interviews shows the importance of addressing local traffic congestion, strengthening skills, and increasing the public sector role in leadership of the entrepreneurship ecosystem.

Skills are a bottleneck

There are significant skills shortages in the region, which have already been identified in the SAP’s Skills Strategy. They partly reflect rapid global technological change, requiring greater responsiveness from the local skills development system. Skills shortages are particularly challenging in the Cambridge sub-region

[1] Skills Advisory Panels (SAPs) have been supported by the government to help Combined Authorities and Local Enterprise Partnerships (LEPs) to fulfil their local leadership role in the skills system by helping them understand their current and future skills needs and labour market challenges. Skills Advisory Panels aim to bring together local employers and skills providers to pool knowledge on skills and labour market needs, and to work together to understand and address key local challenges. More info about their role and governance can be found here.

and in the ICT and life sciences strategic sectors. One specific area of shortage is for data scientists. Employers also report difficulties recruiting people with a good mix of both soft skills and technical skills.

There is also a problem of low skill levels, particularly in Peterborough and The Fens. This partly reflects cultural barriers and negative attitudes in the population to education and training. At the same time, the responsiveness of further education colleges to emerging skill needs has been held back by recent funding pressures, which have reduced their appetite for experimentation.

The skills development system has recently been boosted by the introduction of a national Apprenticeship Levy in 2017. Large employers pay a levy (0.5% of their wage bill), thereby creating a fund in their account which they can access for apprenticeship training. In addition to the actions of the National Apprenticeship Service, local initiatives have been developed in Cambridgeshire and Peterborough to support the use of the Levy funds for training. They include a Skills Brokerage Service to match employers and apprentices, and a Skill Levy Pool to facilitate the transfer of unspent Levy funds to support training in SMEs, potentially firms in the supply chain of the larger enterprises. However, the take up of apprenticeships by employers is still low and this report points to a number of issues that need to be addressed in Cambridgeshire and Peterborough and elsewhere.

One is fragmented skills intelligence. This is due to the current emphasis on firms transmitting their skills needs to individual training providers in a decentralised manner, meaning that information is lacking at the higher level of the regional skills system overall. This problem has been recognised by the SAP, and new responses are being developed locally by the SAP to improve systemic level skills-needs intelligence and responsiveness. In particular, a new Skills Service was launched in May 2020 to improve the matching between the training offered to young people and adults seeking retraining and the skills demand of local industry. The Skills Service is part of the Business Growth Service Cambridgeshire and Peterborough Fund.

The second systemic weakness is the lack of a mechanism to aggregate fragmented skills demand across firms and training providers that can provide the necessary numbers for individual training providers to run specialised training courses cost-effectively; noting that the demand for a particular skill may be dispersed across several different SMEs.

Further skills development issues in the region involve a lack of adequate local training provision in some specific sectors, a lack of capacities among SMEs to identify their own skills needs, inflexibility in apprenticeship standards to allow firms to get the training they need, and difficulties for SMEs to participate in the system due to inflexibilities in the programme regulations.

Conditions for new industry path development vary by sector

A key distinction is made in this report between three “science-based” strategic sectors in the region – life science, ICT and agri-tech, which are concentrated in the Cambridge cluster – and an “engineering-based” strategic sector – advanced manufacturing and materials, which is more widely spread in the region but is relatively important for Peterborough. Critically, the innovation processes and knowledge resources involved in developing these sectors are different.

There are very strong innovation system conditions in the Cambridge cluster for new industry path development in the three science-based sectors. This includes a dense array of sophisticated innovation actors, strong and diverse networks, favourable institutions such as access to finance, and a high level of specialisation and diversity. This gives rise to opportunities for the most radical industry path developments offering the greatest value-added growth in the form of path creation (emergence and growth of entirely new industries based on radically new technologies and scientific discoveries) and unrelated diversification (diversification into a new industry based on unrelated knowledge combinations). To encourage their

emergence, a joint effort is needed between national government, CPCA and the range of local business, research and education stakeholders in cross-sector vision building exercises, research and training projects and mechanisms to boost up-take of key technologies such as ICT and nanotechnology. In addition, physical infrastructure investment is needed to support the Cambridge cluster to overcome growth constraints.

The opportunities for industry path development in the "engineering-based" advanced manufacturing and materials strategic sector are also important, but involve less of a jump from past local industry practice. Many involve industry upgrading, whereby existing firms move up the value chain within global production networks by upgrading skills and production capabilities, change direction based on new technologies, organisational innovations or business models, or develop new niches through better branding, marketing and so on. There are also opportunities for existing SMEs to diversify and grow by building on the competencies and knowledge of existing industries (regional branching). The principal priorities for local entrepreneurship, innovation and skills policies in advanced manufacturing and materials are finding ways to strengthen the innovation capabilities of SMEs and supporting them to access applied R&D and turn it into new products and processes. There are also opportunities to create better knowledge exchange and skills collaboration networks among advanced manufacturing and material firms across the region as well as innovation networks with non-local actors.

Entrepreneurship and innovation are critical for recovery from the COVID-19 crisis

The COVID-19 crisis is causing major economic disruption to entrepreneurship and small business globally. SMEs are suffering demand and liquidity crises, supply chains are being disrupted, business confidence and investment have collapsed. There has been a sharp downturn in numbers of business registrations in many countries and, while the start-up rate has often picked up again after the initial shock, the balance of start-up activity has shifted from opportunity to necessity projects. Key challenges being experienced by firms are the need to accelerate their digital technology adoption and to manage increased indebtedness, which may constrain their ability to invest in innovation, skills and physical capital. From the outset, government has intervened to help firms and workers survive the crisis using a mix of job retention schemes, payment deferrals, and financial support to increase liquidity buffers and sustain investments. However, in the medium- to long-term the attention will shift to structural measures that will promote recovery in a way that will not only replace lost activity but also shift the structure of the economy towards higher productivity, more environmental and social sustainability, and greater resilience. This will require support for economies to develop emerging industries and to generate more innovative entrepreneurship and SME innovation. This report assesses the conditions that need to be generated in Cambridgeshire and Peterborough to achieve such shifts.

Key recommendations

The report makes a series of recommendations, including:

Increase entrepreneurship ecosystem leadership

- Create a joint venture institution for the local entrepreneurship ecosystem. This would involve business, government, academia, labour and broader community actors in monitoring the development of the ecosystem, vision building, networking and common projects.

Improve infrastructure in the Cambridge cluster

- Support the Cambridge cluster by developing a world-leading digital infrastructure, increasing accessibility by combining public transport and cycling, enabling "mobilities of the future", including

driverless vehicles, and increasing urban density for example by increasing vertical density and without encroaching on green space.

Reinforce the skills development system

- Fund one or more pivotal regional actors to create and sustain a network among training providers (including sub-networks by industry/sub-region) to sustain the skills intelligence activity of the local SAP (particularly the skills intelligence and brokerage service), and propose new co-designed curricula and standards and training courses.
- Experiment with different forms of "nudging" policy through a properly designed local experiment (with a counter-factual sample control) to identify effective tools to increase education and training participation by disadvantaged persons in the labour market.
- Increase flexibility in the Apprenticeship Levy system by simplifying the mechanism for standard creation, allowing the mixing of different standards, and introducing some extra form of flexibility for SMEs in terms of reduced time to be spent training outside the company and shorter programmes.

Build SME innovation in advanced manufacturing and materials

- Increase innovation in SMEs in advanced manufacturing and materials by reinforcing measures specifically targeted on them in the areas of training, consultancy and mentoring, innovation projects with higher education institutions (HEIs), and placement of Masters and PhD students in the firms.
- Create a stronger HEI presence in Peterborough focused on undertaking applied R&D of particular relevance to the advanced manufacturing and materials sector and developing training and applied R&D links with local firms.

Building linkages across sectors and actors in life sciences, ICT and agri-tech

- Develop more detailed sector development visions together with platforms and networks for the commercialisation of research outputs relevant to/or originating from the life sciences, ICT, and agri-tech sectors.
- Support cross-sector training and collaborative research projects in ICT and nanotechnology given their importance as key enabling technologies for new industry creation and unrelated diversification.
- Connect firms with knowledge-intensive activities in the sub-regions outside of Cambridge to the Cambridge cluster by creating liaison points to identify such firms and connect them to cluster networks.

International inspiring policy practices

The report outlines the following international inspiring practice policies.

Table 0.1. International inspiring practice policies

Challenge to be addressed	*Name of inspiring practice*	*Country of inspiring practice*	*Brief description*
Gaps in entrepreneurship ecosystem leadership	Joint Venture Silicon Valley	United States	Platform for dialogue among ecosystem actors; continuous ecosystem monitoring
Constraints in access to talent in the entrepreneurship ecosystem	Jheronimus Academy of Data Science	Netherlands	Data science campus for training and start-ups
Local transport congestion	Pro-cycling policies	Netherlands	Bike rental and infrastructure system connected to rail links
Fragmentation in the training system	Multi-stakeholder governance regional network for apprenticeships	Italy	Funding to create a consortium of training providers and to fund individual apprenticeships
Lack of systemic skills intelligence	Lombardy-Bosch Industry 4.0 Talent Programme	Italy	Joint planning of a higher apprenticeship course by a large firm and regional training institutions
Lack of systemic skills intelligence and need to aggregate skills demand	SME co-designed higher apprenticeship in the Turin Intelligent Factory Cluster	Italy	Joint planning of apprenticeship courses by SMEs and training institutions in a regional industry cluster
Cultural barriers to education and training	University enrolment nudging experiment, Puglia region	Italy	Additional information to parents on course failure risks and labour market risks of higher education for their children
Lack of involvement of advanced manufacturing and materials SMEs in innovation collaborations	BIA Programme for Research Driven Innovation, Research Council Norway	Norway	Open competitive grants to innovation projects for the industrial sector
Need for joint sector visions in life sciences, ICT and agri-tech and for cross-sector training and research projects in key enabling technologies	Strategic Innovation Programme	Sweden	Seed funding for sector visions, and finance for associated research, development and innovation projects and demonstration sites
Lack of use of science-based knowledge in SMEs and need for joint sector visions	RegioWIN innovation competition, Baden-Württemberg Cluster Agency	Germany	Cluster organisations facilitate stakeholder development of joint strategies and lighthouse projects for competitive funding

1 The regional economic and policy context

Introduction

Cambridgeshire and Peterborough is located in the east of England. It has a population of approximately 900 000 people and two sizable cities – Peterborough, with a population of approximately 200 000, and Cambridge with a population of approximately 120 000.

The area's local government authorities (the District Councils of Cambridge, East Cambridgeshire, Fenland, Huntingdonshire, and South Cambridgeshire and the Unitary Authority of Peterborough) have voluntarily formed a Combined Authority with responsibilities for transport and economic development policy.

Overall, it is a relatively prosperous and growing region with a tight labour market (some 83% of persons aged 16-64 were economically active in 2019), although productivity is slightly below the England average and population growth is not as high as in some neighbouring areas of the Oxford to Cambridge Arc.

The economy has a relatively favourable industrial structure, with many employment concentrations in growing sectors including life sciences, ICT, advanced manufacturing and materials and agri-tech, each of which have been identified in local strategic documents as strategic sectors for further development.

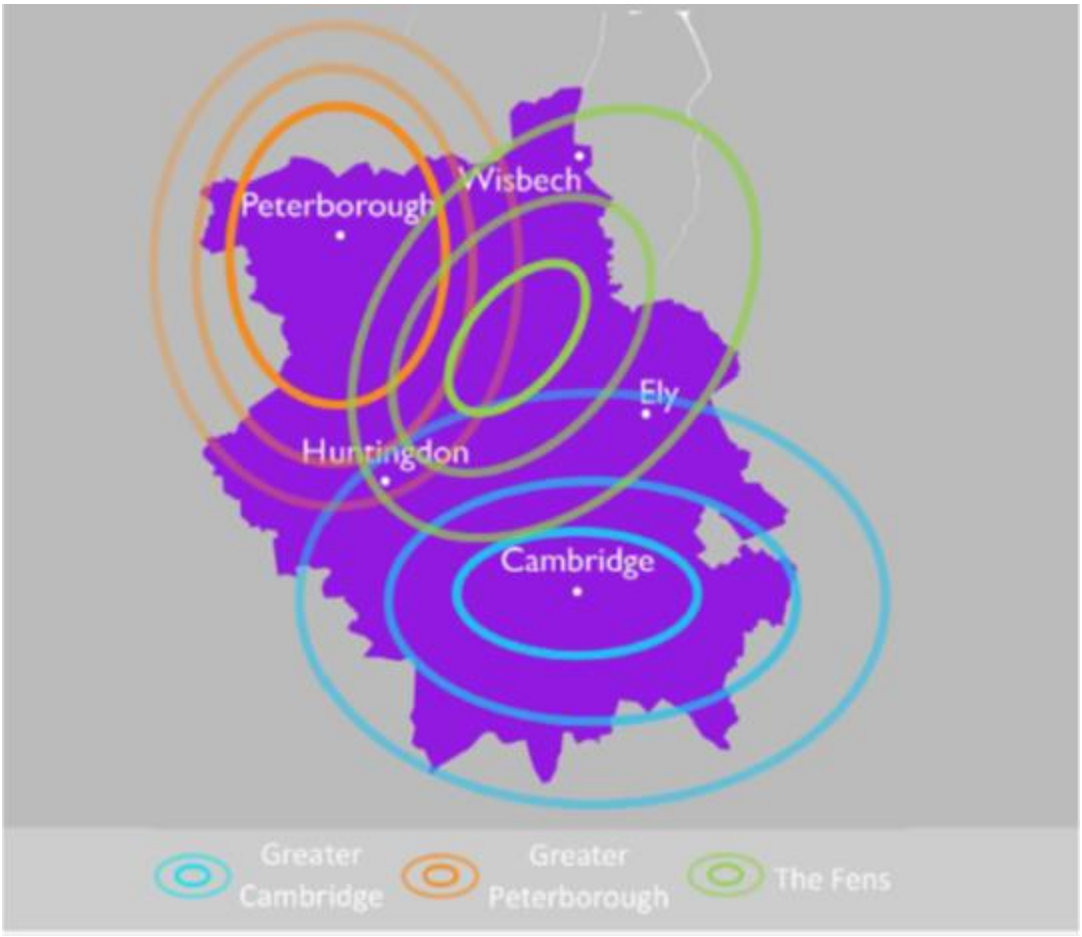
Although the region's entrepreneurship rates are not exceptional (63.8 business births per 10 000 population in 2017 compared with 72.0 business births in Great Britain), many innovative and high tech start-ups have been generated in Cambridge in fields including health, bioscience, ICT and advanced manufacturing, including many university and corporate spin-outs.

There is however a dichotomy in the performance of SMEs in the region between high rates of R&D-based innovation and product innovation on the one hand, and low rates of innovation in SMEs in the areas of business organisation (introducing new business practices, marketing innovation, undertaking design investment for innovation, and sales of innovative products and services) on the other.

There are also important spatial distinctions inside the region between the Cambridge area in the south (Cambridge, East Cambridgeshire, South Cambridgeshire and Huntingdonshire); Peterborough in the north and The Fens. To a significant extent, these sub-regions have distinct labour markets and industry bases. Cambridge is a successful high-tech entrepreneurial cluster. However, its networks, collaborations and spin-out activities tend to be local – based in the city of Cambridge and the near surroundings of South and East Cambridgeshire – or international, rather than in the Peterborough and The Fens areas. Peterborough has had strong recent growth and has a relative focus on manufacturing. The Fens is a more agricultural area with dispersed and isolated settlements. There are also differences across the region in occupations and skills. For example, over 15% of the workforce in Peterborough is in "elementary" occupations compared with only 7.0% in Cambridgeshire and 10.3% in Great Britain. Similarly, the share

of the population with National Vocational Qualification (NVQ) level 4 is only 25% in Peterborough compared with 45% in Cambridgeshire and 39% in Great Britain.

Figure 1.1. The Cambridgeshire and Peterborough Sub-Regional Economies



Source: HM Government and Cambridgeshire and Peterborough Combined Authority (2019) Cambridgeshire and Peterborough Local Industrial Strategy

Developing appropriately adapted strategies and developing synergies and connections across these areas for mutual benefit is an important local policy challenge.

Cambridge

Cambridge is a leading UK, European and global centre for enterprise and a scientific hub generating spinoffs and a successful high-tech economy.

At the heart of this is the University of Cambridge. Most rankings overall and especially those related to research over many years have rated it as being in the top 2 universities in the UK, in the top 2 in Europe and the top 6 in the world. The University is part of the “golden triangle” of Oxford, London and Cambridge – universities which dominate the UK research income and performance rankings – and is responsible for much high-tech innovation. Since the 1960s, the University and its colleges have invested in facilities to support and encourage entrepreneurship.

Because of this, many firms have been attracted to the city and spun off from academia in growth sectors such as ICT, health and life sciences and advanced manufacturing. As a result, the area has acquired a critical mass of entrepreneurial high-tech activity with many organisations no longer dependent on or connected to the University of Cambridge.

The term the "Cambridge Phenomenon" was coined by the Financial Times in 1980 and is in the title of a seminal report by Segal Quince and Partners (1985). Various other terms such as Silicon Fen have also been used. More recently, two substantial works by Kirk and Cotton give a lot of detail and are best accessed through the relevant website, which also identifies substantial further reading[2].

The site claims that in the period 1960-2010:

- 5 000 high tech firms were created
  - 40 000 new jobs were created in them
  - 11 firms reached a value of over USD 1 billion.

It argues that this success stems from three developments that occurred in Cambridge and made it different from other UK university sites in this period:

- A cultural shift at Cambridge about the importance of commerce – traditionally this was frowned upon by the UK academic establishment.
  - A weakening of the UK fear of failure culture at Cambridge.
- A focus on collaboration/sharing involving funders as well as entrepreneurs in Cambridge.

This was all put in place starting in the 1960s. One major area was computing, where Cambridge was very early into the field and from the beginning, put in place structures that allowed the development of products alongside development of theory via a combined "Computer Laboratory".

Success has not come without cost.

- Infrastructure has not always kept pace with expansion. Housing has been an area of concern and Cambridge is in the top 5 of the least affordable places to live in the UK (ranked by average house price divided by average salary), albeit behind Oxford and London (the top 2).[3] It is also ranked as the UK's most unequal city, with the top 6% of earners taking home 19% of the total income generated and the bottom 20% taking home 2%.[4] Similar effects can be seen in Silicon Valley or in Seattle in the United States.
- Other aspects of infrastructure such as transport and services have also not always kept pace. The population of the City of Cambridge has been essentially static for some years (123 000 in 2011 to 124 000 in 2018). Thus the substantial growth in employment has come about from people largely resident outside the city; indeed and some commute times are reported as high[5].
- There is growing concern in the UK and in other countries about the evidence of the income inequalities generated in strong international clusters such as Cambridge, which has its roots in

[2] http://www.cambridgephenomenon.com

[3] Business Insider ranking

[4] The Observer, 12 January 2020 https://www.theguardian.com/uk-news/2020/jan/12/beyond-cambridge-spires-most-unequal-city-tackles-poverty

[5] An Admiral study shows that Cambridge commuters spend 23 days a year in traffic compared to an average of 12 in 20 UK cities. See Cambridge Independent: https://www.cambridgeindependent.co.uk/news/cambridge-is-the-commuter-congestion-capital-of-the-uk-9051674/

divisions caused by divergence in fortunes of those involved in high-tech entrepreneurial sectors, particularly in the health and bioscience clusters, and other sectors of the economy.

- There is also some concern that since 2010 the "Cambridge Phenomenon" has been going through a "mid-life crisis". Life has not been especially easy for innovative firms, which have now had to navigate, in short succession, two global crises, with consequential impacts on financing availability and, in turn, on the time taken for developments to reach the market and generate profits. Encountering difficulties at some point in is perhaps inevitable in the long-term development of a cluster, but seeks to be transitory in the current evolution of Cambridge.

As a high-tech economy, Greater Cambridge forms a major part of the Oxford to Cambridge ARC – a corridor which is home to some 3.3 million people. It is one of the most productive and prosperous parts of Europe. According to the Cambridge-Milton Keynes-Oxford Corridor report by the National Infrastructure Commission[6], the ARC could be the UK's answer to Silicon Valley, indeed some already see it as such, and its coherent growth is a national priority.[7] Two major infrastructure problems are reported as holding back the ARC's success: a lack of sufficient and suitable housing and poor east-west infrastructure, which inhibits opportunities to unlock land for new settlements.

Furthermore, to sustain the high-tech expansion around Cambridge it is necessary to continue to have talented people with appropriate knowledge and skills. The existing universities and firms can and will act as attractors of such people from elsewhere but skills shortages remain, especially at technician level. Thus maintaining and adding to the relevant base of skilled individuals is essential. The area is a very pleasant one to live in and the existing environment and the moves in place to improve transport and services all add to its attractiveness for talented people, sometimes called "the creative class". Being in a high density of similar people with similar interests is a major attractor.

Peterborough

Peterborough is the most populous city in the Cambridgeshire and Peterborough Combined Authority (CPCA) area with a population of 201 000 in 2018. It is an ex-manufacturing city especially famous for bricks. It became a designated "new town" in 1967, benefiting from major public infrastructure investment for growth, and its population has expanded from only 80 000 in 1967. In the 2000s it underwent very substantial economic growth, and was the fastest growing district in the UK in 2005 (6.9%). It is an attractive place for many people to live, as the new town planning allowed more space and room for expansion and office space is available and relatively inexpensive. It has had much success attracting more modern industries, as it is a convenient transport hub, and more recently through championing the green agenda. It retains significant employment links with the county of Northamptonshire, of which it was once part.

The Fens

The Fens still functions as an East Anglian agricultural area with market towns. It has suffered from relatively low levels of investment and relatively low skills. The largest town in The Fens is Wisbech with a population of 32 000. The historic cathedral city of Ely has a population of 18 000 and, like Wisbech, possesses medieval buildings and attracts tourists.

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[6] https://www.nic.org.uk/wp-content/uploads/Cambridge-Milton-Keynes-Oxford-interim-report.pdf.

[7] https://www.nic.org.uk/wp-content/uploads/Partnering-for-Prosperty.pdf.

Socio-economic indicators

Population

As at mid-2018, the region's population was estimated at 852 000 persons[8]. The population has been growing and is predicted to continue to do so. In 2016 the population growth projection to 2026 was Peterborough 8.1%, Cambridge 0.1%, Huntingdon 5.5%, Fenland 6.2%, East Cambridgeshire 6.8% and South Cambridgeshire 6.6%. The growth is currently mainly in those of working age. Cambridge's population is static and planned to remain so, with growth of the cluster spilling over to increased commuting from South Cambridgeshire and East Cambridgeshire. Overall, there is significant projected growth, but other parts of the ARC are projected to grow more strongly (e.g. Central Bedfordshire 12.8%, Aylesbury Vale 14.2%, Milton Keynes 9.4%, and Uttlesfield 11.1%).

Cambridge has a significantly younger profile than the other parts of the region, due mainly to the heavy concentration of students. The University of Cambridge has some 22 500 students and Anglia Ruskin University has some 9 500 in Cambridge (out of a total of 39 000 spread over various sites). Fenland has an ageing population in spite of low life expectancy (in 2001, 49% of the population was under 40; by 2031 it will be 43%).

Employment

Table 1.1. Employment and unemployment

Area	Population aged 16-64 (thousands)	Employment of 16-64 year olds (thousands)	Employ-ment rate (%)	Unemploy-ment, ages 16+ (thousands)	Unemp-loyment rate (%)	Economic inactivity 16-64 years (thousands)	Economic inactivity rate (%)
Cambridge	88	69	78.5	2	2.9	18	20.9
E Cambs	54	45	81.3	1	2.5	9	16.9
Fenland	60	49	76.2	2	3.8	12	19.0
Hunts	109	93	81.6	3	2.8	16	14.8
S Cambs	95	85	85.2	2	2.2	13	13.3
P'borough	125	95	75.3	5	5.0	24	19.7
Total CPCA	532	436	80.2	15	3.7	91	17.4
England	35 049	27 323	75.6	1 165	4.1	7336	21.1

Source: Office for National Statistics.[9]

[8] https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections

[9] https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/datasets/localauthoritydistrictbusinessregisterandemploymentsurveybrestable6

Table 1.2. Unemployment claimants, labour demand and weekly earnings

Area	Claimant count level	Claimant proportion (%)	Labour demand (000s)	Jobs density ratio	Weekly earnings residents, full time (GBP)	Weekly earnings by workplace, full time (GBP)
Cambridge	783	0.9	118	1.34	642	642
E Cambs	391	0.7	40	0.75	574	518
Fenland	925	1.5	43	0.71	496	457
Hunts	919	0.8	82	0.75	600	572
S Cambs	517	0.5	97	1.02	746	706
P'borough	3339	2.7	132	1.06	484	506
Total CPCA	6875	1.8	513	0.98	576	573*
England	781456	2.2	30323	0.87	575	575

Note: The figure for workplace wages is estimated by the author to allow for some migration out of CPCA.
Source: Office for National Statistics.[10]

Overall employment measures are very good in a national context, indicating a largely prosperous region with a tight labour market, especially in the south (Tables 1.1 and 1.2). Peterborough has the lowest employment rate in the authority as well as more unemployment and benefit claimants, but is still reasonable by national standards. The Fens also lags the rest of the region on those measures. The "high tech" area (Cambridge and South Cambridgeshire) offer more highly-paid employment, leading to Cambridge having a very large in-commuting population for its size.

Location and accessibility

Most of the CPCA area is highly accessible, especially with respect to the ease of interworking with the relatively prosperous London and South East regions. Continuation and improvement here will be key to further successful expansion in the Cambridge area, which itself is central to the ongoing future standing of the CPCA region.

Both Peterborough and Cambridge have frequent trains that make the journey to London in 50-55 minutes. Cambridge also has frequent rail connections taking about 35 min to Stansted airport. There is also less frequent and slower connectivity with Birmingham and ports. There are plans to reroute and reopen a railway line between Oxford and Cambridge as part of supporting the policy initiative Oxford to Cambridge Corridor (OCC) joining Oxford, Milton Keynes and Cambridge, but these are several years from fruition.

Peterborough and Cambridge also have good road connectivity to the south via the M11 and A1(M) to London and good east-west links through the A14. However, road connectivity to the north of the region and into The Fens is comparatively poor, with Wisbech to Cambridge (some 60km apart) taking well over an hour for example. The Oxford to Cambridge expressway is another OCC scheme intended to give good road connectivity although the western end is still in the planning stage.

In terms of air links, the region has good access to Stansted, which is London's third airport and the fourth in the UK with steadily rising passenger numbers (28 million passengers in 2018). It has frequent rail connections to Cambridge and stations en-route. It is adjacent to the M11 and is about 50km (40 min) from

10 https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/datasets/localauthoritydistrictbusinessregisterandemploymentsurveybrestable6

Cambridge by road and 100km from Peterborough (70 min). Long haul scheduled flights have had difficulty establishing themselves there and access to London Heathrow and Gatwick airports for such flights is not especially good.

As the result of rapid expansion of the mobile population base, many roads to, in and around Cambridge are heavily congested for significant lengths of time. About 55 000 people commute daily into Cambridge. In the case of central Cambridge, there is little to be done to reduce congestion through increasing road infrastructure and the major solutions lie with developing other forms of transport, further relocation of employment to surrounding settlements, greater teleworking, and increasing urban density in line with smart and vertical city notions. New bus routes continue to be developed connecting science parks and other centres of employment, as do bicycle routes and other transport. A longer distance tram is planned close to the A14 to the north west of Cambridge. A planned Cambridge metro will also improve the situation.

Gross Value Added and productivity

Gross value added (GVA) per head in the region is above the average for England, with particularly strong performance in 2016 in Cambridge and South Cambridgeshire (Table 1.3). Growth of productivity per head has also been broadly in line with the growth rate for England. However, there is strong dispersion of productivity rates within the region, with lagging performance in East Cambridgeshire and Fenland in particular.

Table 1.3. Gross Value Added per head

GBP current prices

	2000	2010	2016	Increase on 2000 (%)	Increase on 2010 (%)
Peterborough	17 446	23 373	27 595	58	18
Cambridge	23 723	34 293	38 900	64	13
East Cambs.	13 666	17 088	21 700	59	27
Fenland	14 419	18 456	22 837	58	23
Hunts	14 807	20 518	25 004	69	22
S Cambs.	19 151	23 994	29 343	53	22
Total CPCA (estimate)	17 500	22 500	27 500	59	22
England	16 720	22 995	27 288	63	19

Source: Office for National Statistics [11]

[11] https://www.ons.gov.uk/economy/grossvalueaddedgva

Existing and potential growth sector specialisations

Key business economy sector specialisations in the region include professional, scientific and technical activities and information and communication technology (ICT) in Cambridgeshire, transportation and storage and administration and support services in Peterborough and manufacturing throughout the region (Table 1.4). The CPCA area is reasonably well positioned in having greater than average numbers of employees in sectors which are expanding nationally (e.g. ICT), although Peterborough is not as well placed as Cambridgeshire.

Table 1.4. Employment by industry

Industry	Cambridgeshire numbers	Cambridgeshire %	Peterborough numbers	Peterborough %	East %	GB %
Total	327 000		117 000			
Full time	225 000	68.8	81 000	69.2	65.2	67.5
Part time	101 000	30.9	35 000	29.9	34.8	32.5
Mining and Quarrying	125	0.0	75	0.1	0.1	0.2
Manufacturing	32 000	9.8	8 000	6.8	8.0	8.2
Elec, Gas, Steam, Air Conditioning Supply	600	0.2	225	0.2	0.3	0.5
Water, sewerage, waste management, remediation	3 000	0.9	900	0.8	0.6	0.7
Construction	14 000	4.3	3 000	2.6	5.5	4.8
Wholesale, Retail, Repair of motor vehicles and motorcycles	42 000	12.8	23 000	19.7	17.1	15.2
Transportation and Storage	10 000	3.1	6 000	5.1	4.9	4.7
Accommodation and Food Services	21 000	6.4	5 000	4.3	6.8	7.5
Information and Communication	18 000	5.5	5 000	4.3	3.6	4.4
Finance and Insurance	4 000	1.2	5 000	4.3	2.4	3.5
Real Estate Activities	4 500	1.4	1 500	1.3	1.5	1.7
Professional, Scientific and Technical	46 000	14.1	6 000	5.1	9.3	8.4
Administration and Support Services	24 000	7.3	22 000	18.8	10.5	9.1
Public Admin and Defence; Compulsory Social Security	9 000	2.8	3 500	3.0	3.0	4.3
Education	41 000	12.5	8 000	6.8	8.8	8.9
Human Health and Social Work	42 000	12.8	15 000	12.8	12.6	13.3
Arts, Entertainment, Recreation	7 000	2.1	2 500	2.1	2.7	2.6
Other Service activities	7 000	2.1	1 500	1.3	1.9	2.0

Source: Office for National Statistics[12].

12

https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/bulletins/businesregisterandemploymentsurveybresprovisionalresults/provisionalresults2017revisedresults2016

At a more detailed level, one of the important potential growth areas in the region is life sciences. The Cambridge Bioscience impact assessment study in 2015[13] reported that Cambridgeshire had 2.5 times the national average employment rate in the field, with 13 800 jobs, and made considerable use of commercialisation opportunities through patenting, start-ups, use of science parks etc. It suggests that the cluster has evolved "mutually reinforcing synergies between the various components which act to stimulate innovation, enterprise and growth." It further suggests that convergence of technologies will be a growth area (e.g. bioscience with nano- technology and information and communications) and this is already being borne out by changes in business profiles. With the arrival of AstraZeneca pharmaceuticals in Cambridge, certain areas of chemicals and pharmaceuticals in which the cluster was not previously specifically active will become easier to develop.

Agri-tech is another sector with potential for more growth, including from start-ups, with the focus on the development in the region of agri-tech innovations that can be exported and used in other regions. These innovative solutions can be tested in the region's agriculture sector. A policy push is needed to develop this sector in the region, responding to a generalised drive for greater productivity, changes in food consumption, changes in costs of labour and climate change.

ICT will remain a major area of new firm formation in the region. The University of Cambridge continues to have a world class Computer Science department generating a very high number of spinouts. Interworking with the Microsoft research facility in Cambridge and many others has led to a very healthy local ICT industry. Technological convergence and cross-sector linkages is again something to encourage and exploit.

Finally, advanced manufacturing is an area of growth worldwide. Many spin-outs as well as spin-ins have occurred through the University of Cambridge Engineering Department's Institute for Manufacturing, creating about 500 firms in the region. In many cases advanced manufacturing and ICT interwork to provide the necessary innovation.

Entrepreneurship and SME innovation

Start-ups

In 2017, the business birth rate was below the Great Britain average although in line with Oxfordshire, a comparable high-tech area (Table 1.5). Business birth rates in East Cambridgeshire, The Fens and Huntingdonshire particularly under-performed compared to Oxfordshire and Great Britain. However, the birth rates were around the national average in South Cambridgeshire, where a lot of the high-tech activity is located, and in Peterborough. The areas in the region with relatively low birth rates also tend to have relatively low death rates, although there was significant positive net change in Cambridge, East Cambridgeshire, South Cambridgeshire and Peterborough. The Fens is notable for significantly less churn in the business stock than other areas, which may be considered a drag on productivity growth.

[13] https://www.phpc.cam.ac.uk/pcu/files/2015/09/CambridgeBioscienceImpact.pdf

Table 1.5. Business births and deaths in Cambridgeshire and Peterborough, 2017

Area	Births (no.)	Birth Rate (per 10 000 population over 16)	Rank in Great Britain (/380)	Deaths (no.)	Death rate (per 10 000 population over 16)	Rank in Great Britain (/380)
Cambridge	635	60.9	143	580	55.7	169
E Cambs.	390	54.9	184	355	49.9	218
Fenland	365	44.1	295	365	44.1	287
Hunts	815	56.5	172	800	55.4	170
S Cambs	920	73.5	105	840	67.1	113
Peterborough	1130	73.6	103	1040	67.8	108
Total CPCA	4255	63.8		3980	58.8	
Oxfordshire	3450	62.3		3130	56.5	
London	92300	131.6		86270	123.0	
Great Britain	375030	72.0		351875	67.6	

Source: Office for National Statistics. [14]

Scale-ups

The Scaleup Institute identified 855 scale-ups in the CPCA area in 2017 (335 by employee growth, 705 by turnover growth and 185 by both)[15]. They accounted for 78 321 employees and turnover of GBP 9.8 billion. This exceeds the England average scale-up rate, especially when looking at those defined by turnover rather than employment size. This may be due to the main areas involved such as ICT, which can be finance- rather than person-intensive.

Interviews conducted by the Institute with the successful scale-ups showed that they most wanted:

- Access to more talent.
- Help with coping with visas and other problems involved in importing talent from outside the UK.
- Help with access to markets within the UK and elsewhere.
- More large corporates nearby.
- More public funding.

SME innovation

Roper and Bonner (2019) have benchmarked SME innovation in 39 local areas in England over 10 criteria. Key findings for the prevalence of innovation in SMEs in the CPCA area are set out in the Table below.

14 https://www.ons.gov.uk/businessindustryandtrade/business/activitysizeandlocation/datasets/businessdemographyreferencetable

15 http://www.scaleupinstitute.org.uk/reviewlep/greater-cambridge-and-greater-peterborough/

Table 1.6. SME innovation rates in Cambridgeshire and Peterborough compared with English LEPs, 2019

Type of innovation activity	% of SMEs in CPCA undertaking the activity	CPCA rank among local areas
Collaboration for innovation	43%	3 of 39
New to market product and service innovation	15%	4 of 35
Product or service innovation	32%	5 of 39
R&D	28%	6 of 38
New methods of work organisation	21%	12 of 39
Process innovation	19%	15 of 38
Design investment for innovation	14%	17 of 36
Sales of innovative products and services	39%	17 of 39
New business practices	23%	23 of 39
Marketing innovation	12%	31 of 36

Source: Roper and Bonner (2019).

SME innovation performance is relatively high in several areas that are frequently related to technological innovation – innovation collaboration, product innovation, and R&D. However, performance is relatively low in less technology-oriented activities including innovation in marketing, business practices, design and process innovation.

Skills profile and local skills development

Skills profile

Peterborough's occupations are substantially lower down the scale of Standard Occupational Classifications 2010 (Soc2010) than the Great Britain average while Cambridgeshire's are substantially above (Table 1.7). For example, Peterborough has 15.2% in "Elementary" occupations compared with a national average of 10.3% and a Cambridgeshire figure of 7.0%.

Table 1.7. Employment by occupation in Cambridgeshire and Peterborough, April 2018 - March 2019

Occupation	Cambs. numbers	Cambs. %	P'borough numbers	P'borough %	East %	GB %
Soc 2010 Major Grade Point 1-3	188 000	55.2	36 500	38.3	46.5	46.8
1 Managers, Directors, Senior Officials	43 100	12.6	7 500	7.9	11.9	10.9
2 Professional Occupations	93 900	27.5	19 400	20.3	19.9	20.9
3 Associate Professional and Technical	51 000	14.9	9 600	10.1	14.6	14.8
Soc 2010 Major Grade Point 4-5	59 500	17.5	17 700	18.6	21.1	20.1
4 Administrative & Secretarial	30 900	9..0	9 000	9.4	10.6	9.9
5 Skilled Trades Occupations	28 600	8.4	8 800	9.2	10.5	10.1
Soc 2010 Major Grade point 6-7	53 400	15.7	15 400	16.1	16.2	16.5
6 Caring, Leisure and Other Service Occupations	31 600	9.3	8 500	8.9	9.3	9.0
7 Sales and Customer Service Occupations	21 800	6.4	6 900	7.2	6.9	7.4
Soc 2010 Major grade point 8-9	39 911	11.7	25 700	27.0	16.1	16.6
8 Process Plant and Machine Operatives	16 100	4.7	11 200	11.8	6.2	6.3
9 Elementary Occupations	23 800	7.0	14 500	15.2	9.9	10.3

Source: Nomis

There is a gap in high- and medium-level skills in Peterborough relative to Cambridgeshire and Great Britain (Table 1.8). Within the CPCA area, the share of the population with qualifications of at least NVQ2 level ranges from 85% in South Cambridgeshire, 81% in Cambridge, 74% in Huntingdonshire, and 74% in East Cambridgeshire, to only 64% in The Fens and 62% in Peterborough (Table 1.9).

Table 1.8. Qualification levels in Cambridgeshire and Peterborough, January 2018 – December 2018

Qualification Level	Cambs. numbers	Cambs. %	P'borough numbers	P'borough %	East %	GB %
NVQ level 4 and above	179200	44.9	30900	25.1	35.3	39.3
NVQ level 3 and above	253000	63.4	53600	43.5	53.1	57.8
NVQ level 2 and above	314200	78.8	78100	63.4	72.8	74.9

Source: Nomis.

Table 1.9. Highest level of qualification by area

Area/Highest level of qualification	NVQ 4+ %	NVQ3 %	NVQ2 %	NVQ1 %	Other %	None %
Cambridge	58	14	9	5	10	4
S Cambs.	55	18	12	9	2	4
Hunts	35	20	19	15	7	4
E Cambs.	35	13	26	14	7	5
Peterborough	26	15	21	16	10	13
Fenland	23	19	22	15	12	9
Total CPCA	39	17	17	12	8	7
England	38	19	18	11	7	8

Source: CPCA Skills Development Framework.

Apprenticeships

Apprenticeship provision in the CPCA area is slightly better than England overall. However, this is an area where England is weak compared with European Union countries. The number of apprenticeships is approximately one-ninth of the number of higher education students. In Germany, that number is close to a half. There is a modest bias in CPCA towards science, technology, engineering and maths (STEM) areas (Table 1.10).[16]

Table 1.10. Apprenticeships completed in Cambridgeshire and Peterborough by sector

Industry	Number	%	% East	% England
Agriculture, Forestry and Fishing	90	2.7	2.7	1.8
Arts, Media and Publishing	0	0.0	0.2	0.2
Business Administration and law	940	28.5	26.8	26.7
Construction, Planning and Built Environment	140	4.2	4.0	4.5
Education and Training	30	0.9	2.2	2.0
Engineering and Manufacturing Technologies	590	17.9	15.6	16.3
Health, Public Services and Care	820	24.8	27.5	27.1

[16] Based on DfE data. To be found at https://cambridgeshireinsight.org.uk/economy/

Information and Communication Technology	110	3.3	2.7	3.1
Leisure, Travel and Tourism	100	3.0	4.1	3.4
Retail and Commercial Enterprise	510	15.5	14.0	14.9
Science and Mathematics	10	0.3	0.2	0.1

Source: ONS Business IDBR data.

One of the longstanding issues in many countries is that there is little status or glamour in being in an apprenticeship, which limits recruitment and retention. The national Apprenticeship Levy is intended to boost apprenticeships but may take time to work through to increased take up (Powell and Foley, 2020). Anglia Ruskin University is offering new "degree apprenticeships" at Bachelors or Masters level, which may increase the attractiveness of apprenticeships in the region.

The Cambridge cluster

Cambridge is a leading innovation cluster

The success of the Cambridge cluster is underpinned by world-class science in the University of Cambridge, University engagement with industry (including through Cambridge Consultants, a key technology transfer firm), intense University and corporate spin-outs, University and college investment in science parks and incubators, the attraction of knowledge-intensive inward investment, and local networks.

Cambridge is one of the world's leading high-technology economies with specialisms in ICT, life sciences and advanced manufacturing. In March 2019, the area hosted some 4 700 knowledge-intensive firms with over 60 000 employees and a combined turnover of approximately GBP 14 billion. Over 3 000 of the firms involve ICT, 550 advanced manufacturing, 440 health/lifescience and 730 knowledge intensive services. The largest concentration is in the city of Cambridge itself, with some 449 knowledge-intensive firms, 15 000 employees and turnover of GBP 4.5 billion.

The modern Cambridge cluster has been identified as starting in 1960 when Cambridge Consultants was formed – a technology transfer company through which business would employ the brains of Cambridge university academics. However, the foundations lay in the presence of several well-established engineering firms[17]. The report, *The Cambridge Phenomenon: The Growth of High Technology Industry in a University Town* (Segal Quince and Partners 1985) played a key part in establishing the reputation of Cambridge as a leading cluster of enterprise and innovation. One of the features of growth was a high level of start-ups, particularly spin-outs from existing firms (Garnsey and Lawton Smith 1998). Growth accelerated during the 1990s.

The cluster is underpinned by important anchor organisations and networks

The University of Cambridge

The University of Cambridge, with its constituent colleges, supports over 1 800 researchers and over 19 000 students. It has hosted 107 Nobel Laureates since 1904 and was ranked sixth in the world in 2019 by QS World University Rankings[18]. It has played a major part in providing and supporting the

[17] https://www.cam.ac.uk/research/innovation-at-cambridge/the-cambridge-cluster

[18] https://www.topuniversities.com/university-rankings/world-university-rankings/2019

entrepreneurial environment of greater Cambridge, through collaborations, fundamental research, education, training, attracting and educating able students and staff, stimulating spin-outs, investing in science parks and incubators, and contributing to local place leadership.

Key leading research edge areas of the University of Cambridge are medicine, biotech and ICT. There are significant moves towards more interdisciplinary work and addressing current major problems such as sustainable development. The University helps translate this research activity into entrepreneurship in the cluster with substantial support services for entrepreneurial staff involved in patenting, firm foundation and consultancy. The University's Institute for Manufacturing has also taken on an anchor role as a consultancy for advanced manufacturing. It offers professional development, events, accreditation and support in areas such as intellectual property as well as more technical support for the growing number of firms located in the region. The university and its colleges have also led in the establishment of nearly all of the science parks and incubators and is a major landowner and a stakeholder in many local businesses and activities. Many organisations are keen to locate high-tech parts of their operation close to it.

The University has also frequently taken leadership roles, initially in setting up the business parks and encouraging staff to be involved. It has generated key leaders of the local entrepreneurship ecosystem. They include Walter Herriot OBE, for many years the managing Director of the St John's Innovation Centre[19], and Herman Hauser, famous for setting up Acorn Computers, spinning out Advanced Risc Machines (now ARM Ltd) from Acorn and establishing Amadeus Capital Partners. In 1998 Herman Hauser co-founded the Cambridge Network with David Cleevely and Alec Broers[20]. They and others have helped steer activities forward and been vocal spokespeople on behalf of Cambridge. There has been a reported tendency to "fatten up start-ups for market" with merger and acquisition activity replacing scale-up activity (compared with Oxford) but this may be a reflection of the different nature of the sectors involved.

Thus the University acts as an anchor for skills, entrepreneurship and innovation and it is critical to maintain its role in these activities.

Large firms

Other anchor organisations for the cluster include major private sector firms such as Astra Zeneca's global headquarters and Microsoft's UK research lab, which provide knowledge and skills to the cluster and a range of local research collaborations.

AstraZeneca, a multinational pharma and biopharma company, moved its global headquarters to Cambridge in 2016, planning to expand its "multitude of collaborations" in the area. The company plans to give Cambridge University researchers access to key compounds in their drug pipeline. It is bringing major collaborations with CRUK and the Medical Research Council to the region and is working with Microsoft on drug discovery.

Microsoft established its Cambridge (UK) research lab over 20 years ago. It works closely with the University and has projects across a wide range of fundamental research and applications. It is a very active collaborator with many other institutions locally and globally. It is active in bringing technology skills to the region.

[19] https://aru.ac.uk/graduation-and-alumni/honorary-award-holders2/walter-herriot

[20] https://en.wikipedia.org/wiki/Hermann_Hauser

Networks

Business and professional networks are strong in the cluster, including formal networks as well as a more informal culture of collaboration among many connected individuals and organisations. By 2008, Cambridgeshire had 59 networks, ranging from large and specialised networks to smaller networks including breakfast clubs (Lawton Smith et al. 2012). Examples of major networks are One Nucleus and the Cambridge Network[21]. One Nucleus, established in 1997 with its headquarters in Cambridge, is a not-for-profit life sciences and healthcare membership organisation centred on the Greater London-Cambridge-East of England corridor. The Cambridge Network 'is a membership organisation that brings people together to meet, share ideas and collaborate for greater success'.

Science parks and incubators

The cluster is also supported by a range of science parks and incubators, which provide support services for innovative and entrepreneurial start-ups and others (Table 1.11).

Table 1.11. Science parks and incubators in Cambridge

Park	Organisations	People	Comments
Babraham Research Campus	60	1 400	Bio incubator
Cambridge Research Park	17		Needs to grow. Current mix including some agritech.
Cambridge Science Park	130	7 500	Nearly 50 years old. Large 79 Tech, 46 LifeSci/medical
Cambridge BioMedical Campus	16	20 000	Health. Major organisations including AstraZeneca a with funding form big sources such as Cancer Research UK and the Medical Research Centre/National Institute for Health Research
Granta park			20 years old Biopharma/Science
Papworth Bioincubator			Hospital based Bio incubator
St John's Innovation Centre	60+	500	Mainly start-ups with about half in Tech/IT

In addition there is a substantial business park at Cambourne with over 300 offices and the University of Cambridge also offers some facilities on its west Cambridge site. There are also new spaces such as the Bradfield Centre3, NW Cambridge Campus, IdeaSpace South (at Addenbrookes) and the Cambridge Biomedical Campus. All of these have opened within the last 4 years and provide supported provision for start-ups and scale-ups.

Investors

There are many sources of funding for start-ups and scale-ups in the cluster, apart from the University and associated bodies. These include Cambridge Enterprise, CIC, Amadeus and IQ capital as well as Cambridge Business Angels[22].

[21] https://www.cambridgenetwork.co.uk/

[22] https://www.syndicateroom.com/angel-investors/networks/cambridge-business-angels

The Cambridge cluster faces challenges with infrastructure and access to talent

The cluster has been growing strongly over recent decades but now faces the important challenge of expanding infrastructure in line with its growth. House prices are twice the national average and Cambridge ranks as one of the least affordable places to live in the UK. Local road infrastructure also needs to be expanded to cope with the scale of commuting into Cambridge (currently 55 000 workers per day), alongside greater public transport options and decentralisation of activities to the city's hinterland.

Access to talent could also become an important constraint. The cluster has tapped into significant immigration from European Union countries in the recent past, both to the University and to local high tech companies, and there is uncertainty about the impact of changes in immigration rules with the United Kingdom's departure from the European Union, which will need a local response. Even before this, skills shortages have been significant, especially at technician level.

Local policy bodies and structures

Cambridgeshire and Peterborough Combined Authority

In March 2017, a devolved economic policy governance arrangement was introduced in Cambridgeshire and Peterborough in the form of the Cambridgeshire and Peterborough Mayoral Combined Authority (CPCA). This is a unitary authority arrangement with an elected mayor, the latter more usually associated with a larger city such as Manchester or London.

CPCA plays an important role in developing and employing local economic intelligence and co-ordinating with central government in prioritising investments. In particular, it supported the development of the 2018 Cambridge and Peterborough Independent Economic Review (CPIER) and developed the Cambridge and Peterborough Industrial Strategy in 2019 in collaboration with national government. The major problems identified as needing action in these strategies remain relevant and in need of attention and it is important to monitor progress in addressing the issues.

Following the disbanding of the Greater Cambridge Greater Peterborough Local Enterprise Partnership (LEP) (April 2017), a successor Business Board, constituted as part of CPCA, was established (September 2018) to take on the area's LEP functions (April 2019). CPCA's Business Board plays a key role advising the Combined Authority Board on enterprise development issues.

CPCA has also appointed a Skills Committee and an Employment and Skills Board, which incorporates a Skills Advisory Panel (SAP). Its main responsibility is to prepare a Skills Strategy addressing skills demand intelligence and skills (mis)matching issues. This supports CPCA in its responsibility for managing the Adult Education Budget.

In addition, each of the six constituent local authority districts has its own council with its own plans and priorities, which should align with those of CPCA.

These arrangements have supported the region in developing partnerships with the national government to channel national funding to address local economic development bottlenecks and in aligning strategies at different spatial scales. Keeping close to central government thinking about government investment priorities (such as in health) will continue to be very important to the region going forward.

Growth Hub

One of the key operational tools of CPCA is the Growth Hub[23], which refers firms to available business development services and business support and can identify and fill local gaps in provision with public and private sector partners. Cambridge and Peterborough are covered by Signpost 2 Grow within the national system of regional Growth Hubs, which also covers the areas of Rutland, West Norfolk, West Suffolk, North Hertfordshire, South Holland, South Kesteven and Uttlesford in Essex[24]. It has a clear role in the region as a focal point for connecting businesses to the help, support and funding needed for growth.

Greater Cambridge Partnership

The Greater Cambridge Partnership (GCP) is a partnership between Cambridge City Council, South Cambridgeshire Council, CPCA and the University of Cambridge. It developed a plan for the development of "Greater Cambridge" – essentially Cambridge and South Cambridgeshire. The plan is consonant with the overall CPCA plan and also the government plan for the OCC. It includes:

- Building 33 500 new homes over 20 years.
- Supporting an increase of 65 000 in population by 2031.
- Supporting 25 000 more journeys daily.
- Providing a green network of public transport.
- Initiating 420 new apprenticeships as soon as possible.
- Supporting economic growth at 7%.
- Addressing issues of air quality and improved health in general.
- Making a smart city environment by sharing data.

This aligns well with the infrastructure and skills problems identified, although the transport infrastructure proposed is largely Cambridge centred (see Silicon Valley for a more networked solution) despite including an orbital bus route. It has identified sectors for expansion as biotech, drug discovery, agri-biotech, animal healthcare, low carbon environment, high tech manufacturing, food, and environment.

The Greater Cambridge partnership negotiated a "City Deal" with central government in 2014, attracting central funds for infrastructure investment of GBP 500 million in 2015-2020 followed by a contingent further GBP 400 million from 2020-2030[25]. The City Deal is very large by the standards of City Deals in general, showing that a convincing case was made in line with then government priorities.

Enterprise Zones

Also important are the area's two established Enterprise Zones, Alconbury Weald Enterprise Campus (www.alconbury-weald.co.uk/enterprise-campus) established in 2012 and Cambridge Compass Enterprise Zone (www.cambridgecompass.com) established in 2016, which comprises five key employment sites across the CPCA area. These zones provide tax breaks and Government support to unlock key

[23] https://cambridgeshirepeterborough-ca.gov.uk/business-board/growth-hub/

[24] http://signpost2grow.co.uk/

[25] https://www.gov.uk/government/news/greater-cambridge-city-deal-signed; https://www.smartertransport.uk/cambridge-city-deal/

development sites, consolidate infrastructure, attract business and create jobs. The benefits for a business locating within an Enterprise Zone are that they may be eligible to receive business rates discount (up to 100% business rate discount worth up to GBP 275 000 per business over a 5-year period) and that the local authority is committed to a simplified planning process and to fast-track planning applications. The CPCA Business Board is responsible for Enterprise Zone delivery[26]. There is significant development space available in these zones.

Conclusions and recommendations

This section highlights two key challenges for developing the Cambridgeshire and Peterborough regional economy:

- Maintaining the conditions for cluster success in Cambridge, especially skills and infrastructure.

The Cambridge cluster is dependent on large numbers of people with high-level skills, who have traditionally been attracted to the location by the University of Cambridge and associated organisations and collaborators. The cluster also faces problems with attracting middle-skill people. These difficulties may exacerbate as migration from overseas may be impacted by Brexit, and because while it is a “nice place” where people wish to locate, high house prices and long commuting times are making it less attractive. These problems need to continue to be addressed through transport and housing infrastructure investment. There may also be potential to improve the supply of middle skill people to the cluster by encouraging teleworking from the rest of the region by increasing digital infrastructure and digital skills.

- Making the region more coherent – economically, politically and technically.

This problem is widely recognised in the CPCA and other planning documents. There are essentially three distinct sub-regional economies based on different activity sets. Measures to encourage further development in Cambridge are led by addressing physical infrastructure constraints and some shortages of intermediate skilled people. The Fens and Peterborough face much lower skill levels and entrepreneurship rates, and require support for skills development and finance and advice for entrepreneurship. In the specific case of agriculture in The Fens, it is likely that the loss of sources of cheap labour in agriculture due to new restrictions on immigration due to Brexit will lead to a (much needed) drive to improve productivity by the use of technology as there is no obvious significant set of UK workers ready and waiting to replace lost immigrants. This represents an opportunity for significant entrepreneurial work in the agri-tech area.

Furthermore, there are few large anchor organisations and entrepreneurial networks to stimulate entrepreneurship and innovation in firms in Peterborough and The Fens. To address this, closer involvement with anchor institutions networks located in Cambridge is essential, at least initially while they grow their own.

[26] https://cambridgeshirepeterborough-ca.gov.uk/business-board/enterprise-zones/

Box 1.1. Recommendations stemming from the regional economic and policy context

1. Maintain the positive conditions for entrepreneurial activities in the Cambridge cluster, especially by addressing constraints in infrastructure and skills.
2. Recognise and respond to the distinct challenges of the three sub-regions. The Cambridge cluster is constrained by infrastructure and talent. Peterborough and The Fens are constrained by skills and finance and support for entrepreneurship and innovation.
3. Seeking to extend the footprint of the Cambridge cluster and its universities to enable firms in the other sub-regions to access some of its networks and initiatives.

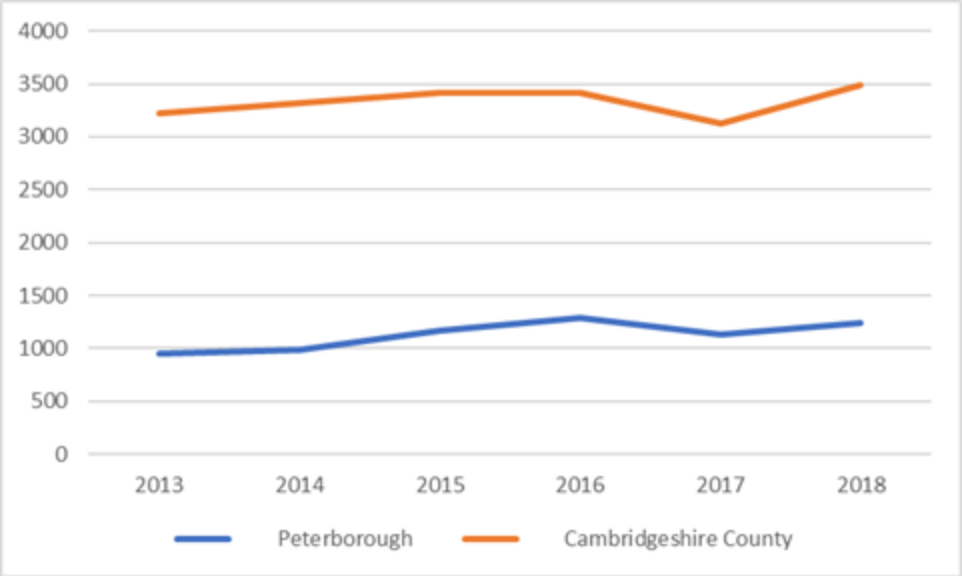
2 The local entrepreneurship ecosystem

The scale of entrepreneurship activity

Driven by the Cambridge cluster in particular, Cambridgeshire and Peterborough have demonstrated long-standing, strong success in generating high-growth, high-tech firms (Garnsey and Cannon-Brookes 1993; Garnsey and Heffernan 2005; Stam and Martin 2012).

The numbers of new enterprises created in Cambridgeshire and Peterborough, which were expanding slowly in 2013-2018, are in line with national dynamics (Figure 2.1). As a share of the business population, the start-up rate is relatively high in Peterborough (16%), and somewhat below the national average (13%) in Cambridgeshire (12%).

Figure 2.1. Number of new enterprise births, Cambridgeshire and Peterborough, 2013-2018



Source: Office for National Statistics – Value Added Tax (VAT) and/or Pay As You Earn-registered businesses and local unit

However, high start-up rates do not necessarily translate into economic benefit: most start-ups do not grow, they are not necessarily innovative or have ambitions for growth, and the majority do not survive past five years. A better indicator of entrepreneurship outputs is the rate of scale-ups.

The Scaleup Institute (2018) identified 855 scale-ups in Cambridgeshire and Peterborough in 2018 out of 4 420 scale-ups in the UK as a whole.[27] According to Office for National Statistics (ONS) data, there were 760 scale-ups in the CPCA area in 2015 out of 31 440 in the UK as a whole (ScaleupInstitute 2017, p. 92).[28] Based on the ONS data, the rate of scale-ups in Cambridgeshire and Peterborough (2 percent of the business population) is twice the national average (1 percent of the business population).

What sets Cambridgeshire and Peterborough apart from any other region in Europe (and almost globally) is the large number of start-ups that grow into large firms, either in employment size (Stam and Martin 2012; CPIER 2018) or valuation. The latter can be measured with CB Insights data on "unicorns": young private firms with a valuation of at least USD 1 billion. In 2018, Europe had 24 unicorns, of which 13 were in the UK: 8 in London, 2 in Cheshire, 1 in Berkshire, Buckinghamshire and Oxfordshire, 1 in North Eastern Scotland and 1 in East Anglia (BGL Group in Peterborough). Many regions in the UK and Europe at large have no unicorns at all. However, the Cambridgeshire region, together with the London and Oxfordshire regions, has been home to many unicorns over the years: 18 according to unofficial statistics (Business Weekly 2019), including Abcam, ARM, Autonomy, AVEVA, Blinkx, CAT, Chiroscience, CSR, Darktrace, Domino, Improbable, Ionica, Prometic, Solexa, Virata, Xaar, and most recently CMR.

Entrepreneurship ecosystem benchmarking

A quantitative entrepreneurship ecosystem quality index has been developed for this study to compare East Anglia (comprising Peterborough, Cambridgeshire, Suffolk, Norwich and East Norfolk, North and West Norfolk, Breckland and South Norfolk) with other UK regions and leading European regions on entrepreneurship ecosystem quality.[29] Ten ecosystem elements are examined following the framework developed by Stam (2015) and using the variables and data sources indicated in Annex 2.A.

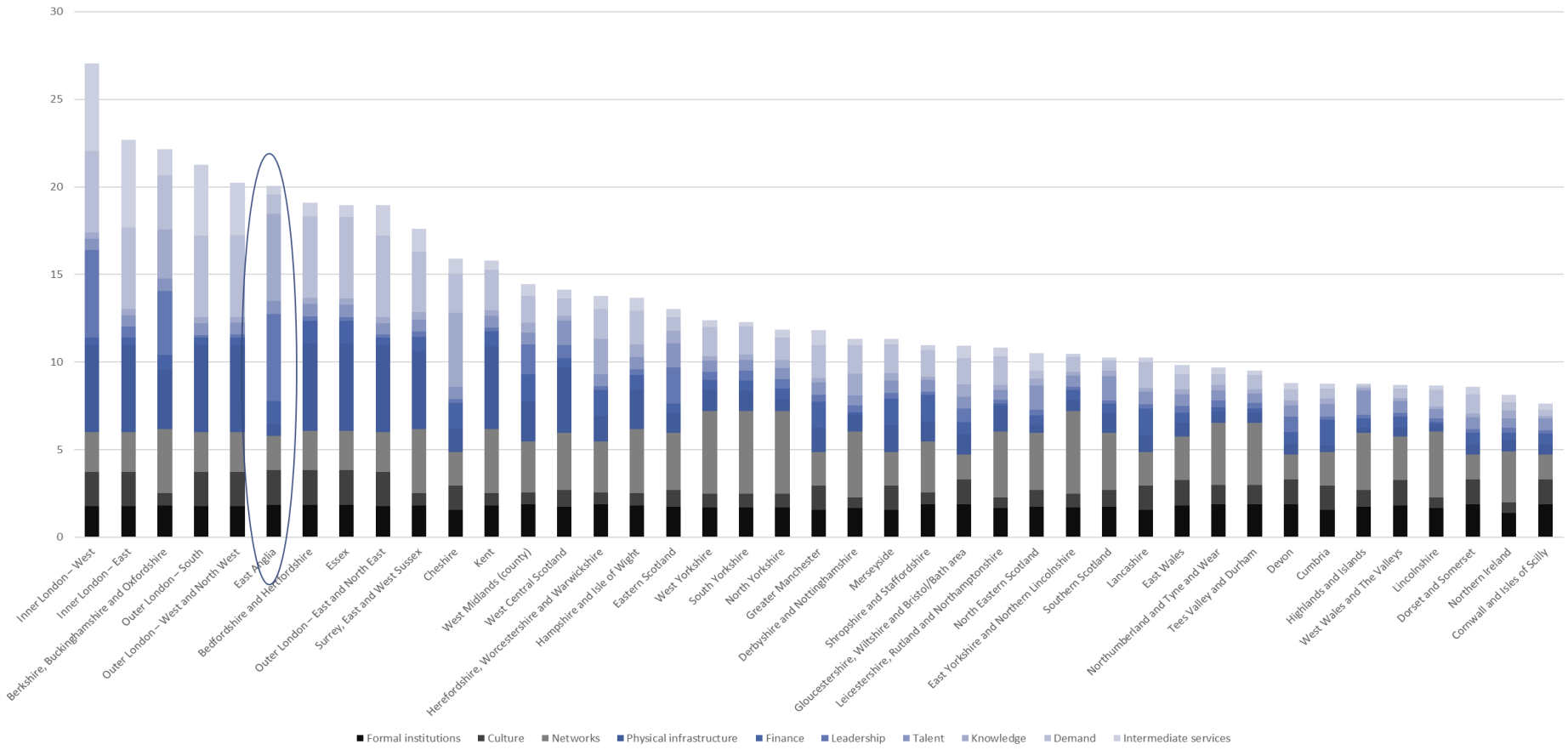
East Anglia has strong entrepreneurship ecosystem quality performance when set against UK benchmarks (Figure 2.2). It has the sixth strongest entrepreneurship ecosystem quality when compared quantitatively across 41 UK NUTS 2 regions. The London regions stand out in entrepreneurial ecosystem quality, together with the Berkshire, Buckinghamshire and Oxfordshire region, East Anglia, the neighbouring Bedfordshire and Hertfordshire region and Essex. East Anglia scores very highly relative to the UK average on culture, networks, leadership, and knowledge. Scores on talent and intermediate services were below the UK average by contrast.

[27] The Scaleup Institute defines scale-ups as firms with 20 per cent growth in employment or turnover per year over a three year period starting with a base of at least 10 employees and full accounts filed at Companies House.

[28] The ONS data use a broader definition of scale-ups, based on the overall business population, not just those filed at Companies House (ScaleupInstitute 2017).

[29] Data are at NUTS II level. More disaggregated data for Cambridgeshire and Peterborough alone were not available for this analysis.

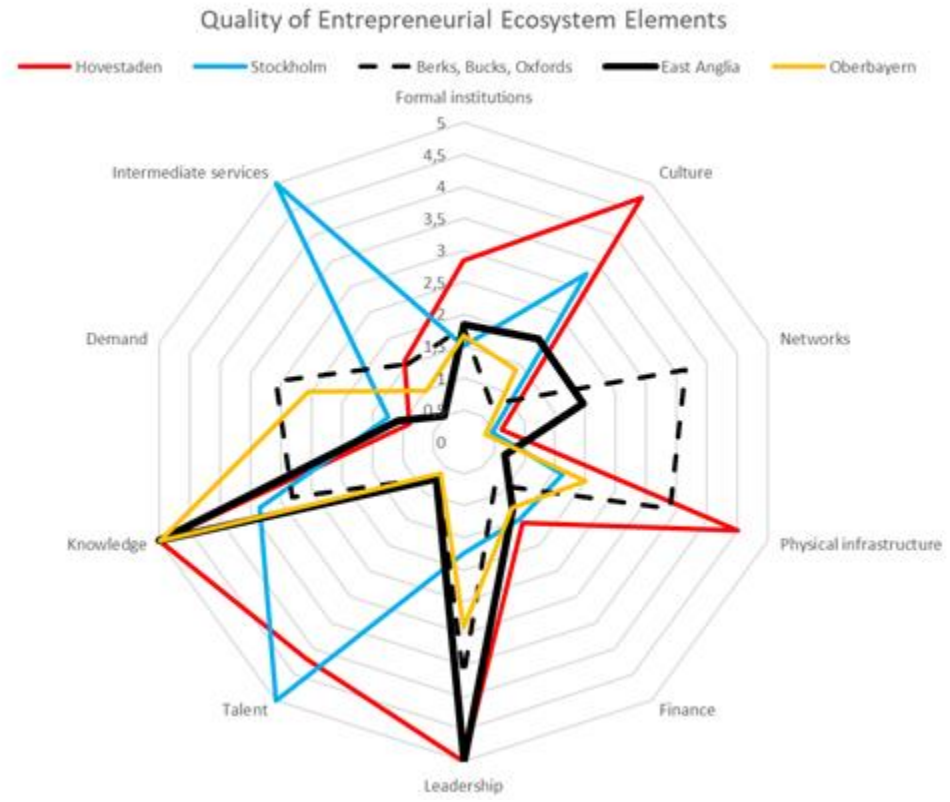
Figure 2.2. Overall entrepreneurial ecosystem quality and element scores of UK regions



Source: See Annex 2.A for data sources

This study also benchmarks East Anglia with four other regional entrepreneurship ecosystems in the top 10 percent of regional entrepreneurship ecosystem quality in Europe – Berkshire, Buckinghamshire and Oxfordshire, UK; Hovestaden (Greater Copenhagen), Denmark; Stockholm, Sweden; and Oberbayern (Greater Munich), Germany. Figure 2.3 shows the benchmark performance.

Figure 2.3. Entrepreneurship ecosystem element scores for East Anglia and European benchmark regions



Source: Annex 2.A for data sources

The diagnosis shows that East Anglia performs very well with respect to leadership and knowledge, and relatively well with respect to all institutional arrangements (formal institutions, culture, networks), and finance.

The weakest points of the local entrepreneurship ecosystem relative to other European top performers lie in the following areas:

- *Physical infrastructure* (transportation and digital infrastructure).
- *Talent* (prevalence of individuals with high levels of human capital). East Anglia performs rather weakly with respect to talent, which is perhaps remarkable for a region that contains Cambridgeshire, but can be explained by other East Anglia sub-regions with very low shares of population with tertiary education.
- *Intermediate services* (employment in knowledge intensive market services and stock of incubators and accelerators). Even though the Cambridge area has a well-known concentration of technology

consultancies (Koepp 2002; Garnsey & Heffernan 2005) and incubators, East Anglia's overall employment in knowledge intensive services is relatively low.

Nonetheless, to some degree, the region may "borrow" some of the advantages of neighbouring regions in transport communications and proximity to London's very high performance entrepreneurial ecosystem, including access to the London finance and talent pool.

Qualitative analysis of the entrepreneurial ecosystem

A qualitative assessment in combination with more fine-grained quantitative data is provided below for each of the ten elements of the entrepreneurship ecosystem framework, taking into account information from background literature and interviews with stakeholders.

Formal institutions

The quality of formal institutions, particularly the quality of government, is relatively high in the United Kingdom, and the overall quality of governance does not differ substantially between UK regions. This element therefore cannot be judged as a weak link.

Entrepreneurship culture

Entrepreneurship culture tends to be built by a wide prevalence of entrepreneurship. The number of new firm births per 1 000 population is not particularly high in Cambridgeshire and Peterborough. However, the successful Cambridge cluster contributes to positive attitudes to entrepreneurship, at least in the Cambridge area.

Networks

The percentage of firms in the business population that collaborate for innovation is relatively high in Cambridgeshire and Peterborough. In addition, the local and global connectedness of the high-tech firms is very high (Garnsey & Lawton Smith 1998; Keeble et al. 1999; Huber 2012). Formal and informal local networks in Cambridge are particularly strong, including cluster organisations representing members in the main strategic sectors of the region. Local government could help reinforce these networks by providing operational support. Particular emphasis is needed to building networks in Peterborough and The Fens in order to connect medium and low-tech business with research and education actors.

Physical infrastructure

One of the key constraints for the development of the Cambridge cluster is that the core of the cluster is constrained in space. The city hosting the core cluster firms and research and education facilities is limited in area and surrounded by green belt land, and has little available greenfield or brownfield sites for development of employment or housing uses. In particular the housing stock has not been able to grow at the same rate as employment growth, leading to rising housing prices. This obliges the cluster employers to increasingly access labour through commuting. However, the cluster suffers from high levels of traffic congestion. This was already an issue decades ago (Baker 2010), but seems to have become worse. This increases constraints for firms to obtain labour and is likely to be a barrier to networking and knowledge exchange. It is also a constraint to a greater dispersal of the cluster across the broader Cambridgeshire and Peterborough region and to integrating actors more closely across the region.

Two major ways to ease these constraints can be pursued. First, improvements can be made to road and rail connections within the city and between the city and surrounding towns. A key part of this solution can be to ensure that there is good cycling infrastructure available at stations being served in Cambridge from surrounding towns, including possibilities for commuters to access rentable bicycles at the railway stations, or secure their own bicycles there. Box 2.1 sets out a model for such reinforced pro-cycling policies for people travelling into Cambridge.

Box 2.1. Pro-cycling Policies, The Netherlands

Description of the approach

There has been a rise of pro-cycling policies in Europe and Northern America. For example, in the Netherlands, a recent policy has involved the construction of large bike sheds in the cities of Utrecht (12 500 bikes), Amsterdam (3 000 bikes) and Rotterdam (5 000 bikes). This has been complemented with a bike renting system at these points. This lowers the traffic delays for cars and reduces the need for car parking spaces in the city. It also lowers air pollution and improves health.

Success factors and challenges

Success factors for these policies are low costs for bike rental and a reduction in free car parking.

Relevance for Cambridgeshire and Peterborough

Adopting the types of pro-cycling policies seen in Europe and America, could help solve the long-standing traffic congestion in the Cambridge area. This would build on Cambridge's reputation as cycling city in a radically modern way. The policy could start with very large bike sheds at central points, especially the railway stations.

Further information and sources

Pucher and Beuhler (2008); Pucher et al (2011); (Carse et al. 2013)

Second, investments can be made to increase the housing stock and improve internal public transport options within Cambridge to keep up with the growth of the Cambridge economy. This may involve changing planning regulations to facilitate methods of increasing urban density without encroaching on green space, for example by building higher in new developments, facilitating housing extensions vertically, and facilitating refurbishments that would enable more households within given properties as long as reasonable standards are maintained. Baker (2010: 303) summarises the challenge: "Cambridge has changed considerably in the past, it is changing rapidly at present, and it will change substantially in the future. "Cambridge" is synonymous with "change" – it is an internationally-recognised centre of innovation. The challenge facing the city is how best to manage change to its built form for the benefit of all who live, work and play there."

Demand

Cambridgeshire and Peterborough does not host a population with strong aggregate purchasing power. However, the region hosts a number of sophisticated users or customers for innovative products and services which can help drive innovation through their demand. This is particularly the case in the

Cambridge cluster, including Addenbrooks Hospital, the University of Cambridge, indigenously-generated global players including ARM and Marshall Aerospace, and branches of foreign multinationals like Microsoft and AstraZeneca. In addition, there may be potential to use local or national public procurement initiatives to stimulate scale-ups further in key sectors of activity for the Cambridge cluster (see Box 2.2).

Box 2.2. Small Business Research Initiative, UK

Description of the approach

The Small Business Research Initiative (SBRI) is a policy instrument to support public procurement of innovation, especially through innovative start-up and scale-up ventures. The SBRI is support nationally by Innovate UK, whilst helps organise pre-competitive public procurement contracts from small businesses by national government departments, government bodies, and local government authorities. As pre-competitive contracting it is compatible with European Union procurement directives.

The initiative involves promoting competitive innovation challenges put out by a public authority inviting applications from a range of potential suppliers of products and services. In a first phase, companies can be funded to develop a proposal for a feasible solution to the new procurement need, or a proof of concept. In a second phase, winning ideas can be funded for development of a demonstrator product or service or prototype, working in collaboration with the procurer. This process can generate innovations that can then potentially be sold to the SBIR procurement provider, if the firm wins a new tender with them, or could be sold by the firm into other markets. In this way public sector organisations can more often serve as advanced lead customers.

It is modelled after the long running SBIR programme in the USA. David Connell – affiliated to one of the leading technology consultants The Technology Partnership and the University of Cambridge's Centre for Business Research – has been a long-time advocate of expanding this programme in the UK (Connell 2017). Awareness needs to be increased of this initiative amongst potential innovation procurers in the UK and link made to potential innovation suppliers in Cambridgeshire and Peterborough, particularly in the Cambridge cluster.

Relevance for Cambridgeshire and Peterborough

Further expansion of the SBRI, especially by Cambridgeshire and Peterborough public sector organisations, may help boost sophisticated demand in key strategic sectors in the regional entrepreneurship ecosystem. Non-local organisations could also be encouraged to set up procurement processes that local scale-ups could apply to.

Further information and sources

Connell (2017)

Leadership

The Cambridge cluster benefits from a recognisable group of entrepreneurship ecosystem leaders consisting of serial entrepreneurs and key figures from the University of Cambridge who are prominent in multiple local networks. On the other hand, visible entrepreneurship ecosystem leadership is less established in Peterborough and The Fens.

The Cambridge Network is an excellent example of local place-based leadership, providing guidance and direction for collective action for the Cambridge cluster. It is a membership organisation that brings people from business and academia together to meet and share ideas, encouraging collaboration and partnership for shared success. Exemplar activities are: 1) fostering closer relationships and sharing ideas between businesses, academia and individuals through a calendar of Member events; 2) facilitating peer learning groups and sharing high-quality training; 3) connecting people and companies for research and partnering; 3) enabling members to find and attract quality candidates to work in Cambridge.

The Cambridge Network facilitates co-operation, action and resource sharing by being a focal point for organisations in the Cambridge cluster. It plays a catalysing role for entrepreneurship by building networks, intermediate services, finance and talent. However, there is a feeling among some stakeholders that the network does not have enough inflow from younger generations, and it does not seem to interact strongly with local government.

Furthermore, some regional business stakeholders point to a lack of common ground, collaboration and alignment between local government and the business community. The CPCA has installed a Business Board (replacing the former Local Enterprise Partnership), to forge a more effective partnership between businesses and the public sector in the region. However, these relationships still need to be built more widely. The CPCA Business Board alone does not suffice for leadership and collective action to improve the local entrepreneurship ecosystem.

The CPIER report provides analysis that can be used as a first step for strengthened collaboration between the public, business, research and education sectors in strategy development, by offering a solid and detailed diagnosis as a starting point for a new policy cycle. An effective place-leadership model, involving a range of stakeholders in developing a common vision and set of actions to address weak links in the entrepreneurship ecosystem, can involve meetings of partners to discuss an ongoing sponsored diagnosis of weak points and how to address them. Box 2.3 offers Joint Venture Silicon Valley as an inspiring international policy practice of this kind, which involves a range of stakeholders in strategy development and shared ecosystem leadership.

Box 2.3. Joint Venture Silicon Valley, United States

Description of the approach

Established in 1993, Joint Venture brings together Silicon Valley's established and emerging leaders to spotlight issues and work toward innovative solutions. Joint Venture not only connects business and academia, but also government, labour and the broader community. It initiates and enables a wide variety of activities to improve the region. Its members include business, but it also has the structured participation of government, labour, foundations, and university leaders, all seated together on the same Board. In other words, Joint Venture is a multi-sector organisation. It is not focused on traditional advocacy, but rather focuses on creating local projects sponsored by its members that have a clear consensus across all the major sectors.

A key activity is the continuous monitoring of the regional economy, and the annual Silicon Valley Index report, produced by Joint Venture's Institute for Regional Studies. Joint Venture also organises the annual State of the Valley conference, with participation of many representatives from the public and private sector. The purpose of the research is to equip Joint Venture for action on a wide range of problems facing Silicon Valley. One of the great strengths of the organisation is that it has scholars working alongside practitioners, and the work is informed by each other. The diagnosis provides a focus to start discussions among the members of Joint Venture.

The Board of Directors authorises Joint Venture's engagement on an issue, after important criteria are met: the problem is documented by research, there is a consensus around the solution, there are champions willing to dedicate time to the effort, there are resources available, and the work is not redundant or competitive with other efforts. The continuous monitoring enables the evaluation of the measures taken and the other economic dynamics that deserve attention of the ecosystem and its leadership to take subsequent action.

Examples of policy actions agreed and developed are the education of municipal employees, elected local government officials, and civic leaders to help guide their understanding of new and future wireless technologies; and a Joint Venture and Silicon Valley Bicycle Coalition regional study (2017) that lays out a vision for the bicycle to become a major mode of travel in Silicon Valley.

Joint Venture provides analysis and action on Silicon Valley's challenges. It is a stewardship organisation. People get involved because they feel a keen sense of responsibility and want to invest time and effort in improving the functioning of the region. The benefits accrue to the region overall, and they would not be possible if Joint Venture did not bring the region's leaders together in a framework of collaboration.

Joint Venture is a 501 (C) 3 organisation, classified as a non-profit. Joint Venture receives funds from more than 30 cities and agencies and more than 100 corporations that invest on an annual basis. The organisation also receives some foundation support for specific projects.

Relevance for Cambridgeshire and Peterborough

The Silicon Valley area provides an interesting benchmark for the Cambridgeshire and Peterborough area, both being world-class regions of high-tech activity and venture capital. Silicon Valley Joint Venture acts as broader platform for dialogue than the current organisations in the Cambridgeshire and Peterborough, bringing in a range of individuals from private, public and non-profit stakeholder organisations to come to a shared vision and consensus on measures that need to be taken to improve

the region built on continuous monitoring of the regional economy and regular dialogues amongst stakeholders.

It differs from the CPCA regular Business Board, in that it brings together a larger range of regional stakeholders, alongside the public sector and businesses, in a more sustainable way, with the objective of forging shared ecosystem leadership. In addition, it structures the diagnosis function in the region by providing a shared and annual monitoring of Silicon Valley's economy and community health. It therefore differs in approach from the CPIER diagnosis, in the sense that it is regular, not one-off, and commissioned by members, not by the government authority.

A similar membership organisation for the region could operate alongside CPCA to support CPCA, with some trigger mechanism for its creation provided by CPCA.

Further information and sources

Saxenian & Dabby (2004)

Talent

Cambridgeshire and Peterborough has a relatively low share of people with tertiary education compared with other top-performing regional entrepreneurship ecosystems. This is largely driven by low tertiary education attainment in Peterborough and The Fens, rather than Cambridge (CPIER 2018), and is related to a low ambition of people to progress into tertiary education and relatively low primary and secondary education attainment.

Furthermore, while Cambridge is a global hotspot of highly-educated science and technology people, Brexit is likely to have a harmful effect on the position of its position in international competition for science and technology talent.

Many business stakeholders also identify a lack of digitalisation skills among SME employees in Peterborough that could affect start-ups, scale-ups and existing SMEs, which is in line with issues in the OECD more generally (OECD, 2021 forthcoming). Box 2.4 gives an international example of a potential policy response to this digital skills gap.

Box 2.4. Jheronimus Academy of Data Science (JADS), Netherlands

Description of the approach

The Jheronimus Academy of Data Science (JADS) was founded in 2015 by the Province of North Brabant in co-operation with the Municipality of 's-Hertogenbosch, Tilburg University and Eindhoven University of Technology. It has created a new knowledge infrastructure to support data-driven practices by start-ups and established SMEs and large firms in the region and beyond.

The Academy enables the study, research and application of data science through bachelor and graduate programmes, Data Science Centres and incorporation into existing data science ecosystems. The Mariënburg Campus in Den Bosch is a data science hotspot: the campus offers modern education facilities, as well as space for start-ups. It is designed as a place where interaction, networking, training, education and the exchange of skills and know-how feed the data science community.

Relevance for Cambridgeshire and Peterborough

This policy model can be used as inspiration on how to solve lack of digitalisation skills – especially in the Peterborough area. One obvious way to connect the strengths of the Cambridge region to the weaknesses of the Peterborough region is to establish a joint venture in line with the JADS example, in which the University of Cambridge (in particular the Institute for Manufacturing) and Anglia Ruskin University collaborate with one of the Peterborough colleges to develop a digitalisation hot spot for local start-ups and SMEs.

Such a joint venture would combine the scientific strengths of the Institute for Manufacturing with the broader connectedness of Anglia Ruskin University and the local foothold of the Peterborough colleges, to realise an effective diffusion and development of digital skills amongst SMEs in the Peterborough area.

Some stakeholders also identify a lack of managerial and marketing skills in (potential) scale-ups in Cambridgeshire. The region is developing an infrastructure for developing entrepreneurial skills for building scale-ups within the University of Cambridge (Centre for Entrepreneurial Learning) and by the Cambridge Network (School for Scaleups, see Box 2.5).

Box 2.5. School for Scaleups, Cambridge, UK

This programme is open to all high-growth businesses and social enterprises, either for the founding leadership team or for people in operational roles, built on the guiding principle that growth demands leadership at all levels. The active learning programme runs with a cohort of 12 delegates meeting face-to-face every six weeks for a formal workshop. The cohort works together over 14 months with 11 modules focusing on different aspects of leadership skills. Delegates value the close relationship with peers as a strength of the programme and the community-centric nature of the School. Participants are also offered additional training, individual coaching and mentoring from Cambridge Network if appropriate. Successful scale-up business leaders visit the School on a regular basis to share their experience and give their insights on issues faced by members. On completion of the course, scale-up business leaders benefit from the Cambridge Network CEO group, which acts as 'the board you can't afford' on a continuing monthly basis. The School was designed with input from a number of successful and respected leaders in local high-growth companies such as ARM.

Source

Scaleup Institute (2017, pp. 92-93)

Finance

The supply of finance, and venture capital in particular, is very good in the region. The quantitative measure (derived from BVCA data) for the ecosystem benchmarking reported above probably underestimates the strength of the finance element, especially for the Cambridge cluster (see Stam and Martin 2012). Next to London, Cambridge is probably one of Europe's best developed locations with respect to venture capital.

In spite of an abundant supply of entrepreneurial finance in the cluster, some stakeholders perceive an increasing concentration of angel finance in smaller numbers of active business angels, and an increasing share of foreign venture capital. This could come to constrain the access of innovative start-ups and scale-ups to local early/stage growth finance in the future if the trends are realised.

Knowledge

Cambridgeshire and Peterborough is an exceptional knowledge-intensive region, with very high levels of R&D investments, particularly in the Cambridge cluster.

Intermediate services

The quantitative benchmarking indicates that the prevalence of intermediate services in the region according to ONS measures is around the country average. However, the quantitative data do not fully capture the rich supply of all kinds of enterprise services provided by a large set of incubators, science parks, and campuses in the Cambridge area (Waters and Lawton-Smith, 2002). Regional stakeholders do not tend to perceive intermediate services to be a constraint to the development of the entrepreneurship ecosystem.

Conclusions and policy recommendations

Both the quantitative and qualitative analyses identify talent as one of the most important weak links of the Cambridgeshire and Peterborough entrepreneurship ecosystem. In particular, low quality primary and secondary education and resulting low tertiary education in Peterborough and The Fens, especially a lack of digitalisation skills, is a constraint. Access to high-skilled labour is also an issue, in particular in the context of increased difficulties in tapping into immigration from European Union countries following Brexit.

Physical infrastructure is a further constraint. There is significant congestion in the Cambridge cluster, which has been problematic for decades. This is manifest in traffic congestion and high housing prices in Cambridge, which constrains accessibility to the cluster, although it is in many respects a sign of recent cluster success. Lack of affordable housing is a problem in almost all flourishing entrepreneurial ecosystems, including London, Stockholm, Copenhagen, and especially Silicon Valley.

Finally, there seems to be a lack of productive interaction between business and higher education and with local government. Even though the Cambridge Network provides an excellent leadership role in the cluster, it mainly focuses on the interaction between science and business, providing a catalyst for innovation relations that combine ideas, knowledge and resources from a variety of sectors. The CPCA Business Board and Skills Advisory Panel also create connections, but mainly focused on specific issues and local government driven. There does not seem to be equally good private and stakeholder-led leadership or support for connecting medium- and low-tech business and higher education (especially in the Peterborough region), and the Cambridge Network does not strongly connect to local government.

Box 2.6. Recommendations on the local entrepreneurship ecosystem

1. Strengthen ongoing structural monitoring of the Cambridgeshire and Peterborough economy and its entrepreneurship ecosystem elements, building on the Cambridgeshire and Peterborough Independent Economic Review (CPIER). This monitoring could also include broader quality of life issues, as is done by comparable regional intelligence organisations abroad.
2. Create a joint venture institution involving a broader range of local stakeholders than currently reached by the CPCA Business Board, including members from business, government, academia, labour and the broader community. The joint venture institution would monitor the local entrepreneurship ecosystem and strengthen the dialogue on how to solve weak links. It could be set up for example as a non-profit organisation with funding from local government authorities and business, with a Board to review proposals and agree actions.
3. Develop an institute in Peterborough that provides education and training programmes, including focuses on enhancing digitalisation skills, entrepreneurial skills and technical skills, potentially backed by Anglia Ruskin University and/or the University of Cambridge Institute for Manufacturing.
4. Make the physical infrastructure future proof by developing a world-leading digital infrastructure; enabling mobilities of the future, including driverless vehicles; increasing accessibility to Cambridge by bicycle in combination with public transportation; and increasing “urban density”, for example by increasing vertical density and without encroaching on green space.

Annex 2.A. Indicators and data sources for the entrepreneurship ecosystem benchmarking

Ecosystem element	Description	Empirical indicators	Data sources
Formal institutions	The rules of the game in society	Two composite indicators measuring the overall quality of government (consisting of scores for corruption, accountability, and impartiality) and the regulatory framework for entrepreneurship (number of days to start a business, difficulties encountered when starting a business, the barriers to entrepreneurship and the ease of doing business)	Quality of Government Survey and the Regional Ecosystem Scoreboard
Entrepreneurship culture	The degree to which entrepreneurship is valued in a region	A composite measure capturing the regional entrepreneurial culture, consisting of entrepreneurial motivation, cultural and social norms, importance to be innovative and trust in others	Regional Ecosystem Scoreboard
Networks	The connectedness of businesses for new value creation	Percentage of SMEs that engage in innovative collaborations as a percentage of all SMEs in the business population	Regional Innovation Scoreboard
Physical Infrastructure	Transportation infrastructure and digital infrastructure	Four components in which the transportation infrastructure is measured as the accessibility by road, accessibility by railway and number of passenger flights and digital infrastructure is measured by the percentage of households with access to internet	Regional Competitiveness Index
Finance	The availability of venture capital and bank loans to firms	Two components: availability of venture capital, availability of bank loans for capital investments	Regional Ecosystem Scoreboard
Leadership	The presence of actors taking a leadership role in the ecosystem	The number of coordinators on H2020 innovation projects per 1000 inhabitants	CORDIS (Community Research and Development Information Service)
Talent	The prevalence of individuals with high levels of human capital, both in terms of formal education and skills	Eight components: tertiary education, vocational training, lifelong learning, innovative skills training, entrepreneurship education, technical skills, creative skills, e-skills	OECD Regional Innovation Database; OECD Regional Education Database; Regional Ecosystem Scoreboard
New Knowledge	Investments in new knowledge	R&D expenditure as percentage of Gross Regional Product	OECD Regional Innovation Database
Demand	Potential market demand	Three components: disposable income per capita, potential market size expressed in regional GDP, potential market size in population. All relative to EU average.	OECD Regional Economy Database; Regional Competitiveness Index
Intermediate services	The supply and accessibility of intermediate business services	Two components: the percentage of employment in knowledge-intensive market services and the percentage of incubators/accelerators per 1000 inhabitants	Eurostat and Crunchbase

Further information on these indicators: Leendertse, Schrijvers, and Stam (2020)

3 Skills

Introduction

Skills and training systems in advanced economies need to adapt to two key pressures:

1. An accelerated pace of technological change reinforced by convergence of technologies. This requires skills for the adoption of new technologies and digitalisation and the introduction of Industry 4.0 across the economy.
2. The growth and evolution of global value chains and increased regional competition for high value-added tasks. This requires investment in skills for high value-added tasks and retraining where local skills are made redundant as firms offshore.

There are also several other significant pressures. Some of them are country- or region-specific, for instance de-industrialisation processes, the rising cost of education, or the lack of appropriate active labour market policy. Others are general, such as the coming transition towards a green economy that is likely to imply a profound industry restructuring process in many sectors.

The pressures are bringing about a re-articulation of skills across advanced economies, but this is being held back by a lack of flexibility in education and training systems, with curricula that are sometimes no longer suitable in the labour market while businesses report a lack of skills availability in a form of skills mismatching.

The provision of the necessary skills in a region needs to be seen as a collective action problem involving a range of employers and training organisations. Developing the right skills requires a systemic approach at regional level, which is able to respond to the dynamics of local industrial specialisations and complex local interactions between skills demand and educational choices, perceptions, risk attitudes, and labour market institutions (Filippetti and Guy, 2020). There has therefore been significant recent devolution of skills responsibilities in several OECD countries, particularly with regard to vocational training (Filippetti et al., 2019).

As part of this, a process of increased devolution of skills and training policy and efforts to address policy development in a more integrated way across stakeholders are underway in the UK – including new arrangements in Cambridgeshire and Peterborough. The Department for Education (DfE) and the Education and Skills Funding Agency (ESFA) have been working with the CPCA on the devolution of the Adult Education Budget. CPCA has been given responsibility for the Adult Education Budget and collaborates with central government on policy to strengthen the apprenticeship system. It has appointed a Skills Committee and an Employment and Skills Board – incorporating a Skills Advisory Panel (SAP) and

disposing of an Adult Education Budget[30]. Using these arrangements it has prepared a Skills Strategy for the region.

However, Cambridgeshire and Peterborough needs to address locally a number of long-standing problems in the UK as a whole in addressing the process of re-articulation of skills. Notably, these UK structural problems include skills shortages, as identified in the Government's Made Smarter Review of 2017, and a tendency to encourage academic rather than vocational learning routes to enter the labour market. A range of OECD work has investigated these issues and potential policy responses in the case of the UK (OECD, 2020; OECD 2017a; OECD 2017b; OECD 2015; Barr et al, 2019). This section focuses on how they are manifested in Cambridgeshire and Peterborough and the local responses that CPCA and its partners are making.

Local skills development needs

Skills gaps in the Cambridge cluster

Local business stakeholders identify skills shortages as a significant constraint to the development of the Cambridge cluster, even though the cluster is able to draw on skilled workers from wider UK and foreign labour markets. For example, Rand Europe reports that 26% of establishments in the Cambridge area had at least one vacancy in 2019, rising to 53% in life sciences. There are three main causes: a tight labour market, detachment between industry and training provision, and lack of flexibility in training offers.

Tight labour market. Unemployment was close to the natural rate in the Cambridge area in 2019 and has been for some years. This has created several tensions in the labour market, which have been reinforced by a growing diaspora of local graduates looking for a job outside of Cambridge. Local firms compete among themselves for the students with the most suitable skills as well as with the business sector in London and the rest of the UK, and to some extent at an international level.

Detachment between industry and training. With the dramatic growth of the high-tech cluster, industry has become progressively detached from the regional education system. The cluster has a growing demand for specialised skills that the regional education system is not able to provide while more and more companies are coming from abroad, often with an orientation to hire on the UK and foreign labour markets to fill skills needs.

Lack of flexibility in training offers. High-tech companies require new skills and competences as a result of a fast-changing technological environment. For example, data scientist is a specific skill profile that is increasingly demanded and is crucial in life sciences for example. Soft skills are also lacking more generally[31]. The education system does not seem to be responding fully to these new industry needs, reflecting a rigidity in adapting their curricula.

Further development of higher-level training such as Level 3 apprenticeships could help to address these issues. However, currently, to access the government apprenticeship funding, a 20% minimum threshold

[30] The Adult Education Budget provides a tool to support learners to secure foundation skills, progression and diversification and is pivotal in supporting the needs of local people into employment.

[31] Soft skills include adaptability, attitude, communication, creative thinking, work ethic, teamwork, networking, decision making, positivity, time management, motivation, flexibility, problem-solving, critical thinking, and conflict resolution.

amount of time must be spent on occupational off-the-job training during the apprenticeship activity. This has been identified as a major rigidity especially for Level 3 apprenticeships in SMEs.

Low skill levels

Within the Cambridgeshire and Peterborough region as a whole, low skill levels are a problem especially in Peterborough and The Fens, although there are also some issues within the Cambridge area. For example, some 15% of the population in Peterborough aged 16 to 64 years old and 8% in The Fens has no qualifications (CPIER, 2018). An underlying issue is a cultural barrier, whereby families – especially low-income families – lack awareness of and trust in the returns from investment in education and training. As a consequence, regional colleges point to a major difficulty in engaging people in further education. As identified in the Government's Made Smarter Review of 2017, digital technologies are expected to bring about major changes in the way production is organised and the supply chain managed in many sectors and a lack of digital skills is a major obstacle to ICT adoption in firms.

Lack of articulation of skills demand

An additional issue in the region as a whole, is a lack of articulation of skills demand by the private sector, especially SMEs in manufacturing, where changes in digital technologies are affecting skills needs very swiftly. Business managers are often not fully aware of major changes currently taking place in their sector and the consequences for their business. Skills, competences, and organisational processes all face the risk of obsolescence. The CPIER (2018, p. 108) report also points to a lack of incentives for schools to provide accurate information that enables young people to make the best decisions on their vocational education and training based on an awareness of regional skill needs. The SAP has started to address this issue. While previously support activity was based on information gathered from students, the SAP has activated a labour market information (LMI) service aiming at supporting school-aged children and careers advisors. The LMI service gathers information directly from the labour market, particularly among the most relevant employers.

Lack of aggregation of SME training

Even when managers are fully aware of the need to re-train their workforces and of the skills needed, they may lack a practical solution to fill this gap because of a lack of appropriate training supply. This is exacerbated by limited incentives for SMEs to train and limited means for SMEs to put together their training with specific suppliers offering nonetheless tailored approaches, so as to build enough critical mass for training.

Local skills development structures

Devolution and CPCA

Skills policy is an important part of the process of devolution of economic responsibilities to the Combined Authority. The Combined Authority is responsible for the Adult Education Budget.[32] The county council of

[32] In the period August 2019 to July 2020 it had responsibility only for the following adult education functions from the Apprenticeships, Skills, Children and Learning Act 2009 ('the 2009 Act'): (1) section 86 which relates to education and training for persons aged 19 or over; (2) section 87 which relates to learning aims for such persons and provision of facilities; and (3) section 88 which relates to the payment of tuition fees for such persons; see here.

Cambridgeshire and the unitary authority of Peterborough are the local education authorities (CPIER, 2018).

This arrangement does not include apprenticeships. However, the Cambridgeshire and Peterborough Devolution Deal with the Government establishes that they "will collaborate to maximise the opportunities presented by the introduction of the apprenticeship reforms, including the levy, and to work together on promoting the benefits of apprenticeships to employers in order to engage more small businesses in the apprenticeship programme. The Combined Authority will explore the potential of introducing an Apprenticeship Training Agency to the area, funded through local resources" (p. 15). A challenge for the regional stakeholders is to ensure that the Apprenticeship Levy is delivered as effectively as possible locally.

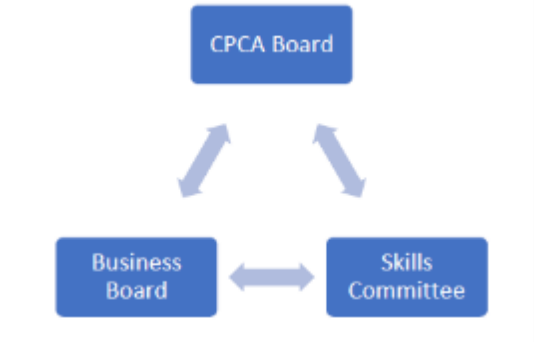
Regional governance of skills and the skills strategy

The CPCA has appointed a Skills Committee, which is an executive committee of the Combined Authority Board. The Board retains responsibility for agreeing key strategies, in particular the Skills Strategy, as well as for all matters requiring a budget allocation. The Board also appoints the Committee, which comprises four members: chair, two Board members, and a Board Member from Cambridge City Council or South Cambridgeshire District Council. The Skills Committee may make recommendations to the Combined Authority Board on the Skills Strategy and the skills budget.

In Autumn 2018, a newly-formed Business Board was created to represent the business sector of the area. The Business Board is responsible for steering the Local Growth Fund allocation. It is a non-statutory body which acts as the Local Enterprise Partnership (LEP) for the CPCA area. It is independent of the CPCA, and operates as a private-public sector partnership, which focuses on the key business sectors the region.[33]

The governance of the CPCA is depicted in Figure 3.1.

Figure 3.1. Key bodies in CPCA supporting skills policy design



Source: Skills Committee Minutes, 3 April 2019.

[33] See here.

In April 2019, the Skills Committee agreed to create the Employment and Skills Board (which acts as the area's Skills Advisory Panel, SAP)[34] for Cambridgeshire and Peterborough. The SAP has several objectives, including among others: (i) engage with employers and providers and provide skills advice to the Board of CPCA; (ii) develop a clear understanding of current and future local skills needs and the local labour market as well as the present skills and employment support provision in the local area; (iii) focus on the needs of future learners and employers which have been identified by local partners, including colleges, university providers and employers; (iv) raise the profile of apprenticeships with local employers and providers.

SAPs in the country are mostly responsible for the identification of skills demand and skills mismatching through in-house analysis as well as by commissioning analysis outside. The CPCA skills identification strategy is based on two main pieces of commissioned analysis:

- the 2018 Cambridge and Peterborough Independent Economic Review (CPIER), supported the drafting of the Cambridge and Peterborough Industrial Strategy in 2019; and
- the 2018 Hatch Regeneris' Report,[35] which is employed for identifying the current and future skills needs of local and regional businesses.

The Employment and Skills Board/SAP is connected with the Skills Committee as well as with key stakeholders in the business sector, training providers and actors in adult education. As such, it aims to be a gateway between the Skills Committee and the key actors of the local skills system.

Within the devolution of skills provisions outlined above, the CPCA is responsible for outlining its priority provision through the Skills Strategy.[36] The Skills Strategy has been aligned to the Local Industrial Strategy and the CPIER and its recommendations. It has been drafted with adult education providers and various other stakeholders, with the general aim of creating "an inclusive world-class local skills eco-system that matches the needs of our employers, learners and communities". In particular, the following three key priorities have been put forward:

- Achieve a high-quality offer tailored to the needs of the three sub-regional economies;
- Empower local people to access education and skills to participate fully in society, to raise aspirations and enhance progress into further learning for work;
- Develop a dynamic skills market that responds to the changing needs of local business.

The process of devolution in skills policy outlined above is in line with experiences in most other OECD countries. This is certainly a first step towards making skills policies more effective. At the same time, the resources and powers provided to the regional authorities would need to be boosted to put in place a robust and comprehensive local skills policy. However, the structure and resources of the CPCA itself in the skills area are still quite underdeveloped for the role of delivering the skills strategy, especially in terms of personnel.

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[34] Skills Advisory Panels (SAPs) have been supported by the government to help Combined Authorities and Local Enterprise Partnerships (LEPs) to fulfil their local leadership role in the skills system by helping them understand their current and future skills needs and labour market challenges. Skills Advisory Panels aim to bring together local employers and skills providers to pool knowledge on skills and labour market needs, and to work together to understand and address key local challenges. More info about their role and governance can be found here.

[35] Hatch Regeneris. Cambridgeshire and Peterborough Combined Authority Skills Strategy Evidence Base Report, (2018), available here.

[36] See here.

Key local skills policy initiatives

Reforms of the UK apprenticeship system

The apprenticeship – understood as a combination of learning in school and training in a workplace – is increasingly emphasised in many OECD countries as a second pillar for entering the labour market alongside formal education. The European Commission, for example, adopted an initiative to boost apprenticeships in Europe in June 2016, with the view that "by providing direct links between theory and practice, between education and the labour market, quality and effective apprenticeships are concrete ways to help young people to enter the world of work".[37] In the UK, several recent reforms have been in this direction.

Over time, the UK has shifted from a supply-based to a demand-driven organisation of training, based on industry and local priorities in a system aiming at spurring local markets for skills and training. This includes the creation of new employer-led occupational apprenticeship standards to replace apprenticeship frameworks. Under the apprenticeship standards, training providers have greater autonomy and flexibility to meet the identified industry needs. This "puts the onus on training providers to meet employer and learner needs, given that as beneficiaries of a demand-led approach, employers and learners will bear an increasing share of the overall costs of training".[38]

The result is a system of apprenticeship standards that are employer-led, meaning that employers can specify exactly what is required from an apprentice in each specific role. Apprenticeship standards outline the knowledge, skills, and behaviours (KSBs) required to carry out a certain job role. Employers can use the "find apprenticeship training" service to search for suitable apprenticeships and identify approved training providers that can deliver that training. Some 739 standards have been identified, going from "abattoir worker" to "workboat crewmember".

The Government has also reformed the funding of apprenticeships. Starting in April 2017, all UK employers in the public and private sector with a pay bill of over GBP 3 million are required to contribute 0.5% of their annual pay bill to the Apprenticeship Levy. The Levy has been designed to counteract the long-term decline in employer investment in training in the UK. Anglia Ruskin University, for example, is offering "degree apprenticeships" at Bachelors or Masters level to leverage the Apprenticeship Levy funds. The emphasis on the Apprenticeship Levy has encouraged firms, especially SMEs, to think about using apprenticeships in order to reap the opportunities offered by the Fund. Furthermore, the Government has undertaken a series of reforms to improve the quality of apprenticeships. These include a minimum duration of 12 months and a requirement for 20% of the training to be undertaken off the job.

However, in the UK as a whole, participation rates in apprenticeships are below expectations. Between the introduction of the Apprenticeship Levy in 2017 and 2019, there was a fall in the number of apprenticeship starts.[39] This reflects difficulties in involving employers. A report prepared by CIPD about the employers' view on apprenticeships found that employers thought that only about 5% of hard-to-fill

[37] See here.

[38] Government Office for Science. "The UK skills system: how aligned are public policy and employer views of training provisions?", 2016.

[39] CBI Learning on the job, September 2019.

vacancies are suitable for apprenticeship and that companies do not believe that apprenticeship is suitable for addressing recruitment needs in areas such as engineering and technical jobs.[40]

At the same time, there has been significant growth in older apprentices on higher-level courses, while younger learners – and those at lower qualification levels – have been most impacted by the fall in apprenticeship starts.

In terms of apprenticeship levels, apprenticeships is still weighted towards Level 2. The more skill intensive, Level 3 apprenticeships are lagging behind. This is problematic in that only Level 3 apprenticeships can be considered as a real alternative to the academic path and are central to the objective of meeting industry demands for Industry 4.0 skills.

Skills and Talent Hub

The Skills and Talent Hub (STA Hub) is a major overarching skills development project developed by CPCA for Cambridgeshire and Peterborough. It is identified in the Local Industrial Strategy and Skills Strategy as a development to support Key Theme #3: Develop a Dynamic Skills Market that Responds to the Changing Needs of Local Business. Its main aim is to create better connections between all the skills and training ecosystem actors, namely employers, training providers, and learners. Its funding will include the following sources: revenue funding allocated within the CPCA 2019-23 Budget for the implementation of the Local Industrial Strategy and Skills Strategy; capital funding sought from the remaining Local Growth Fund (LGF) allocated by the Business Board; potential allocation of Adult Education Budget underspend; in-kind contributions from key partners; and the European Social Fund (ESF).

The Hub is based on three pillars.

1. **A Skill Service and Brokerage Service** to support the promotion of apprenticeships and to connect employers, providers and learners. A new skills brokerage contract has just been concluded and will supersede the previous contract.
2. **Apprenticeship Standard and Levy System Specialists.** These workers will be trained to support levy-paying employers to maximise the utilisation of their allocated levy funding by helping them design trailblazer apprenticeships or better exploit existing apprenticeship standards to meet their current and future training needs.
3. **Skills and Talent Brokers** to work by telephone and face-to-face between firms, schools, talent and skills providers to create and enable T-Level industry placements, traineeships, apprenticeships, graduate placements, employee upskilling and career retraining opportunities.

Apprenticeship Levy Pooling Service

The Apprenticeship Levy Pooling Service was launched in November 2019. It includes a Levy Pledge signed by the Mayor – i.e. a joint letter from the Education and Skills Funding Agency (ESFA) and the CPCA – as a letter of indemnity and assurance to Levy Employers. The latter is a pledge to commit to sharing up to 25% of their unspent levy through a Levy Transfer. This supports SMEs that would not otherwise have had the funding to recruit apprentices and training providers that are low on non-Apprenticeship Levy funding. The service was launched in November 2019. However, the number of requests has been lower than expected, reflecting in part the impact of the COVID-19 pandemic, which

[40] See here.

has significantly reduced apprenticeship activities. This has also delayed the planned establishment of a dedicated web portal for the Levy Transfer. The plan is now to make it part of the STA Hub (see above).

New training projects

Several new skills and training projects have been introduced in Cambridgeshire and Peterborough, which have been funded in the past by the European Social Fund, including:

My Future, Young People Support Programme. Started in 2019, this project, managed by The Consultancy Home Counties Ltd, supports young people from across Cambridgeshire, The Fens and West Norfolk who are not in employment, education or training (NEET) or at risk of becoming NEET, to gain qualifications and achieve goals such as getting a job, into education, training or an apprenticeship. The programme provides work experience and pre-employment training opportunities including routeways to traineeship and apprenticeship opportunities. It also offers English, Maths, IT, Business Start-Up and vocational training as well as employment trials, internships and volunteering opportunities. It is planned to run until July 2021.

Work Routes. This programme aims to help long-term unemployed or economically-inactive people to start and sustain work. It is delivered across Cambridgeshire and Peterborough by public services provider Reed in Partnership. The programme is set to support 2 100 jobseekers in Cambridgeshire and Peterborough over a three-year period.

Employ-Ability Peterborough Plus. This programme is based on a personalised approach with a tailored package of support interventions designed and commissioned with participants, in the areas of Peterborough, The Fens, Kings Lynn and West Norfolk.

Skills Support for the Workforce Programme. This is a programme co-financed by the Education and Skills Funding Agency and the European Social Fund in partnership with the Business Board of CPCA designed to support training for SMEs. It provides training needs analysis, flexible training, on-the-job vocational training, and recognised accredited qualifications and training courses. It will focus in particular on key sectors for skills support identified by the Business Board for the area, namely Agriculture and Food, Advanced Manufacturing, Life Sciences, Logistics, IT and Digital, Health and Social Care, Construction.

Target apprenticeship. This project has been launched to encourage the uptake of apprentices and increase the number of apprenticeships being offered across Cambridgeshire and Peterborough. The programme is led by the College of West Anglia, in partnership with West Suffolk College. It is directed to companies with less than 250 employees which have not been involved in apprenticeship over the past three years.

Opportunities for further strengthening local skills and training

Increase higher education opportunities

There is a clear need to offer more local higher education opportunities in Peterborough and to market them effectively, as also highlighted in the Skills Strategy. It is always tempting for cities to want their own university but the costs are significant and the resultant body is likely to have low status. An alternative is to encourage Anglia Ruskin University to increase its provision in Peterborough and to move more applied research and industry-related training there.

Increase awareness and trust about the returns on investment in education and training

One of the bottlenecks, particularly in Peterborough and The Fens, is that many families without higher education experience doubt the returns to investment in education and training. In other OECD countries, specific policies have been designed to reduce cultural barriers to further and higher education. Box 3.1 describes a pilot nudging policy involving information provision on the returns to education in Italy that has been showing significant success.

An additional approach to strengthening local skills and training, which would be complementary to increasing the supply of higher education opportunities and the demand for them, would be to invest in reinforcing the quality of further education colleges in order to make them more attractive for students who do not want to pursue university education. An approach used in Italy is the recent introduction of a new education track named *Istruzione e Formazione Tecnica Superiore (IFTS)*, i.e. High-level Technical and Vocational Education, which relates to the European standard of non-academic post-secondary education and training.[41] This introduces a new type of post-diploma school for both employed and unemployed people who wish to train for high-level technical profiles. A minimum standard for the competences is established at the national level and the regional governments then identify the specific competences of each course based on the local skills needs. The results are so far encouraging: one year from the end of the course 50% of students find a job, increasing to 64% after two years.

[41] This is similar to the German case of the Universities of Applied Sciences, which, contrary to standard universities, offer practice-oriented academic courses**,** where the focus is more on professional application than theory and the training is adapted to the requirements of professional life.

Box 3.1. A nudging experiment to foster academic enrolment by students from low-education background families, Italy

Context

Several regions in the south of Italy face high unemployment, particularly among young people. One of the reasons is lack of acquisition of skills through higher-level education, particularly among families without a higher education background.

Low-educational attainment families tend to invest less in academic education, even when the prior educational performance of their children is satisfactory. This is often due to informational biases affecting their educational choices, which stem from factors such as the cost of education, the chances of success, and risk-aversion. As a result, children from low-educational attainment families are underrepresented in tertiary education, which decreases their employability, perpetuating a vicious circle between family background, education investment and performance in the labour market.

Description of the approach

This project involves a pilot test to see if it is possible to increase higher education participation by addressing information biases driving education choices in low-education families. The information biases are assessed as following two dimensions: (1) low-educated families – compared to high-educated families – are more concerned with the risk of failure at university (even when their children perform well at school); (2) low-educated families overestimate the occupational risks associated with choosing a university education.

The experiment was carried out in the region of Puglia in the south of Italy, a region with one of the highest rates of youth unemployment in Italy and Europe.

Families face a choice in their upper-secondary education track between a non-academic track (e.g. technical or vocational diplomas) and an academic track (classical or scientific diplomas), according to the school chosen. The latter is the usual track leading to enrolment in tertiary education. Thus, by choosing non-academic diplomas in their upper-secondary school, students considerably reduce their opportunities of enrolling in university, although this is still possible.

Two groups of students were selected for the experiment, both from low-educated families and with good performance at school: the treated and the control group.

In a first step, the mothers of all the students were interviewed by asking a set of questions about their beliefs and preferences about their children's track choices. The survey showed that low-educated mothers attached more importance to choosing tracks that are not too challenging for their children and that thus present lower chances of failure. Moreover, they tend to overestimate the importance of short-term returns attached to a non-academic diploma and underestimate the long-term returns attached to an academic track. Thus, low-educated parents are more concerned about the failure risks and the occupational risks, whereas college-educated parents attach more importance to the long-term return of a university degree. These differences are significant and systematic.

In a second step, the mothers of the treated group received an additional standardised message that explained in detail that (1) their children had the proficiency to successfully attend university; (2) the academic track performs as well as the non-academic (i.e. technical or vocational) track in the labour market, even if students do not wish to continue to university after high school graduation. This message

was further reinforced with a brochure explaining in detail the real occupational returns of the different education tracks.

The results show that students were more likely to enrol in the academic track after their parents had received the additional information.

Success factors and challenges

This intervention exploited a scientific understanding of potential information biases and responses. It is not particularly costly, and once effectiveness has been demonstrated, has the potential to be scaled up and replicated in other contexts.

Relevance for Cambridge and Peterborough

The provision of more accurate information on returns to higher education could help address cultural barriers to higher education in low-education background families.

Fill gaps in available further education courses

The region has a number of further education colleges, but their courses involve a fairly traditional mix of activities. In line with the UK overall, much of the further education offered is of the general type and reflects what are perceived as the immediate skills demanded by local people. There is a need for further efforts to diversify courses and better match with emerging skill needs as well as to upgrade some of the courses to link better with recent developments in ICT and advanced manufacturing. A series of funding cuts over a period of time has made further education providers across England retrench and be disinclined to experiment with new courses and approaches. Issues arise with a lack of adequate local training providers in some specific sectors, which CPCA is seeking to address by trying to involve training providers from outside the region.

Another issue raised by the regional colleges is a lack of competitiveness to hire specialised trainers on the market. Training providers in adult education are competing with both the educational system, including the tertiary education, and the business sector, when hiring specialised personnel. This is particularly problematic in those cases – e.g. engineering – in which a tight labour market creates a significant gap between wages offered in the private sector and wages that can be offered by the colleges. Some additional targeted funding and incentives may be required to increase new course availability in this context.

Assemble holistic skills intelligence

At this stage, there is a lack of actors responsible for the identification of the skills needs of the region and its sub-regions. The Skills Strategy is a good starting point, although it remains at a higher – strategic – level. The need to “achieve a high-quality offer tailored to the needs of the three sub-economies” is spelled out in the Strategy. The SAP also carries out skills intelligence activity based on external advisors and reports, and the Business Growth Service has just been finalised, including a “Skills and Apprenticeship” service intended to provide a more comprehensive view of skills gaps by linking demand for training and re-training with employers and skills providers. However, the current approach is heavily dependent on firms identifying their current and future skills demands and expressing this to an appropriate training provider. This has its limits. Frequently SME managers are not fully aware of the current major changes that are taking place in their industry and the changes needed in their skills, competences, and organisational processes.

This is the case for instance in the manufacturing and ICT sectors, where companies have to respond to the Industry 4.0 revolution, which is bringing about major changes, not only in terms of competences, but also in terms of new organisational structures of the firm. The identification of the new skills is particularly complicated because of the growing intersection between the boundaries of scientific and technological domains; in short: technologies are blurring. This is very much the case in the advanced manufacturing and ICT strategic sectors, where there is an increasingly overlap between engineering, technical competences and ICT competences – i.e. technological convergence or the blurring of the boundaries of technologies. The implication is the need for a systemic analysis to be carried out at the industry level, i.e. above the level of the firm.

Most companies, especially SMEs, lack the capabilities and resources to carry out this type of analysis on their own. The private sector may tend to be biased towards short-term specific skills, while at the system level it is also important to have a workforce with general and portable skills to sustain innovation. Skills identification therefore requires a meso-level approach rather than a micro-level approach.

As an illustration, some of the skills that are going to be needed in the life science strategic sector do not exist today and therefore cannot be created within a demand-driven system. The identification and definition of new skills standards have to be the result of a coordinated activity among the industry, the institutions, and the training providers.

Similarly, the adoption of digital skills in the agri-tech strategic sector can improve the level of productivity significantly. However, for this to occur, the introduction of new skills in the firm is required in the first place; re-training of the existing labour force is insufficient. The effective adoption of digital technologies in this context requires a significant transformation of the whole production process, which entails a change in the organisation of the whole sector. That cannot be obtained without a co-ordinated effort given the presence of complementarities, such as, for instance, between the agri-tech firms, the providers of the new technologies, and the education system.

Other OECD countries, such as Italy, Germany and Sweden, have devolved skills intelligence activity to a network of actors, where the trade unions and the industry associations play an important role. Such a network for skills intelligence could help support the SAP in Cambridgeshire and Peterborough.

Aggregate skills demand

Even when businesses are fully aware of the need to retrain their workforces and of the skills they need, the demand for training, especially that stemming from SMEs, is scattered among many firms and disparate skills. In many cases, SMEs need some mix of training even for the same worker (e.g. technical plus soft skills). At the same time, the SME may approach a range of different training suppliers without co-ordination with other local SMEs. This creates an extreme fragmentation of the demand for training that is not easily matched by training supply. Aggregation of the demand for skills by different SMEs would create opportunities for training.

The activity of skill brokerage and the Levy Pool that are part of the new Skills Strategy of the CPCA are expected to go into this direction. Furthermore, some systemic initiatives, such as the STA Hub, could play more of a pivotal role. However, these initiatives are still in their initial stages, and it is unlikely that they will have the resources on their own to tackle the fragmentation problems effectively. A complementary role in coordination could be played also by regional colleges. They have a long-term experience in training, including vocational training, and also a specific knowledge of the territory.

Develop new local/regional skills networks

An important part of the response to developing more collective skills intelligence and more joint training initiatives across several firms could be the creation of new regional and local skills networks. These networks would:

- identify current and future skills needs (skills intelligence activity), including new profiles and new standards; and
- act as *loci* to favour the matching between demand and supply of training.

This would address a coordination failure that is hampering the effective functioning of the current market-driven system in the provision of training.

Box 3.2. A regional network for governance of apprenticeships, Italy

Context

As in the UK, Italy has increasingly relied on apprenticeships to increase the skills of young and unemployed people, and it has come to represent one of the main pillars of the dual education system, in which, following the German model, education works hand-in-hand with on-the-job training. Since 2015, it has been the main path for young people to enter the labour market.

However, enrolment has been lower than the expectations and apprenticeships are still not perceived by students as an effective alternative to formal education. The national government and regional governments have therefore put in place a number of policies and grants to support apprenticeship. The programme described here is one of those policies. It aims at supporting a systemic approach that will address coordination failures that can occur when information is lacking and demand is sparse and fragmented. The approach is adopted at a regional level since training is a decentralised activity in which regional governments retain responsibility and because much of the demand and supply of labour is local.

Description of the approach

The programme involves the creation of a territorial network for apprenticeships at all three levels,[42] aiming in particular:

- to encourage Level 1 and Level 2 apprenticeships to improve skills and employability and reduce school drop out for people aged between 15 and 25;
- to encourage Level 3 apprenticeships to improve higher-level skills and employability for people aged between 18 and 29 by means of tertiary education.

The programme funds the creation of a temporary consortium in which there is at least one training provider (training school, technical school, university, research centre etc.). The objective is to create a network to start an “appropriate” number of apprenticeships by means of one or more of the following activities:

- research activity;
- initiatives to incite intermediate actors (e.g. professional associations) to promote apprenticeship within industry;
- activities to increase awareness and information diffusion about apprenticeship opportunities;

[42] Apprenticeship is organized into three levels and lasts normally between 6 months and 3 years. Level I and Level II allow the worker to gain technical qualification. Level III allows the worker to gain a tertiary-level education (both BA and MA level) as well as research doctorates.

- design of new apprenticeship training programmes at each of the three levels.

The network created by the consortium can include a range of actors: secondary and technical schools, universities and research centres, adult training facilities, technical and professionals poles, professional organisations, local municipalities, trade unions, chambers of commerce etc.

The funding consists of an initial lump sum of EUR 10 000 and an additional EUR 540 for each new apprenticeship contract activated.

Success factors and challenges

The programme is currently under way, and hence an ex-post evaluation of the impact is not available. However, it is clear that the small financial contribution has the potential to establish territorial networks and hence address fragmentation of demand, lack of awareness and lack of coordination.

Relevance for Cambridgeshire and Peterborough

This case provides insights for Cambridgeshire and Peterborough on how to address the fragmentation of the training system and increase the aggregation of demand across firms. In the case of Cambridgeshire and Peterborough, the regional colleges could play the role of network coordinator. The establishment of a network, with moderate financial support, can trigger cooperation, circulation of information, and ultimately encourage the establishment of a more integrated regional training system.

Box 3.3. Bosh Industry 4.0 Talent Programme, Lombardy, Italy

Description of the approach

This case concerns a co-designed higher apprenticeship programme in the Lombardy region aimed at creating a new occupational profile – Industrial IoT Specialist – which is an emerging area of demand in advanced manufacturing. The programme seeks to address problems of limited enrolment in higher-level apprenticeships, a separation between education and work in higher education apprenticeships, the need to develop new skills for Industry 4.0 (especially in big data, data analytics and data visualisation), and the need to co-ordinate and integrate industry demand for skills with the training supply over time.

Robert Bosch SpA (a large advanced manufacturing firm) was the programme designer and location for the on-the-job training, while Cefriel (a training provider) provided the off-the-job training. The Lombardy regional government and several regional social partners, such as the Regional Council for Education, Training and Work, the employers' associations and the local trade unions were also involved.

Participants in the programme were between 23 and 29 years old (the maximum apprenticeship age), with a European Qualifications Framework (EQF) Level 6 (required to access a level I University Master) or higher.

The off-the-job training is in the form of a Level I University Master Course, which corresponds to EQF level 7. It involves a course of 200 annual hours structured around eight main areas (General aspects of Industry 4.0; the Internet-of-things, Big Data; Advanced Simulation; Models; Smart and Cooperative Robotics; Technologies, Sensors and Additive Printing; Deepening Courses), aimed at providing basic skills (computational thinking, coding, modelling, algorithmic problem-solving, complex system identification), technical skills (specialist knowledge of business sectors, business models, mastery of specialised tools, scouting for best technologies) and soft skills (critical thinking, team work, interdisciplinary knowledge and

competences). The off-the-job training was funded by regional government resources. Cefriel received EUR 180 000, corresponding to a ceiling per trainee of EUR 10 000.

For the on-the-job activity, apprentices were placed in the various Robert Bosch plants in Italy.

At the end of the two-year apprenticeship students receive a certificate of Industrial IoT Specialist. This includes the technical and professional skills of the Data Scientist in areas such as Big Data, Cloud Computing, Machine Learning, Wearable Sensors and Collaborative Robotics.

Success factors and challenges

The success of the project depended on two main factors.

Firstly, the whole structure of the course (i.e. the contents, the curricula, the beneficiaries, etc.) was co-designed by Bosh and the training centre. This co-design acted as an effective means of coordinating training provider curricula and industry needs in a fast-changing environment. It allowed the articulation of the potential skills needs of Bosch and adaptation of course content by training providers provide employable courses. This in turn created a great appeal for students. Co-design also improved sustainability, in that the idea is to reshape every year or two the contents of the Master courses in order to keep the pace with the needs of today's business world.

The second source of success is the fact that Bosch is a large player internationally and nationally, with a well-established reputation. This increases the awareness and trust of students, who perceive the course as instrumental to get a job in one of the best companies in the area. To this extent, firm-oriented apprenticeship increases the perception of employability and thus the success of the initiatives.

Relevance for Cambridgeshire and Peterborough

This programme illustrates a way of increasing the number of higher-level apprenticeships in Cambridgeshire and Peterborough. It illustrates the importance of co-design of training between industry and training institutions and flexibility of apprenticeships in providing training for emerging Industry 4.0 competences.

Box 3.4. Higher apprenticeship programme for SMEs in the Turin Intelligent Factory Cluster, Piedmont, Italy

Description of the approach

This case concerns the joint planning of an apprenticeship course by firms and training providers in the Turin Intelligent Factory Cluster. This cluster is characterised by networks of companies linked by supply chain relations and/or partnerships in Research and Technology Development cooperation projects and revolves around large players mainly in the automotive, aerospace and mechatronics sectors. The aim was to carry out large-scale training and re-training in digital technologies affecting advanced manufacturing, particularly additive manufacturing, artificial intelligence, collaborative robotics and industrial automation.

The creation of the course was stimulated by the decision by the regional government (Piedmont Region) to link grants for industrial innovation and research (under the European Regional Development Fund) with initiatives to promote vocational education and training (under the European Social Fund) under its 2014-2020 Regional Operational Programme for the European Structural and Investment Funds.

The apprenticeship was co-designed by the university Politecnico of Turin (a training institution), Skillab (a training company), several SMEs in the cluster, and the Piedmont regional government. Skilllab had a key role to play as a training company specialised in support for mechanical and mechatronics companies with specific experience in vocational training that can combine technical-specialist skills, with 'horizontal' expertise (or soft skills), such as market analysis, communication and managerial and organisational skills.

The apprenticeship was established as a University Master course (EQF 8) at the Politecnico of Turin in additive and advanced manufacturing and industrial automation. The training course lasted 1 200 hours, spread over two years. This was distributed between 400 hours of off-the-job training (funded by Piedmont Region through the European Social Fund) and 800 hours of on-the-job training in SMEs. At the end of the course, the apprentices are awarded the certification of University Master (EQF Level 8).

Success factors and challenges

One of the challenges that this project responds to is that of developing appropriate specialised training in a fast-moving environment given rigidities in training curricula. Higher apprenticeship Master courses are characterised by broad autonomy in the design and implementation of training contents and activities.

Another challenge the project responds to is the presence of several obstacles in university-industry collaboration.[43] The co-design procedure between the business sector and the training providers helped overcome this problem.

Thus, the flexibility of the programme, coupled with co-design and university-industry collaboration, helped to shape training that was responsive to local company needs for cross-cutting skills with the aim of facilitating the integration of innovations in industrial automation, additive manufacturing, and the digitisation of new production processes.

A crucial challenge was also not only to develop technical skills but also soft skills. The presence of Skillab in the partnership was strategic in this aspect. The support with soft skills was especially important for SMEs, since the latter are typically less prepared for introducing radical innovations because they often imply the introduction of organisational innovations. The role of Skillab was vital in providing horizontal competences that facilitate organisational reshaping in SMEs introducing radical innovations.

A further challenge was to coordinate the different needs of the various SMEs participating in the programme. This problem was addressed in two ways. Firstly, by involving all of them during the design phase. Secondly, by the contribution of an intermediate actor, namely Skillab, which helped in identifying the training needs of each SME.

Relevance for Cambridge and Peterborough

[43] Crescenzi, R., Filippetti, A., Iammarino, S., 2017. Academic inventors: collaboration and proximity with industry. Journal of Technology Transfer, 42, 730–762.

Despite some recent improvements, on balance, apprenticeship provision in England is still very much weighted towards the intermediate level, or Level 2, with very few starts at higher level. In this, England is still lagging considerably behind the best systems in Europe – such as Germany, Switzerland and Austria – where nearly all apprenticeships are at advanced or higher level. Level 2 intermediate apprenticeships can play a role in supporting young people to develop their employability skills; however, there are concerns over the quality of many apprenticeships at this level and on the returns they provide to individuals and a generalised perception that "apprenticeship is not regarded as a meaningful alternative to university and the apprenticeship route will be regarded as a second-class option for non-academic students".[44]

This programme illustrates an approach to development of a university-industry partnership for a high-level apprenticeship, based on three pillars: (1) sharing responsibilities in a multi-level network; (2) flexibility and customisation in course design and implementation; (3) orientation towards radical innovation, such as additive manufacturing.

The programme also illustrates an approach to articulating the skill needs of different SMEs and coordinating their individual demand for training through co-design. The lack of a full understanding of SME skill needs is one of the weaknesses of the training system in Cambridgeshire and Peterborough, especially regarding apprenticeship. In Piedmont, the presence of an intermediate actor (Skillab) was important in supporting training needs assessment. In Cambridgeshire and Peterborough, the empowerment of pivotal actors, such as Skills Hub in the Peterborough area, can help to resolve this problem.

Finally, the case illustrates how a multi-level territorial network, including several stakeholders, from the regional government, to the industry association, local trade union etc., can improve collaboration between industry and the training system.

The fragmentation problem might seem to be less important in the Cambridge cluster, because of the presence of some well-established informal networks and the support of some strategic and consolidated actors in skills and training, such as Cambridge Network and Cambridge Ahead. However, even here several stakeholders are keen on the establishment of a co-ordinated mechanism dedicated to skills and training.

This activity should co-ordinate with the current activities of the SAP to identify skills demand. In particular, the Skills Strategy identifies the need for skills tailored to the industry needs of the three sub-regions, as based on the priority sectors identified in CPIER report (which includes: Health and Social Care, Agri-Tech and Food, IT and Digital, Life Sciences, Construction, Logistics and Distribution, Education and Professional Services, and Advanced Manufacturing) and evidence from the Hatch Regeneris Report[45] on the current and future skills needs of local and regional businesses. In addition, the regional pivotal actors should leverage and sustain an informal network to collect and exchange information about skills and training needs and convey this information to the SAP. It should also encourage co-design of training courses and provide continuous stimuli for further skills and training policies.

[44] CIPD. Assessing the early impact of the apprenticeship levy. Research Report, July 2018.

[45] Hatch Regeneris. Cambridgeshire and Peterborough Combined Authority Skills Strategy Evidence Base Report, (2018), available https://cambridgeshirepeterborough-ca.gov.uk/assets/Employment-and-Skills/Cambridgeshire-and-Peterborough-Combined-Authority-FINAL-DEC-2018-Appendix-A.pdf.

The international case studies in Boxes 3.2-3.4 discuss how different types of actors in a region, such as major training centres or hubs, can work as facilitators in the identification of skills needs and in matching training demand and supply.

In the case of Cambridgeshire and Peterborough, a good practice in this regard is iMET, an advanced technical training centre based in Alconbury Weald Enterprise Campus developed to deliver higher-level training for the manufacturing, built environment and science and technology sectors. It started its activities in 2018, funded by the CPCA through the Local Growth Fund. It has the facilities to provide an environment for teaching both theoretical and practical skills and bringing businesses together from a range of different sectors. However, its activity has recently stopped due to a withdrawal of funding from the Cambridge Regional College, probably due to a lack of demand for its services. In a fast-change environment, in which technological change requires updated and new skills, the flexibility provided by actors such as iMet in providing training represents a significant added value compared to formal education. Hence, it is advisable to start planning a re-start of this actor in the post-COVID-19 environment, possibly strengthening its marketing, business brokerage and fund-raising capacities to ensure success.

Development of regional skills networks is currently the major opportunity for strengthening skills policy in Cambridgeshire and Peterborough. There is a plethora of different actors, such as the CPCA, Cambridge Ahead, and the Regional Colleges that act in isolation, or within informal networks. The international experiences reported here, and other experiences in countries that are traditionally strong in vocational training, such as Germany, involve several regional actors, such as regional governments, local trade unions, local industry associations, and regional hubs, with a specific mandate and dedicated resources to coordinate skills policies and training activities in the region and reduce the regional skills mismatch by linking labour supply and demand in co-designed apprenticeship programmes. Industry 4.0 in Italy and Germany is a case in point – the involvement of regional trade unions and employers' associations has played a key role from the initial identification of the skills needs to the training provision, in contrast to the British case where this is mostly left to the 'market'.

Increase flexibility in apprenticeship standards

One of the difficulties that SMEs face in making use of the Apprenticeship Levy is that of fitting their needs into the required occupational standards. This is related to a rigidity in the standards, as stressed by several stakeholders. The problem is twofold. It is not always easy to fit a skills need within one standard. In addition, firms, especially SMEs, frequently need training included in different standards. For example, in manufacturing, workers need training in various different engineering and digital fields. Firms also often want a mix of both technical skills (e.g. mechanical engineering) and soft skills (e.g. creativity, team working, etc.).

The fast pace of technological change will continuously challenge the definition of the existing standards and this is one of the reasons for the significant amount of unspent Levy budgets. More flexibility of training and increasingly mixed skills are required, and this is not coherent with the current functioning of the system.

Support internships

While the Apprenticeship Levy has encouraged firms, especially SMEs, to consider training where they may not otherwise have done so, to some extent the growth of apprenticeships may be coming at the expense of other training approaches. According to the business and adult education sectors, internships can be more flexible, work-oriented, and shorter than apprenticeships and may therefore be particularly suitable to filling specific skills gaps, especially for SMEs. The use of internships through the Apprenticeship Levy is limited by its requirement that 20% of the training must be undertaken off the job.

This is a significant constraint for SMEs, although large firms in the area are not strongly affected by this in their ability to use the Levy.

Conclusions and policy recommendations

Skills and training systems need to be increasingly locally adapted and inclusive of industry and education stakeholders in identifying emerging skill needs in their sectors and delivering appropriate training. The recent process of devolving increased skills and training responsibilities to the local area in Cambridgeshire and Peterborough is introducing some elements of flexibility. However, there is further to go.

Skills policy and training activities in the region still lack a unitary framework to carry out skills intelligence, aggregate fragmented demand for skills and provide incentives for training. There are some important local initiatives, such as the STA Hub, that can take an overarching role and help resolve the fragmentation issue, but they are still in their initial stages and it is unlikely that they will have the power to tackle the fragmentation problem fully. The Apprenticeship Levy can also increase the supply of industry-relevant skills, but it also lacks a system-level analysis of the future skill needs and a co-ordinated network of training and industry actors.

Rather, the major bottlenecks identified in the provision of training and skills in the area are:

- fragmentation of the training system and skills intelligence;
- lack of awareness and trust about the returns in investment in education and training among low-education background families;
- lack of flexibility in the apprenticeship system nationally;
- lack of SME involvement in the Apprenticeship Levy.

While it is too early to assess the impact of COVID-19 on training and skills, there is little doubt that the labour market will be profoundly affected by the current crisis. Unemployment may rise in an uneven way within the economy, and a close monitoring of the labour market impacts will be required, including a sectoral/industry approach to identify those sectors, places and population groups that will require a stronger push in re-training. In addition, an interruption of the international mobility of the labour force is expected to exacerbate the tightness of the labour market in Cambridge, particularly that related to the high-skills labour force.

Some policy recommendations are proposed below.

Box 3.5. Recommendations on skills development

Address fragmentation of the training system and skills intelligence

1. Fund one or more pivotal regional actors to create and sustain a network among training providers (including sub-networks by industry/area). The network should organise skills intelligence, co-design new curricula and standards, co-design training courses, and carry out campaigns to improve awareness of training and skills needs for SMEs. This should be carried out in collaboration with the local Employment and Skills Board (i.e. the Skills Advisory Panel) and include regional industry associations and regional trade unions.
2. Create sub-networks of the regional network, articulated by industry/area.
3. Introduce a funding pilot to create training networks in specific regional strategic sectors, e.g. life sciences or agri-tech.

Increase awareness and trust in the returns to investment in education and training

4. Start a national information campaign to increase awareness of the returns to education, including technical education and vocational education, for youth, adults and drop-out students. This should start at a sufficiently early stage of education.
5. Experiment with different forms of local "nudging" policy through a properly-designed local experiment. This should seek to identify effective tools to increase education and training participation by disadvantaged persons in the labour market – e.g. dropout students, low-education background families, and adults with low/obsolescent skills.

Increase flexibility in the apprenticeship system nationally

6. Simplify the mechanism for standard creation through bottom-up approaches.
7. Allow the mixing of different standards – i.e. cross-standard curricula. This could be realised through a voucher or portfolio approach that gives students a total number of hours to be used across different standards, and/or a modularisation of the standards, i.e. dividing each standard into sub-modules that can be included within a single programme;
8. Introduce some additional flexibility for SMEs with potential to use the system in terms of amount of time to be spent in formal training outside the company and duration of the programme, particularly in terms of allowing shorter programmes.

Address weaknesses in the Apprenticeship Levy

9. Devote earmarked funding to sustain the co-design of high level apprenticeship programmes involving universities and large firms.
10. Promote specific programmes to involve SMEs belonging to the same strategic sector to co-design apprenticeship courses with universities and regional colleges.
11. Introduce the opportunity to devote underspent Levy funding to other forms of training or tools, e.g. internships.

4 Knowledge exchange and industry path development

Introduction

Knowledge exchange and industry path development are key drivers of entrepreneurship, innovation and economic development in advanced economies, with processes playing out largely at regional level. Knowledge exchange – among universities, research organisations and firms – is the basis for learning and innovation, underpinning high value-added growth, but it requires both knowledge networks and firms with the capacity to absorb knowledge and translate it into new products and processes.

New industry path development is how regional economies respond to structural economic changes resulting from factors such as globalisation and technological change. It too is critical to higher value-added growth. The new industry path opportunities depend on regional preconditions in terms of existing industry mixes; knowledge, competence and resource bases; local and global networks; and institutional configurations (including for instance the entrepreneurial culture).

Cambridgeshire and Peterborough has an extremely dense and well-functioning regional innovation system for knowledge exchange and industrial path development offering a number of industry path development opportunities. In this chapter the opportunities will be explored together with the policies that will favour them. A key distinction needs to be made among the four strategic sectors of the region between:

- the science-based sectors – life sciences, ICT, and agri-tech – which are concentrated in the Cambridge cluster, and
- the engineering-based advanced manufacturing and materials sector – which is spread out more evenly across the region, with a centre in Peterborough.

These are discussed in turn below. It should be noted that the focus of the section is on locally-differentiated policy tools that can be applied in combination with other national policy tools to support knowledge exchange and industry path development, such as R&D tax credits.

The science-based sectors – life sciences, ICT and agri-tech

There are radical development opportunities for the region in new industry creation and unrelated diversification

The Cambridge cluster is a global centre for knowledge-intensive economic activities in general. Within this, it has unique concentrations in two of the strategic sectors identified in the region's Local Industrial Strategy and Science and Innovation Audit – life-sciences, and digital and information technologies (ICT).

Furthermore, the region has key agri-tech research strengths for the development of enabling technologies for agriculture and horticulture (agri-tech).

The life sciences, ICT and agri-tech sectors typically apply formal innovation processes and R&D, even using scientific approaches for generating new knowledge and innovations. Accordingly, such firms recruit staff with academic or scientific qualifications, often hired from universities. Codified knowledge plays an important role in their R&D inputs and outputs (e.g. patents). Firms based on analytical knowledge tend to generate more radical technological product and process innovations. The innovation processes involved are significantly different to those used in advanced manufacturing and materials.

Knowledge exchange and new industry path development in life sciences, ICT and agri-tech are underpinned by a very high quality entrepreneurship ecosystem and innovation system in the Cambridge cluster:

- **Actors:** The Cambridge cluster is home to world-leading organisations. The University of Cambridge with its 800 year old history and track record of producing over 100 Nobel Price laureates is one of the best universities in the world. The region's two universities both consider it a priority to promote knowledge exchange with business, including within the region. Global business leaders such as AstraZeneca in the life-sciences and Aveva and ARM in information technologies are strong anchor firms. Research institutes such as Genome Research ltd., more than a dozen science parks and incubators, and venture capital firms such as Cambridge Capital complement the system for innovation and entrepreneurship. Firms also contribute with their own R&D investments, which equips these firms with the necessary absorptive capacity to identify and use new science-based knowledge as well as network with research organisations.
- **Networks:** One of the outstanding features of the Cambridge ecosystem is tight networks crossing academia, research, and business as well as different sectors. Cambridge is a hub in global innovation networks in life-sciences and ICT. Key network organisations are Cambridge Network and Cambridge Ahead, which – together with some 60 other network organisations – provide the fabric through which information, knowledge, and resources flow and are allocated. The most outstanding attribute, however, is not the number of formal networks, but the informal, social people-to-people networks, which have grown in a bottom-up manner (i.e. not stimulated through government intervention) over decades.
- **Institutions:** Entrepreneurship blossoms in Cambridge, as evidenced by a relatively high number of technology start-ups compared to other regions in the UK. While this can be partly attributed to more technological opportunities for university and corporate spin-offs, as well as strong support structures, local stakeholders suggests that a culture of entrepreneurship is an important additional explanatory factor. As regards governance processes, the Cambridge ecosystem has largely evolved in a bottom-up manner, i.e. through the actions and interactions of people over time. Local government plays an important role in providing for infrastructure, utilities, housing, and social services. However, it has played a limited role in the support system for innovation and entrepreneurship in the cluster and has a very limited policy repertoire if it would want to play such a role.

This environment underpins strong opportunities for policy to support the most radical forms of new industrial path development in the science-based sectors of the cluster, i.e. new industry creation and unrelated diversification, based on technological advances made in the three sectors.[46]

Only a few places have the potential to give birth to new industries. Cambridge is one of them. A range of new industries may emerge from the technological advances made in life sciences, ICT, and agri-tech in the cluster. The life sciences sector, for instance, could spur a new industry in regenerative medicine. The importance of a strong and differentiated regional innovation system for the creation of a new industry is exemplified by the case of Tampere in Finland. World-leading research in regenerative medicine has been conducted in Tampere and efforts were made to create a new industry. However, the struggles of Tampere to create a new industry were related to a lack of entrepreneurial capital, finances, knowledge about business models, firms that could take this technology to markets, etc. (Sotarauta and Mustikkamaki, 2015). The more complete innovation system and entrepreneurship ecosystem in Cambridge could provide better preconditions for the formation of such a new industry.

The Cambridge cluster also offers the preconditions for unrelated diversification – i.e. innovation based on combining existing unrelated knowledge and creating new-to-the-world products. This could involve innovation that stems, for example, from the combination of analytical science-based knowledge with synthetic knowledge (new combinations of existing knowledge) in more traditional sectors, for example in new technologies for agriculture and food production.[47] This is most applicable in the strategic sector of agri-tech (new technologies for agriculture and food production).

Facilitation of linkages across sectors and actors

New industry creation and unrelated diversification typically require knowledge transfer and resources from a variety of sectors and industries that are not necessarily connected. Hence, it is recommended to facilitate linkages between sectors and between actors at both the local and national scale. A joint effort between national government and CPCA is required. This is because non-local actors will need to be involved, the resources required to generate new markets are greater than those available to local players alone, and the social benefits will arise nationally as well as locally.

This suggests that CPCA with national government should mediate the development of joint visions across sectors and spatial scales for the long-term development of technology, industry, and society. This could be achieved through the establishment of long-term projects or platforms that aim at bringing together actors from the business community, research, local and national administration and policy makers, and civil society. In particular, cross-sector linkages will contribute to increasing the commercialisation of research output relevant to/or originating from life sciences, ICT, and agri-tech across industries, sectors, and scientific disciplines. It can be encouraged by support for the activities of the local networks and cluster organisations in these sectors as well as networks that cross the boundaries of industries, sectors, and scientific disciplines. Box 4.1 offers the example of such a policy approach being pursued in Sweden. A

[46] These development pathways are taken from the conceptual framework for the OECD local entrepreneurship ecosystem and emerging industries project, which distinguishes three broad types of regional development path – Upgrading, Diversification, Emergence – and seven sub-categories – Upgrading I. Climbing Global Production Networks, II. Renewal, III. Niche Development; Diversification I. Related, II. Unrelated; Emergence I. Importation, II. New Creation.

[47] Typical cases of unrelated diversification discussed in the literature are the integration of biotechnology in the food industry to produce functional foods or the use of nanotechnology in the textile industry to produce functional fibers (Grillitsch et al., 2018).

joint venture organisation can also be instrumental in facilitating these cross-industry initiatives, such as discussed in chapter 2 with respect to the local entrepreneurship ecosystem.

At the same time, CPCA and national government should support training and cross-sector research projects in general purpose technologies such as ICT and nanotechnology, given their importance for life sciences and agri-tech (and advanced manufacturing). This should include support for outreach activities of universities, technology mediation, and funding facilities for pilot collaborative projects between research and industry.

Box 4.1. Strategic Innovation Programmes, Sweden

Description of the approach

Strategic Innovation Programmes (SIP) is part of a wider initiative called the Strategic Innovation Areas, a policy initiative which explicitly targets system innovation. It was launched by the Swedish Government in 2012 and is delivered by Sweden's Innovation Agency (Vinnova), Energy Agency (Energimyndigheten) and Research Council for Environment, Agricultural Sciences and Spatial Planning (Formas). The initiative has a two-fold objective: (1) to improve international competitiveness and (2) to address global societal challenges. It consists of two sets of interrelated activities: the Strategic Innovation Agendas and the Strategic Innovation Programmes (SIP).

The Strategic Innovation Agendas provide seed funding to stimulate formulation of agendas and alignment of expectations on how to address certain global societal challenges with potential to generate industrial and technological renewal. Funding is distributed in small amounts to initiatives shaped and implemented by actors from academia, business and society, much in line with the triple helix strategy already established in Vinnova's historical policy portfolio. In total 136 agendas have been financed, which suggests a rather explorative and experimental approach.

The second set of activities was named Strategic Innovation Programmes (SIP). Drawing on the inputs and insights generated through the Strategic Innovation Agendas, Vinnova opened a call for large-scale strategic investment into some of the agendas with the highest potential, based on the roadmaps formulated in the agendas and the constellations of actors composing them. The SIP programme is therefore organised with a profound bottom-up ambition in which design as well as implementation is decentralised to the participants of respective consortia with as little involvement of the innovation agency as possible. The actors involved have significant opportunity and autonomy to decide on strategic as well as operational activities.

In total 17 SIPs were set up in 2016-2017, dominated by four research areas (all primarily related to technology/engineering, reflecting Swedish strength areas). The Swedish Government allocated approximately EUR 64 million in 2017. To this should be added at least the same amount in matching funds by participating actors (from both the private and public sector). Combined with the related initiative "Challenge Driven Innovation" (UDI), the SIP initiative represented 30% of Vinnova's total innovation support, and is thus a significant part of the public sector's investment in the Swedish innovation system. As a result of this programme, the overall government funding going to strategic innovation has increased substantially.

At an operational level, the SIP initiative is focused on different types of measures, such as financial support to research, development and innovation projects and demonstration sites. Other activities are facilitation of knowledge creation and diffusion through conferences, business advice and incubation activities, and commissioning of various outlook and evaluation reports. The most common way of organising the financial support for research, development and innovation projects and demonstration sites is through open calls for proposals, which are assessed by panels of expert reviewers. Some programmes also work with more targeted projects defined and assessed by the programme committees. Examples of the latter are market analyses and capacity building projects.

Success factors

The overall aim of the SIPs is to stimulate innovation processes that lead to a system change, i.e. to radical forms of new path development for enhanced competitiveness and directed towards solving

societal challenges. The underlying rationale for these programmes is that multiple actor groups need to be involved and engaged because of the society-wide implications of system change. This goes beyond the implementation of a technological solution and may require fundamental changes in rules and regulations, building legitimacy, changing behaviour etc. Some of the success factors of the SIPs in this respect are:

- Aligning initiatives and innovations across different actor groups towards solving challenges that are important for society while being open enough to allow for experimental processes.
- Developing new capabilities among actors to work with complex, open-ended projects.
- Developing networks across sectoral and industrial boundaries.
- Dealing with conflicts of interests across different actor groups.
- Facilitating institutional change and institutional entrepreneurship.
- Supporting experimentation, testing, and demonstrating, as well as exposing experiments to selection pressures for further funding.
- Promoting social acceptance to emerging solutions.

Obstacles encountered and responses

Grillitsch et al. (2019a) analysed two SIPs and found the following challenges and responses taken to address the challenges:

- Directionality:
  - Direction needs to be provided in an actionable manner across a large number of actors, while being open enough to allow for learning and experimentation.
  - A large number of actors need to be involved. A system of match-making was put in place and Innovation Agendas were combined to create more ambitious and inclusive SIPs
  - Due to the large number of actors, there are conflicting interests. These were not directly addressed in the SIPs but the formulation of objectives was broad to avoid conflict. On the other hand, the broad objectives did not stimulate institutional change, which was a weakness of the observed programmes.
- Experimentation:
  - Few actors engaged in experimentation. Project managers tried to influence this by providing feedback in a step-by-step application process and proposing to include additional actors or combining projects to facilitate experimentation.
- Demand articulation:
  - Awareness and capabilities about innovation procurement were low. Projects were therefore initiated to generate experience in the public sector with innovation procurement.
  - Insufficient user-producer interactions: As response to this issue, the involvement of actors along the value chain was promoted.
- Policy learning and coordination:
  - The variety of actors involved substantially decreased from the time of establishment of the SIPs to the implementation of concrete projects. SIPs were increasingly led by academia. As a response, surveys with the business sector were conducted to identify projects. Initiatives were also set up to provide better dialogue between the programme implementers, programme management, and actors involved.

Relevance for Cambridgeshire and Peterborough

This programme illustrates a means of supporting new industrial path creation in life science, agri-tech, and ICT in Cambridgeshire and Peterborough. While the Cambridge cluster is outstanding in research and knowledge-intensive businesses, the wider involvement of society and government in transformation processes is more limited. What CPCA can take from the SIPs is the approach of connecting society and local, regional, and national government with HEIs, research organisations, and firms through actively facilitating mission-oriented networks and engaging in long-term visioning exercises. On the other hand, the scale of financial support required for strategic innovation projects is substantial and requires partnership between CPCA and national government.

Sources of further information

https://www.vinnova.se/en/m/strategic-innovation-programmes/

Coenen L., Grillitsch M., Hansen T., Miörner J., Moodysson J. (2017) Policy for system innovation - the case of Strategic Innovation Programs in Sweden, Papers in Innovation Studies, No. 2017/4, CIRCLE, Lund University

It should be recognised that the major opportunities for participation in new industry creation and unrelated diversification are likely to occur in the Cambridge area, and that there are strong barriers to the spread of these highly knowledge-intensive activities to other locations of the CPCA area because they depend on the close connections between universities, research organisations, and firms, and the fully-fledged support system for innovation and entrepreneurship provided in the Cambridge cluster. This Cambridge support system should be maintained and strengthened with continued investments in research and education together with improvements in physical infrastructure to reduce congestion.

However, this does not mean that particular firms located in other parts of the CPCA territory are precluded from taking part in highly knowledge intensive activities, as networks can be built with the core (Grillitsch and Nilsson, 2015). A study in Germany found for instance that approximately 30% of the German World Market Leaders are located in small towns, of which 65% are in a peripheral location (Vonnahme et al., 2018).

This suggests that measures should be taken to integrate lead firms with (potential for) knowledge-intensive activities that are located in Peterborough and The Fens with the heart of the Cambridge cluster. This could be achieved by working with liaison points that identify such firms and connect them to networks. This could be done in cooperation with the established networks and cluster organisations in the cluster, but partly also using the business advisors of the Growth Hub.

The engineering-based sectors – advanced manufacturing and materials

There are opportunities in industry upgrading and related diversification

Advanced manufacturing and materials is a key sector for Cambridgeshire and Peterborough. In particular, Peterborough has a particular tradition and concentration in engineering-based manufacturing. However, the sector is spread throughout the region. For example, in the Greater Cambridge Area advanced manufacturing and materials provides approximately the same number of jobs as life sciences.

Overall, the sophistication of the innovation system in the sector in Peterborough is at only a medium level, due to the following:

- **Actors:** There are a number of vocational skills development actors in Peterborough, including such as Peterborough Regional College, Peterborough City College and the Guild House Campus of Anglia Ruskin University in Peterborough. However, overall HEIs are weakly represented in Peterborough. Peterborough hosts approximately 300 advanced manufacturing and materials companies including some leading players such as Caterpillar Perkins, Dresser-Rand and Redring Xpelair. Leading advanced manufacturing and materials firms can also be found in the Greater Cambridge Area (e.g. Marshall of Cambridge) and the Fens (e.g. Stainless Metalcraft). Despite such lead firms, other actors are weak in terms of using cutting-edge knowledge, resource endowments and financial capabilities as compared to highly innovative regions.
- **Networks:** Several recent initiatives such as Opportunity Peterborough and the Manufacturing Club in St. Neots aim at improving regional networks. In addition, some equipment manufacturers like Baker Perkins produce machinery for the food sector, pointing to cross-sector value chain linkages. Firms in the sector are also seeking connections to research and training organisations in other national manufacturing centres, such as the UK Advanced Manufacturing Catapult Centre facility in Coventry. However, overall the networks between business and universities/research organisations are limited. Partly, this has to do with the weak presence of universities in the region (Anglia Ruskin University being the most prominent). Partly, however, the business sector has not seen much value in linking up to universities. Firms in the sector are also less connected globally as compared to the firms in life sciences, ICT, and agri-tech.
- **Institutions:** One focus in the policy of Opportunity Peterborough and preceding development agencies has been to attract firms to the region, whereas less emphasis was placed on supporting existing firms to grow. CPCA aims to change this by providing growth mentoring to existing firms in the future. Many stakeholders report that the aspiration level in Peterborough is rather low, contributing for instance to low educational attainment. There is also a certain lack of regional identity in Peterborough, which could be attributed partly to a (perceived) devalorisation of the industrial heritage and to large population growth. As regards governance processes, collaboration between the local authority in Peterborough and business, universities, and civil society is important for discovering development potential and setting priorities. However, such cross-sector linkages are still limited.

Given these innovation system conditions, new industry creation and unrelated diversification is less likely than in the region's science-based sectors. Instead, the focus should be on industry upgrading and promoting related diversification.

- **Upgrading**: Industry upgrading involves renewing industries by adopting new technologies (e.g. in digitalisation and automatisation), which will allow firms to engage in innovation-driven competition, achieve higher-value added growth, and occupy stronger positions in global production networks. It requires a broad enhancement of all elements in the support system for innovation and entrepreneurship, i.e. addressing all the weak spots identified in the assessment of actors, networks and institutions above.
- **Related diversification:** This refers to a diversification into a new industry based on an edge in an existing industry. It requires a higher level of capabilities than upgrading and therefore targets mainly the leading firms in the sector. An example in the CPCA area is provided by the firm Metalcraft, which used its competences from producing containment vessels in the medical industry for MRI scanners to branch out to the nuclear industry, offering waste containers for decommissioning. A growth opportunity for advanced manufacturing and materials firms with a

strong competence in one market niche is to branch out into other niches where these competences can be of high value.

When considering policy priorities for promoting upgrading and related diversification in the sector, it is very important to recognise that most of the firms in the advanced manufacturing and materials sector use a different type of knowledge base to firms in the science-based sectors (Asheim and Gertler, 2005; Asheim et al, 2016). Whereas firms in the science sectors tend to use an analytical knowledge base for radical innovation exploiting science and R&D, firms in advanced manufacturing and materials tend to use a synthetic knowledge base for incremental innovation, whereby they combine pre-existing knowledge in new ways. Typically, the synthetic knowledge based innovations are stimulated by interactions with clients or suppliers, or service firms. Tacit knowledge, often exchanged through face-to-face contacts, plays a key role in such contexts. Sectors dominated by synthetic knowledge include machinery, engineering and automotives.

The synthetic knowledge base is most widespread but tends to offer less of a competitive edge than the analytical knowledge base used by the science-based sectors, or combinations of those (Halkier et al., 2010; Blazek and Kadlec, 2019). The innovations are often of incremental nature, fixing practical problems of clients, but this limits the opportunities to move into higher value-added economic activities. Recent research has shown that a combination of a synthetic and an analytical knowledge base is the most conducive for innovation and firm growth in synthetic knowledge based industries (Stramback and Klement, 2012; Todtling and Grillitsch, 2015; Grillitsch et al., 2017; Blazek and Kadlec, 2019; Grillitsch et al, 2019b). Therefore, a move to higher value-added activities in advanced manufacturing and materials requires not only upgrading of the existing knowledge base but also creating the conditions for integrating and exchanging analytical knowledge.

A strategy of seeking to employ analytical knowledge for related diversification in advanced manufacturing and materials in Cambridgeshire and Peterborough needs to overcome four key obstacles in the innovation system – namely:

1. a lack of “absorptive capacity” of many local SMEs to integrate analytical knowledge;
2. a lack of applied R&D in HEIs facing towards these firms. These are also issues, to a lesser degree, in the case of achieving industry upgrading;
3. low ambition of SMEs to engage in innovation-based competition;
4. limited networking involving local SMEs.

These obstacles are all also relevant to promoting industry upgrading in this strategic sector.

Building absorptive capacity

Absorptive capacity is critical to enable firms to identify and make use of relevant knowledge (Cohen and Levinthal, 1990; Zahra and George, 2002). This is particularly an issue in relation to accessing and integrating analytical knowledge provided by HEIs. Such knowledge will help firms to make use of new developments in areas such as automatisation, ICT, and material sciences (e.g. related to metal surfaces or packaging of food). However, SMEs in advanced manufacturing and materials in Cambridgeshire and Peterborough tend to have a low share of workers with academic or scientific training, invest little in R&D, participate infrequently in research collaborations and lack pro-innovation management practices. As a result, the firms tend to lack awareness about the opportunities generated by scientific advances and, even where they are aware, tend to lack the capacity to make use of new scientific knowledge in their innovation processes. While there are some large anchor organisations in the region that are very resourceful in building up absorptive capacity for analytical knowledge provided by HEIs and research organisations,

such as Caterpillar Perkins, Dresser-Rand, Marshall of Cambridge, Redring Xpelair, or Stainless Metalcraft, this is not typical for SMEs in the sector.

An approach to building absorptive capacity, and encouraging the combination of engineering competences with analytical, science-based knowledge is to invest in the skills of the owners, managers, and employees. This includes enhancing the share of workers with academic training, for instance through recruitment from universities. It also includes reinforcing measures for SME workforce training, consultancy and mentoring for SME management in pro-innovation practices, encouraging SME participation in innovation projects with HEIs, and support for hosting/supporting master and PhD theses and industrial PhDs.

An interesting example is a training and social networking programme recently organised by the regional cluster organisation in the peripheral region of Mo i Rana in Norway, which is dominated by mining and metal processing. The programme targets Bachelor and Master students employed by one of the leading companies in the region. It has succeeded in attracting a university-trained workforce to the periphery and in increasing the capabilities of manufacturing firms to engage in research-driven innovation. The relevance of this example relates to the fact that engineering jobs in the advanced manufacturing and materials sector, many of which located outside the economic heart of the CPCA territory, may not be the first choice for university-trained workers. A further example is given in Box 4.2, which illustrates how the Norwegian Research Council stimulates applied R&D collaborations between HEIs and SMEs with the aim of increasing the knowledge absorption capacities of SMEs.

Box 4.2. Programme for User-driven Research-based Innovation, Research Council of Norway, Norway

Description of the approach

The Research Council of Norway supports company-driven projects that incorporate extensive R&D activities. One of the largest programmes is the Programme for User-driven Research-based Innovation (BIA). The programme aims to enhance both the breadth and the quality of the research conducted in the industrial sector, hence promoting innovation and value creation in a competitive framework that is increasingly being shaped by international markets and global societal challenges. It is a complement to industry-oriented thematic programmes and other instruments for industry-oriented research.

The programme's most important activity is funding for research-based innovation projects in industry. It holds open competitions for grants for Innovation Projects for the Industrial Sector, where the key criteria for awarding funding are research content, level of innovation, potential for value creation, and relevance and benefit to society. This is the Research Council of Norway's primary instrument for providing funding to all segments of Norwegian trade and industry seeking to use R&D to become more innovative, competitive and internationally oriented.

The programme seeks to award funding to ambitious projects in which project participants demonstrate a major commitment to achieving good results. It actively promotes collaboration between companies and research groups and among companies, both nationally and internationally.

It often supports creative and experimental work methods and emphasises the need to disseminate research findings and boost understanding of the importance of industry-oriented research.

Operational objectives are to promote:

- new or greatly improved processes, products, services and business models;
- more green innovation for sustainable restructuring of industry;
- greater cooperation on innovation between companies and R&D institutions and among companies;
- new international partnerships;
- new participants and enhanced collaborations in R&D projects;
- increased awareness among companies and investors about R&D as a competitive advantage;
- use of private capital to generate innovation in companies;
- development of innovation-oriented R&D expertise in Norwegian trade and industry;
- development of industry-relevant expertise in Norwegian R&D institutions

Success factors

To succeed, the BIA programme must provide attractive and stable funding to Norwegian trade and industry. It therefore issues annual calls for proposals within a budget framework that is large enough to encourage companies to seek funding. In order to achieve the greatest impact on industrial innovation, the programme seeks to steer its funding towards:

- funding projects that require expertise and resources beyond those possessed by the companies on their own;

- projects that entail a higher level of risk than the companies may be expected to take on alone;
- ensuring that funding criteria and application requirements enable companies to focus on their own strategies and priorities;
- employing a selection process in which the best quality projects are selected, independent of thematic area or branch of industry;
- ensuring that the projects awarded funding continue to maintain a focus on value creation.

Obstacles encountered and responses

One of the challenges is to stimulate R&D-driven innovation in industries and firms that have not tended to use R&D. Such firms have limited knowledge of working with research-based projects and limited absorptive capacity to identify, generate and use research-based knowledge. The following steps have been taken to counter this problem:

- providing advice on project concepts and project outlines to help to improve project proposals;
- arranging contract negotiation and start-up meetings to help to reinforce the strategic basis for the R&D projects within the companies and to facilitate effective cooperation between project participants;
- closely following up projects via status meetings in order to contribute to effective project implementation and maintain focus on innovation potential and realisation of value creation, thereby ensuring that these remain the basis for prioritising R&D activities;
- funding networking measures to create meeting places for projects and project participants to exchange experience and disseminate research results and best practice, thereby laying the foundation for new initiatives and collaborative relationships.

Relevance for Cambridgeshire and Peterborough

Advanced manufacturing and materials firms in Cambridgeshire and Peterborough need to increase their knowledge absorption capacities in order to participate in knowledge exchanges. They also need to shift towards more research-driven innovation offering greater impacts on competitiveness and markets by complementing their existing synthetic and engineering-based knowledge with analytical, science-based knowledge. This programme uses competitive research grants to industry to this end. Funding for similar calls fostering research-driven innovation in the advanced manufacturing and materials sector in Cambridgeshire and Peterborough is one way to promote higher value-added growth.

Sources of further information

www.forskningsradet.no

Strengthening access to applied R&D

The second major obstacle to related diversification and industry upgrading in the advanced manufacturing and materials sector is that the principal focus of most of the academic research in the region is on producing knowledge at the research frontier. There is less orientation towards applied R&D, but it is applied R&D that is of more direct relevance for advanced manufacturing or materials firms.

Moreover, most of the HEI institutes and research organisations are located in Cambridge and not well accessible for firms in other parts of the CPCA area (notwithstanding the ARU facility in Peterborough).

Commonly the research contacts of the HEIs and research organisations are either very local with highly research-intensive firms (e.g. AstraZeneca) in Cambridge itself, or global with other leading research centres in the respective academic fields.

Indeed, there are a number of mismatches between local research and the needs of advanced manufacturing firms:

- In the nature of the research – between production of basic research and use of applied R&D.
- In time horizons – with local firms having a much shorter time horizon for their innovation activities than institutes working on basic research.
- In space – with most of the research facilities in Cambridge rather than other parts of the region.
- In mindsets – several local advanced manufacturing SME stakeholders report that do not find it relevant to contact HEI institutes and research organisations in Cambridge, and find that they speak a different language (not surprisingly as the knowledge base is different).

Firms need counterparts in the university/research sector that have an interest and are working on applied research and development.

To address this issue it would be productive to establish a stronger HEI presence in Peterborough with a focus on applied R&D of particular relevance for the advanced manufacturing and materials sector, and to create links to advanced manufacturing and materials firms in the region with training and R&D projects relevant to these firms. This action could include sponsoring academic positions with time earmarked for applied research and industry collaboration, and collaboration with industry for master and PhD theses. It could be achieved by extending the branch of ARU in Peterborough with the explicit goal to enhance university-industry interaction in advanced manufacturing. iMET could also make and levy brokerage can also make valuable contributions.

The HEI operating in Peterborough would need to have a regional vision aimed at responding to local industry needs for applied R&D and align time horizons, projects and performance measures of academic staff to the goal of regional outreach and collaboration. One example of this approach is the regional collaboration of Karlstad University in Sweden, where sponsored professorships in areas of particular relevance for local industry had the clear objective of enhancing university-firm collaboration, stimulating research-driven innovation in industry, and thereby promote high-value added growth.

Involving SMEs in innovation networks

In order to enhance SME involvement in innovation networks, a mix of interventions is recommended:

- **Strengthen the network** among firms in advanced manufacturing and materials by providing operational support to a cluster organisation for the sector that covers the whole region.
- **Identify relevant sources of knowledge in complementary** fields (e.g. digital and information technologies, automatisation, marketing, nanotechnologies, etc.) and provide platforms for firms to meet respective research and knowledge providers. This includes creating focal points for the region's firms in local HEIs to propose relevant applied research projects.
- **Organise stronger inputs by local SMEs** in advanced manufacturing and materials to the setting of skills agendas by local colleges of further education.

A strong support system for the advanced manufacturing and materials sector needs to be developed as a regional initiative covering the whole of the CPCA area, given that advanced manufacturing firms are found in each sub-region – Cambridge, Peterborough, and The Fens. There are currently some initiatives to improve networking within the sector in specific geographical areas, for example the network of Opportunity Peterborough and the Manufacturing Club in St. Neots. However, to enhance innovation

capacity in the sector it will be paramount to stimulate the inflow of new knowledge and this is at risk if networks are closed. While the existing networks do make efforts to reach out to manufacturing centres elsewhere, for instance to the Manufacturing Technology Centre in Coventry, there is a danger that focusing on networks that are too local will reinforce regional barriers, in particular, between Peterborough, The Fens and the Cambridge area. In particular it is important to support networking between firms in Peterborough and The Fens with advanced manufacturers in Cambridge, which may already engage in university collaborations. It is therefore recommended that policy should seek to develop a support system for advanced manufacturing and materials that is open and promotes inclusion of all advanced manufacturing and materials firms in the CPCA area. CPCA can play an important role in initiating and supporting such a system.

Furthermore, a focus on related diversification suggests the need for openness to other sectors. This is important, on the one hand, for using capabilities in the advanced manufacturing and materials sector to generate growth in other sectors (e.g. using the capabilities in other sectors such as agri-tech and food-processing). On the other hand, this may contribute to knowledge spillovers that enhance the capabilities of advanced manufacturing firms (e.g. benefiting from technologies in ICT or nanotechnologies).

Most of the successful regional business innovation network support structures are open networks, promoting exchange outside the region and between clusters, as well as among regional firms and organisations. An example is “Clusterland Upper Austria”. This is an umbrella for several clusters such as plastics, automotive, clean-tech, mechatronic, food etc. These cluster organisations provide support and facilitate networking within their sectors regionally but also extra-regionally. This means that the members of the cluster organisations are not only from Upper Austria but may also be from other regions in Austria. Furthermore, through being organised under one umbrella, “Clusterland” provides for activities that promote networking and knowledge exchange between all the clusters within the umbrella.

Developing SME ambition to innovate

Another bottleneck for enhancing value-added is a low level of ambition among many advanced manufacturing SMEs to engage in innovation-based competition and to seek leadership in world market niches. The majority of the region’s firms in this sector are competing on a cost basis. This means that their margins are low and their costs also have to be low for them to survive on the market. It leaves little room for investments in technology and innovation, which in the short-run is a burden for the bottom line, potentially threatening firms’ existence.

Targeted mentoring and consultancy combined with pilot innovation projects could form the heart of the policy response to this challenge. Firms will only invest in knowledge exchange and innovation if they believe that their investments will pay off. However, such investments are likely only to yield their benefits in the medium- to long-term. It is therefore important to enable firms to experience the medium- and long-run impacts of a shift in business strategy from cost- to innovation-based competition. Participation in innovation pilot projects, potentially with the involvement of mentors and consultants, can demonstrate the benefits. However, there needs to be public support to make such pilot projects feasible in the context of tight margins. Such innovation pilot projects ideally link together a set of firms and knowledge providers (HEIs, research institutes). Such pilot innovation projects will (even if the innovation is not successful) enhance the absorptive capacity of firms and create/strengthen networks among the firms and knowledge providers. Box 4.3 provides an international policy example illustrating how this can work.

Box 4.3. RegioWIN innovation competition, Baden-Württemberg Cluster Agency, Germany

Description of the approach

Baden-Württemberg is one of the most innovative regions in Europe and has been a leader in establishing a participatory policy approach. It has long been considered as a best practice example of policies for clusters and regional innovation systems (e.g. Cooke and Morgan, 1994). Its leading position in Europe is related to the presence of strong R&D institutes, HEIs, vocational education and training organisations, innovation intermediaries, and industrial sectors, connected together through networks and supporting institutions. Various platforms and types of dialogues have been established, such as business talks with chambers, professional associations and unions, sectoral dialogues, thematic dialogues, and regional dialogues. RegioWIN is a recent example of one of the region's measures to further promote its regional competitiveness and innovation performance.

RegioWIN is an innovation competition that is part of the region's smart specialisation (S3) policy approach, which seeks to provide a prioritisation for public and private regional innovation funding through a process of entrepreneurial discovery. This is a bottom-up process where the insights from a wide variety of stakeholder groups about future opportunities and regional strengths are considered.

As part of the entrepreneurial discovery approach, this competition provided an incentive for regions, towns, and municipalities to engage in a dialogue with actors from business, society, academia and public administration to work on regional development concepts. The established cluster organisations were important actors in facilitating these dialogues. One of the innovative approaches was to avoid an ex-ante definition of regional boundaries. This means that municipalities could connect based on their perceived functional complementarities, with the one limitation that each municipality could be part of only one regional strategy.

The objectives of the competition were to contribute to:

- Strengthening research, technological development and innovation in key growth sectors defined by the regional government.
- Strengthening efforts to reduce CO2 emissions in all areas of the economy.

The competition was organised in two phases:

First, regional actors were asked to define joint strategies for their selected spatial areas. The strategies should include joint objectives for a regional innovation and growth profile. They should be based on socio-economic analyses and a regional dialogue about strengths and weaknesses, and opportunities and threats. The proposals were evaluated by an independent jury and a selection was made of which regions could participate in phase 2.

In the second phase, the focus was on so-called "lighthouse" projects, which needed to relate directly to the regional strategy. This included detailed planning of costs, financing, and activities for each project, which needed to be ready for implementation. In total, 21 of the 61 proposed lighthouse projects were financed, with total funding of EUR 107 million from the EU and regional funding sources. Each lighthouse project could receive up to a maximum of EUR 10 million.

Success factors

- One of the key success factors, as identified by the programme managers, was that *a priori* the geographic territories were not defined, which allowed the actors to consider the real complementarities and connections in space. Furthermore, this made it necessary for local

authorities to engage with new stakeholders and reflect upon traditional administrative boundaries.

- A key factor for success more generally is a culture of dialogue across business, universities, government, and civil society, which has been cultivated in the region for a long time.

Obstacles encountered and responses

Despite Baden-Württemberg being an often-cited best practice example of regional innovation policy, many firms do not see the importance of innovation activities for their growth and survival. This is partly related to the region's economic success in recent years. Many also find it difficult to combine a regional innovation perspective with daily activities. Capacity-building work might be required with some companies to support them in identify how to participate in and benefit from regional innovation strategies.

Relevance for Cambridgeshire and Peterborough

This programme illustrates a method to stimulate SMEs to become engaged in innovation and in the incorporation of science-based knowledge through financing pilot innovation projects. One of its strengths is that it incentivised different actors to work across traditional administrative boundaries in defining and implementing regional strategies for innovation. This approach could be used in Cambridgeshire and Peterborough to identify key innovation projects with a variety of stakeholders that could create connections across Cambridge, Peterborough and The Fens.

Sources of further information

https://wm.baden-wuerttemberg.de/de/innovation/

Conclusions and policy recommendations

It is important to distinguish the regional pre-conditions for knowledge exchange and new industry path development between the science-based and engineering-based strategic sectors of the region. Cambridgeshire and Peterborough has an extremely strong innovation system and high specialisation and diversity in the science-based sectors, although they are strongly focused on Cambridge. The engineering sectors are more broadly spread across the region, but the innovation system is less strong.

The pre-conditions in the region in terms of actors, networks and institutions and the level of industrial diversity, imply the following main opportunities for transition towards higher value-added and higher growth potential activities in the regional economy:

- Science-based sectors – life sciences, ICT, agri-tech:
  - path creation (emergence and growth of entirely new industries based on radically new technologies and scientific discoveries).
  - unrelated diversification (diversification into a new industry based on unrelated knowledge combinations).
- Engineering-based sectors – advanced manufacturing and materials
  - Upgrading (major change of a regional industrial path through moving up the value chain based on upgrading of skills and production capabilities; use of new technologies or organisational

innovations or business models; or development of niches through integration of branding and marketing)

- related diversification (diversification into a new related industry for the region building on competencies and knowledge of existing industries).

A number of obstacles have to be addressed to facilitate knowledge exchange and new path development in these areas, all focused on building networks and linkages for innovation, namely:

- Science-based sectors – life sciences, ICT, agri-tech:
  - building linkages across sectors and actors.
- Engineering-based sectors – advanced manufacturing and materials
  - building knowledge absorption capacity in SMEs;
  - strengthening access to applied research;
  - involving SMEs in innovation networks;
  - developing SME ambition to innovate.

International policy practices in the area of cluster development can provide inspiration – focused on provision of public seed funding for collaborative local innovation projects.

Specific recommendations for policy development are set out below.

Box 4.4. Recommendations on knowledge exchange and new industry path development

Advanced manufacturing and materials

1. Create a stronger HEI presence in Peterborough focused on applied R&D of particular relevance for the advanced manufacturing and materials sector, and on training and R&D links with local firms. This could be achieved, for example, by enhancing the presence of Anglia Ruskin University (ARU) in Peterborough or establishing a new University in Peterborough. Extending ARU's presence would have benefits in terms of building a critical mass of competences.
2. Provide operational support to a cluster management organisation for the sector covering the whole region, including exchange with other clusters and sectors within and beyond the region. The strongest existing structure is Opportunity Peterborough, which could be given the mandate and resources to orchestrate and develop a support structure for advanced manufacturing for the region. In terms of signalling and marketing, this support structure may also include Cambridge in the name (e.g. Manufacturing Innovation Center (MIC) Cambridge-Peterborough). It is very important that leading firms in the region are involved.
3. Introduce programmes at the national or regional level, with funding granted conditional to the mobilisation of actors across the region, as a trigger for initiating regional cluster and HEI-industry partnerships.
4. Increase the innovation capacities of advanced manufacturing and materials SMEs by reinforcing their participation in innovation projects with HEIs. Both HEIs and the cluster management organisation should have an important role. A variety of tools such as Professorships partly sponsored by industry, masters and PhD degrees undertaken in collaboration with firms, industrial PhDs, etc., can be used to promote the collaboration.
5. Expand consultancy and mentoring for SME management in innovation capabilities.
6. Create platforms and focal points in local HEIs to enable the region's firms to identify relevant sources of knowledge in complementary fields (e.g. digital and information technologies, automatisation, marketing, nanotechnologies, etc.) and meet knowledge providers. Events and workshops should also be organised to combine insights with practice (e.g. 1/3 of the time presenting technological opportunities and 2/3 of the time practising and playing around to see how a new technology can be relevant).
7. Initiate SMEs in innovation collaborations by offering public support (financing and brokerage) for pilot innovation projects between firms and knowledge providers (university, research institute etc.). This could be organised at the national level or at the regional level.

Life sciences, ICT and agri-tech

8. Develop sector development vision, platforms and networks for the commercialisation of research outputs relevant to/or originating from the life sciences, ICT, and agri-tech sectors. This should bring together actors from business, research, education, local and national government, and civil society and include activities that cross boundaries of sectors and scientific disciplines. The process should include support for, and happen in coordination with, the activities of networks and cluster management organisations in these sectors. A national programme with financial incentives should be considered to support the process.
9. Support cross-sector training and collaborative research projects in ICT and nanotechnology given their importance as key enabling technologies for life sciences and agri-tech (as well as

for advanced manufacturing). This should include outreach activities of universities, technology mediation, and funding for collaborative projects between research and industry. Regional networks (e.g. the Cambridge Network) or knowledge support structures are well placed to facilitate cross-sector interactions.

10. Integrate individual firms with (potential for) knowledge-intensive activities located outside the Cambridge area by working with liaison points to identify such firms and connect them to networks. This should be carried out in cooperation with the established networks and cluster organisations but also making use of the business advisors of the Growth Hub.

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