Government
Office for Science

Services Transformed: Growth Opportunities for the UK Service Economy

A report by the UK Government Chief Scientific Adviser

CONTENTS

This report is one of a number of Government Office for Science Blackett reviews, which are named in honour of Patrick Maynard Stuart Blackett, Baron Blackett OM CH PRS

To refer to this report, please use:

Government Office for Science 'Services Transformed: Growth Opportunities for the UK Service Economy'

FOREWORD

The Industrial Strategy set out our ambition to boost productivity across the UK - making the most of our services sector is critical to this. Services are vital to the UK economy, accounting for nearly 80% of GDP, and the UK is a global leader in business services, finance, design, law, accountancy, consultancy and the creative industries. We have the potential for sustained growth in these sectors, particularly with the application of new technologies such as artificial intelligence, machine-learning, big data and blockchain.

The rapid pace of technological change that we are witnessing across all sectors of the economy is already having a disruptive impact on the services sector and will continue to do so for the foreseeable future. To retain service sector competitiveness, UK firms must therefore embrace technology along with the new business models and processes that these technologies enable.

In this report, Professor Sir Mark Walport, in his role as the Government Chief Scientific Adviser, analysed the power of technology to enhance current service business models, build on existing service sector strengths and create new competitive advantage for the UK in areas such as servitisation – manufacturing firms branching into selling services as well as products. The report also looked at some of the challenges faced by the sector, such as increasing automation changing the nature of digital business.

These are important insights as we implement our Industrial Strategy. We have already announced £20m funding from the Industrial Strategy Challenge Fund for 'next generation services', which will help tackle some of the challenges identified and enable this dominant sector of our economy to grow further. We have also identified Artificial Intelligence and Data as a Grand Challenge for the UK. We are dedicating resources across government and beyond to understand how we might make the most of UK strengths in this area and be at the forefront of the industries of the future, as well as help firms and people make the transition to new ways of working. In addition, we are working with organisations like 'Be the Business' to boost productivity in firms, many of them in the services sector, up and down the country.

The report represents a 'call to action' for services companies to engage and make the most of the opportunities created by the Industrial Strategy and by the changes in the global economy. Government has an important role to play in setting the right conditions and acting as a catalyst. Yet, as the Industrial Strategy sets out, ultimately it is the services companies, working effectively with government, regulators, academia, innovators and entrepreneurs, who will determine the future of the UK services sector.

I am grateful to Sir Mark and the panel of experts who advised him for this timely report and I look forward to continuing to see this sector prosper in the future.

Rt Hon Greg Clark MP
Secretary of State for Business,
Energy and Industrial Strategy

EXECUTIVE SUMMARY

This report is about the power of services to generate growth and prosperity in the UK, as service industries are transformed by new technology and business models.

Services dominate the UK economy. In 2016, they accounted for 74% of private businesses, 79% of their employment and 72% of their revenue. The sector remains a major source of our global competitiveness. The UK is second only to the US in service exports, which totalled £245 billion in 2016.

Just as manufacturing and production were disrupted by the industrial revolution of the 18th and 19th centuries, the information revolution is now disrupting the provision of services. Service industries around the world are being disrupted by both information technologies and the new business models that come with them.

For example, servitisation is transforming the world of manufacturing. In the aircraft industry, companies are selling power-by-the-hour instead of jet engines. This changes incentives for the manufacturer of the engine. The customer wants reliable and long-lasting jet engines, and the manufacturer wants a steady income stream. So the contract is for the service of keeping aircraft flying. That generates more predictable revenue, encourages preventative maintenance through sensor innovation, and raises profitability because less material product is used.

This is just one example of an extraordinary array of developments in the service sector, such as platform IT companies and other businesses that power the service economy. These are changing the nature of work. New IT platforms provide new opportunities for work and enable increased self-employment and more distributed working patterns at home and other remote locations. Service workforces in some sectors are becoming globalised, creating new international competition for labour.

New technology is also automating and augmenting jobs previously done by humans. As well as changing and eliminating some jobs, it will create completely new types of job, some of which we cannot yet imagine. The duties, rights and responsibilities between employer and employee will need to evolve.

The digital revolution encompasses an array of new and emerging technologies including machine learning and artificial intelligence, advanced data analytics and distributed ledger technologies – all made possible by the rapidly developing global infrastructure of the internet. While the new digital infrastructure improves the quality of life for many, it comes with new threats and vulnerabilities. These vary from cyber security threats to questions about how to tax and regulate companies that aim to operate as supranational entities. There is hardly any business that will be unaffected by these extraordinary advances in technology.

How to keep up?

So what does this mean for the UK? What do government, other policy makers, regulators, businesses and citizens need to do? We enter this revolution as a global leader in professional and business services, ranging from retail, financial, legal and health services to the creative industries. Moreover, the UK's world-class base in science, engineering, technology, social sciences, arts and humanities means that we are well placed to capitalise on the new opportunities. However, with opportunities come challenges, which threaten to leave the UK behind if not addressed.

One challenge for the service sector is productivity. The UK has seen productivity fall across the economy as a whole, and especially in services. Moreover the top 25% of businesses in each sub-sector are approximately 2 to 5 times more productive than the bottom 25%. The opportunity for government and the service sector is to close this gap by spreading best practices from high performing to low performing businesses.

Achieving this is at least as much down to improving management as to modernising technology.

A second challenge stems from automation. Some forecasts suggest that up to 30% of existing UK jobs have a high likelihood of being automated by 2030. In itself this should be a cause for both optimism and concern. History shows that automation often leads to new kinds of job. Around 6% of UK jobs in 2014 were of types that did not even exist in 1990, mostly due to new technologies in services like computing and communications. Moreover, technological innovation drives productivity and wage growth, boosting the economy in unforeseen ways. However, the fact that automation is turning from physical to cognitive tasks means that the net impact on jobs and wages may not follow historical precedent. Policy may then have a role supporting those affected during transitional periods.

The third and perhaps greatest challenge comes from the nature of some of the new digital businesses. They sit astride many countries and have pervasive impacts on the fundamentals of how society works. Some of these companies have developed massive market power and lightning-fast innovation cycles. They are generating technology so novel that its societal implications may be tested and emerge in the field, rather than anticipated or tested in development.

Nation states have been wrong-footed by the speed, scale, sophistication and power of this disruption. And because of its global nature, nation-level regulation is difficult. There is a risk that over-regulation may limit the opportunities for citizens and businesses to participate and interact with global communities, but failure to regulate effectively – both nationally and internationally – could lead to negative social outcomes, especially if personal and private data are used in harmful ways.

What do we know so far?

All these challenges must be addressed to ensure the future success of UK services. The backdrop of rapid demographic, political and economic change makes a report on this largest sector of the UK economy especially timely. In particular, the dominance of UK services coupled with the potential impact of recent innovations makes it a perfect subject for a Government Office for Science Blackett review.

Last year also saw the publication of the Industrial Strategy, which aims to create an economy that boosts productivity and earning power throughout the UK. Amongst many investments, the Strategy's 'next generation services' project will provide up to £20 million to help service industries identify how technologies such as artificial intelligence can transform operations.

This report's 5 chapters consider how we safeguard and build on our strengths in services; how automation may affect the sector; how we capitalise on emerging platforms; how we exploit servitisation; and how we spread success throughout the UK. The report also contains links to the Industrial Strategy's 5 foundations: Ideas, People, Infrastructure, Business environment and Places, providing a services sector perspective on many key Industrial Strategy issues.

The chapters have been written by a panel of independent experts drawn from academia and business, and represent their own viewpoints. The Government Office for Science is extremely grateful to these experts for their guidance and thoughtful contributions to the report.

While the role of government is to provide leadership and catalysis, the business and academic communities must play their part too. They can help ensure success by developing new business models, creating and adopting new technologies, providing new education and skills, and engaging with the Industrial Strategy's funding and opportunities.

To help maximise the UK's potential as a global service hub, we make 11 recommendations below for government and the private sector. They are laid out alongside chapter summaries below.

CHAPTER SUMMARIES AND RECOMMENDATIONS

Chapter 1: Preserving and building on UK strengths

The UK is more reliant on services than any other G7 country, with the percentage of employment in the sector rising from around 49% in 1961 to 80% in 2016. We have strengths in many areas from financial services through to the creative and cultural industries. But even though services dominate the economy, we persistently undervalue them.

Part of the problem is definition. The service sector holds an incredibly diverse mix of companies, which has led us to define services negatively – as anything other than manufacturing and extraction. Meanwhile, the perception of manufacturing as high-value has meant that services are often misperceived as low-value and low-skilled. This can be avoided by defining services positively in terms of what they provide, to give a clearer sense of how important the service sector is to the economy and society as a whole. Services:

- connect people through telecommunications and social media
- transport people and cargo
- create, generate, manipulate and organise information
- safeguard people and possessions
- maintain and preserve the places and things we value
- entertain, inform and educate

We need more accurate ways to map and measure the activities and value chains that comprise the service sector. Government, industry and the public all need to understand better how services create and distribute value. In particular, we need to measure the value of personal service industries, such as education and social care, in ways that better reflect the importance of personal and social wellbeing.

Recommendation 1: The Office for National Statistics should work with academia to develop new methods for mapping value chains as well as measuring research and development in the service sector. Opportunities to pilot and test new methods include the SERVCOM survey of service sector outputs and revisions to the Standard Industrial Classification.

Trading services

Globally, trade in services has grown even more rapidly than trade in goods in recent years. That should be an opportunity for the UK with its highly developed service sector. But of course if we can export services to other countries, then those countries can also export services to the UK and potentially take business from local companies. Government and industry need to understand better how the potential to trade services at a distance is developing in order to take advantage of opportunities when they arise.

Recommendation 2: Industry and sector councils should raise the level of horizon-scanning to anticipate and monitor emerging opportunities and challenges to their services. In addition, government should undertake detailed studies to better understand how the potential to trade services at a distance is developing, and how this tradability will affect individual services.

This must be a long-term priority for government and industry, which should continue to find ways to monitor and improve the understanding of trade in services. We recognise that the Department for International Trade is already conducting studies in this area and commend their focus on:

- consulting with industry to understand what is important in international services trade
- exploring with BEIS and Office for National Statistics (ONS) options to improve the measurement of modes of supply

- integrating the services economy into econometric models
- working across Whitehall to understand sector-specific UK interests and develop whole-of-government positions for each service sector
- using the OECD and World Bank Services Trade Restrictiveness Index and associated research to better understand barriers to international services trade

Industrial strategy

The chapter includes a review of ways the government is seeking to protect the UK's competitive advantage. Foremost among these is the new Industrial Strategy, which aims to foster world-leading businesses, create better-paid jobs and drive growth across the UK. The Department for Business Energy and Industrial Strategy (BEIS) has commissioned a series of sector reviews to help develop the Industrial Strategy, which show how every industrial sector is now underpinned by the application of information technology and increasing automation.

It is crucial that UK policy supports these transformative digital technologies – as well as the associated science, engineering, social sciences, arts and humanities that are essential to getting the most out of these technologies and avoiding harms.

Recommendation 3: BEIS should build on the Bazalgette review of creative industries, the Maier review of industrial digitalisation, the Bell review of the life sciences sector and the Hall and Pesenti review of artificial intelligence to strengthen the service sector through the Industrial Strategy. Government and business should work together on the collected recommendations from these reviews. To support the service economy, this process can exploit sector deals, place-based policy making and support development of education, skills and lifelong learning, and the work of UK Research and Innovation and the Industrial Strategy Challenge Fund.

Chapter 2: Automation

With the rise of machine learning, artificial intelligence and robotics, intellectual labour as well as physical labour is increasingly vulnerable to automation. New technologies often enhance human labour rather than replace it, and the power of artificial intelligence may augment human abilities, leading to non-cognitive or 'soft skills' being more valued on the job market.

Given the number of jobs potentially affected, the UK must be pragmatic about the future of automation. Workplace training and reskilling will be of increasing importance. If the UK's strengths in STEM are automated, then to equip our workers of the future we will need to retool the educational system to bridge arts, sciences, technology and business. This will mean training those entering the workforce and retraining those already in the workforce. Government must act as a catalyst here, but industry also has a part to play – so our next recommendation is twofold.

Recommendation 4: (1) Government needs to close the skills gap in STEM subjects such as data science, and ensure that our education system cultivates creative, social and critical thinking skills. (2) Industry needs to make a commitment to lifelong learning in the workplace by providing courses that train and reskill existing employees, rather than relying on new employees to fill skills gaps.

This recommendation is particularly important for ensuring that the UK has the skills necessary to benefit from the technological innovation driving future productivity and wage growth.

Chapter 3: Digital disruptors

The information revolution is yielding other innovations including the Internet of Things, virtual reality and platforms. Many services have already been profoundly affected: financial services by online banking, retail businesses by e-commerce and the music industry by streaming platforms.

Customer interaction is of paramount importance in services, and emerging platforms are disrupting the sector by allowing businesses to address customer needs with unprecedented efficiency

and effectiveness. These platforms can be thought of as virtual marketplaces where suppliers and customers interact and do business. Peer-to-peer digital platforms have generated an explosive growth in the sharing economy and collaborative consumption.

The UK should be well placed to exploit these trends. It has world-class academic excellence in many digital areas, including computational modelling, financial technology, computer gaming, autonomous systems and artificial intelligence. In addition, the UK also has a well-deserved reputation for its regulatory and standards institutions, which help to protect consumers from adverse outcomes.

We need a wider public debate about the impact of digital disruption and the information revolution, perhaps stimulated by the recent Taylor report on the future of work[1], and the Royal Society and British Academy report on data governance[2]. This public debate should cover all aspects of service and automation, data and identity, ethics and practices.

Recommendation 5: Government and industry should jointly conduct a public debate on the impact and regulation of digital disruption, especially with regard to ensuring the protection of casual employees. There should be similar analysis and debate of the market and regulatory status of incumbent businesses and potential disruptors to help produce a level playing field. This could be facilitated through the work of the Alan Turing Institute and the Open Data Institute.

Diffusing innovation

The pace of productivity growth has declined across the OECD over the past decade. One factor is that digital innovations are diffusing from frontier companies to laggard companies more slowly. Service sector companies at the OECD frontier have an average productivity growth of 3.6%, whereas laggards average just 0.4%. Moreover, this gap is 50% wider in the UK than other OECD countries.

To rectify the UK's productivity slowdown, we need to encourage the development of innovation in the service sector and the diffusion of innovation through it. This has also been a focus of Charlie Mayfield's Productivity Leadership Group.

Recommendation 6: Government, industry and academia should work together to raise productivity, encouraging the adoption and diffusion of innovation across the service sector. Government procurement could be used to incentivise support for SMEs as a key part of the supply chain to government, as is done in the USA. Schemes for place-based support from BEIS, Department for Communities and Local Government (DCLG) and other departments should consider how to incentivise diffusion of best practice, which needs to be in management and leadership as much as in technology.

This recommendation echoes the Maier review of industrial digitalisation and highlights the need to digitally enable businesses, as well as build awareness and confidence in new technologies, business models and managerial practices. For example, UK Research and Innovation could use existing networks of demonstration centres to inform and inspire business leaders about the potential of recent innovations for their company.

Boosting broadband

As services such as retail and tourism are increasingly digitalised, the success of these industries depends on the consistency of broadband coverage. Having universal high-speed broadband across the UK would maximise the number of digitally enabled service companies.

Recommendation 7: The Departments for Digital, Culture, Media & Sport (DCMS) and BEIS should continue developing a coordinated approach that takes into account business broadband concerns and ensures businesses can benefit equally from digital technology initiatives to help drive productivity and economic growth.

Encouraging new technologies

The report 'Technology and Innovation Futures 2017'[3] from the Government Office for Science identified 8 potential government policy levers to support emerging technologies, outlined in Table 1. All of these are relevant to the service sector.

Early intervention	Market framing	Adoption and integration
Catalyser Analyse value chains to identify which technologies present opportunities and long-term value to the UK	**Regulator** Ensure regulation is sufficiently agile and permissive to enable technology interactions and innovative applications	**Intelligent customer** Develop a procurement environment that encourages big businesses to engage with SMEs in public contracts – allowing them to demonstrate capability and build commercial links
Innovation facilitator Create test beds for developers to try out applications in real-world settings, assess scalability and engage with the public	**Standard setter** Use insights from 'living labs' to develop UK standards – setting the global agenda by 'showing, not telling'	**Platform provider** Scale up deployment of proven technologies in national infrastructure, the NHS and other public services
Skills planner Prepare for growing demand for workers with multi-disciplinary technical skills, and mitigate the impact of robots and machine learning replacing unskilled and graduate-level roles	**Fiscal incentiviser** Deploy financial and other mechanisms to stimulate innovation and market growth	

Table 1: Government policy levers for supporting emerging technologies (Technology and Innovation Futures 2017)

Recommendation 8: Analysts and policy makers and those who deliver public services should work across government to understand how the government policy levers identified in the Technology and Innovation Futures report 2017 can be applied to greatest effect in the service sector.

Government should consider how to implement this cross-cutting recommendation. It will require strong leadership and cross-departmental working. Possible avenues could include a ministerial group and/or a single empowered ministerial leader supported by a group of senior officials from the key departments.

Chapter 4: Servitisation

The boundaries between products and services are becoming increasingly blurred – a process known as servitisation. Traditionally, manufacturers made profits by providing services that supported their products. But now, for example, engineering equipment is being offered as part of an outcome-based contract which guarantees uptime. Rather than buying tyres, a haulier can now buy miles on the road.

So providers and customers are entering into contractual relationships rather than merely engaging in transactions. The next step is to contract on the basis of outcomes, so the provider is paid by how effectively the customer uses the product. The series of steps from providing spare parts, to guaranteeing uptime, to outcome contracting, can be seen as an increasing alignment of interest between provider and customer. Progression along this series of steps is being facilitated by new technologies such as GPS, cloud computing and big data. For instance, the Internet of Things allows data streaming and system optimisation to occur in real time.

Delivering outcome-based contracts is risky and challenging. To servitise effectively requires firms to manage the risks of deeper engagement in customer operations. For instance, providers often find that they are increasingly dependent on their customers for data and resources. Firms must then learn how to understand and mitigate the risks that come with delivering outcome-based contracts.

Government could use its large procurement power to help, providing outcome-based contracts that allow companies to develop this knowledge and capacity.

Recommendation 9: Government should consider using outcome-based contracts and avoiding over-prescriptive specifications. This approach to procurement will allow providers of assets to servitise and innovate their business models using digital technologies. It will be important to carefully examine and test outcome-based contracts and regulatory approaches to avoid unintended consequences and to achieve the full set of desired outcomes.

The convergence of digital technologies allows for the bundling of services that had previously remained separate. For example, outcome-based contracts can involve a bundle of technical, financial, insurance and legal expertise. UK national existing expertise in these areas and our recognised strengths in arbitration, mediation and expert determination could establish the UK as a world-leading exporter of outcome-based contractual services.

Recommendation 10: The development of outcome-based contracts offers great opportunities to the UK. Industry, academia and leadership councils should together explore the possibilities for provision of outcome-based contractual services. Horizon-scanning will be essential to anticipate, monitor and assist in the identification of emerging opportunities in this area. Innovators should be encouraged to look across sectors and think more broadly about potential opportunities for servitisation and where the UK could create new comparative advantage.

Chapter 5: Spreading success

For historical reasons, many successful service industries are clustered in London and the south-east. However, digital technologies mean that people are increasingly free to work almost anywhere. This brings a new opportunity for places across the UK to compete for human capital.

Research shows that jobs alone are not enough to attract and retain skilled people. Other factors including quality of life and innovation culture also contribute to a place's attractiveness. Successful creative businesses can be stimulated by an urban buzz attracting skilled workers and encouraging collaboration.

Public and private service enterprises need to work together to attract and retain the human capital necessary for service industries to thrive. That includes education, housing, transport, health and social care, culture and law. To spread service sector success across the whole of the UK, we must focus on collaborative enterprises that provide the infrastructure people need to live, work and play.

Another problem for service companies in the UK's regions is lack of capital investment. If service companies are to grow outside London and the south-east, then the investment infrastructure for businesses needs to become more distributed and sophisticated.

Recommendation 11: Government should use sector and city deals to develop and build on existing financial ecosystems across the UK with the aim of reducing regional disparities. This will require mass data collection to measure and evaluate the planning and implementation of these deals.

Given the importance of human capital, the government's policy on skills and apprenticeships is particularly relevant. That includes the Apprenticeship Levy, introduced in April 2017, which aims to reverse the trend of underinvestment in apprenticeships. It will be important for government to work with industry to review the impact of the levy and wider apprenticeship reforms, particularly in the area of services.

CHAPTER 1

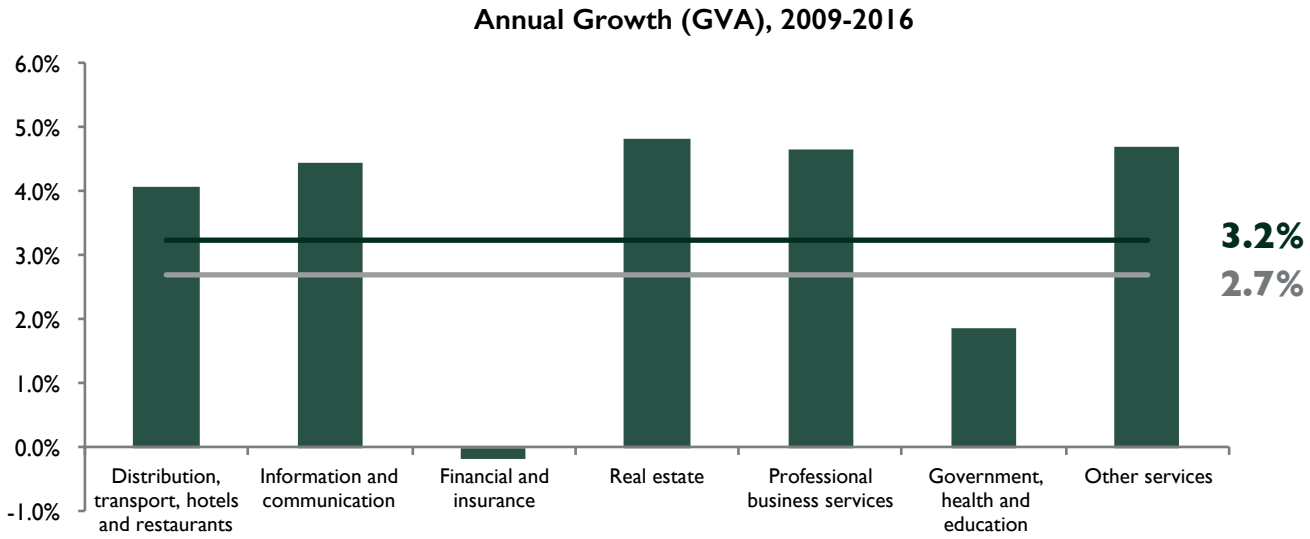
PRESERVING AND BUILDING ON UK STRENGTHS

Services provide around four-fifths of UK jobs and value added, and earn the UK a surplus in international trade. Yet the sector often gets much less attention than manufacturing. The UK is particularly strong in financial services, professional and business services, the creative and cultural industries and higher education. The UK needs to ensure that future trade deals and migration policies enable these successful industries to reach foreign markets and global talent, so they can continue to prosper.

PRESERVING AND BUILDING ON UK STRENGTHS

Across the world, national economies are increasingly service-driven, and the UK is no exception. In 2016, services contributed 80.2% to UK economic output measured by gross value added. That is higher than the US (79.5%), France (78.8%) and Germany (69.1%)[4]. Services in the UK account for 74% of private businesses, 79% of private businesses' employment, and 72% of their turnover/revenue[5].

The overall annual rate of growth in services from 2009 to 2016 was 3.2%, compared with 2.7% in other sectors. That hides a disparity between service sectors, as growth above 4.5% in professional and business services, real estate, and information and communication, contrasts with near zero growth in financial and insurance services (Figure 1).



Source: ONS GDP low level aggregates, 2016

Figure 1: Even though some service sectors have seen low growth, on average they have grown faster than the rest of the economy (grey line) over recent years. Source: ONS GDP low level aggregates, 2016.

ATTENTION ON SERVICES

Services are dominant in the UK economy, but do they receive sufficient attention? This depends on how we define the sector. Services are often defined by what they are not. Service products are not material, they are not storable, and they are not transportable. This 'everything that is not' definition is used by national statistical agencies worldwide including our own Office for National Statistics (ONS). It derives from the three-sector model of the economy which was developed around the middle of the last century. This identifies the primary sector, or extractive industries (agriculture and mining); the secondary sector, or productive industries (manufacturing, construction and energy); and tertiary sector, which is services – everything else.

This model was developed at a time when making things was regarded as particularly important for economic development, and so the secondary sector was what really mattered. Services were considered frothy and insubstantial – 'the cappuccino economy'.

Strong and vibrant manufacturing, agriculture and construction sectors are vital, and we should continue to make the most of them. However, it is essential to recognise the competitive advantage that the services sector offers. Services provide around four-fifths of jobs and gross value added in

the UK. By contrast, manufacturing now accounts for about 10% of GVA, construction around 6%, energy and mining 3%, and agriculture less than 1%[6]. In terms of value added, an improbable doubling of the size of manufacturing would be matched by a much more achievable 12% increase in services. The recent interactions between the two sectors however are where services are being truly transformative. The idea of selling a product as a service (e.g. monthly charges for everything from music and video, to the transportation of goods and people, to provision of engine up time in airplanes) is dramatically changing business models, customer supplier relationships, and consumer benefits, as the service sector enters new and innovative territory.

WHAT SERVICES DO

Help people. Education services help people to learn. Health services help people to recover from illness and prolong lives.

Lift burdens, for example by providing secretarial support, and by providing waiter services in a restaurant.

Connect people, through telephony and social media.

Provide and deal with information. Insurance companies are information processors, as are retail banks.

Create, generate and manipulate ideas and knowledge, including scientific and market research, design, architecture, engineering consulting.

Provide security and safeguard people and possessions, for example through legal services, police and defence forces.

Move people and things.

Clean up and preserve things we value, through waste disposal and heritage services for example.

Provide entertainment and experiences.

Build and change culture.

PRODUCTIVITY GAP

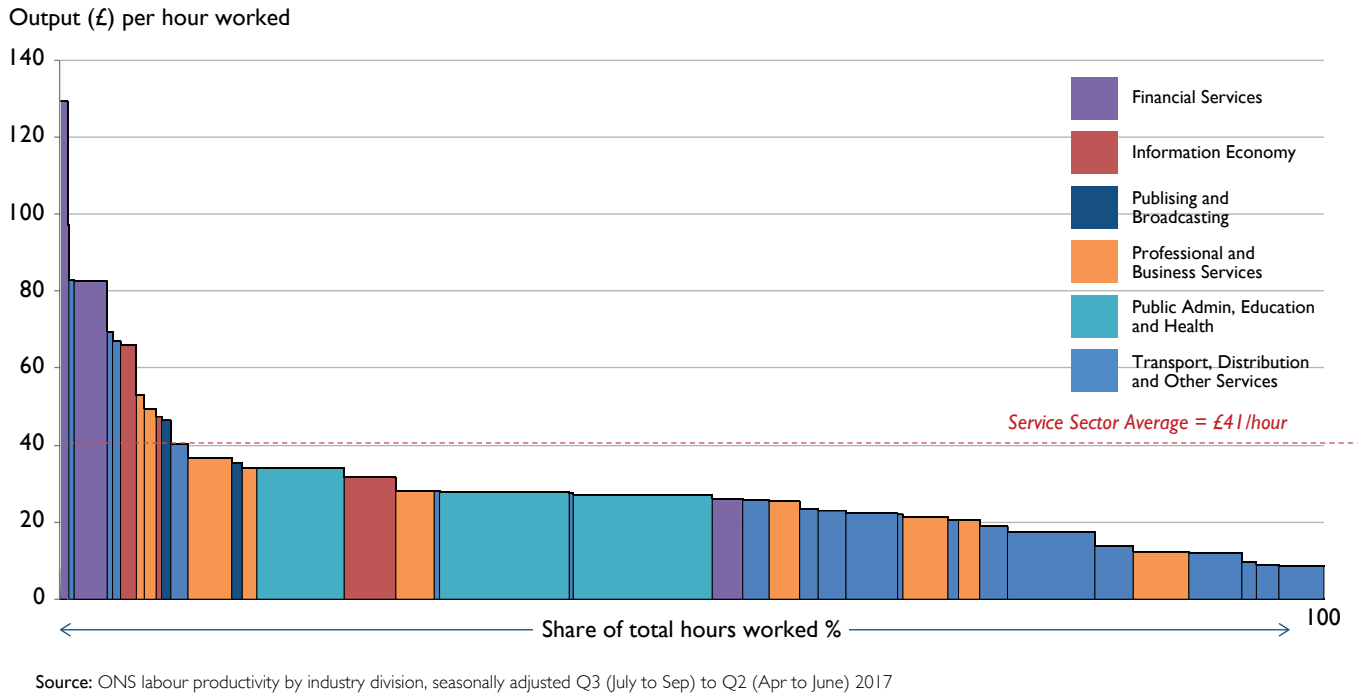
A key measure of competitiveness is productivity: the amount of output produced for a given level of effort or resource. Official statistics tend to focus on labour productivity, the hours worked or jobs required to add a given amount of value. By this measure, UK productivity is well below that of its main competitors, and weak productivity growth since 2008 means that the gap has widened further[7], with workers in France and Germany on average producing as much in 4 days as UK workers do in 5.

Knowledge-based services such as finance, digital and creative sectors tend to have higher labour productivity than customer-facing and back-office support services (Figure 2). That partly reflects variations in capital intensity across sectors, which aren't captured by these official measures of productivity and may also be limited by the difficulty of measuring the added value of services. For example, while search engines have become increasingly valuable business tools, it is hard to capture the effects of quality improvements in a meaningful fashion[8].

Within the same industry, some firms achieve much higher productivity than others. ONS analysis estimates that the top 25% of businesses in each sub-sector are around 2 to 5 times more productive than the bottom 25%[9,10]. The UK's top firms are world class, but there is a long tail of mediocre performers. The same goes for other countries. The OECD found that a small set of frontier firms are steadily pulling ahead of the rest over time[11]. Service sector companies at the OECD frontier have an average productivity growth of 3.6%, whereas laggards average just 0.4%[12]. Comparisons with other advanced

countries also suggest that both the degree of dispersion in productivity performance is larger in the UK and has widened more in the UK than in other counties. The dispersion of service sector productivity is more than 50% higher in the UK than in other advanced economies[13]. This suggests that new ideas are not filtering down to or being adopted by following firms as effectively as they used to be.

Here is the challenge for the service sector: bring up the long tail of mediocre productivity by developing and commercialising new services, and encourage the adoption and diffusion of innovation.



Source: ONS labour productivity by industry division, seasonally adjusted Q3 (July to Sep) to Q2 (Apr to June) 2017

Figure 2. Labour inputs and productivity by service sector in the UK, 2015. The width of each bar indicates the sector's share of total hours worked in the service economy. Source: ONS labour productivity by industry division, seasonally adjusted Q3 (July to Sep) to Q2 (Apr to June) 2017.

STRENGTHS BEYOND FINANCE

PwC estimate that the financial and insurance services industry raised £71.4 billion in taxes in 2015/16 – amounting to 11.5% of the UK government's total tax take[14]. This is equivalent to around 60% of the NHS net expenditure of £117.2 billion[15].

Clearly we should not neglect this golden goose. But we have other strong service sectors that earn overseas income and provide high paying, vital jobs – including professional and business services, creative and cultural industries, the digital sector and higher education. Professional and business services accounted for 11% of UK output and more than 4.6 million jobs in 2016. The UK had a trade surplus of £23 billion in this sector. In 2015, the digital sector provided a trade surplus of £13.6 billion. Its trade is growing much faster than overall services trade, and exports are growing faster than imports (exports in 2015 were 32% higher than in 2010)[16]. Meanwhile, higher education providers received £4.5 billion in tuition fees from 311,000 non-EU students in 2015/16, a total income that has doubled since 2007/08[17]. International students also contribute to the UK economy through their living expenses.

To better understand our strengths in detail, we need better ways of understanding how value is created from services, and traded across countries. We also need to map more effectively the size and structure of the service sector and understand sectors in terms of their occupational make-up.

GROWING TRADE

The UK is second only to the US in global service exports. In 2016, we exported £245 billion of services, up from £228 billion in 2015[18]. UK service companies also attract a large amount of international investment: £629 billion of inward foreign direct investment in 2015, two-thirds of the UK total[19].

We have established export strengths in professional and business services, financial and insurance services, and telecommunications, computer and information services. Taken together, these service sectors contribute more than 27% to UK exports, and 9.5% to world exports. World exports in these areas of UK specialisation have also been growing faster than the global average over the past 10 years (Figure 3).

Conventionally, services have been difficult to trade at distance, but today international trade in services is growing rapidly. To a large extent this is driven by the rapid growth and diffusion of information technology and extensive and low cost air travel. Once the output of a service activity can be codified and digitised, it can be transmitted globally. Professional services, for example, generate products that can be stored and accessed repeatedly. Professional services automation software is gaining prominence in architecture, accounting, legal services and management consulting[20]. Other services are becoming more tradable due to reduced costs of travel and communication. Lower travel costs have helped weddings to become an export industry, for instance. Customer services can be provided by overseas call centres. Financiers, lawyers and accountants can work for clients based anywhere in the world.

So it is becoming more important than ever to strike trade deals and other agreements that favour activities in which we have a potential competitive advantage. Given our existing pattern of trade, it is understandable that the immediate priority is seeking trade deals with our existing major trading partners, including the EU.

Table 1 shows the UK's major trading partners in goods and services. We already benefit from trade deals with 11 of them through membership of the EU (including the recently ratified Canada deal), so there is a need to consider how to maintain these benefits after leaving the EU.

Although services remain less tradable than goods overall, trade in services is difficult to define and measure, so may be greater than officially reported figures. It is also notable that the geographical reach of trade in services is expanding. Both these phenomena need to be better understood if the UK is to build on its apparent competitive advantage.

We also need to be alert that as services become more tradable, some industries that have been sheltered from international competitors, perhaps through regulation, may suffer and contract. Liberalised trade deals could further expose these weaker UK service sectors to overseas competition.

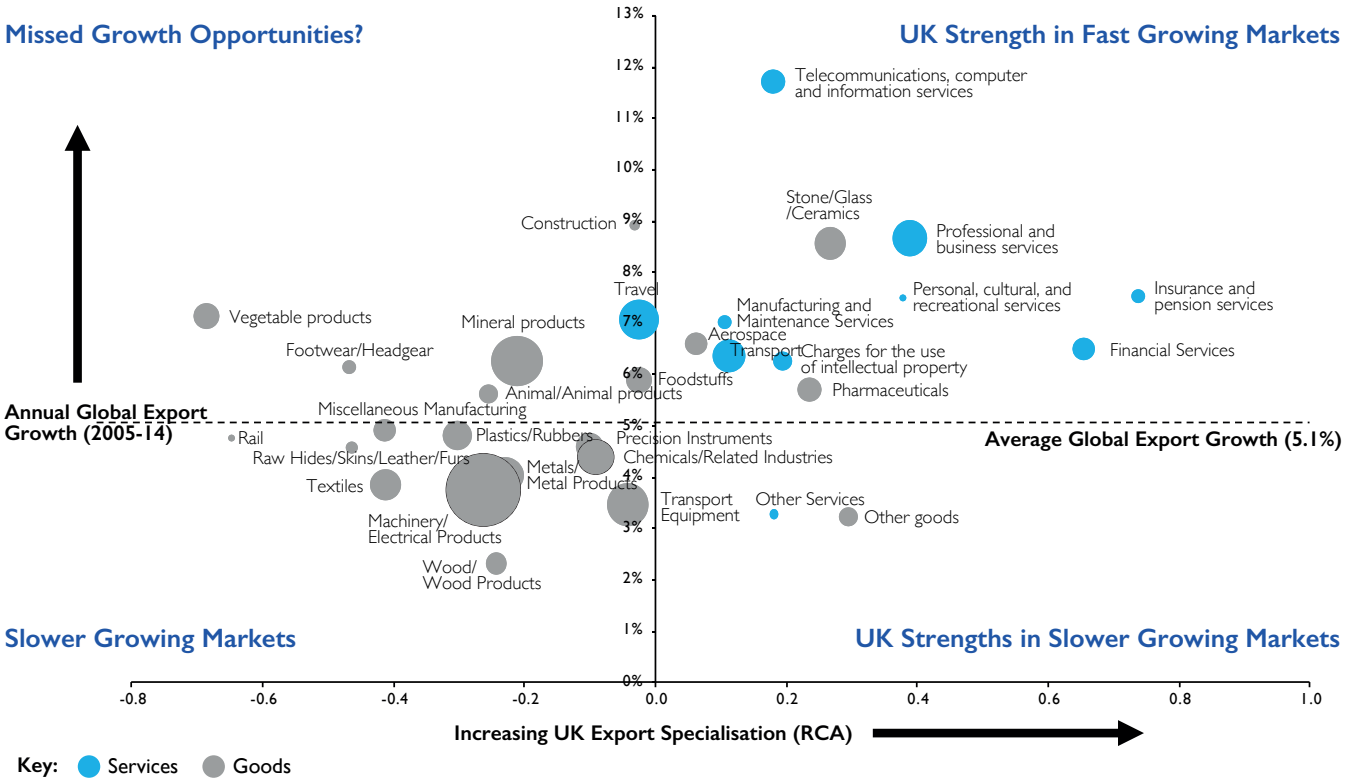


Figure 3. UK export specialisation versus global export growth, 2005-2014. Specialisation is measured as revealed comparative advantage (RCA): the sector's percentage contribution to UK exports, divided by the sector's percentage contribution to global exports. Area of bubble reflects sector's share of global exports.
Source: International Trade Centre data, 2014.

2016	All trade £bn	Goods exports £bn	Services exports £bn	Good imports £bn	Service import £bn	Goods balance £bn	Services balance £bn	Overall balance £bn
US	165.9	47.4	52.1	36.6	29.7	10.8	22.5	33.3
Germany (EU)	124.2	33.1	16.1	65.8	9.3	-32.7	6.7	-26.0
Benelux (EU)	120.7	20.0	13.8	25.5	12.1	-5.5	1.7	-3.8
China (incl. HK)	76.3	30.7	18.8	60.1	11.1	-29.4	7.7	-21.7
France (EU)	71.5	17.2	9.4	13.6	7.2	3.7	2.2	5.9
Ireland (EU)	47.4	19.8	5.8	47.2	3.4	-27.4	2.4	-25.0
Spain (EU)	42.6	10.1	7.2	17.5	5.2	-7.4	2.1	-5.3
Italy (EU)	39.9	9.7	4.9	14.8	13.2	-5.1	-8.3	-13.4
Switzerland	34.7	8.6	12.4	10.1	3.6	-1.5	8.8	7.3
Japan	24.0	6.8	3.1	2.8	2.0	4.0	1.1	5.1
Norway	20.6	5.0	7.4	8.2	3.2	-3.2	4.2	1.0
Sweden (EU)	19.3	4.9	3.4	5.4	1.7	-0.5	1.7	1.2
Poland (EU)	17.3	4.7	2.5	2.6	1.9	2.1	0.6	2.7
Canada	15.4	4.7	6.2	6.5	1.9	-1.8	4.3	2.5
India	15.4	4.6	1.5	4.8	0.5	-0.2	0.9	0.8
All of above	835.3	227.3	164.8	321.5	106.1	-94.2	58.7	-35.5
	73%	75%	67%	73%	69%	70%	64%	83%
Elsewhere	302.7	74.8	80.6	116.0	46.9	-41.2	33.7	-7.5
	27%	25%	33%	27%	31%	30%	36%	17%
All countries	1138.0	302.1	245.4	437.5	153.0	-135.4	92.4	-43.0

Table 1. The UK's major trading partners in goods and services (ONS Pink Book, 2017)

CONCLUSION

To a great extent the UK's future depends on how our export-oriented, high income generating services can increase overseas earnings, and whether services generally can maintain high levels of employment.

The UK has established global strengths in professional and business services, finance and insurance, and telecommunications, computer and information services. We need to better understand our service strengths, for example by mapping value chains, rather than relying on outmoded models of the economy such as the 3 sectors model.

How robust are these strengths is a multi-billion dollar question. The short answer is that we do not know. It depends on our future trade arrangements and the pace and nature of technological change. At least these are known unknowns – that is, we know that we need to know more about them. We live in uncertain times, and now more than ever we need government and businesses to invest in looking over the horizon.

CHAPTER 1 CASE STUDY

Evidential, a fused business

Fused businesses bring together data, science, technology and creativity to increase productivity, improve services and reduce costs. A prime example is Evidential, an expert witness company that is helping to transform the way evidence is presented in UK and EU courtrooms.

Evidential specialises in presenting evidence using animations and graphic visualisations – from maps plotting cell phone data to 3D printed models that can be used to show injuries. It also offers expert witness services, analysing CCTV footage, audio recordings and computer data.

Founder Sean Murphy studied graphic design at the University of Hull in the 1990s and had planned to work in TV graphics before he spotted a job ad for an imaging expert in the video department of the Greater Manchester Police, where he worked as an imaging consultant and later as an expert witness.

Evidential's team of forensic scientists, graphics designers, illustrators, software developers, investigators and ex-police officers have built a suite of media solutions including video enhancement and analysis, audio enhancement and voice comparison, crime scene reconstruction, forensic photography, cell mapping and 3D body injury mapping. Their prime customer is the criminal justice market, in particular Her Majesty's Court and Tribunal Service and other government agencies such as police forces and the Prison Service. Evidential have provided expertise in some of the UK's highest profile cases including the Morecambe Bay tragedy, the murder of Rhys Jones in Merseyside, the Soham investigation, the Poly Peck fraud trial, and the Joanna Yeates murder in Bristol.

The company was named in Creative England's CE50 list, which highlights innovative creative companies based outside of London. It is also one of 10 future leaders identified by Creative England this year.

The value of electronic presentation of evidence has been proved by the Crown Prosecution Service, who say that it reduces courtroom costs and time by 33% while increasing juror engagement rates by as much as 80%. An average Crown Court trial costs £3,900 per day with high-profile cases costing up to £30,000 per day. With over 21,000 such cases in 2014 alone, the cost saved by using electronic presentation is up to £3 billion[21].

CHAPTER 2

AUTOMATION

Machines have transformed agriculture and manufacturing over the past few centuries. Now with the information revolution, they are moving from heavy lifting to heavy thinking, and beginning to transform service industries too.

AUTOMATION

The industrial revolution was driven by new and improved machines such as textile mills and steam engines, which automated what had once been manual tasks in manufacturing. Today, service activities are being automated by the new digital machines, including:

The Internet of Things, sensors, and big data. Attaching sensors to interconnected everyday objects generates data, which can then be shared and analysed using artificial intelligence and machine learning.

Artificial intelligence (AI) and machine learning. These exist on a spectrum from technologies able to perform specific tasks, to algorithms trained to read data and make predictions, to neural networks that can cope with greater complexity.

Augmented reality and virtual reality (AR and VR). AR supplements the natural world with additional information – for example overlaying information on physical objects in see-through displays. VR is real or simulated environments in which a perceiver experiences artificial presence.

Robotics. These are machines that can move and perform complex tasks, such as service robots and autonomous vehicles.

JOBS AT RISK?

Fear that technology will destroy jobs is nothing new. In the 1930s John Maynard Keynes predicted that by 2030, technologies would replace human labour to the extent that the average working week would have shrunk to just 15 hours. Of course, it did not work out like that. As old jobs are replaced by technology, new demands and new jobs emerge. PwC has estimated[22] that around 6% of all UK jobs in 2014 were of a kind that did not exist at all in 1990, and in London the proportion was around 10%. Many of these are part time and freelance, as smartphones, social media and other internet technologies cut the costs involved with starting and stopping work[23,24,25,26].

But we cannot afford to be complacent. As we have seen with heavy industries such as coal and steel, the rapid decline of an industry can be painful even if other jobs are emerging. If people are unable to retrain, they may suffer long term unemployment.

Today, technological change is already affecting service jobs. We increasingly bank online, so retail banks are closing branches (more than 1,000 in the last two years). We also shop online, potentially reducing jobs in retail but creating others in parcel delivery.

These are not isolated examples. According to a 2017 report[27] from PwC, around 10 million jobs in the UK are at risk of automation by the early 2030s. The risks are considered highest in service activities involving physical labour, such as wholesale and retail, administration and support, and transport and storage (Table 1). A 2015 speech[28] by Andy Haldane at the Bank of England puts the total at 15 million jobs, again mostly in low-wage physical activities including sales and customer service, care and leisure (Figure 1). A 2017 McKinsey report[29] agrees: activities most at risk from automation are those that involve physical effort, or are predictable and structured.

This continues the trend of technology replacing physical labour, but a big question is what will happen to intellectual labour. Haldane estimates a lower risk of automation for professional occupations, managers, directors and senior officials; but Susskind and Susskind[30] argue that the traditional professions are vulnerable to a wave of technological change. A report by Deloitte also forecasts that nearly two-fifths of jobs in the legal sector will be automated in the next ten years[31]. Meanwhile jobs that combine both intellectual and physical skills will probably be much more difficult to automate.

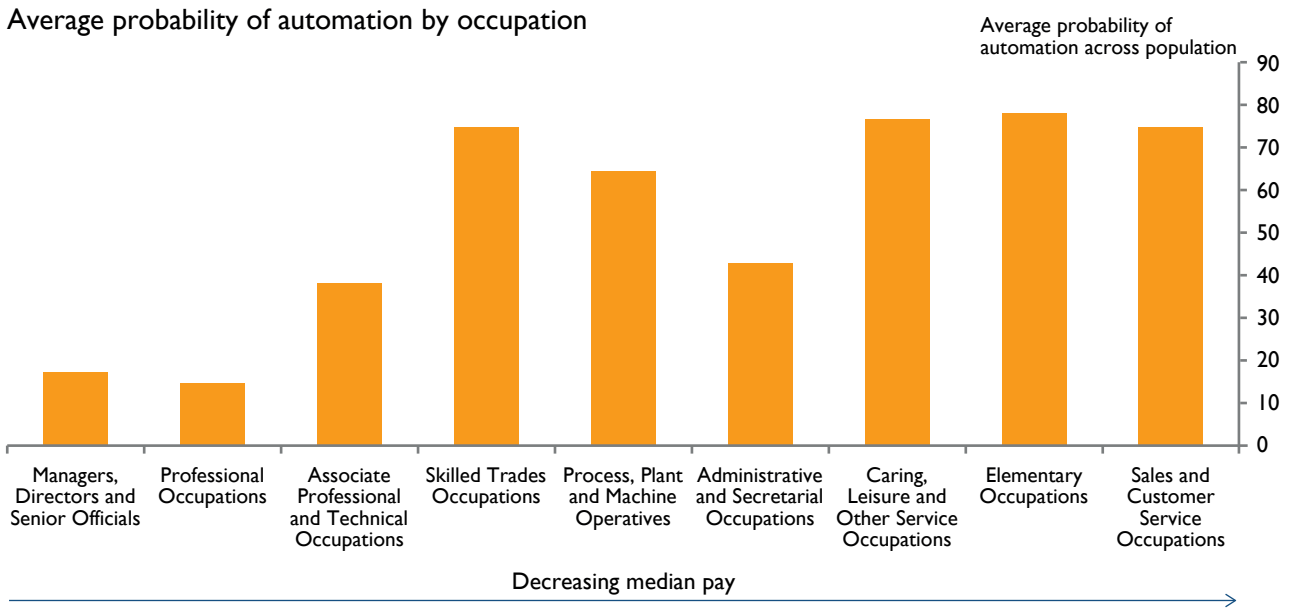
Even if total employment is not hit, a danger is that skilled jobs are being replaced by lower-skilled jobs. However, there is some evidence that in manufacturing, automation actually increases the

demand for skilled jobs, replacing lower-skilled and management roles[32]. Automation may assist in maintaining growth with a reducing working population.

Overall, we still need to understand how technologies and people will combine to be economically productive in the future.

Industry	Employment share (%)	Job automation (% at high risk)	Jobs at high risk of automation (millions)
Water, sewage and waste management	0.6	62.6	0.13
Transportation and storage	4.9	56.4	0.95
Manufacturing	7.6	46.4	1.22
Wholesale and retail trade	14.8	44.0	2.25
Administrative and support services	8.4	37.4	1.09
Financial and insurance	3.2	32.2	0.35
Public administration and defence	4.3	32.1	0.47
Electricity and gas supply	0.4	31.8	0.05
Real estate	1.7	28.2	0.16
Information and communication	4.1	27.3	0.39
Professional, scientific and technical	8.8	25.6	0.78
Accommodation and food service	6.7	25.5	0.59
Construction	6.4	23.7	0.52
Mining and quarrying	0.2	23.1	0.01
Arts and entertainment	2.9	22.3	0.22
Agriculture, forestry and fishing	1.1	18.7	0.07
Other services	2.7	18.6	0.17
Human health and social work	12.4	17.0	0.73
Education	8.7	8.5	0.26
Domestic personnel and self-subsistence	0.3	8.1	0.01
Total for all sectors	**100%**	**30.0%**	**10.40**

Table 1. Jobs at risk of automation according to PwC 2017



Source: ONS, Frey and Osborne (2013), Bank calculation
Notes: This chart shows the estimated average probability of automation across occupations using the probabilities in Frey and Osborne (2013) weighted by UK employment

Figure 1. Risk of automation by occupation

NEW SKILLS FOR HUMANS

Technologies not only replace people, they also enhance human abilities. Haldane argues that the new technologies will assist and favour people capable of tasks that require high-level reasoning – "large logical leaps of imagination rather than repeated small experimental steps. In a world in which machines come to dominate tasks involving core cognitive processing, the importance of, and skill premium attached to non-cognitive skills is likely to rise. The high-skill, high-pay jobs of the future may involve skills better measured by EQs than IQs, by jobs creating social as much as financial value. Yet our education system, at present, has a strongly cognitive slant. Perhaps in future that will need to change, with as much effort put into cultivating social CVs as academic ones".

The World Economic Forum (WEF) Future of Jobs Report, 2016 noted that creativity will become one of the top three skills workers need. Whereas negotiation and flexibility were high on the list of skills for 2015, by 2020 the WEF forecasts they will drop out of the top ten as further automation and machine learning improves and begin to make more decisions for us[33]. Emotional intelligence, which doesn't feature at all in the top ten today, will become one of the skills needed by all. So equipping the new work force will not only involve enhanced STEM skills, but also more emphasis on creativity and critical thinking[34]. This provides an opportunity for the education sector.

If human employees require more flexible skills, involving more complexity, they may become more difficult to manage using traditional controlling styles. That will affect the way that companies are organised, with business models becoming more distributed and companies outsourcing more to smaller independents.

DIGITAL ETHICS

Increasing automation raises several ethical issues. Among these are the risk of bias, robot rights and responsibilities, and locating liability for automated actions. For example, algorithms and artificial intelligence can be discriminatory, especially when trained on a dataset that has existing discrimination built into it, although might at least be made transparent through open-source software[35].

There are also concerns over privacy, and the collection and use of data from things and people. The social and ethical implications of technology adoption need to be considered, and this should not be left to the innovators or entrepreneurs.

The impact of technology on society is neither automatic nor inevitable, and can be influenced and managed through open debate and democratic regulation. This will help us to arrive at a new set of practices and governance, a new common-sense way of doing things for the information revolution.

FUTURES

Automation is inevitable, and it will affect the nature of services and of work. It could lead to a desirable future for humans, where automation is used to replace the less attractive aspects of work, and where we work creatively alongside the machines to the benefit of all. Or we might face a future where the majority of work is performed by machines and there are severely reduced employment and income opportunities, reducing demand for products and services – unless we bring in measures to redistribute the wealth created by the machines. Or growing aversion to digital automation and quasi-monopolies could lead to withdrawal and antagonism, along with punitive laws surrounding data and its usage, intellectual property and encryption.

Steering towards a more desirable future will need appropriate regulation, governance and investment.

CHAPTER 2 CASE STUDY

Evolving the service model

For centuries, insurers have provided a simple and essential service: they help customers manage the risks of everyday life by stepping in when bad things happen, generally with financial compensation on the basis of pooled risk.

Emerging technologies now offer insurers the potential to evolve, and ultimately transform, the model to one of risk prevention rather than mitigation. Connected devices in homes, and vehicles with built in telematics capability, generate vast volumes of data. Smart analysis of this data can offer insurers – and customers – an early warning system, enabling them to take preventative action before a significant loss occurs.

Aviva, the UK's largest insurer, has taken a number of steps to incorporate these technologies into its service offering. It has built a digital garage in Hoxton, London, housing cross-functional teams of staff largely from disciplines aimed to help capitalise on these innovations, such as data science and digital customer experience.

In 2016, Aviva started trials of LeakBot – a smart connected device designed by HomeServe Labs to detect mains water leaks in consumer homes. Water leaks are the second biggest driver of home insurance claims in the UK, and typically cause considerable distress and damage. The technology enables early detection of leaks, which can then be rectified before they become a big problem.

Through its internal venture capital arm, Aviva has also make investments in a number of technology start-ups that could ultimately disrupt the industry, including:

- Cocoon, an internet-enabled home security device that alerts homeowners to movement within a house through monitoring of low frequency sounds, outside the range of human hearing
- Roost, a US-based start-up with a number of innovative connected devices including a smart battery that enables customers to install sensors into their homes in a simple and affordable way

This is a rapidly evolving area, whose success will ultimately rely on consumer uptake. However, the rapid evolution of consumers' use of technology over the past decade – with corresponding increase in expectations of the service industry – suggests that companies need to keep abreast of technological innovation if they are to continue to meet consumer needs.

CHAPTER 3

DIGITAL DISRUPTORS

Digital technology is already transforming service sectors including finance, retail, music and entertainment. Platforms, for example, can make services more efficient and effective, widening the choice for customers and the market for suppliers. As discussed in previous chapters, automation will change the employment landscape. The challenge is to use this disruption to increase productivity and employment, and improve quality of life for all.

DIGITAL DISRUPTORS

The information revolution is built on the digitisation, collection and processing of real world information. By making this information machine-readable, it can be shared and accessed globally; the information has been 'liquefied'[36]. This makes for better and faster data collection and manipulation, and decision making, all with reduced human input.

Among the most important technologies enabled by digitisation, platforms can be thought of as virtual markets connecting providers and users. They create a place where suppliers and customers can interact to create value[37]. Platform owners use software, including artificial intelligence and machine learning (see below), to match users efficiently. Platforms become more attractive to each user as they grow in scale, leading to natural monopolies. Acquiring and exploiting usage data can become more important to the platform owner than the original services.

Along with the rise of automation (Chapter 2), these digital disruptors are changing the way both professional and personal services are delivered. Service industries involve a strong interaction with the customer, who starts the service delivery and often creates value in the service process. This leads to particular challenges: customers are unpredictable in their arrival time, the nature of their request, their capability, the effort they are prepared to expend and their feelings on the quality of the service received. These challenges can reduce productivity and quality. Traditional methods to deal with these uncertainties include building spare capacity of space, time and people - which can result in waste (a recent report[38] estimated that typical waste levels in service are as high as 50%) and unsatisfied demand. The automation of services is a way to tackle these issues and increase productivity.

Digital technology such as artificial intelligence and machine learning, virtual and augmented reality, and the Internet of Things can remove some of the physical and time constraints associated with services. Meanwhile platforms do things differently, and have different economics underlying them. Platforms challenge existing business models, in which value passes as a flow along the supply chain ending up with the customer. Increasingly, the production of data as part of the service is becoming valuable to service providers as it can help to provide a more complete usage picture.

These technologies are already having a huge economic impact. In 2014 more than 15% of GDP was generated by digitally intensive industries, predominantly in the service sector[39]. To look more closely at how new technologies are changing services, we will take the example of the leisure industry.

LEISURE

The leisure sector suffers perhaps more than other areas from unpredictable demand. It is also highly personal, part of the growing experience economy. Digital technology is now disrupting this industry in several ways.

Distribution channels

Digital technology has transformed tourism distribution. The internet made it possible for hotels and airlines to sell directly to consumers. Along with new sources of information, including crowdsourced reviews, this cuts out intermediaries such as high-street travel agents.

However, travel agents and other intermediaries have now found ways to use online platforms to fit themselves back into the supply chain, serving those unwilling to use the internet or unhappy with e-commerce service levels – in particular with service recovery if there is a failure. Today, online tourism intermediaries have turned into information aggregators, who search and sort information on various travel deals.

Smart tourism

Smart tourism means gathering information about tourist activities through linked sensors and the Internet of Things and analysing it to

identify movement patterns, all with the aim of improving the traveller's experience. In Singapore for example, the Tourism Information and Services Hub holds information for tourism stakeholders, including SMEs and app developers. It has developed the One Singapore app and smart kiosks to guide visitors.

Future developments could include using big data analytics and new models of travel to free resources and ensure sustainable use of sensitive environments. That would bring citizen science to bear on environmental management, making communities better able to determine the economic and social value of local sites such as coral reefs.

Reinvented tourism

Augmented and virtual reality are already disrupting the production and consumption of entertainment. This is being extended into tourism.

AR overlays on your phone or tablet can help tourists retrieve and process information on buildings, objects and exhibits. This can enhance perception and thought processes, and aid in decision making. Museums, galleries and parks can overlay exhibits with information through touchscreen displays, smartphones and wearable devices. San Francisco's de Young Museum was among the first to introduce a Google Glass-powered exhibition[40] in 2015, letting visitors access audiovisual materials and testimonials revealing the story behind Keith Haring's artworks.

VR, meanwhile is moving from a niche technology into the realm of everyday experience. Cheap VR viewers such as Google Cardboard and an abundance of tourism content make it easier to take virtual tours of cities and attractions. With its ability to simulate intricate, real-life situations and contexts, VR has been touted as a substitute to actual travel – offering the potential for virtual visits to real destinations. That could be beneficial for vulnerable natural and cultural heritage sites threatened by mass tourism.

A snag is that VR might discourage real world tourism, so local communities miss out on revenue. On the other hand it could act as a powerful marketing tool, offering compelling imagery to potential tourists in a 'try before you buy' experience.

Robotics

Service robots are increasingly able to deliver leisure services such as check in, service delivery, and food preparation. This enables faster and more consistent delivery, and passes some service functions on to the customer.

Tourism platforms

Platforms have disrupted accommodation (Airbnb), transport (Uber), food delivery (Deliveroo), and tourism (Trip4Real). By allowing people to serve one another by sharing resources, these platforms reduce prices and increase service delivery speed and convenience, and often offer an enhanced sense of community and interdependence. They also give tourists an authentic experience of being served by locals.

Peer-to-peer accommodation has changed the ways people travel. They tend to travel more often, stay longer and participate in more activities. Budget hotels are already suffering from the growth of Airbnb, but there may be mutual benefits within the wider industry as traditional hotel chains are now collaborating with platforms, using them to accommodate their own customers when overwhelmed with demand.

Successful platforms develop new markets – starting perhaps with a simple delivery service, then extending that to offer related products and services. For example, Deliveroo are building on their knowledge of real-time customer demands and trends by creating pop-up kitchens to meet specific food demands that are not available locally. And in developing autonomous vehicles, Uber can exploit their knowledge of routes, customer demand and regulation.

A SERVICES REVOLUTION

As we have seen, digital innovators are increasing customer satisfaction in leisure by improving the speed, transparency and reach of service delivery, as well as increasing customer interaction and choice and allowing better and more sustainable use of resources. This is true across all types of service: professional, financial, creative, health, personal, social and government. Some examples are given in Table 1.

Digital disruptors are affecting not only manual activities but also the creative areas of design and decision making. Less susceptible at present are activities that are unpredictable and require elements of dexterity and adaptability.

The revolution in service delivery is at an early stage. It will enhance customer experience, simplify processes, improve use of existing and potential capacity, and allow better informed decisions and improved information flows. Technological changes, brought about by entrepreneurs exploiting profitable new spaces and solving problems, will make advanced management practices developed in manufacturing easier to implement, bringing further gains in productivity.

Service sector/ industry	Disruptor				
	Internet of Things, sensors and big data	Augmented and virtual reality	Robotics	Artificial intelligence and machine learning	Platforms
Wholesale	Condition monitoring, location tracking	Staff training	Picking and loading	Purchase patterns, routing and scheduling	B2B e-commerce
Retail	Beacons for targeted advertising, movement patterns	Pre-purchase trials, visualisation of purchase in context	Loading, service staff replacement	Consumption patterns, movement patterns, matching online and offline behaviour	B2B, B2C and C2C
Repair	Condition based monitoring	State monitoring and efficiency	Repetitive predictable tasks	Usage patterns, diagnostics and predictions	Trade and tool hire
Transport	Location and movement, mapping, scheduling and routing, arrival times	State monitoring and reporting and diagnostics, staff training, route design	Autonomous vehicles	Movement pattern analysis and prediction for smart cities; smart buses	C2C ride sharing, B2C services
Storage	Condition monitoring	Staff training, design	Picking and loading	Routing and scheduling	B2B trading
Accommodation	Movement patterns	Viewing and selection	Check in, cleaning and maintenance	Movement patterns and design	B2C and information aggregators
Food services	Condition based monitoring, usage and wastage	Training and design	Preparation and service	Consumption and purchase patterns	Delivery and creation
Publishing and broadcasting	Usage patterns	Personalised entertainment and gaming	Production	Consumption and purchase patterns, content production	Social media networks

Telecom, IT and information services	Condition monitoring and network design	Design	Production	Content production	Operating systems
Finance and insurance	Movement and behaviour patterns	Training and design	Service chatbots and advisers	Pattern recognition and pricing	Fintech B2B and B2C, C2C crowdfunding
Real estate	Pricing patterns	Viewing and information overlays		Pricing and movement patterns	Property trading platforms
Professional services, research and development	Condition monitoring 24/7 service	Training and design, simulation, projected mapping	Production	Pattern recognition and diagnosis, full data audits, legal and tax case review	Recruitment, B2B and B2C services for development, identity and security
Professional admin and support	Condition monitoring, usage	Training and design	Investigation	Pattern recognition and diagnosis	Recruitment, rental and leasing platforms
Public admin and defence	Condition monitoring, location tracking, cyber security	Usage and design	Service chatbots, semi-autonomous weaponry	Pattern recognition, cyber security and warfare, evidence collection, crime detection and prevention	B2C service delivery
Education	Movement and behaviour monitoring	Training and design	Personalised learning and teaching	Personalised learning and teaching, machine translation	Massive open online courses
Health, residential care and social work	Condition based monitoring, smart toys and bandages, 3D mapping	Training and diagnostic information overlays, haptics for design and training	Operations, care services, cleaning services	Diagnosis and prognosis, digital assistants	B2C recruitment
Arts, entertainment and recreation	Condition monitoring, movement patterns, emotional monitoring	AR overlays and VR experiences, personalised gaming, improved access	Training and haptic experiences, pleasure bots	Pattern recognition and personalised entertainment and services, improved accessibility, mood measurement, digital assistants	B2C entertainment services

Table 1. Examples of how digital disruptors are used in different service sectors.
B2B refers to 'business-to-business'; B2C, 'business-to-consumer'; and C2C, 'consumer-to-consumer'.

DIGITAL OPPORTUNITIES FOR THE UK

How can we take advantage of this revolution in services?

From things to processes

Opportunities still exist to develop new services through digital technology. Some involve rethinking the business and organisational model – for example offering a service instead of a product (Chapter 4). This could become more valuable as services are unbundled into pay per use – for example autonomous vehicles may be priced and insured on a pay per use basis rather than an ownership basis.

The UK could use this kind of thinking to turn its expertise in academic excellence, and its reputation for probity into a service. For example, the National Physical Laboratory are building on their reputation for measurement integrity by developing time as a service. Time that is more accurate than that based on GPS can be transmitted to users for time stamping contracts and trades, for example.

New platforms

There is potential to develop new platforms beyond the existing areas of transport and entertainment. For instance, platforms could assist in healthcare and education by enabling a wider range of suppliers to participate, with decentralised delivery methods, expanding customer choice. Co-operative, non-profit platforms could deliver social care and education, by connecting people socially[41]. The government could aid innovation by delivering some government services through platform technologies. At one end of the scale this could mean platforms allowing more citizen participation in government decisions. At the more radical end, a platform could enable the purchase of education or social care from providers, as today accommodation is purchased from Airbnb. These developing models could be licenced for use abroad.

Globalised services

Here the UK could exploit several competitive advantages. Strength in intellectual property rights could translate to an international trade in patents expertise. With our proven legal and financial expertise, the UK could become a global centre for writing digital contracts, especially in the growing field of outcome-based contracts, where performance and rewards need to be clearly defined (Chapter 4). Media and creative strengths could be exploited by increasing the attractiveness and accessibility of UK generated content.

Regulation and standards

Starting with early engineering standards such as screw threads and rail gauges, British standards have helped to create global markets, and today the UK's regulatory and standards institutions have good reputations. This provides opportunities.

We can experiment with regulatory approaches to digital disruption. We need to develop both a thriving multi-platform infrastructure and an ethical approach to using artificial intelligence and data ownership, which could be encouraged by using regulatory sandboxes originally developed to assist fintech growth.

That could be extended to providing regulation as a service. Building on the UK's strengths in arbitration, mediation, and expert determination services, we could create procedures for contracts using distributed ledger technology, establishing UK procedures as de facto standards. It could be developed as a platform, in which the curation and algorithm development would be the intellectual property to be exploited.

One long-standing and successful UK service export is standards within a voluntary market framework. Voluntary standards can effectively complement regulation while supporting competition, and could have a key role to play in building trustworthy and safe modern service industries.

Local currencies

New technologies such as distributed ledgers could support new local currencies, turning money into a social good. The Bristol pound and the Brixton pound, supported by local government and credit unions, already help to facilitate trade within local communities, encouraging local diversity and resilience. Experimenting with the use of a distributed ledger to operate these complementary currencies could add to the security of these systems, allow for currency appreciation, and encourage experimentation. This could encourage regional development from the bottom up.

Data ownership and identity

Data has been described as the fuel of the future[42]. Each service transaction and subsequent use of a product or service generates large amounts of data, which can be used for e-commerce and targeted advertising. The issue of data ownership remains contentious, as does privacy and identity. We could take a lead in using digital technologies to create a strong secure identity system that removes duplication and offers an improved and targeted identity service to users.

DIGITAL CHALLENGES

There are considerable challenges to fully realising the benefits of digital services in the UK.

Platform monopolies

With platforms, the more users there are, the more attractive the platform. This has led to some platforms becoming quasi-monopolies, pushing the boundaries of competition and regulation, as shown by recent EU fines levied on Google for market abuse. Their power enables digital platforms to extend beyond their original purpose – raising questions such as, will all self-driving cars be operated by Uber or Google?

Technology diffusion

Since 2008 and possibly before, productivity growth has stalled. Haldane[43] makes two connected points on productivity performance. In contrast to a few high-performing companies, most companies cluster at a very low level of performance. This seems to be a universal feature found in every sector, region and firm size. Increasing the productivity of these low-performance forms by 25% could boost UK productivity close to German and French levels. The second point is that management practices are important in achieving short and long term productivity growth. One link between the two is technology diffusion – in cases where management in the high-productivity firms are exploiting new technology, that others are not.

New measures of value

While productivity is closely related to growth in manufacturing and GDP[44], it has several drawbacks when applied to services[45]. The quality of a service is often hard to measure in purely financial terms. This is particularly true in education, social services and healthcare, which have tended to see low productivity returns despite the valuable human service they provide. Improving productivity in services by reducing labour content or cost can lead to a reduction in quality perceived by the customer. Traditional financial measurement systems cannot capture the value of creativity or expertise. And concentrating solely on productivity can lead to the relegation of other economic and social concerns, such as inequality and equal treatments.

So we need new service-oriented measures to complement economic productivity.

That should include non-financial measures based on outcome, satisfaction[46] and usage, which are made possible by new technology.

The use of life-based indicators[47,48] could help address such problems as an ageing population and climate change. For example, measuring social and health care outcomes using a measure such as quality-adjusted life years could raise the profile of both the service and the employee. The New Economics Foundation[49] found that there is a lack of coherent indicators in many areas including wellbeing, social fairness and sustainability.

CONCLUSION

We are probably at the beginning of a long transition in the information revolution. Digital disruption offers ways to improve service productivity and explore new business models, offering more convenience to both customers and providers. But this is not just about technology adoption. Improvements in service delivery involve a complex interaction between the service itself, the customer, and the people providing the service. A customer and person-centric view is required, along with the appropriate educational and financial environment to prepare and nurture people and organisations during the transition.

CHAPTER 3 CASE STUDY

Alchemy VR

Alchemy VR specialises in immersive storytelling through virtual reality. VR allows users to become immersed in events that they would not be able to experience otherwise, such as joining astronaut Tim Peake in his descent from the International Space Station.

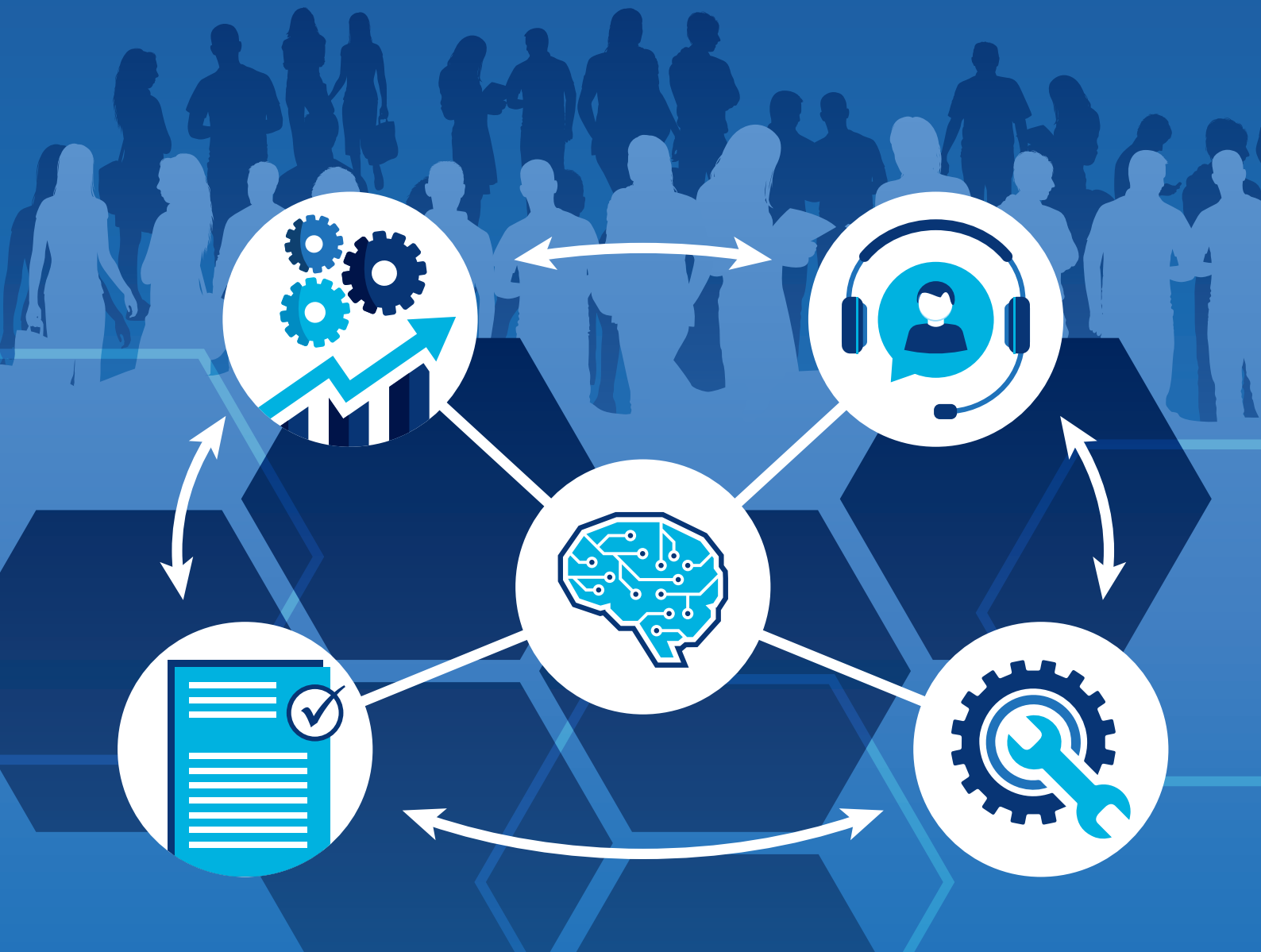
Since 2014 the company has produced content across a variety of digital platforms and a broad range of topics from natural history to space exploration. For each commission Alchemy draws on a broad range of experts and craftspeople including video compositors, audio designers, camera technicians and marketing strategists.

The company's educational experiences were some of the earliest non-gaming content to launch on Sony PlayStation VR. They have also developed mass-audience VR experiences. *David Attenborough's First Life VR* at the Natural History Museum in London allowed up to 60 people to take part in the experience simultaneously. Internal museum evaluation found that 84% of visitors learnt something new about the natural world and in addition to this 68% of visitors felt the experience gave them a new understanding of the museum's scientific work, suggesting that VR can be a powerful tool to engage the public with science.

CHAPTER 4

SERVITISATION

The boundary between manufacturing and services is blurring, as solutions replace products and outcomes replace outputs. This provides new opportunities for UK firms to create and capture value, improve productivity and boost competitiveness.



SERVITISATION

Manufacturing firms have traditionally made and sold products, but that is changing. More and more of them are offering services and solutions – the end results that customers want. This phenomenon is known as servitisation[50,51,52]. While it is not new, developments in technology and business models are making it more widespread.

Through its Mindsphere platform, Siemens offers services designed to maximise the uptime of equipment. John Deere couples GPS location data with satellite imagery to help farmers maximise yield from the fields they tend. Volkswagen has launched Moia, a separate company that provides mobility solutions, including fleet-based commuter shuttles. This is an example of mobility as a service (MaaS), an area that will be covered by the forthcoming Government Office for Science project on the future of mobility which will look at the transport system and the broader implications for society out to 2040.

THE SERVICE STAIRCASE

In the past, many manufacturers have sold original equipment at or close to cost, and secured additional revenue from spares, repairs and consumables. In this model, vendor and consumer interests can diverge. Beyond a threshold there are diminishing returns to increasing investment in product reliability, particularly where brand reputation commands less of a premium. Interests can align more closely if manufacturers shift focus to provide services and solutions.

Take, for example, a manufacturer that has traditionally sold construction and mining equipment. Such long-use machines could provide sustained revenue streams from parts and maintenance. A service level agreement on parts availability increases uptime for users, so improves alignment of incentives (at the cost of increased supplier inventory). Interests become further aligned with vendor guaranteeing uptime, or even vendor contracting on the basis of outcome (for example cost per tonne of material extracted).

An example of this increased alignment is Caterpillar, who run a business called Job Site Solutions. Trucks are fitted with weighing scales that ensure they are optimally loaded, while GPS tracks their location and speed to optimise cycle times.

This series of options can be seen as a service staircase (Figure 1). Climbing the staircase increases alignment of interests, but could also increase risk for both parties as they become more dependent on one another.

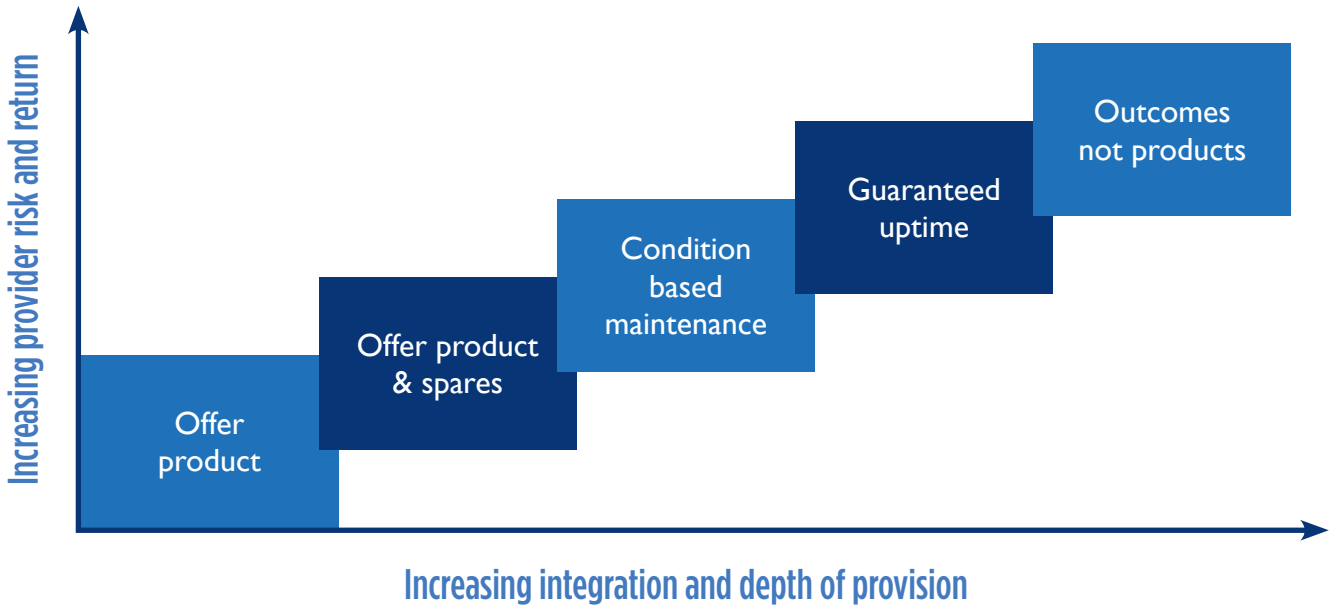


Figure 1: The service staircase (Neely, A.D., The Cambridge Service Alliance, University of Cambridge)

WHY SERVITISE?

The main reasons come under 4 headings:

Economic

Manufacturers in developed economies, with high labour costs, can compete in a world of cheap labour by servitising. They shift the focus of competition away from the product and towards high value innovative services.

Servitisation can also open a huge new market opportunity. Providing maintenance and support can be more profitable than selling the original product: if a piece of capital equipment sells for €1 million then typically it will consume around €4 million in spares and consumables through its working life – and the margin can be 10 times as high as on the original equipment. Service and support activities also provide a more stable revenue stream, which can smooth the effect of lumpy product sale revenues.

Strategic

There are 5 strategic reasons for servitisation.

Lock in customers. Products are sold close to cost but revenue is sustained on the provision of spares and consumables. Think of razors and their spares; printers and ink cartridges; cars and the spares used in service.

Lock out competitors. As demand for high margin service and support grows, new entrants are attracted to the services market. Many equipment manufacturers are partnering with their customers to create a strong competitive position and lock out these potential new entrants.

Differentiate between competitors. Some customers value the stability that service and support contracts offer. A fixed price can mean predictable maintenance costs, and transfer risk from the customer to the service provider. If a manufacturer can offer these benefits, it can give them an advantage over their rivals, if they can afford the transferred risks.

Fulfil customer demand. Many customers now demand that their providers offer service-based contracts. Budget airlines for example often lease rather than buy aircraft, avoiding the capital costs of ownership. Airlines also can contract for uptime (power by the hour), rather than engines. The interests of the original equipment manufacturers are now aligned with those of their customers: it is in everyone's interest for the asset to be available and working.

Use service to sell. Caterpillar talk about the first sales being made by the sales department and every subsequent sale being made by the service department. Volvo Cars seek to persuade their dealers that every service encounter is a chance to

build customer loyalty and secure a repeat purchase – and their data show that repeat business depends on both product quality and service quality.

Environmental

In car sharing schemes, for example, consumers no longer need to take physical ownership of their own car. This shared access has potential to cut the environmental impact. The emphasis on product service and uptime also incentivises manufacturers to innovate with respect to sensors and data that improve preventative maintenance, ultimately reducing lifetime product replacement costs and overall use of materials.

For assets that can be digitised, there is often no need to manufacture a physical product. We don't need to print books or make DVDs. Instead the data that enables people to access content can be shared electronically, eliminating resource-hungry production and distribution.

Technological

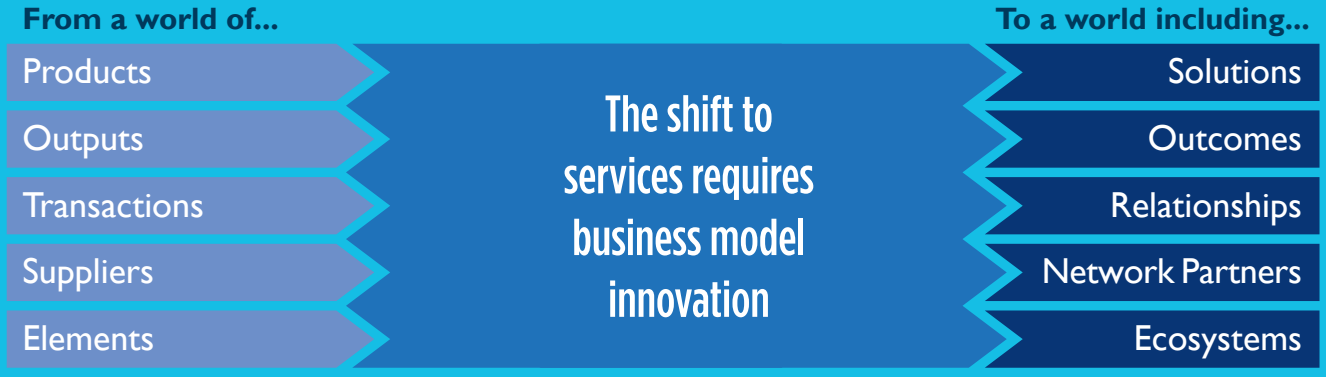
At one level technology is an enabler of servitisation, but the existence of the technology means that people will seek to exploit it. As the world becomes more instrumented and greater volumes of data are collected remotely, the potential for new and innovative services grows. Construction equipment is remotely monitored and the data used to make predictions about engine wear and the need for service and support. GE has models that allow it to recommend to customers the routes their airplanes should fly so they extend engine life. When planes fly over deserts the sand causes pitting in the engine, but a different form of wear and tear occurs when planes fly over oceans. So GE now recommend to customers how long their planes should fly to the Middle East and when they should switch routes and start flying over the ocean. These predictive analytic models are becoming more and more widespread in industrial circles, as well as healthcare, insurance and finance. The ability to capture and analyse big data opens up new opportunities for service innovation.

The UK government has commissioned a review of industrial digitalisation, under the leadership of Jürgen Maier, CEO Siemens UK. The 'Made Smarter Review' explores the role that new digital technologies might play in changing the economic landscape[53].

SHIFTING CONCEPTS

Servitisation involves 5 shifts on an abstract level: from products to solutions; from outputs to outcomes; from transactions to relationships; from suppliers to network partners; and from entities to ecosystems.

As manufacturers servitise they are expected to provide solutions that support or complement their products. Providers of complex engineered equipment are often encouraged to offer contracts that guarantee outcome or availability. These contracts are often long term, so providers are not engaged merely in transactions, but in relationships. Often several providers cooperate to support complex services – forming partnership networks around specific contracts. The networked nature of these collaborations makes it important to consider the industrial ecosystem when analysing complex services.



Neely, A.D., The Cambridge Service Alliance, University of Cambridge

SIX FUTURES

Digitised data, the cloud, GPS technologies, sensors and monitoring devices have already allowed firms to develop new servitisation business models, and the trend will continue. As more and more devices are connected to the internet, streaming back data in real time, there will be ever greater opportunities for system optimisation. Looking at these trends we can sketch out 6 future scenarios.

Shared resources through platforms

Airbnb is an example of a new model where excess accommodation capacity is shared with those who need it - Airbnb provides the platform to make these connections. Another example is BlaBlaCar, where drivers announce their route and invite others who wish to join them to flag their interest.

These shared-resource models could be much more widespread. Factories sometimes have spare capacity, sometimes excess demand. Offices have spare desks some days and yet are filled to the brim on others. Balancing capacity and demand at an individual organisational level is challenging, but new platforms could allow organisations to share resources. Those resources may be physical assets in hospitals, factories and offices; or materials and consumables (shared inventory); or even people.

Platform-based models open up new opportunities for manufacturers. Successful businesses can be created just by providing and operating a platform. At a more advanced level, businesses are exploring how they might create platforms not just to share capacity, but to share other valuable resources. For example, Apple's iStore is a platform for sharing resources such as apps. In the industrial world GE and Siemens are both creating platforms – Predix and Mindsphere – designed to support the sharing and utilisation of apps for industrial activities, such as remote monitoring of products and use of resources. These platforms will provide a foundational infrastructure for firms as they servitise.

Products as a service

Rather than taking ownership of a product, the customer may simply access the product when they needed to use it. Car firms are increasingly adopting this business model. Some through car sharing services, such as ZipCar, while others are encouraging customers to enter into long term car leasing agreements, with the expectation that customers will replace their cars on a regular basis. Le Tote and the Mr Right Collection provide similar services for clothing. For fixed monthly fees customers are able to lease clothing and accessories for a month.

Redistributed manufacturing

We have seen UK manufacturing move overseas to low-cost economies, but new technological developments such as 3D printers might change that trend, as manufacturing becomes more distributed and localised. One day towns and villages across the country might have their own 3D print shop, producing spare parts on demand. Then instead of having to create and stock large inventories, companies could sell a digital file and the right to print out a part.

Connected manufacturing

As more devices are equipped with sensors and connected to the internet, there will be opportunities for greater control over manufacturing and associated activities. Knowing in real time the location of assets and resources will make coordination within factories and across supply chains much easier.

The new world of digitalised manufacturing (often known as Industry 4.0) will create new opportunities for service businesses. Businesses will need to create and maintain the digital infrastructure which will be the backbone of digital manufacturing. They will need to provide services to support firms as they seek to analyse and extract insight from the ever-increasing volumes of data that their day to day operations create. In a world of connected manufacturing new high-value, data analytics based service jobs will be created.

Infrastructure as a service

Moving beyond products, firms are now exploring how they might provide infrastructure as a service. Rather than individuals owning their own infrastructure, sets of houses or apartments can share infrastructure. Qatar Cool, for example, is providing district cooling in Doha. They guarantee to provide a regular flow of cold water through pipes to cool down office blocks and residential apartments. As sensors in buildings start to measure more things, there will be more opportunities to control our environments.

The new age of public services

The purpose of the education system is to educate people so they are ready for their future. The purpose of the health system is to heal people, manage health status, and prevent ill health. The purpose of the prison system is to serve the principles of justice and encourage prisoners to turn their lives around. The purpose of social care is to provide support for those in need. In recent years the public sector has started to commission some services on the basis of outcomes, rather than simply paying for the inputs the systems consume. Clearly this is easier said than done. There are complex questions of attribution and dependencies that make commissioning for outcomes challenging – but as with all servitisation models, commissioning for outcomes will align the interests of the provider with the public sector more closely. The public sector will need to carefully examine potential unintended consequences, to ensure that the standards and quality of the intermediate steps in outcome delivery are met.

HOW THE UK CAN TAKE ADVANTAGE

Each scenario above offers opportunities for the UK. We could aim to be the leading environment for firms to experiment with different models of service provision – the UK as an innovation centre, a services and solutions testbed.

Develop capability

As providers climb the service staircase they develop closer relationships with their customers, often taking on new and greater risks as they become more dependent on their customers for information and resources. Developing the organisational capability and confidence to understand and accept these risks takes time. Initial contracts with government will enable providers to develop the skills and capabilities they need to successfully deliver services and solutions.

Encourage innovation

Servitisation requires firms to innovate their business model, identifying new ways to create value for providers and customers. Government can encourage experimentation in business models by deliberately designing procurement competitions to support business model innovation. A key requirement in tenders could be to identify how the proposed solution is innovative and creative, making best use of new technologies and approaches.

Enable platforms, data and infrastructure

Many firms are deliberately seeking to create new platforms for service industries. There are potential issues with market dominance of platform providers creating significant barriers to new entrants. Governments need to carefully consider how to optimise the competitive landscape for platform providers.

Platforms become more valuable with size. Uber works when enough drivers and customers have signed up. The iStore works because of the range of apps that are available through it. It is easier to scale up when you have a large market, so the UK government could support firms to scale by creating access to large markets. This can be achieved through procurement programmes in the UK and/or international programmes.

Promote interoperability

A quarry might operate some Caterpillar equipment, some Komatsu and some Volvo. In airports, different vendors will provide different subsystems. In hospitals, different equipment providers will support different departments. Yet to optimise the system that is the quarry or the airport or the hospital requires a holistic approach where data generated from different assets can be pooled and shared. Data interoperability standards, so that data can be shared and made available in an analysable form, could create new opportunities to drive competition, system level analysis, and optimal operation.

Create skills and knowledge

In an increasingly digitalised world, where new business models are enabled by data and analytics, we need to develop new skills. Working with leading ICT firms, government and industry can create national programmes and materials that enable lifelong learning. Developing a digitally literate and analytically minded workforce will be essential for future success.

Build confidence and awareness

Often firms complain that they are not clear how digital technologies are going to shape their operations and supply chains. The UK needs to create a network of innovation and demonstration centres, perhaps using existing infrastructure, where leaders of firms can be educated and inspired about the potential of digital technologies to enable servitisation.

CHAPTER 4 CASE STUDY

Perfecting the CEMEX Model

The long-term working relationship between CEMEX, Finning and Caterpillar® has resulted in the UK's first integrated equipment management contract at its Dove Holes limestone quarry in Buxton. The eight-year £11 million contract sees Finning and CEMEX working together with Caterpillar and Cat Finance to deliver a whole-site solution, incorporating the latest equipment, technology and quarry management expertise.

The new managed solution was 18 months in the making, beginning with an extensive analysis of the operation at Dove Holes by experts from the Finning Managed Solutions team and Caterpillar. By combining the latest Caterpillar technology with the on-the-ground experience of the CEMEX site team, Finning were able to develop a managed solution that would deliver key improvements to the site.

These included a 15% increase in production and a 10% reduction in machine operating hours, in addition to practical changes to the layout of the site. A key part of the delivery of these improvements is the ongoing performance management and optimisation of new and used equipment onsite, which will see the overall fleet reduced in size by 6%.

Using the latest communications technology, fitted to new and existing equipment, the whole fleet will be monitored by Finsight engineers. This team will liaise with onsite Finning engineers that form part of the CEMEX team, to manage the preventative maintenance and repair programme of all Cat and competitor machinery, ensuring contractual uptime targets and efficiency gains are achieved.

CHAPTER 5

SPREADING SUCCESS

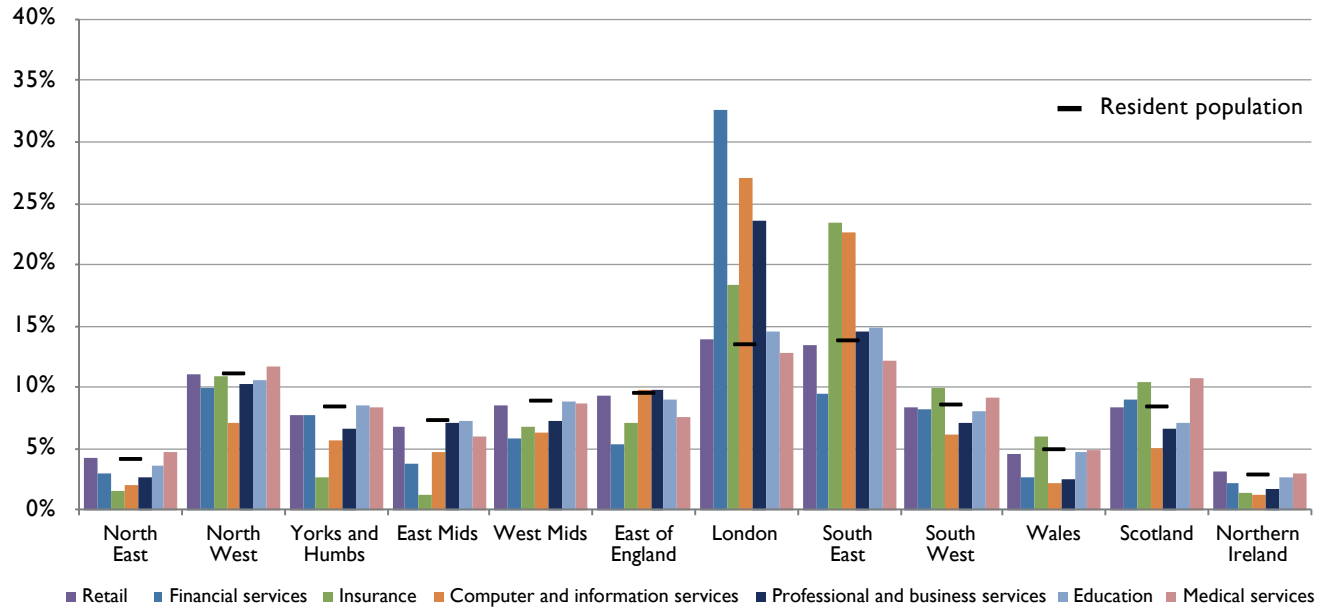
As technology unshackles workers from their offices, places around the UK have a new chance to attract talented people and rebalance the economic dominance of London and the south-east. Towns can improve their quality of life and foster a culture of innovation by aligning culture, education and other systems. More widely distributed investment, collaboration between small and big businesses, and the right balance of skills will all help to spread success in services throughout the country.

SPREADING SUCCESS

Over the past decade, many parts of Britain have not shared in the growth experienced by London and the south-east. From 2009 to 2014 London's economy grew by 28.9%; greater Manchester and Birmingham by only 15.2% and 16.3%[54]. GVA per head in London is 2.3 times as high as in the north-east, while in Camden and the City of London it is 20 times higher than Dudley, Northumberland or Blackpool[55].

We now have a chance to change this. For historical reasons, many of the firms responsible for the UK's success story are clustered in London and the south-east, but today digitisation increasingly means that people no longer have to live close to an office or other workplace. Instead they can choose their home on the basis of quality of life. Places that can attract the best talent will draw and retain other businesses and workers to their rich, lively and diverse environs.

Success also needs to spread from large to small. Because of their limited resources and market access, SMEs and microbusinesses in particular will need help to take advantage of the changing nature of services.



Source: ONS Business Register and Employment Survey, 2015 and ONS population estimates, mid-2015

Figure 5: Service industry employment shares by area.
Source: ONS Business Register and Employment Survey, 2015 and ONS population estimates, mid-2015

NEW STRATEGIES

The government's new Industrial Strategy aims to steer our economy to the areas of our greatest advantage and tackle our known weaknesses, ensuring growth reaches all parts of the country.

It has identified grand challenges - including the ageing society, clean growth, the future of mobility, artificial intelligence and the data revolution - to help put the UK at the forefront of industries of the future. Key policies include major increases in research and development investment, technical education and STEM skills, infrastructure investment, sector deals and a focus on improving productivity, and policies to support the development of local industrial strategies.

Learning the lessons of the past is imperative. The service sector and the creation of intangible assets

has often been perceived as being secondary to the need to rejuvenate manufacturing or halt the decline of traditional industries (Chapter 1). We know, however, that automation, AI and digitisation are having a profound impact on all sectors, whether service-based or manufacturing (Chapter 2). Deloitte Insight, for example, forecasts that 39% of jobs in the legal sector stand to be automated in the next 10 years[56].

If the UK is to build a more inclusive economy, so that wealth and growth prospects are more evenly distributed, we need to design forward-thinking strategies built on strengths and opportunities.

COMPETING FOR PEOPLE

A critical input into our service industries is skilled human capital. So for a location to have a successful service sector, it must attract and retain skilled and talented people.

Digital tools, networks and platforms have reduced the need for people to physically turn up to an office or other workplace. Many businesses already operate through distributed communities, with staff living in different countries. This means that:

- we need to continually invest in and improve digital infrastructure and skills
- cities and regions can compete for human capital on their quality of life

Both cities and rural communities can attract and retain the best talent by being pleasant and easy to live in, and presenting an aesthetic and a vibe beyond the utilitarian[57]. As workforces become more geographically distributed we need to think about how we replicate the social functions of the workplace – personal interaction, stimulation, idea generation – through place-based strategies that complement digital collaboration.

SPECIAL PLACES

Cities and other communities need to become 'stickier' – attracting and retaining skilled and talented workers. To help places do this, we need them to understand and celebrate their distinctiveness by building on their assets and developing their strengths.

Research published by PwC finds that, while jobs and employment opportunities are necessary to attract and retain human capital, they are not sufficient[58]. The other features that make a place attractive are:

- a culture of innovation
- high quality of life
- high intellectual capital

The last of these means that stickiness has a positive feedback. Talent attracts talent. Similarly, research by NESTA[59] shows that advertising and software firms are very often found near both high-tech manufacturing businesses and knowledge-intensive business services. Other creative sectors that provide content and cultural experiences show weaker, although still significant, patterns of co-location with knowledge-intensive business services. The research suggests that this is because of several factors including links between value chains, shared infrastructure and knowledge spillover. NESTA also point to the presence of creative firms generating an 'urban buzz' that attracts skilled workers and encourages collaboration: the clustering of like-minded people with shared values and aspirations.

To attract the vital intellectual capital that the UK's future economy will depend on, cities and towns need to invest in cultural and social infrastructure, and build a visible, local investment climate to encourage enterprise.

Innovation and research and development

In 2015 research and development spending in the UK was 1.7% of GDP. This contrasts with an OECD average of 2.4% (2016). Since 2000 South Korea has doubled its spending on research and development; China has increased its spend from 1.9 to 3.1% and Germany from 2.4 to 2.7%. In contrast the UK's level has remained unchanged. Some point to the UK's strength in services as a reason for our low research and development spend, but the US economy, which has a similarly strong service sector, committed 2.78% of GDP to R&D in 2015[60].

Much investment within the service sector is directed at technology rather than content development. It is manifestly not 'all about the pipes', however. Content is not a by-product of new technology; it drives enterprise and the

marketability of new tech products. Content creation pushes technological innovations. This is clear in the development of augmented and virtual reality technologies. The global AR/VR markets are forecast to be worth $150 billion by 2020, but this will not be achieved in a vacuum – high-quality apps and content must be created to capture the imagination of the consumer and encourage the mass adoption of headset technology. Content often pushes technological innovations and encourages innovative ways of doing things. The increasing demands of UK-produced blockbuster films is a good example. Productions such as Star Wars, Harry Potter, and Gravity have required visual effects crews in Britain to find innovative solutions in post-production that match the ambitions of the director and film studio, rather than vice versa.

Investment

The UK is home to only 6 of the world's 177 tech unicorns (start-ups valued at over $1 billion). We have struggled to commercialise research, create new companies and scale them up.

Much has been written about the UK's dearth of new companies of the scale of Google, Amazon or Facebook, and there is some evidence of capital market limitations. Many in the UK tech community want to stay working in the country, but that becomes more difficult if their owners want them to relocate.

Financing innovation and growth in the service sector remains challenging, particularly for SMEs. Investing in intellectual property is still inherently risky, and for those SMEs who make it past the start-up phase and establish revenue generating businesses, the intangible nature of their IP often frustrates their access to growth funding.

To grow big, businesses need a strong and connected supply of finance – from start-up to scale-up. In the 2016 Scale-Up survey[61], 62% of creative businesses acknowledged that they would be able to grow their company faster if they had better access to growth capital finance. This is an even greater issue for businesses outside London.

Compared with our OECD counterparts, the UK ranks low in fixed capital investment and scale-ups[62]. This is a cause for concern, especially as the wider equity market is slowing[63]. It is further compounded by the UK's declining access to the European Investment Fund since Article 50 was triggered. Previously the fund accounted for one-third of all UK venture capital investments[64]. The slowdown has particularly challenging implications for risk capital and investment in IP.

We need to grow the equity market beyond London and the south-east, as the British Business Bank has highlighted, with last year's Small Business Equity Investment Tracker showing only two regions outside London – the south-east and West Midlands – experiencing year-on-year increases in equity deal numbers between 2011 and 2015 and no region other than London having seen continuous year-on year increases in the total annual investment between 2011 and 2015[65].

Many of our cities and regions have little 'smart money' – early-stage investment that brings with it the skills, experience and contacts of investors. Few investors in start-ups – known as business angels – are active outside the London-Cambridge-Oxford triangle. In other regions, there is also lower awareness of angel investing, as shown in their low take-up of tax relief available through the Enterprise Investment Schemes[66].

We must ensure that the UK's financial ecosystems become more distributed and more sophisticated. And given that the UK simply does not have the money to rival the US or Japan, we should consider innovative solutions for this this kind of investment, as recognised by the government's commissioning in 2017 of a patient capital review.

Collaboration

Collaboration is a feature of our digital and connected world. The service sector is increasingly operating on a project basis, bringing diverse disciplines and skills together, both within large companies and in groups where freelancers/sole traders/micro-businesses come together and then disperse on completion of the project.

Other collaborations are between big businesses and smaller entrepreneurs. Entrepreneurs can benefit from larger companies' market access, customer bases and distribution networks; larger firms can take advantage of faster innovation and the creativity that often flourishes within a

smaller-scale business. Research by Accenture found that 82% of large companies say they can learn from entrepreneurs about how to become a digital business, with 50% believing they need to work with entrepreneurs to be sufficiently innovative[67]. However, the survey also uncovered obstacles, with entrepreneurs questioning partners' commitment to supporting the growth of their businesses and fear about loss of IP. And while 71% of large companies reported successful collaboration with entrepreneurs, little more than half of entrepreneurs agreed.

These trends bring an increase in innovation, help to build services ecosystems, and create new markets. Cities need to invest in the connectors and brokers who facilitate this sort of collaboration.

Skills

Some of these new skills required by automation (Chapter 2) could be encouraged with a hybrid approach to skills and executive education – an approach that crosses the divides of our current education systems between the arts, sciences, technology and business sectors. This would help to create the challenger businesses of tomorrow, and attract and nurture the people needed to build vibrant cities and regions.

Service businesses, from advertising through the professional services, are increasingly becoming 'fused' businesses, exploiting both creative and technical expertise. Many rely on interpreting and exploiting substantial data sets which require information management and technical skills and then ensuring that their user-interaction is creative and engaging, requiring design and communication skills (see Evidential, page 20).

The entrepreneurs leading these businesses are as likely to have a background in arts and humanities as in science, technology, engineering or maths. Teams that combine these skills excel at problem solving, innovating, and adding value in the creative digital economy. Recruiting such blended teams is a relatively new phenomenon. Previously engineers went into engineering and designers went into design, but now for example Land Rover Jaguar are recruiting games designers for their interface systems because they understand user engagement.

Recent research[68] in Brighton shows the emergence of fused business clusters combining art and design skills with technology expertise to create a competitive advantage. These businesses have shown double-digit growth rates in turnover and employment.

Apprenticeships

Employers have generally welcomed the government's new focus on technical education, skills and training, but the project-based and freelance nature of the digital economy and the increasingly globally-diffuse nature of the service sector may present challenges in terms of businesses being able to offer apprenticeships and access associated funding. As the apprenticeship reforms bed in, it will be important for the service sector to work with government to identify how employers can meet their skills needs through apprenticeships.

CONCLUSIONS

UK cities and regions can attract and retain talented people by improving their quality of life; paying attention to culture and other intangible strengths as much as to the wires and fibres of digital infrastructure. We can use a systems approach to drill into the detail of what strengths are located where, then by building on these assets throughout the country we can support business growth targeted at future opportunities. Education policy can help by putting more emphasis on the liberal arts in parallel with science and technology – not STEM (science, technology, engineering, and mathematics), but STEAM (including arts).

At the same time we need to address a troubling lack of finance for growing companies. And we can encourage the trend of collaboration between entrepreneurs and big business, so small companies gain market access while big businesses benefit from entrepreneurial innovation.

CHAPTER 5 CASE STUDIES

New Manchester

The economic slump in Greater Manchester through the 1970s and 1980s hit not only traditional heavy industry, but also creative industries. Yet today it is a vibrant, entrepreneurial and distinctive centre of creativity, boasting the Manchester International Festival, MediaCity UK and the creative centres and facilities of the Space and Sharp Projects.

This renaissance may be partly due to the pivotal investments made in the city when it hosted the Commonwealth Games in 2002. Starting with the construction of sporting facilities including the National Squash Centre and the velodrome that hosts the National Cycling Centre, the event kicked off a regeneration project that reached across the city.

In 2011, several BBC departments relocated to Salford Quays. Following the BBC relocation, dozens of digital, content and creative businesses established themselves nearby, resulting in a 70% growth in new digital companies. Manchester now has the second largest media hub in Europe (London being the largest). Overall the move boosted the UK economy by £277 million in just one year[69]. This is equivalent to approximately 5% of the GVA of Salford, 2% of the GVA of Manchester and 6% of the GVA of the UK's programming and broadcasting sector.

Another cause of this creative ferment may be that Manchester is home not just to world-class culture but to one of the largest clusters of computer science graduates in Europe and some of the world's leading science and technology researchers, making it a natural home for fused businesses.

Silicon Spa

The games industry is a global export opportunity for the UK. Not only do we make great games, we are also strong in the technology and machine-learning that underpins them. And this is a big market: Newzoo's Global Game Market Report[70] reveals that 2.2 billion gamers across the globe are expected to generate $108.9 billion in game revenues in 2017.

Unlike many industries in the creative sector, the games industry in the UK is not concentrated in London. Some 85% of employment in games is outside the capital[71] and Leamington Spa in the West Midlands is one hotspot.

Silicon Spa is an established games cluster centred on Leamington Spa and taking in Coventry and the towns of Warwick and Southam, with over 50 studios directly employing some 1,500 people and supporting a wider base of contractors[72]. These are highly skilled and productive jobs, generating an estimated £188 million in GVA in 2015. Local companies include Codemasters, Fish in a Bottle, Pixel Toys, Modern Dream, Radiant Worlds, Kwalee, Playground Games, Exient, Sega Hardlight and Ubisoft Leamington.

The Serious Games Institute in Coventry is an internationally recognised centre of excellence in applying games technologies to learning, professional development and research. A spin off from the School of Computing, Engineering and Mathematics at Coventry University, the Institute takes skilled graduates from Coventry and the University of Warwick in a range of technical and creative disciplines. Silicon Spa is an outstanding example of developing regional economic growth through local specialisation.

Eagle Labs

With the increased automation of formerly manual services, Barclays found itself with more physical space than it needed. To make use of this redundant space, the company developed the Eagle Labs programme.

Each Eagle Lab provides physical locations where business and technology innovations can set up and be nurtured. Today Eagle Labs are home to over 500 people from 200 businesses. But it is more than just a desk rental business. As well as being a space for communities to collaborate, each lab provides access to mentors, experts and events, to help developing companies with:

- business planning
- finance and fundraising
- rapid prototyping and product design
- translating ideas into viable propositions
- marketing and market access
- business incubation
- scaling up

The first Eagle Lab opened in Cambridge in December 2015, and provides rapid prototyping and event facilities. Since then Eagle Labs have opened in Barclays premises and third party sites, with partners such as business incubators, public libraries and universities. There are now 12 locations in the UK, with plans to expand to 18 by the end of 2017.

A conscious effort is being made to reach regions outside London and the south-east. These venues attract businesses with high growth potential creating a virtuous circle of benefits for the space itself as well as the wider area. For example, the Cambridge Eagle Lab has become a centre of excellence for young artificial intelligence companies, several of which have outgrown the space less than a year after receiving eight-figure sums in funding.

Other companies may find themselves with under-used assets. They could be encouraged to use these for the benefit of local communities, perhaps using some financial incentive that would support service industries across the UK.

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REFERENCES

REFERENCES

[1] Taylor M and others 'Good Work: The Taylor Review of Modern Working Practices' 2017. Available at https://www.thersa.org/discover/publications-and-articles/reports/taylor-review-of-modern-working-practices

[2] Royal Society 'Data management and use: Governance in the 21st century' 2017. Available at https://royalsociety.org/~/media/policy/projects/data-governance/data-management-governance.pdf

[3] Goverrnment Office for Science 'Technology and Innovation Futures 2017'. Available at https://www.gov.uk/government/publications/technology-and-innovation-futures-2017

[4] Central Intelligence Agency 'The World Factbook: GDP composition by sector' 2016. Available at https://www.cia.gov/library/publications/the-world-factbook/fields/2012.html

[5] Department for Business, Energy and Industrial Strategy 'Business population estimates', 2016. Available at https://www.gov.uk/government/statistics/business-population-estimates-2016

[6] Office for National Statistics, UK GDP low level aggregates, 2016 current prices. Available at https://www.ons.gov.uk/economy/grossdomesticproductgdp/datasets/ukgdpolowlevelaggregates

[7] Office for National Statistics, 'International comparisons of UK productivity first estimates: 2015' Available at https://www.ons.gov.uk/economy/economicoutputandproductivity/productivitymeasures/bulletins/internationalcomparisonsofproductivityfirstestimates/2015

[8] Bean C 'Independent review of UK Economic Statistics' 2016. Available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/507081/2904936_Bean_Review_Web_Accessible.pdf

[9] Based on analysis of UK firm-level data from the ONS Annual Business Survey (ABS) and the Inter-Departmental Business Register (IDBR). This covers the non-financial business economy and thereby excludes firms in public administration, financial and insurance activities, and real estate. Source: ONS, Labour productivity measures from the Annual Business Survey: 2006 to 2015. See also: Field S and Franklin M 'Microdata perspectives on the UK productivity conundrum' Office for National Statistics 2013. Available at http://webarchive.nationalarchives.gov.uk/20160112172148/http://www.ons.gov.uk/ons/dcp171766_329419.pdf

[10] ONS January 2016 Economic Review. Available at: http://webarchive.nationalarchives.gov.uk/20160130062936/http://www.ons.gov.uk/ons/rel/elmr/economic-review/january-2016/art.html

[11] McGowan M A and others, 'The future of productivity' OECD Publishing 2015. Full report available at http://www.oecd.org/eco/OECD-2015-The-future-of-productivity-book.pdf

[12] Dan Andrews, Chiara Criscuolo and Peter N. Gal 'Frontier firms, technology diffusion and public policy: Micro evidence from OECD countries'. Available at: https://www.oecd.org/eco/growth/Frontier-Firms-Technology-Diffusion-and-Public-Policy-Micro-Evidence-from-OECD-Countries.pdf

[13] Haldane A, 'Productivity puzzles' 2017. Available at http://www.bankofengland.co.uk/publications/Pages/speeches/2017/968.aspx

[14] City of London Corporation and PwC, 'Total tax contribution of UK financial services' 2016. Available at https://www.cityoflondon.gov.uk/business/economic-research-and-information/research-publications/Documents/research%202016/total-tax-report-2016.pdf

[15] HM Treasury, Public Expenditure Statistical Analysis 2016, p.28. Available at https://www.gov.uk/government/statistics/public-expenditure-statistical-analyses-2016

[16] Department for Digital, Culture, Media and Sport 'Economic estimates of DCMS Sectors' 2017. Available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/640628/DCMS_Sectors_Economic_Estimates_2017_Employment_and_Trade.pdf

[17] Universities UK 'Patterns and trends in UK higher education 2017'. Available at http://www.universitiesuk.ac.uk/facts-and-stats/data-and-analysis/Documents/patterns-and-trends-2017.pdf

[18] Office for National Statistics, UK Balance of Payments, The Pink Book: 2017. Available at https://www.ons.gov.uk/economy/nationalaccounts/balanceofpayments/bulletins/unitedkingdombalanceofpaymentsthepinkbook/2017

[19] Office for National Statistics, 'Foreign direct investment involving UK companies: 2015'. Available at https://www.ons.gov.uk/economy/nationalaccounts/balanceofpayments/bulletins/foreigndirectinvestmentinvolvingukcompanies/2015

[20] OECD, 'Services Trade Policies and the Global Economy' OECD Publishing 2017. Available at http://www.oecd.org/publications/services-trade-policies-and-the-global-economy-9789264275232-en.htm

[21] Open Justice, 'The truth about criminal cases' 2016. Available at http://open.justice.gov.uk/courts/criminal-cases/

[22] PwC 'UK Economic outlook' 2017. Available at http://www.pwc.co.uk/economic-services/ukeo/pwc-uk-economic-outlook-full-report-march-2017-v2.pdf

[23] Deloitte, 'Technology and people: The great job-creating machine' 2015. Available at http://www2.deloitte.com/content/dam/Deloitte/uk/Documents/finance/deloitte-uk-technology-and-people.pdf

[24] Deloitte, 'From brawn to brains: The impact of technology on jobs in the UK' 2015. Available at http://www2.deloitte.com/uk/en/pages/growth/articles/from-brawn-to-brains--the-impact-of-technology-on-jobs-in-the-u.html

[25] Frey C B and Osborne M A, 'The future of employment: how susceptible are jobs to computerisation' 2013. Available at http://www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf

[26] Mokyr J, Vickers C and Ziebarth N L, 'The history of technological anxiety and the future of economic growth: Is this time different?' The Journal of Economic Perspectives 2015: volume 29, pages 31-50

[27] PwC, 'UK Economic Outlook, March 2017'. Available at: https://www.pwc.co.uk/economic-services/ukeo/pwc-uk-economic-outlook-full-report-march-2017-v2.pdf

[28] Available at http://www.bankofengland.co.uk/publications/Pages/speeches/2015/864.aspx

[29] McKinsey Global Institute 'A future that works: Automation, employment and productivity' 2017. Available at http://www.mckinsey.com/~/media/McKinsey/Global%20Themes/Digital%20Disruption/Harnessing%20automation%20for%20a%20future%20that%20works/MGI-A-future-that-works-Executive-summary.ashx

[30] Susskind R and Susskind D 'The Future of the Professions: How Technology Will Transform the Work of Human Experts', Oxford University Press 2015

[31] Deloitte 'The future of talent in UK law firms' 2016. Available at https://www2.deloitte.com/uk/en/pages/audit/articles/developing-legal-talent.html

[32] Muro M and Andes S 'Robots seem to be increasing productivity not costing jobs' Harvard Business Review 2015. Available at https://hbr.org/2015/06/robots-seem-to-be-improving-productivity-not-costing-jobs

[33] World Economic Forum 'The 10 skills you need to thrive in the Fourth Industrial Revolution' 2016. Available at https://www.weforum.org/agenda/2016/01/the-10-skills-you-need-to-thrive-in-the-fourth-industrial-revolution/

[34] McKinsey Global Institute 'A future that works: Automation, employment and productivity' 2017. Available at http://www.mckinsey.com/~/media/McKinsey/Global%20Themes/Digital%20Disruption/Harnessing%20automation%20for%20a%20future%20that%20works/MGI-A-future-that-works-Executive-summary.ashx

[35] Howgego J, 'Enforce the right to an explanation' New Scientist 27 May 2017

[36] Normann R, 'Reframing Business: When the map changes the landscape' Wiley 2001. Available at http://eu.wiley.com/WileyCDA/WileyTitle/productCd-0471485578.html

[37] Parker GG, 'The Platform Revolution: How networked markets are transforming the economy' Norton 2016

[38] Rehse O and others, 'Tapping into the Transformative Power of Service 4.0' BCG 2016. Available at https://www.bcg.com/publications/2016/tapping-into-the-transformative-power-of-service-4.aspx

[39] techUK 'The UK Digital Sectors after Brexit' 2017. Available at https://www.techuk.org/insights/news/item/10086-the-uk-digital-sectors-after-brexit

[40] McGee M 'San Francisco Museum is First to offer Google Glass-Powered Art Exhibit' Glass Almanac 2014. Available at http://glassalmanac.com/san-franciscomuseum-first-offer-google-glass-powered-art-exhibit/6717

[41] Castells M and others, 'Another economy is possible' Wiley 2017

[42] Economist, 'Data is giving rise to a new economy' 2017. Available at http://www.economist.com/news/briefing/21721634-how-it-shaping-up-data-giving-rise-new-economy

[43] Haldane A, 'Productivity puzzles' 2017. Available at http://www.bankofengland.co.uk/publications/Pages/speeches/2017/968.aspx

[44] Krugman P, 'The Age of Diminished Expectations' MIT Press 1994

[45] Professional and Business Services Council 'Productivity Measurement Issues' working paper, unpublished

[46] Grönroos C and Ojasalo K, 'Service productivity: Towards a conceptualization of the transformation of inputs into economic results in services' Journal of Business Research 2004. Available at http://www.sciencedirect.com/science/article/pii/S0148296302002758

[47] World Economic Forum, 'Global Competitiveness Report 2015-2016: Appendix A' 2016. Available at http://reports.weforum.org/global-competitiveness-report-2015-2016/appendix-a-measurement-of-key-concepts-and-preliminary-index-structure

[48] Wallis S, 'Five measures of growth that are better than GDP' World Economic Forum 2016. Available at https://www.weforum.org/agenda/2016/04/five-measures-of-growth-that-are-better-than-gdp

[49] New Economics Foundation, 'Seven principles for measuring what matters' 2009. Available at http://neweconomics.org/2009/01/seven-principles-measuring-matters

[50] Vandermerwe S and Rada J, 'Servitization of business: Adding value by adding services' European Management Journal 1988: volume 6, pages 314-324. Available at http://www.sciencedirect.com/science/article/pii/0263237388900333

[51] Neely A, 'Exploring the financial consequences of the servitization of manufacturing' Operations Management Research 2008: volume 1, pages 103-118. Available at https://dspace.lib.cranfield.ac.uk/bitstream/1826/4012/1/Neely_Financial_Consequences-2009.pdf

[52] Baines T and Lightfoot H, 'Made to serve: How manufacturers can compete through servitization and product service systems' John Wiley & Sons, London 2013

[53] An interim report is available at http://industrialdigitalisation.org.uk/

[54] Office for National Statistics,'London leads UK cities in economic recovery' 2015. Available at http://webarchive.nationalarchives.gov.uk/20160106003539/http://www.ons.gov.uk/ons/dcp171766_426950.pdf

[55] Office for National Statistics, 'Regional gross value added (income approach), UK: 1997 to 2015' 2016. Available at https://www.ons.gov.uk/economy/grossvalueaddedgva/bulletins/regionalgrossvalueaddedincomeapproach/december2016

[56] Deloitte 'Developing legal talent' 2016. Available at https://www2.deloitte.com/uk/en/pages/audit/articles/developing-legal-talent.html

[57] Florida R, 'The Rise of the Creative Class' 2002. Basic Books

[58] PwC 'Cities of opportiunity' 2016. Available at http://www.pwc.com/us/en/cities-of-opportunity.html

[59] Chapain C and others, 'Creative clusters and innovation' NESTA 2010. Available at http://www.nesta.org.uk/sites/default/files/creative_clusters_and_innovation.pdf

[60] Henry M, 'US R&D Spending at All-Time High, Federal Share Reaches Record Low' American Institute of Physics 2016. Available at https://www.aip.org/fyi/2016/us-rd-spending-all-time-high-federal-share-reaches-record-low

[61] Scaleup Institute 'Scaleup review 2016' 2016. Available at http://www.scaleupinstitute.org.uk/wp-content/uploads/2016/11/infographic_scale_up_review.pdf

[62] HM Government, 'Building our Industrial Strategy' 2017. Available at https://beisgovuk.citizenspace.com/strategy/industrial-strategy/supporting_documents/buildingourindustrialstrategygreenpaper.pdf

[63] Beauhurst, 'The Deal' 2017. Available at http://about.beauhurst.com/the-deal-2016-overview

[64] Financial Times, 'UK Tech Investors face loss of significant funding after Brexit' 10 May 2017

[65] British Business bank 'Small business equity investment tracker' 2016. Available at http://british-business-bank.co.uk/wp-content/uploads/2016/05/97-Small-Business-Equity-Investment-Tracker-Report.pdf

[66] UK Business Angels Association, 'Building our Industrial Strategy – Response to the Green Paper from UK Business Angels Association' 2017. Available at https://3pymgx13iq6338mm7t4caazw-wpengine.netdna-ssl.com/wp-content/uploads/2015/09/UKBAA-response-to-Industrial-Strategy-Green-Paper-17-April-2017.pdf

[67] Accenture 'Harnessing the Power of Entrepreneurs to Open Innovation' 2015. Available at https://www.accenture.com/t20151005T162506__w__/us-en/_acnmedia/Accenture/next-gen/B20/Accenture-G20-YEA-2015-Open-Innovation-Executive-Summary.pdf

[68] Sapsed J and others, 'The Brighton Fuse' 2017. Available at http://www.brightonfuse.com/wp-content/uploads/2013/10/The-Brighton-Fuse-Final-Report.pdf

[69] KPMG, 'The role of the BBC in supporting economic growth' 2015. Available at https://assets.kpmg.com/content/dam/kpmg/uk/pdf/2017/02/roleofbbcsupportingwebaccess.pdf

[70] Newzoo 'Global games market report' 2017. Available at https://newzoo.com/solutions/standard/market-forecasts/global-games-market-report

[71] https://gamesmap.uk

[72] BOP consulting and others 'Games Industry in Coventry and Warwickshire' 2017. Available at http://ukie.org.uk/sites/default/files/cms/docs/Games%20Industry%20in%20Coventry%20and%20Warwickshire%20-%20A%20Blueprint%20for%20Growth.pdf

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