Developing University Spinouts in the UK

Key Trends in Spinout Activity, Investments and Investor Involvement

A Technical Note for Research England to support the Independent Advice of Mike Rees on University-Investor Links
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About the Author

Tomas Coates Ulrichsen is a Research Associate at the Centre for Science, Technology and Innovation Policy (CSTI) at the University of Cambridge. His core research interests lie in understanding the roles and contributions of universities to innovation systems and how they can drive technological innovation, industrial transformation and economic growth. A core strand of his research focuses on understanding the nature and contributions of different types of knowledge and technology transfer modes, and the capabilities, practices and infrastructure that are required within universities to develop and sustain them. He is currently working on developing new sources of evidence on university-industry knowledge exchange to inform policymaking activity.

Tomas also provides expert advice to Research England, other government agencies, and universities on university-industry knowledge exchange. In recent years he has been a member of a number of expert groups including the McMillan Review of Good Practice in Technology Transfer and the Knowledge Exchange Framework Metrics Technical Advisory Group. He has undertaken extensive quantitative and qualitative analyses of the impact of knowledge exchange funding and his work has been instrumental in providing a robust evidence base to underpin government spending cases in this area. Previously he was an Assistant Director of a leading economic policy consultancy where he led and managed a number of high profile evaluations of research and innovation funding programmes.

Executive summary

This technical note provides insights into the nature and scale of USO activity emerging from UK universities and the involvement of investors in the commercialisation process and the development of these companies. It also explores key trends in the wider investment landscape for USO development and reflects on how one might assess performance of UK universities in generating USOs that move beyond volume measures.

Most USOs formed based on intellectual property generated within the university emerge from attempts to commercialise new technologies or ideas resulting from research projects. Choices have to be made as to the most appropriate pathway for commercialisation which could include, for example patenting and licensing the IP to an existing company, or forming a new venture to continue its commercial development and application. Given the origins of the IP at the heart of USO formation in research, it is to be expected that the majority of such companies will emerge from the more research intensive universities. This is not to say that other universities do not undertake valuable entrepreneurial activities leading to new companies being formed by staff and students. However, these wider types of companies are not the focus of this report.

Underpinning the technical note is an analysis of a number of datasets including data provided by Beauhurst on the investment deals into university spinouts; the UK's Higher Education Business and Community Interaction (HEBCI) survey which provides university-level information on the nature and scale of spinoff activity and the investments they secure to foster their development; and a database of individual USOs linked to some key basic company information (year of incorporation and industrial activity) built by the author bringing together different data sources including Beauhurst, Spinouts UK (now part of Beauhurst) and Gateway to Research.

Key findings emerging from the analyses are highlighted below.

Types of USO

Different types of companies emerge from universities. These can be categorised along different dimensions such as the business model to get IP to market; the sector of the product or service being commercialised through the USO; and the ownership models for the IP. These have implications for the scale of investment required, support available, and challenges faced.

Volume and concentration of USO activity

Approximately 3000 IP-based spinouts have been created by UK universities over the period 2003 – 2018. Just over half of these companies emerged from higher research intensive HEIs. A further 1,000 academic staff start-ups emerged over this period. The largest 6 research universities generated by far the most USOs per institution compared to other groups of universities.

In terms of trends, UK universities have been generating USOs in broadly similar numbers over the period 2003 – 2018 albeit with some tentative evidence of cyclicality in these trends.

Investments into USOs

Over the period 2011 – 2018, IP-based USOs secured approximately £8.86 billion in external investments to support their development. Since 2008, the amount of external investment raised has increased substantially in real terms (from approximately £991 million in 2008 to £1.5 billion in 2018), with some evidence of cyclicality, particularly for IP-based spinouts where universities retain ownership of the IP.

At a more granular level, analysis of Beauhurst data (which captures primarily equity-based investment deals into USOs secured from 2011 onwards, although companies themselves may have been formed prior to this date) suggests that investments have grown in USOs at all stages (seed, venture and growth) over the period 2011 – 2018.

Investments secured into USOs are even more concentrated that the numbers of companies formed. The largest six research universities secured almost half of the external investments recorded in HEBCI over the period 2011 – 18, compared to generating 16% of USOs. Together with other research intensive universities they generated approximately half of USOs but secured around 95% of external investments. In addition, the analysis shows that these the average amount invested per USO is much larger in these research intensive universities compared with other institutions. This may reflect in part the types of products and services being commercialised but may also reflect their ability to access external finance.

Types of investors into university spinouts

Private equity and venture capital investors are the most common type of investor in USOs. Business angels, commercialisation companies (such as the IP group), and universities are also frequent investors. The analysis of investor types also highlighted the role of the devolved governments, and local and regional governments as investors in USOs, particularly in the seed and venture stages. By contrast, corporate investors are relatively more common at the growth stage than in other stages.

The analysis of investors also revealed a growing concentration of deals in USOs within a small number of investors, particularly at the seed and venture stages. The top 5 investors (based on number of deals in USOs) were involved in 32% of seed stage deals in USOs over the period 2017-18 and 44% of venture stage deals. This is up from 24% and 33% respectively for the period 2011-12. This raises an important question as to whether this trend is positive for the UK system of nurturing USOs. On the one hand it could reflect a maturing of the investor market and the accumulation of experience in investing in these types of companies (which were historically out of many investor's comfort zones). On the other hand too much concentration could decrease the resilience of the system as it becomes more exposed to the effects of key changes in a particular investor (e.g. change in geographical focus of investments out of the UK; change in investor appetite for risk and involvement in USOs etc.).

The technical note also explored the role of Innovate UK in supporting the development of USOs. Their mission is to provide public support for businesses to develop and realise the potential of new ideas, including those emerging from the research base. As such they should, in principle be a source of support for USOs as they seek to develop and commercialise their new technologies and ideas. By linking the dataset of USOs at the company level to information on the recipients of Innovate UK funding, the analysis found that 26% had received some form of support. Of the 800 companies benefiting from Innovate UK funding, almost 60% were involved in a collaborative R&D grant and 44% received a grant to support feasibility studies. The new investment accelerator programme –although relatively small compared with other programmes – was by far the most likely to engage with USOs, with 56% of recipients of this type of support by a spinout. What is not clear from this analysis is what 'good' should look like in terms of how Innovate UK supports USOs: should we expect many more USOs to benefit from their funding? Are their funding programmes appropriately designed to enable USOs to benefit from them?

Trends in wider investment landscape

The technical note also explored trends in the wider venture capital investment landscape in the UK. It found that the UK is slowly closing the gap in the amount of equity finance as a percentage of GDP compared with the US. Compared to Germany, France and Canada, over the period 2015 – 2017, the UK invested significantly more through equity finance once the scale of the economy is taken into account. A detailed analysis by the British Private Equity and Venture Capital Association also shows that, over this period, VC investments at the seed stage, other early stages, and later stages of company development have grown substantially, although have fallen at the start-up stage.

A key trend in VC funding both globally and nationally is the rise of corporate venture capital (CVC). Whilst in some ways similar to traditional private VC funding, it differs in key respects. In particular while private venture capital typically pursue a singular objective to maximise financial returns and hold committed capital in a fund for 10 years, CVC investments typically assess performance both on financial and strategic objectives and can take a longer term perspective. Evidence generated by CB Insights suggests a significant rise in CVC activity in the UK. In addition, as of 2018 the UK has been securing a greater proportion of global CVC investments. Importantly, for USOs, the global trend is towards more CVC investments at the seed stage of companies. The analysis of investor types in USOs over the period 2011 – 2018 suggests that corporate investors are now involved in more deals, although they do not appear to be becoming relatively more important than other forms of capital.

Assessing university performance in generating USOs

Assessments of university performance in generating USOs need to move beyond measures of activity – i.e. the volume of spinouts produced. A number of alternative measures are suggested in this data annex that attempt to move towards more 'trajectory' or outcomes measures of performance. These include:

- The ability of a universities USOs in raising external investment, *controlling for sectoral/technological variations*
- The time taken for companies to progress towards an exit or becoming established in the marketplace, *controlling for sectoral/technological variations*
- Survival rates of USOs, *controlling for sectoral/ technological variations*.
- Appropriate measures of growth in the value of USOs (i.e. accepting that many early stage companies may take a number of years before generating turnover let alone profits, *controlling for sectoral/technological variations*
- Comparison of returns to investment for university-focused funds vs other venture funds

The ability to generate USOs is also driven by the strength of the entrepreneurial ecosystem in which the university is linked into (note this does not necessarily have to be geographically proximate to the particular university). As such, comparative assessments of the strength of the ecosystems within which universities are inserted can be instructive in informing an understanding of the likelihood of successful development of USOs.

International comparisons of USO activity and performance

International benchmarking of USO activity and performance at both the national level and university level can provide valuable insights into the strength and weaknesses of the UK university system in generating USOs and where it needs to be strengthened. However, such comparisons are typically very challenging as data is frequently not collected in the same way or to the same definitions. In addition, the structure of the industrial and entrepreneurial ecosystems in different countries can be very different which result in different decisions being made on appropriate commercialisation pathways, or types of support required. Nevertheless, and recognising these caveats, some useful comparisons can be made. The evidence suggest that:

- UK has five universities in the top 10 globally when ranked in terms of the amount of venture capital raised over period 2013 – 2017.
- On key metrics such as the volume of spinouts generated per £research income in the year 2015/16, the UK did not perform quite as well as the US but it is a similar order of magnitude once the size of the research base is taken into account.
- The UK compares favourably against US in terms of strength of entrepreneurial ecosystem at the national level and the amount of capital raised to invest in USOs. Key UK locations identified as globally competitive entrepreneurial locations in a 2014 study included Cambridge, London and Oxford
- On the general availability of venture capital for start-up firms (including USOs), the UK still lags behind the US although appears to be closing the gap.

Overall, the technical note suggests an overall strengthening of UK universities in generating spinouts that are able to secure increasing amounts of external investments. And while there are some weaknesses in the system, leading UK universities compare well with their US counterparts in generating USOs valued by the market.

Contents

1 Introduction

This technical note provides evidence on the spinouts emerging from UK universities and key trends in activity, the scale of external investment at different stages of company development to support these companies on their journey to commercialise university intellectual property (IP), and the types of equity-based investors involved. It was generated to provide a quantitative evidence base to support the independent advice being developed by Mike Rees on university-investor links for Research England.

The focus of Rees' advice is on the development of university spinouts (USOs) formed to commercialise intellectual property (IP) generated within UK universities. As such the analyses presented in this technical note focus primarily on this particular form of company emerging from universities. It does not examine the many other technology or knowledge exchange pathways through which technologies and ideas can be developed and commercialised. In addition, while the technical note recognises the importance of academic and student entrepreneurship activities that see new companies being created to develop new products and services that are not based on IP generated within the university, these activities are deemed to be out of scope for this study.

Underpinning the analyses in this technical note is a dataset constructed by the author that integrates information from the following key data sources:

- Information at the deal-level of USOs provided by Beauhurst – the data covers deals secured from 2011 onwards although companies may have been formed prior to this date; deals covered are equity-based
- Information on the names of USOs and the universities from they emerged, from the Spinouts UK website. As with Beauhurst, this dataset was built bottom-up, with USOs identified either through the press, technology transfer office websites, or information provided directly by universities. They were acquired in 2018 by Beauhurst.
- Information at the company level on USOs emerging from Research Council funded research, from Gateway to Research (emerging from research mostly funded post-2006)
- Information on the nature and scale of USO activity at the university level, from the Higher Education Business and Community Interaction (HEBCI) surveys from 2002/03 – 2016/17
- Other publicly available sources of information on the nature and scale of investments into USOs such as that provided by the Global University Venturing 2013-17 data review

Drawing on these data sources, the technical note provides a detailed analysis on the nature of USO activity emerging from universities across the length and breadth of our nation. It examines in detail the nature and scale of investments being secured to support the development of these companies and identifies key trends in investment activity. The note goes on to explore the nature and scale of, and trends in, the wider funding landscape that underpins USO formation and development. It then reflects on how performance of UK universities in generating USOs could be assessed and explores some of the available metrics. Lastly, it brings together what is known from the academic literature on the factors shaping successful commercialisation of IP through USOs.

2 The university spinout development pathway and types of spinouts

Before examining the strength and performance of UK universities in generating USOs, it is helpful to first understand the general university spinout development journey and the variety of companies that emerge. This is crucial as different types of companies will face different challenges in its journey to market and its ability to create and sustain competitive advantage.

2.1 University spinout development pathway

The formation of a university spinout forms part of the process of the commercialisation of research that sees inventions and ideas emerging from university research activities developed towards commercial application. The broad stages of the initial phases of this journey are set out in detail in the seminal book by Scott Shane on academic entrepreneurship in 2004 (Shane, 2004) and are captured here in Table 1.

During this process a number decisions will have to be taken, not least by the academic inventor to disclose their new technology or idea. Subsequently, those involved in the early phases of the commercialisation process – often the university's technology transfer office or partner in collaboration with the academic – will have to make decisions on whether or not to formally protect the IP (e.g. through a patent), and the most effective and appropriate pathway to be taken to commercialise the IP. Choices include whether or not to set up a spinout company, attempt to find an existing company to license the technology to, or indeed undertake further translational or applied research to develop the technology before taking it into the commercial sphere.

The choice over whether or not to seek to license a technology or commercialise it through a USO is shaped by a range of factors. Shane (2004, 2001) argue strongly that the characteristics of the technology play an important role in this decision Table 2.

It is very important to note here that university spin-outs are atypical examples of start-up companies (even technology-based startups) (Shane, 2004). In addition to being based on cutting-edge technology often based on very sophisticated science or engineering, companies are also very early stage ventures when they are formed. The former director of the MIT Technology Licensing Office, Lita Nelson, reflected in Scott Shane's book that while venture capital investors often refer to USOs as seed stage companies, they are actually 'minus two stage companies'. Unlike typical seed stage companies, many university inventions are not yet at a stage that is of interest to industry; they are very embryonic and may not have reached the prototype stage let alone demonstrated manufacturability and practicality in the market and represent high risk investments (Pressman et al., 1995; Shane, 2004).

Table 1 Stages of the commercialisation process
Sources: Shane (2004), UNICO (2006) and McMillan (2016)

Stage of commercialisation process	Comments and issues
Funded research	Research funded through variety of sources including industry, to produce new knowledge. In some cases, as a result of this process, technological inventions may emerge with commercialisable potential
Creation and disclosure of invention	Two conditions must be met: inventor must believe they have invented a new technology (not just produced a research result) and inventor must believe they have to disclose their invention to the university (decision influenced by university's policies towards disclosure)
Decision to seek IP protection	• Evaluation of invention disclosure: - Purpose is to determine whether a university should protect (patent/copyright) invention. - Determine whether inventor has made 'material use' of university facilities in creating invention - influences who owns IP • Conditions for TTO to seek to patent - must believe inventor has invented something novel, non-obvious, and valuable technological advance (conditions of receiving patent) - technology must be embodied in some form that can be patented rather than just being tacit knowledge residing in inventor's head - expect that profits from licensing invention will exceed cost of patenting it
Marketing the technology	• Ability to find private sector entities to licence and commercialise inventions • Role of inventors in helping to identify potential licensees • Incredibly difficult because many university inventions are not at a stage that is of interest to industry… too embryonic, not reached prototype stage, let alone demonstrated manufacturability and practicality in the market. Typically require substantial investments in product, and market development, and many will never succeed... high risk investment (Pressman et al., 1995:52)
Optioning the technology	• Because of technical and market uncertainty of invention, potential licensees often unsure whether they would like to license them. Often take options to license, giving time to evaluate technologies further before they make decision to license. Process of optioning helps to mitigate technological/market uncertainty inherent in university inventions. • Some considerations: - Length of option? - Fields of use of option? - Exclusivity of option?
Licensing decision	• When licensing does occur, typically only one company interested in obtaining rights. Just 22% of technologies have more than one party interested (Jensen and Thursby, 2001). As a result, university cannot typically drive hard bargains on terms • Typically hard to insist on upfront fees other than covering patenting costs. Most of compensation is in form of royalties on sales of successfully commercialised products • Some considerations - Exclusivity of license? - Fields of use of license?
Decision to spin-out	• Most of time, established companies license IP - approx. 86%. Existing companies have a variety of advantages in commercializing university technologies e.g. market knowledge, relationships with customers, distribution systems, & related products. • University spin-outs are atypical examples of start-up companies. In addition to cutting-edge technology often based on very sophisticated science or engineering, companies are also very early stage ventures when they are formed. • Comparing university spin-outs to the typical start-up, which VCs refer to as seed stage companies… Lita Nelson (former Director of MIT's TLO) refers to USOs as 'minus two stage companies'. Unlike typical seed stage companies, typical USO begins with technology that has not been reduced to practice, has no business plan, no management and a need for capital to create the company that would bring these benefits together. • Very difficult to identify business opportunities from university technology. Importance of inventor in providing information to help recognized opportunity • Empirical evidence suggest that inventors often found spin-outs when fail to licence to established companies (Lowe, 2002)… because inventors have better knowledge about the value of their university invention than do other parties.

Table 2 Characteristics of technologies favouring spin-outs and licensing options
Source: Shane (2004)

Characteristics favouring spin-out route	Characteristics favouring licensing route
Radical	Incremental
Tacit	Codified
Early stage	Late stage
General-purpose technology (with multiple application areas)	Specific-purpose
Significant customer value	Moderate customer value
Major technical advance	Minor technical advance
Strong IP protection	Weak IP protection

Shane also notes the particular difficulties in identifying business opportunities from university technology, not least because they are likely to be disrupting the status quo. As Christensen finds in his seminal work on the innovator's dilemma (Christensen, 1997), incumbents are often blinded to value of disruptive technologies as their systems and decision making tools, often driven by financial return, will bias against them. They often only realise the value potential after it is too late and a newcomer company – often driven by passion and belief in the potential for the technology to deliver value and disrupt the status quo rather than financial projections of value – has secured their foothold in the market. These peculiarities of USOs create particular challenges when searching for potential investors (Shane, 2004; UNICO, 2006).

Post-spin-out technology and product development

After a USO has been created there are then typically a range of subsequent technological and product development challenges that need to be addressed (Shane, 2004) (Table 3). While the reference is now relatively dated and will likely not cover all subsequent areas of development for different USOs commercialising different types of technology, it does does provide a sense of the wide range of areas where significant further effort is required.

Table 3 Areas of further development for university spin-outs
Source: Shane (2004)

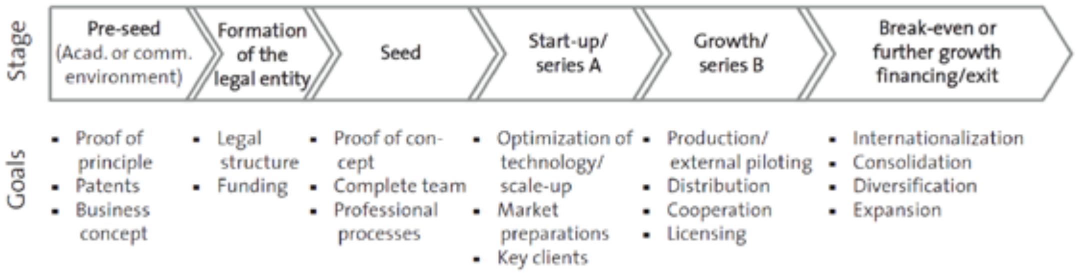
Area of further development		Comments and issues
Additional technical development	Proof of principle	• Without proof of principle, impossible to create a prototype let alone a product/service that would solve a customer problem or meet customer need
	Prototype development	• Many spin-outs lack prototypes of their products at time of spin-out even if achieved proof of principle in the lab. • even if have prototype, may need additional prototype development e.g. because change in market application; initial prototype does not work properly or not as effectively as founders need to meet customer needs
	Product development process	Turn prototypes into products/services appropriate for the commercial environment. • Productizing the invention - often need additional technical development to turn technology into product/service. Must transform tech to meet customer need/problem. Also will often need to combine technology with standard features that competitor products and service have e.g. documentation, packaging, support services etc. • Ability of founders to develop capabilities of product development. This is a very different capability to doing research. • Do founders have commitment to product development? • Product development time horizon can be long. Markets / customer needs can change and competitor landscape can change leading to missed opportunities. Can also lead founders to underestimate time/money required to develop successful spin-out • Product development uncertainties: - will technology adapt to commercial environment; - will founder have competence to turn invention into product; - will complementary technologies necessary to support product/service be developed in time

Table 3 (…continued)

Area of further development		Comments and issues
Additional technical development (…continued)	Changes to make technologies appropriate for commercial environment	• Improving performance - e.g. to include new set of performance factors not present in research environment • Enhancing robustness - e.g. to stresses of real world • Adding supporting technology - e.g. by creating tools, supporting technologies, documentation, support services etc. because customers do not by technology… they buy a solution to a problem... So have to develop all things that are needed for a product to solve customer problem. • Scaling-up - Invention only produced in very small volumes at outset. How to produce at commercial scales of production? Often requires new ways of producing technology and/or significant changes in technology during the product development process. - Hard to get customer feedback until produce at scale because customers find it hard to see a product or service in the form that they would use it… • Increasing ease of use - making function of technology easier for customers - Form may need to change to meet standards or make appealing to customers - proper documentation needs to be developed/provided - adapting technology to fit technical standards prevailing in industry • Changing mechanisms and architecture - to adapt to customer preferences - to reduce costs - to enable manufacture at scale and/or speed - to exploit more readily available / effective commercial components
Developing a market for the technology		Significant market uncertainty… • Sufficient demand? • Customers willing to pay? • Can produce product / service economically? • Can it provide better solution to customer needs than alternatives?
Securing financing		Critical need to demonstrating the value of ventures. • Scale of markets • Proprietary technology - Investors favour spin-outs with strong patent protection - that possess patented technologies… easier to finance USOs with exclusive rights to patents - Potential investors focused very heavily on spin-outs IP position when deciding whether or not to fund it • General purpose technologies: Greater flexibility & adaptability – Gives investors more options if initial application field does not work out • Social ties: Founder-investor social ties… Help to mitigate information asymmetry and uncertainty… build trust

Alongside the technology and product development journeys is the need to secure investments to fund these development and the growth of the company (Rittershaus, 2016; Wilson and Silva, 2013). Figure 1 depicts the different financing stages of a typical university spinout in the chemical sector (Rittershaus, 2016). It sees companies journey from the pre-seed stage at which entrepreneurs are developing the proof of principle, seeking patents and developing the business concept through to the seed stage at which proof of concept is developed and teams are put into place, the startup phase and the raising of Series A funding. This enables USOs to optimize the technology and scale it up to full scale production, and prepare for market launch. Series B funding then supports market development and growth of the company.

Figure 1 Typical stages of university spinout financing
Source: Rittershaus (2016)



The stages identified in Figure 1 are broadly consistent with the definitions used by Beauhurst in their datasets on USOs and which will underpin much of the empirical analysis in this technical annex (Table 4).

Table 4 Definitions of USO development stages used by Beauhurst
Source: Anderson Law (2018) citing Beauhurst

Stage	Beauhurst definition
Seed	A youngish company with a small team, low valuation and funding received (low for its sector), uncertain product-market fit or just getting started with the process of getting regulatory approval. Funding likely to come from grant-awarding bodies, equity crowdfunding and business angels.
Venture	A company that has been around for a few years, has either got significant traction, technology or regulatory approval progression and funding received and valuation both in the millions. Funding likely to come from venture capital firms.
Growth	A company that has been around for 5+ years, has multiple offices or branches (often across the world), has either got substantial revenues, some profit, highly valuable technology or secured regulatory approval significant traction, technology or regulatory approval progression, funding received and valuation both in the millions. Funding likely to come from venture capital firms, corporates, asset management firms, mezzanine lenders.
Exited	The company has done an initial public offering or been acquired. (We do not consider management buy-outs to be exits, i.e. reasons to stop tracking companies, but rather a trigger for starting to track a company.)

2.2 Types of university spinouts

A number of attempts have been made to identify different types of USOs and key distinguishing features (see e.g. Hewitt-Dundas, 2015; Minshall and Wicksteed, 2005). Minshall and Wicksteed, through discussions with university TTOs distinguish three key types:

- Spinouts with identifiably high growth potential, even if there are considerable risks that the potential will not be realised
- Spinouts that are likely to be serious businesses in that they create employment and generate profits, but which may have limited or slower growth potential
- Spinouts that are legal vehicles for the commercial development of a technology which, in due course, is likely to be commercialised through the license or sale of the IP.

A key feature highlighted by Hewitt-Dundas is the business model of the USO employed (Figure 2). They find this has an important influence on the development profile for the companies and the way.

Figure 2 Different business models employed by USOs
Source: Hewitt-Dundas (2015) based on survey of UK USOs

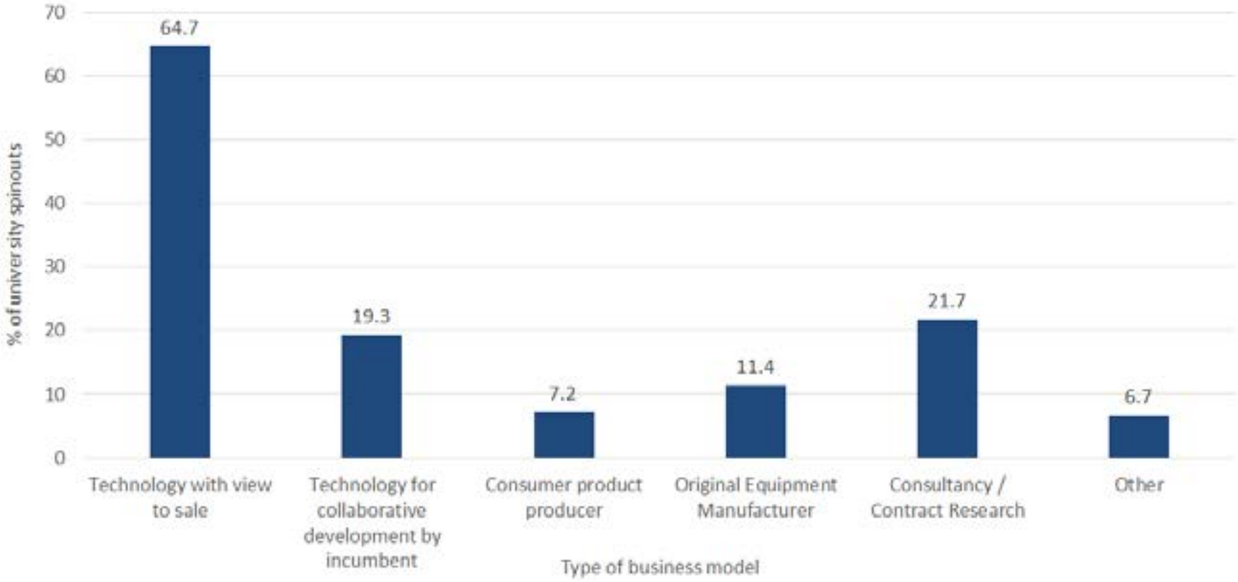
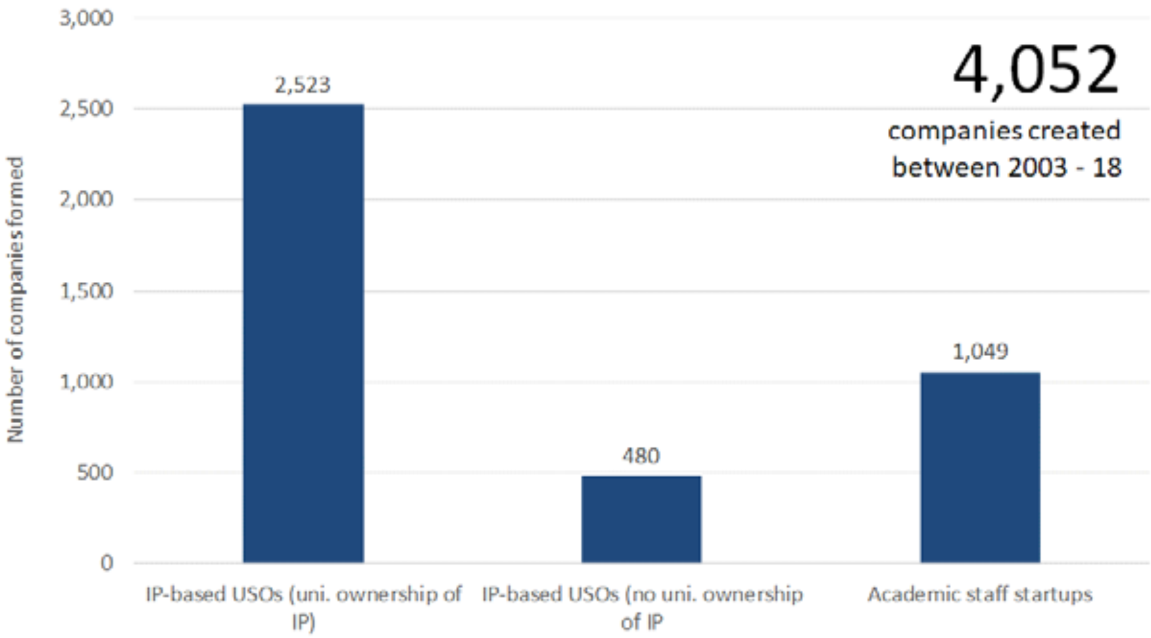


Figure 3 Types of university spinouts and staff startups identified in the HEBCI survey over the period 2003 – 2018
Source: HEBCI surveys 2002/03 – 2017/18



The long-running annual Higher Education Business and Community Interaction (HEBCI) survey collects a variety of data on USOs from all universities in the UK. Data includes the number of companies formed in the year, number of active companies, employment and turnover of active firms, and the amount of external investment raised (note, this is not limited to equity-based investments). It distinguishes different types of USOs emerging from universities based on whether they are formed by staff or students and, if by staff, whether the company is a 'spinout' set up to exploit IP generated within the university or a 'startup' in which its activity is not based on IP originating from the university. For spinouts, it further distinguishes those companies for which the university has retained some ownership of the IP and those for which it has released the IP (e.g. through sale of shares and/or IP). Furthermore, more recently it introduced a further category identifying 'social enterprises'.

Data from the HEBCI survey suggests that just over 4,000 university spinouts and staff start-ups were created during the period 2003 – 2018 (Figure 3). Of these, the majority were spinouts in which the university retains ownership of the IP (2,500), with a further 12% being spinouts in which the university does not own the IP (480). Just over 1,000 companies were academic staff start-ups not based on university generated IP.

Other studies and reviews (see e.g. McMillan, 2016) have highlighted the importance of sectoral variations in university spinout activity – providing examples of engineering hardware, human therapeutics, and software – not least in terms of whether spinout company formation is the most effective route to commercialising university generated intellectual property, the scale of investments required to further develop the technology or knowledge in order to deploy it in the marketplace, the timescales involved, and the types of challenges faced. Key differences in technology transfer between the life sciences and physical sciences were captured as in Figure 4

Figure 4 Technology sector differentiation in technology transfer
Professor E Autio, Imperial Business School
Source: reproduced from McMillan (2016)

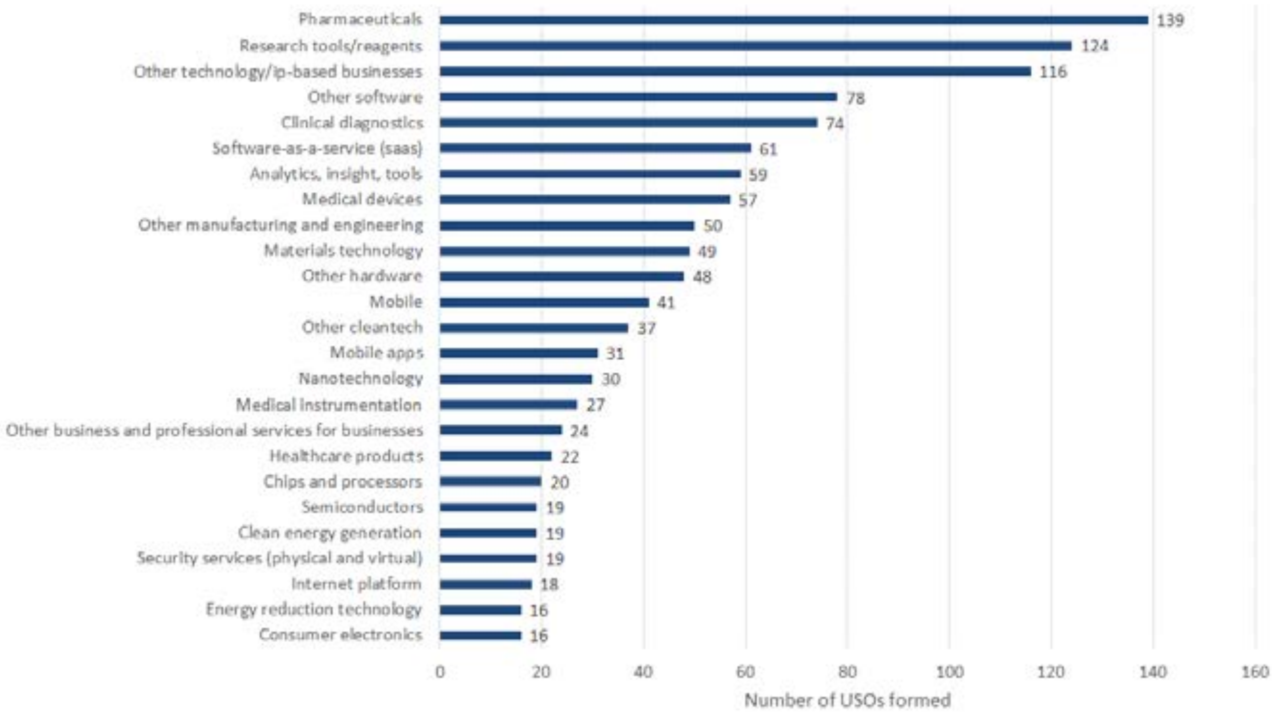
Aspect	Life Science	Physical Science
Driving Force	"*Science*"	"*Engineering*"
Innovation Mode	Linear, sequential, based on *discovery*	Interactive, based on *recombination*
Nature of Need	*Exists*, solutions missing	Often *emergent*, plenty of alternative solutions
Nature of Market and the Innovation Process	Structured, established, sequential	Often emergent, changing, interactive
Type of Research Contract	*Long-term*, basic research	*Short-term*, application development
Key Bottleneck	Scientific *discovery*	*Customer adoption*, positive feedback
Role of IPR	Basis of *licenses*	Determines business model, *mode of market entry*

An analysis of the USOs identified in Beauhurst dataset (a subset of all USOs formed – see discussion in section 4) shows the significant variation in the numbers of USOs formed by sector (Figure 5). This, as I shall show later, has a significant impact on the scale of investments raised.

2.3 Distinguishing university spin-outs from other high-technology start-ups

The university spinouts are sometimes compared to other types of high-technology start-ups (for example corporate spin-outs (CSOs)) (Hewitt-Dundas, 2015; Zahra et al., 2007). However, in making such comparisons, it is important to recognise that USOs are typically very different types of new ventures, attempting to commercialise very different types of technologies and have very different resource requirements (Druilhe and Garnsey, 2004; Shane, 2004; Wright et al., 2006).

Figure 5 Number of USOs formed by sector, (top 25 sectors)
Source: author's analysis of Beauhurst database



Note: USOs can be categorised into multiple sectors. 229 USOs are categorised into 1 sector; 302 USOs are categorised into 2 sectors; 145 USOs are categorised into 3 sectors; 72 USOs are categorised into more than 3 sectors (maximum of 6 sectors)

The commercial knowledge and experience of founders is also very different in USOs compared with other high-tech companies (Druilhe and Garnsey, 2004). Wright et al. – in their 2006 paper on UK and European universities and their spin-out activities – highlighted a number of these differences (see table below). Many of these characteristics increase the risks associated with investing in USOs. While some of these factors could be remedied by changes in approach or support provided by universities, some of them reflect the inherent nature of the IP emerging from universities (e.g. longer term investment horizons and higher variability of returns).

Table 5 Characteristics of university spin-outs in comparison with high-technology start-ups
Source: Wright, Lockett, Clarysse and Binks (2006) survey of venture capital firms. Note: respondents ranked each factor as: 1, strongly disagree"; 2, "disagree"; 3, "neither agree nor disagree"; 4, "agree"; 5, "strongly agree".

Rank	Compared to high-tech companies, USOs are more likely to	Mean
1	Require building a management team	4.4
2	Require a longer investment time horizon	4.3
3	Require close monitoring	4.2
4	Require several rounds of funding	4.2
5	Have higher variability of return	3.6
6	Fail	3.6
7	Involve protracted pre-deal negotiations	3.5
8	Be small niche market companies	3.3
9	Pose valuation difficulties	3.2
10	Have financial structuring problems	3.1

It is also important to recognise that not every university will or should seek to transfer technologies and knowledge through the formation of a USO, particularly formal companies based on specific pieces of university-generated IP. Hence, the absence of any (significant) USO activity may be due to the type of knowledge being generated and hosted in the university rather than due to a lack of capabilities to engage in such activity or the lack of a local entrepreneurial ecosystem, although these factors will inevitably partly explain variations between those that do engage in USO activity.

3.1 Grouping universities to reveal differences in spinout activity

To analyse USO activity across universities it is helpful to cluster institutions into groups with similar characteristics. Underpinning most spinouts based on university intellectual property (as opposed to other forms or non-IP based staff or student startups) is research activity that leads to the generation of novel technologies and ideas that have commercial potential. As such, it should not be expected that universities with little research activity will generate many, if any, IP-based spinouts (although entrepreneurial activity of other forms such as staff and students forming non-IP based startup companies may well be expected).

Evidence suggests that the scale of universities can lead to economies of scale in the provision of support to technology transfer activities. Therefore, in grouping HEIs to explore key trends in IP-based spinout generation, it is instructive to focus on two key dimensions: the scale of research activity, and the intensity of research activity. In addition, specialist higher education institutions (HEIs) are likely to experience different dynamics in technology transfer from more broad based universities, in the homogeneity of types of USOs they are likely to generate as well as the type and focus of support they are able to provide. As a result of this, specialist institutions were treated separately from broad discipline based institutions.

Figure 6 plots the relationship between a university's scale (based on the number on average academic FTEs over the period 2003-17) and its research intensity (based similarly on the average research intensity over this period) for non-specialist HEIs.

A visual inspection suggests four distinct groups of universities:

- Largest 6 research universities
- Other research intensive universities
- Smaller, medium research intensive universities
- Less research intensive active universities

Specialist HEIs were grouped into two groups based on their disciplinary specialisations:

- Specialist STEM universities
- Arts, social science and other specialist universities

Figure 6 Relationship between research intensity (average, 2003 – 17) and the number of academic staff (average FTEs, 2003 – 17)
Sources: HESA data

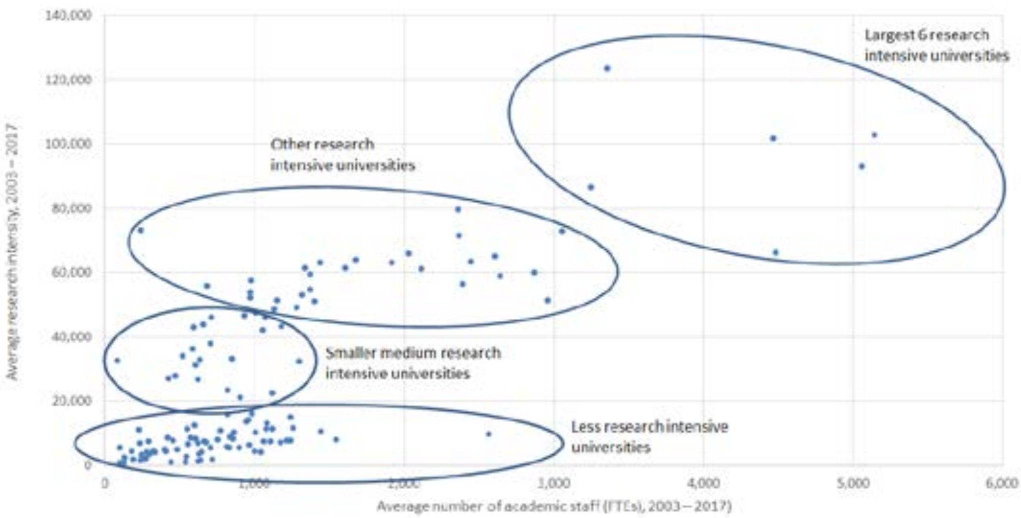
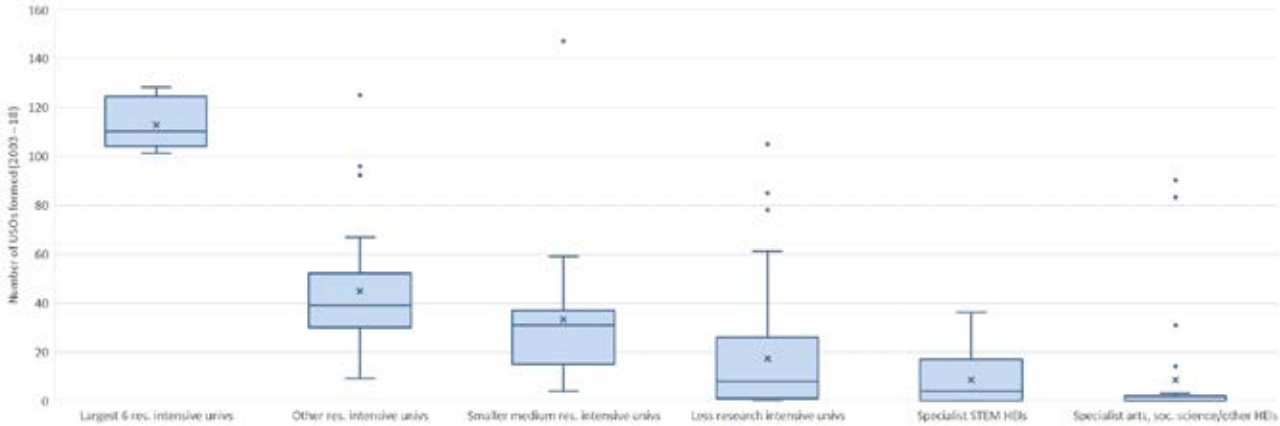


Figure 7 explores the utility of these groups in revealing differences in the level of USO activity over the period 2003 – 18. It shows the groups are able to reveal important differences in the levels of activity, and the dominance of the largest 6 research universities in the UK (the universities of Cambridge, Oxford, Manchester, and Edinburgh, and Imperial College London and University College London). I use these university groups in my subsequent analyses of USO activity and performance.

Figure 6 Relationship between research intensity (average, 2003 – 17) and the number of academic staff (average FTEs, 2003 – 17)
Sources: HESA data



Note: the chart is a box and whisker plot. The box represents the upper and lower quartile range, and the line within each box represents the median value for each group. Cross within each box represents the mean value of the group.

3.2 University-level differences in spinout activity

Table 6 and Table 7 provide a range of contextual and technology transfer related data and metrics for a selected group of universities. The universities were selected to cover a range of institutions in different contexts, covering the different regions of the UK and the different university groups. The intention is to highlight the significant variations in university contexts, research scales and priorities by universities that generate at least moderate levels of USO activity. They were not selected to be in any way representative of the university group or region in which they are based.

These tables highlight in particular:

- Significant variations in the discipline portfolios of universities, particularly outside the largest six research universities
- Significant variation in the amount of venture capital investment activity in the region in which the university is based
- Even amongst broadly similar universities
  - o Significant variation in the number of disclosure per £100 million research income
  - o Significant variation in the licensing income per £1000 research income
  - o Significant variation in the number of USOs per £100 million research income

It is important to note that the variations in these key commercialisation metrics, even between the largest six research universities, may or may not reflect performance differences between the institutions in commercialising research outputs through spinout companies. Part of the differences may also reflect different choices about the pathway and how they engage with their academic community to identify potentially commercialisable technologies and ideas.

In addition, some of this variation may also be explained by the significant differences in the disciplinary portfolios of universities and the sectors of application of technologies emerging from these portfolios. For example, the University of Durham generates many more spinouts per £100 million of research than Cardiff University, while Cardiff generates significantly more in licensing income per £1000 research income. It is possible that this is in part due to the fact that the research portfolio of Durham is dominated by activity in engineering, physical and computer sciences while Cardiff has much greater proportion of activity in clinical and biological sciences

Table 6 Commercialisation metrics for selected universities: largest six research universities
Sources: analysis of HESA data and HEBCI surveys

Context	University grouping	Largest 6 research universities					
	Region / Nation	South East	London	East of England	London	Scotland	North West
Basic information	Total income (£000s, average for 2011 – 18)	1,366,300	1,204,800	1,656,300	924,500	850,200	959,600
	Academic staff FTE (average for 2011 – 18)	6,100	5,700	5,000	3,700	3,700	4,600
	Total research income (£000s, average for 2011 – 18)	653,200	553,300	538,200	463,700	335,300	326,700
Research discipline portfolio (percent of total research grants and contracts)	Clinical medicine & biological sciences	66	68	61	56	65	49
	Arts, humanities and other disciplines	6	5	5	0	4	2
	Engineering, physical, mathematical and computer sciences	23	25	33	43	25	44
	Social sciences, business and management	6	4	3	1	7	5
Research portfolio by source of funds (percent of all research income)	Public sources	61	68	64	66	75	71
	Non-public sources	39	32	36	34	25	29
Commercialisation activity	Number of disclosures (average, 2011 - 18)	350	120	170	330	130	340
	Licensing income from royalties (£000s, total, 2011 - 18)	113,400	49,400	84,600	17,900	22,400	13,800
	Licensing income from sale of shares in spinouts (£000s, total, 2011 - 18)	46,300	7,100	44,100	15,200	0	5,500
	Number of USOs (HEBCI database) (total, 2011 - 18)	91	66	51	58	67	56
	Number of USOs (USO database) (total, 2011 - 18)	111	59	138	57	49	44
Commercialisation metrics	Disclosures per £100 million research income	54	22	32	71	39	104
	Licensing income per £1000 research income	244	102	239	71	67	59
	USOs per £100 million research income	14	12	9	13	20	17
	Licensing income per academic staff (£ per academic FTE)	26,200	9,900	25,700	8,900	6,100	4,200
	USOs per 000s academic staff	15	12	10	16	18	12
Regional venture capital activity	Overall venture capital investments (£millions) by region 2017	71	229	33	229	48	7

Table 7 ***Commercialisation metrics for selected universities: other universities and HEIs***

Sources: analysis of HESA data and HEBCI surveys

Context		Bristol	Sheffield	Cardiff	Queen's Belfast	Durham	Leicester	Brunel	Coventry	Royal College of Art	Cranfield
	University grouping	Other research intensive						Smaller, medium res. intensive	Less res. intensive	Arts specialist	STEM specialist
	Region / Nation	South West	Yorkshire and the Humber	Wales	Northern Ireland	North East	East Midlands	London	West Midlands	London	East of England
Basic information	Total income	537,800	572,400	486,500	323,100	322,300	302,200	202,300	275,300	45,200	174,600
	Academic staff FTE	2,600	2,800	2,600	1,600	1,500	1,500	900	1,600	100	600
	Total research income	195,800	192,400	143,200	108,100	80,900	75,700	33,000	12,200	5,000	53,300
Research discipline portfolio (percent of total research grants and contracts)	Clinical medicine & biological sciences	43	33	59	52	14	60	10	17	0	9
	Arts, humanities and other disciplines	3	2	2	6	23	8	3	4	100	0
	Engineering, physical, mathematical and computer sciences	51	61	26	35	51	27	82	70	0	84
	Social sciences, business and management	3	5	13	7	13	5	6	9	0	6
Research portfolio by source of funds (percent of all research income)	Public sources	81	80	77	82	84	78	89	87	75	65
	Non-public sources	19	20	23	18	16	22	11	13	25	35
Commercialisation activity	Number of disclosures (average, 2011 - 18)	100	100	80	50	60	40	20	130	90	40
	Licensing income from royalties (total, 2011 - 18)	5,600	21,900	13,500	60,000	600	4,100	200	1,100	100	4,100
	Licensing income from sale of shares in spinouts (total, 2011 - 18)	1,800	400	11,900	51,200	900	200	0	100	0	0
	Number of USOs (HEBCI database) (total, 2011 - 18)	26	12	13	30	15	42	14	40	58	33
	Number of USOs (USO database) (total, 2011 - 18)	35	10	12	21	8	3	5	5	28	2
Commercialisation metrics	Disclosures per £100 million research income	51	52	56	46	74	53	61	1,066	1,800	75
	Licensing income per £000s research income	38	115	177	1029	18	57	6	103	20	78
	USOs per £100 million research income	13	6	9	28	19	55	42	328	1167	62
	Licensing income per academic staff (£ per academic FTE)	2,800	8,000	9,800	69,500	1,000	2,9007	200	800	1,000	6,800
	USOs per 000s academic staff	10	4	5	19	10	28	16	25	580	55
Regional venture capital activity	Overall venture capital investments (£millions) by region 2017	12	18	18	3	1	7	229	14	229	33

Table 8 Number of USOs of different types generated by different types of HEIs, 2003 – 2018
Source: HEBCI surveys 2002/03 – 2017/18

HEI type	Percentage of USOs by type in total for group			Number of USOs	Number of USOs per HEI	*Number of HEIs*
	University IP-based USOs	University non-IP-based USOs	Academic staff startups			
Largest 6 research universities	72	10	17	677	113	*6*
Other research intensive universities	69	10	21	1,207	45	*27*
Smaller medium research intensive universities	62	14	24	632	33	*19*
Less research intensive universities	50	10	40	1,181	17	*68*
Specialist STEM HEIs	82	5	14	111	9	*13*
Specialist arts, social science and other HEIs	50	30	20	244	8	*29*
Total	62	12	26	4,052	25	*162*

Table 8 shows that different types of USOs formed by universities in each group. It highlights in particular that research intensive HEIs and the STEM specialist HEIs are more likely to generate spinouts in which the university retains some IP ownership, while less research intensive HEIs are more likely to form academic startups.

Note that graduate start-ups are not the focus of the report and are therefore not included in the analysis. Looking at data on this activity (not shown here for reasons of space) shows that the number of graduate startups per HEI is much more evenly distributed across the different groups, with activity of this type higher in the largest six research universities, less research intensive universities, and arts and social science specialist institutions.

4 A note on the data sources on university spinouts

Before turning to an analysis of key trends in USO activity and performance it is important to understand the data sources underpinning these analyses.

For many years, the primary source of evidence on USO activity and trends was the HEBCI survey. Disregarding the first few years early in the life of the survey while questions and definitions settled down, HEBCI requires universities and HEIs to report on the scale of USO activity emerging from their institution (number of companies formed and external investment raised), and on a number of variables relating to the survival or USOs and their current scale (turnover and employment). Over the period 2003 – 2018 the survey suggests that just over 4,000 USOs have been formed of which 2,500 were IP-based spinouts in which the university retained some IP ownership; 480 were spinouts in which the university did not retain ownership of IP; and 1,050 were academic startups.

More recently, a number of databases have emerged which collect a broader range of information on USO activity emerging from UK universities. Chief amongst these was Spinouts UK and Beauhurst, with the latter acquiring the former in late 2018. These companies work to identify spinouts from the 'bottom-up' and provide company- and even investment deal-level information on the USOs. In addition, the opening up of databases on the outcomes from research funded by the Research Councils allows us to further identify and cross-check spinouts based on IP from this research. A significant advantage of such micro-level databases is the potential to link these data into other datasets to gain much richer insights (see e.g. Chaix et al., 2019). In addition, if the spinout company identification process is robust, such data provides a much more reliable evidence base on USO activity as it is easier to verify and test the accuracy of the data.

In developing this report, I brought together these various datasets including:

- 748 companies identified by Beauhurst as university or academic spinouts that have received equity-based investments[1]
- 2,744 companies publicly identified on the Spinouts UK website
- 499 companies identified in Gateway to Research as spinouts from Research Council funded research.

These companies were combined into a consolidated USO database for this report (hereafter referred to as the USO database) leading to a total of 3,074 unique organisations being identified. The company names were then linked to their unique UK company reference number with all but 169 of the combined list returning a positive link. Using these reference numbers key information available through company accounts on the companies (such as their current status, sector of operation, etc.) could be extracted from company financial databases.

In developing the USO database for this report it became immediately clear that each of the data sources has different levels of coverage across the UK university landscape. Part of this may be due to how the companies in the particular database are identified. For example Gateway to Research will only provide information on companies emerging from Research Council funded research. As such USOs emerging from research funded by other sources will not appear. Beauhurst focuses on companies with high growth potential and this included 'academic spinouts'. In addition, their data largely focuses on equity-based deals and as such may not capture USOs financed through other means (e.g. debt-financing, family financing etc.). Spinouts UK (until their acquisition by Beauhurst) explicitly sought to capture both spinouts and startups emerging from universities and worked with individual universities as well as with other data sources to compile their lists.

Table 9 provides an analysis of the degree of overlap between data sources on USOs. Spinouts UK identifies by far the most USOs. Many of the USOs identified by Beauhurst are also in the Spinouts UK database. However, only a few spinouts identified through Gateway to Research are in the Beauhurst database. Part of the explanation of the lack of significant overlap between data sources may lie in differences in coverage. For example Beauhurst tracks an additional 433 university spinouts that did not receive any equity-based investments. This data was not available to the author as part of the analysis for this technical annex. It is possible (although as yet not verified) that some of these companies may well have been identified through Spinouts UK or Gateway to Research. Another possible explanation of the relatively poor overlap between Beauhurst and Spinouts UK datasets and Gateway to Research is down to how different organisations define and categorise an IP-based university spinout.

1 Beauhurst tracks a further 433 university spinouts that have not received any equity-based investments. These companies and associated data were not available to the author for the analyses in this technical note.

Table 9 Number of USOs identified in each data source and overlap between sources
Sources: author's analysis of Beauhurst, Spinouts UK, Gateway to Research

Data source	Beauhurst	Spinouts UK website	Gateway to Research (2006 – 2017)
Beauhurst	**748***	634	155
Spinouts UK website		**2,744**	270
Gateway to Research (2006 – 2017)			**499**

* Note: Beauhurst data provided to this project included USOs in receipt of equity based investments. Beauhurst tracks an additional 433 university spinouts that did not receive equity investments.

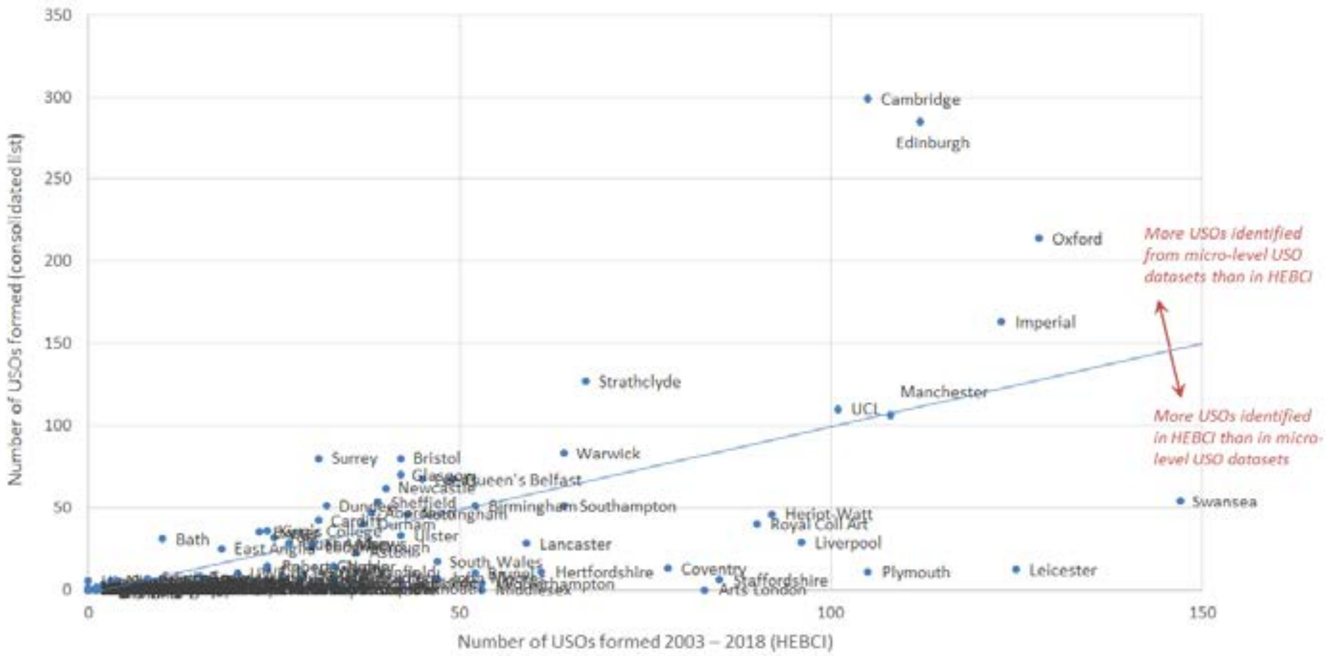
To further examine the coverage of HEBCI and USO database I explore the extent to which they capture both spinouts and startups. The Spinouts UK website helpfully identifies each company as a university spinout or a startup. As a first approximation, I have assumed that USOs emerging from Gateway to Research are spinouts based on university IP. Table 10 presents the results of this analysis, and compares the coverage of the USO database with HEBCI across these different types of USO. It shows that the databases are broadly consistent in terms of coverage across these different types of USO.

Table 10 Comparison of the number of USOs formed by type during the period 2003 and 2018 identified by the HEBCI surveys and in the USO database
Sources: author's analysis of HEBCI surveys, and USO database (Beauhurst, Spinouts UK, Gateway to Research)

Type of USO	Number of USOs formed (2003 - 2018)		Proportion of USOs by type	
	HEBCI	USO database	HEBCI	USO database
Spinouts	3,003	1,502	74	71
Of which:				
Spinouts (Univ. owned IP)	*2,523*	*n/a*	*62*	*n/a*
Spinouts (No univ. ownership of IP)	*480*	*n/a*	*12*	*n/a*
Academic staff startups	1,049	425	26	20
Other	n/a	84	n/a	4
Not known	n/a	99	n/a	5
Total	4,052	2,110	100	100

The next question is the extent to which these datasets biases towards particular types of HEIs. One way of exploring this is to compare the number of USOs identified by the HEIs themselves through HEBCI with the number of companies linked to their institutions through the combined micro-level databases. This is shown in Figure 8. The line represents the same number of USOs being identified in each data source. Universities positioned above the line have more USOs identified through the micro-level USO database than in HEBCI, while for those below the line the USO database identifies fewer USOs than in HEBCI.

Figure 8 Data coverage between USO database and HEBCI



It is immediately clear that the consolidated USO database is biased towards the larger, more established research universities, while the less research intensive and smaller universities are less well represented. This is further highlighted when looking at the proportion of USOs identified in each database emerging from universities in each group (Table 11). Seventeen percent of USOs in HEBCI emerged from the largest six research universities. By contrast 39% of USOs in the USO database were attributable to these universities. Other research intensive universities generated 30% of USOs based on an analysis of HEBCI compared with 42% based on the USO database. By contrast, USOs emerging from less research intensive universities form 29% of all USOs identified by HEBCI but just 7% in the USO database. This bias needs to be borne in mind when interpreting results from the analyses that follow.

Table 11 Comparison of the number of USOs formed by HEI type during the period 2003 and 2018 identified by the HEBCI surveys and in the USO database
Sources: author's analysis of HEBCI surveys, Beauhurst, Spinouts UK, Gateway to Research

HEI type	Number of USOs formed		Proportion of USOs, by HEI type	
	HEBCI	USO database	HEBCI	USO database
Largest 6 research universities	677	804	17	39
Other research intensive universities	1,207	862	30	42
Smaller medium research intensive universities	632	199	16	10
Less research intensive active universities	1,181	143	29	7
Specialist STEM universities	111	18	3	1
Specialist arts, social science and other universities	244	38	6	2
All UK universities	4,052	2,064	100	100

5 Volume of spinout activity from UK universities

This section explores trends in the volume of USO activity emerging from UK universities and the patterns of activity across the regions and nations of the UK. Given the significant differences in coverage between the HEBCI and USO databases I present analyses of the volume of USO activity based on both data sources.

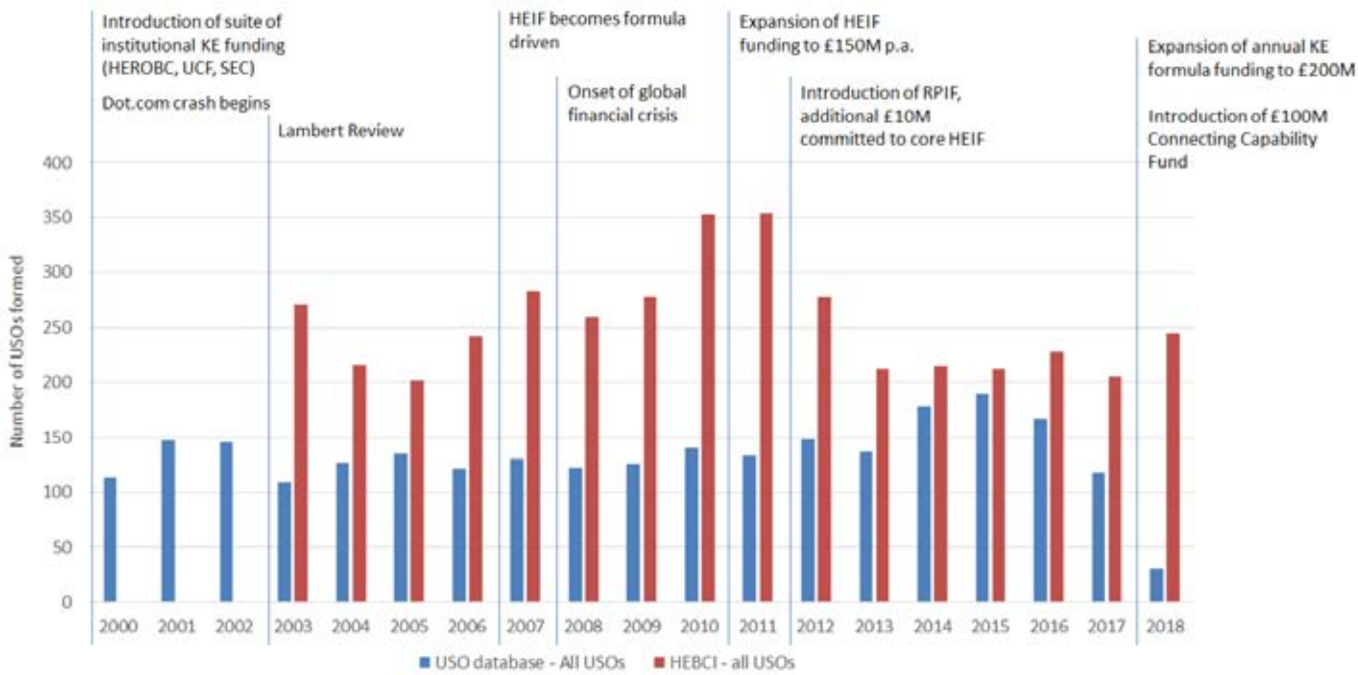
5.1 Trends in the volume of university spinout activity

Figure 9 presents the trends in the volume of USO activity. Based on an analysis of the year of incorporation of firms identified in the micro-level USO database the numbers of USOs formed each year remained relatively stable between 120 and 130 per year between 2004 and 2009. Interestingly the number of USOs formed each year (based on the USO database) rose after the onset of the economic recession in 2008 to almost 190 in 2015. It has since dropped back to almost 120 in 2017. If we now look at the trends based on the HEBCI survey (which is based on university self-reporting and clearly captures the activities of a wider range of universities than the USO database), a slightly different trend pattern emerges. Here there is a more marked increase in spinout activity almost directly following the onset of the recession, before USO activity levels drop back to the formation rate of around 200-220 USOs per year.

Figure 10 shows that a three quarters of all USOs (identified in the USO database) were formed since 2002, with half formed since 2008, and a quarter since 2013. This profile of formation and the rate of formation is consistent with the recent study of Hewitt-Dundas (2015).

Figure 9 Trends in USO activity, 2000 - 2018

Sources: analysis of USO database, based on year of incorporation of all USOs identified in Beauhurst, Spinouts UK and Gateway to Research; author's analysis of HEBCI surveys

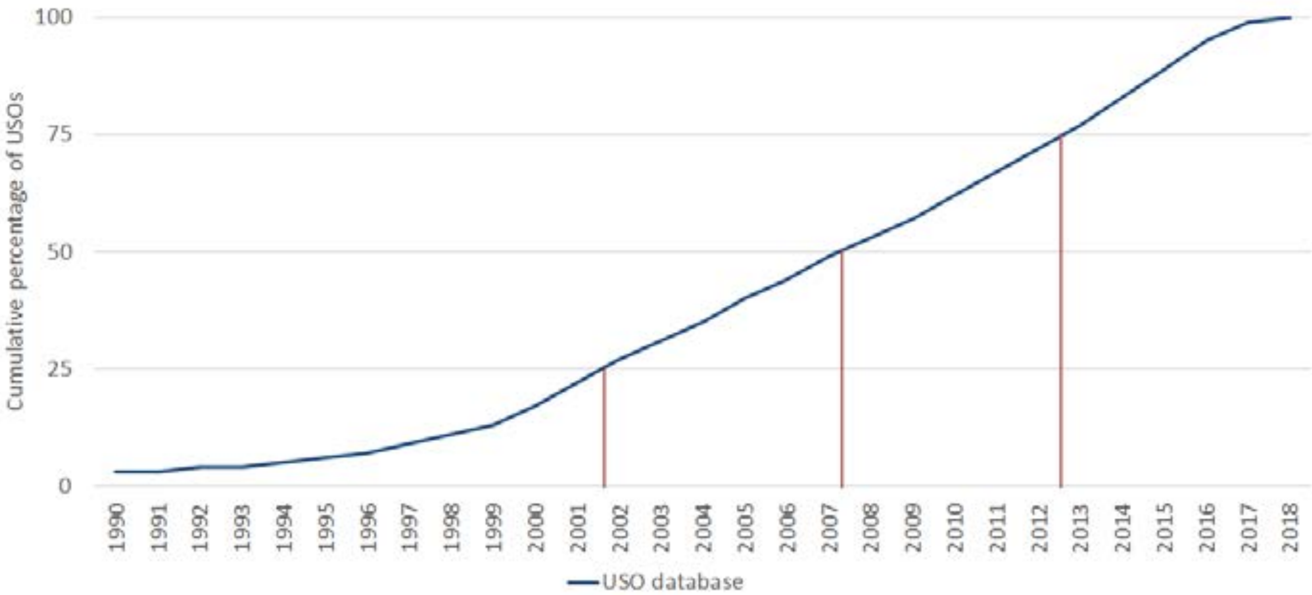


Notes:

1. HEROBC: Higher Education Reach Out to Business and the Community fund; UCF: University Challenge Fund; SEC: Science Enterprise Challenge fund; HEIF: Higher Education Innovation Fund; RPIF: Research Partnership Investment Fund;
2. The value for 2018 for the USO database is 30. It is likely due to the incomplete coverage for this year for the company lists drawn from the Spinouts UK public database and from the Gateway to Research data portal. It is therefore not presented in this figure.

Overall, picture emerging from this set of analyses based on both data sources suggest a relatively stable contributions of universities to the stock of entrepreneurial new companies entering the economy.

Figure 10 Cumulative percentage of USO formation by year of incorporation (%)
Source: analysis of USO database, based on year of incorporation of all USOs identified in Beauhurst, Spinouts UK and Gateway to Research

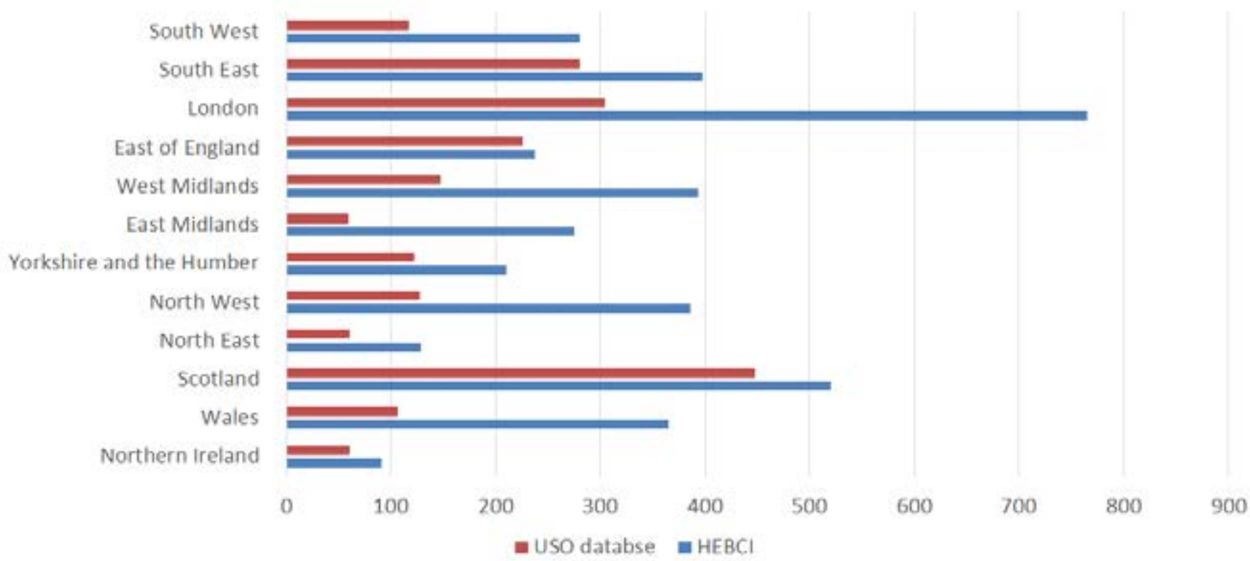


5.2 Patterns of university spinout activity across the regions and nations of the UK

Figure 11 presents the patterns of USO activity across the regions and nations of the UK based on analyses of both data sources. The dominance of USO activity in the Golden Triangle including London, the South East and the East of England is evident as is the significant activity emerging from Scottish universities.

The figure also highlights areas where there are significant discrepancies between the two data sources which would change, for example, the overall pattern, notably activity from West Midlands-based universities and those in the North West. Analysis of the HEBCI data would suggest these regions have much higher levels of USO activity than would be inferred from the micro-level USO database.

Figure 11 Volume of university spinout activity 2003 – 2018, by the regions and nations of the UK
Sources: author's analysis of the USO database, HEBCI surveys



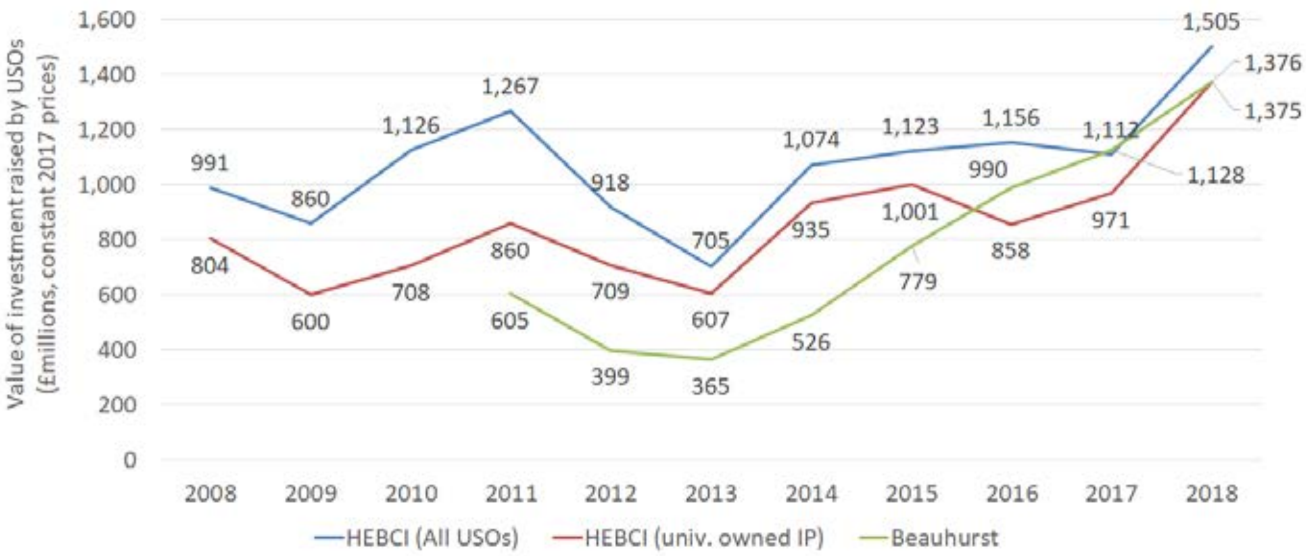
6 Scale and nature of investments in university spinouts

The report now moves on from the trends and regional patterns in the volume of USO activity to the scale of investments raised to support the commercialisation of their core product or service offering. Data on the scale of investments made into USOs is available through the HEBCI survey, once again based on self-reporting by universities. I was also provided access to the Beauhurst data which provides deal-level information on the amount of investments raised by the 748 USOs in their database categorised by the stage of development of the company (seed, venture, growth and established) at the point it received the investment. This allows for a much richer set of analyses than is possible through HEBCI. However, given the bias of this dataset towards the larger, more research intensive universities, it provides better insights into USOs emerging from these types of HEIs than into other universities.

Furthermore, while USOs are identified in Beauhurst that were formed many decades ago, information on the scale and types of investments raised only begin in 2011. By comparison, data on the external investments raised for USOs available in HEBCI begin in 2008.

6.1 Trends in the scale of investments raised by university spinouts

Figure 12 External investments in university spinouts, 2008 – 2018
Source: author's analysis of Beauhurst database and HEBCI surveys



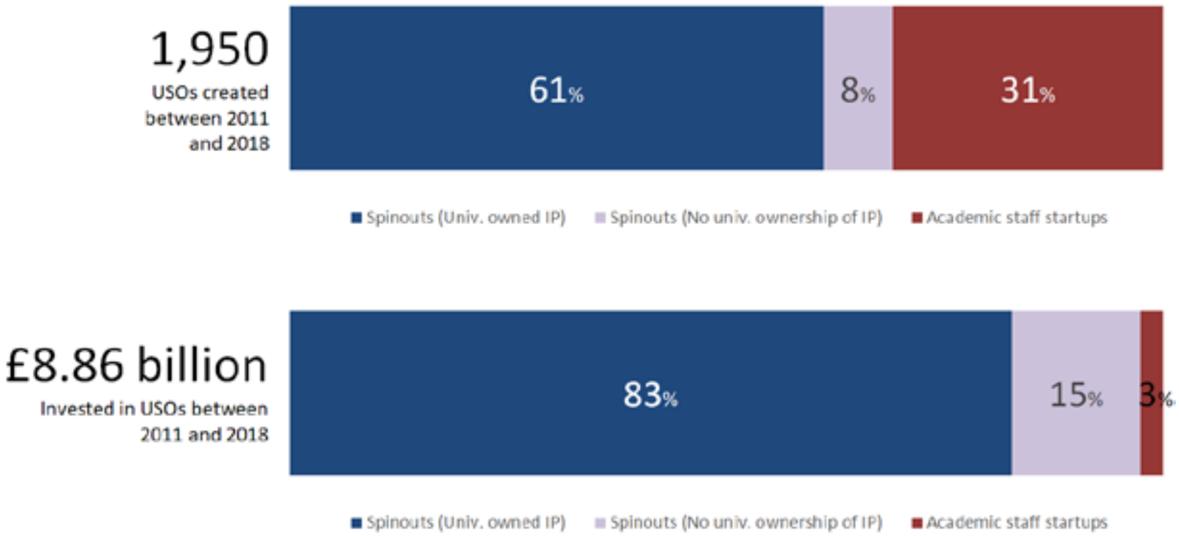
Note: spike in external investment in HEBCI data in 2010 and 2011 is down to unusually high returns by a small number of universities (Cambridge, Bath, and Edinburgh).

Figure 12 presents the trends in the scale of investments raised by USOs based on the analyses of both HEBCI and Beauhurst data sources. The evidence from Beauhurst suggests a steadily increase amount of investment is being secured by USOs, rising from just under £365 million in 2013 (in constant 2017 prices) to £1.376 billion in 2018; a rise of just over £1 billion in real terms over the period 2013 – 2018.

The HEBCI-based trend analysis suggests a more varied pattern of performance of USOs in raising external investment. For USOs in which universities retain some ownership of IP, the amount of external investment raised exhibits some cyclicality (in real terms) although there is an overall increase in the amount raised between the trough in 2009 and 2018 (of £645 million). If all types of USOs are included in the HEBCI analysis (i.e. including IP-based USO for which the university does not retain any IP ownership and academic startups), the amount of investment raised increased significantly between 2009 and 2011 before dropping back to a low of £705 million in 2013. Since then the amount raised has increased dramatically to £1.5 billion in 2018, albeit with four years of relative stagnation between 2014 and 2017.Diving into the details of individual university responses to HEBCI around this period, the significant rise and fall in external investment data appears to be down to a small number of large research intensive universities reporting significant levels during this period which fall dramatically subsequently. At the time of publication of this technical annex, the reasons for the very high levels of external investment reporting by these universities to HEBCI had not been identified and warrant further exploration.

Figure 13 shows that much of the external investment raised by USOs (as reported by HEIs in their returns to the HEBCI survey) are secured both those spinouts in which the university retains some ownership of the IP. While such companies constitute 61% of the USOs formed between 2011 and 2018, they capture 83% of the reported investment. Similarly, IP-based spinouts in which the university does not retain any IP ownership represent just 8% of companies formed during this period, but secure 15% of the external investment. Academic start-ups, by contrast, represent 31% of the USOs formed but secured just 3% of the reported investment.

Figure 13 Scale of external investments in different types of USOs over the period 2011 – 2018
Source: author's analysis of HEBCI data



6.2 Variations in investment raised for spinouts across geography and university types

Figure 14 shows that the amount of investment raised by USOs is heavily concentrated in those companies emerging from universities located in the Greater South East (London, South East and the East of England) and Scotland despite the number of USOs formed being (a bit) more evenly distributed across the country. Causes of these variations should be examined further. In particular effort should be made to disentangle structural causes related to the nature of the USOs and the technologies they are commercialising (for example, are universities in the greater south east generating likely to commercialising technologies with much greater investment requirements than their counterparts located outside this region) from other factors (such as spatial variations in the availability of investment capital) from university-specific performance differences in commercialising IP.

Figure 14 Regional variations in investments in USOs and number of USOs formed over the period 2011 – 2018
Source: author's analysis of Beauhurst database and HEBCI surveys

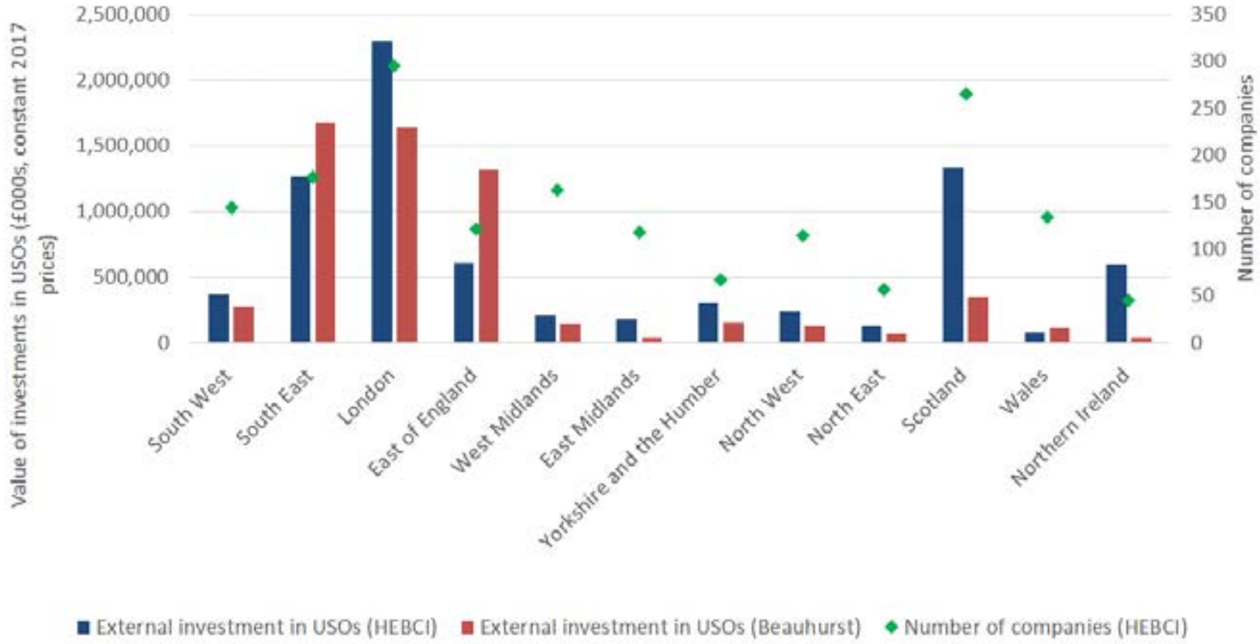


Table 12 Variations in the total investment secured by different types of HEIs for different types of USOs, 2011 – 2018 (£ millions, constant 2017 prices)
Sources: author's analysis of HEBCI surveys and Beauhurst database

HEI type	External investment, by type of USO (HEBCI)			Total investments raised by USOs		Proportion of total by HEI type		*Number of HEIs*
	Spinouts (Univ. owned IP)	Spinouts (No univ. ownership of IP)	Academic staff startups	HEBCI	Beauhurst	HEBCI	Beauhurst	
Largest 6 research universities	4,154	83	121	4,357	4,453	49	75	*6*
Other research intensive universities	2,755	1,184	59	3,998	1,257	45	21	*27*
Smaller medium research intensive universities	232	11	37	279	158	3.2	2.7	*19*
Less research intensive active universities	105	5.5	9	120	48	1.4	0.8	*68*
Specialist STEM universities	57	4	0	61	2	0.7	0.0	*13*
Specialist arts, social science and other universities	14	30	0	45	47	0.5	0.8	*29*
All UK universities	7,316	1,318	226	8,860	5,965	100	100	*162*

Analysed by university group, it is also evident that the vast majority of the total investments raised by USOs were for companies emerging from the largest six research universities and other research intensive institutions (based analyses of both HEBCI and Beauhurst). USOs emerging from these two groups together account for over 90% of investments raised.

The average investment per USO shows a similarly skewed pattern, with USOs emerging from the largest six research universities securing significantly more than companies originating from other universities (Table 13). There average investment per USO formed between 2011 and 2018 is around £4.5 million (based on HEBCI data). Based on the data available through Beauhurst, the average investment raised per company was £6.8 million over this period.

Table 13 Average investment in USOs formed between 2011 and 2018
Source: author's analysis of HEBCI surveys, Beauhurst database

HEI type	Average investment (£000s) per USO formed from 2011-2018	
	HEBCI	Beauhurst
Largest 6 research universities	11,201	10,529
Other research intensive universities	7,001	3,543
Smaller medium research intensive universities	998	2,378
Less research intensive active universities	220	749
Specialist STEM universities	877	985
Specialist arts, social science and other universities	479	463
All UK universities	4,548	6,776

The estimates here of the average investments raised are, overall, consistent with, albeit a higher than, the evidence compiled by Hewitt-Dundas (2015) in her profile of university spinouts. Her study went on to show that the amount of investment raised by USOs depended on business model adopted, with those based on the provision of consultancy and contract research raising far less than those seeking to develop technology for collaborative development by an incumbent (£867,000 compared with £3.9 million).

Table 14 Average investment in USOs by type of business model (£)
Source: Hewitt-Dundas (2015) based on survey of UK USOs

	Investment to date	t	p
	£ Mean		
Technology with a view to sale	2,683,812	-.240	.811
Technology for collaborative development by incumbent	3,902,041	-1.749	.081
Consumer product producer	3.309,156	-.450	.653
Original Equipment Manufacturer	2,541,792	.082	.935
Consultancy/Contract research	866,963	2.593	.010
Other	4,921,705	-1.633	.103

Note: Six separate t-statistics were calculated. T-statistics are calculated for USOs adopting each business model as compared to all other USOs in the sample.

Overall, the picture is one of heavily skewed patterns of investment, with significant concentrations in the Greater South East and Scotland, and in USOs emerging from the larger research intensive universities, and in particular the largest six research universities.

6.3 Scale and trends in investment in spinouts by stage of development

The Beauhurst database allows us to probe further the types of investments being made in USOs, in particular the scale of activity and investments being made at different stages of development of the USOs themselves, namely seed, venture, and growth. Beauhurst define these stages as:

Seed: A youngish company with a small team, low valuation and funding received (low for its sector), uncertain product-market fit or just getting started with the process of getting regulatory approval. Funding likely to come from grant-awarding bodies, equity crowdfunding and business angels.

Venture: A company that has been around for a few years, has either got significant traction, technology or regulatory approval progression and funding received and valuation both in the millions. Funding likely to come from venture capital firms.

Growth: A company that has been around for 5+ years, has multiple offices or branches (often across the world), has either got substantial revenues, some profit, highly valuable technology or secured regulatory approval significant traction, technology or regulatory approval progression, funding received and valuation both in the millions. Funding likely to come from venture capital firms, corporates, asset management firms, mezzanine lenders.

Figure 15 presents the number of deals and average deal size in USOs over the period 2011 – 2018 based on information available from Beauhurst. Over this period just over 1,000 seed funding deals were secured by USOs, 860 deals for USOs in their venture stage, and 232 deals for USOs in their growth phase. The average deal size grows with as the company moves through these development stages (as expected) from an average of £1.1 million per deal at the seed stage; to £3.2 million at the venture stage; and £10.3 million at the growth stage.

Figure 15 Average size of investment deals in university spinouts, by stage of company evolution at the point of the deal over the period 2011 – 2018
Source: author's analysis of Beauhurst database

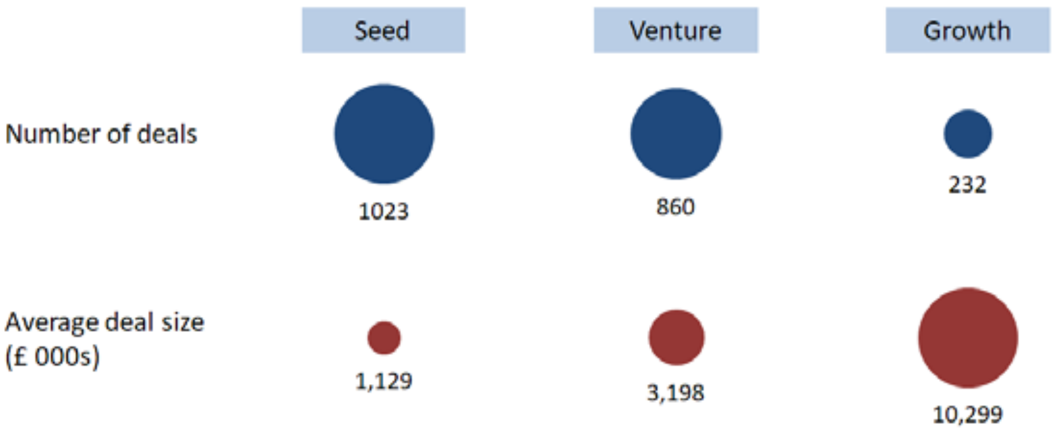


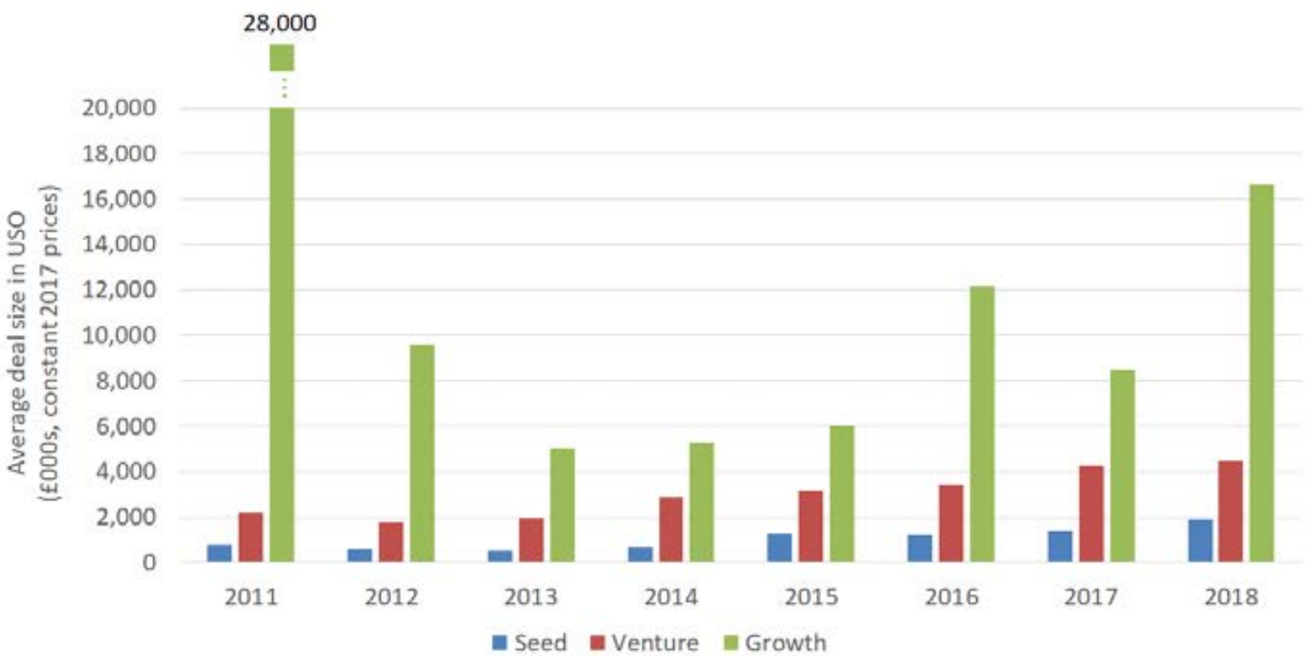
Table 15 Trends in the number of deals and scale of investments in university spinouts
Source: author's analysis of Beauhurst database

	Company stage at point of deal	2011	2012	2013	2014	2015	2016	2017	2018	Absolute change 2011 – 18 (%)
Number of deals	Seed	86	104	97	125	137	154	166	154	68
	Venture	68	85	84	113	125	112	143	130	62
	Growth	14	20	31	22	39	36	38	32	18
Total investment raised (£millions)	Seed	63	59	49	82	164	183	222	288	226
	Venture	148	147	162	323	392	379	591	566	418
	Growth	395	192	152	116	222	426	314	499	104

Table 15 shows that the number of deals with USOs at each of these stages of development has grown substantially over the period 2011 – 2018. Similarly, the total amount of investments being made into USOs emerging from UK universities in each of these stages has increased substantially over this period with an additional £226 million being invested at the seed stage; £418 million at the venture stage; and £104 million at the growth stage.

Figure 16 presents the average deal size at each of the stages over the period 2011 – 2018. It shows that, in real terms, the average size of investment has increased for seed-stage and venture-stage, while growth-stage investments exhibit a bit more volatility year-on-year. This is likely due the much smaller number of investments in this category and the dependence of the scale of investment on the nature of the technology or product being scaled-up and commercialised.

Figure 16 Trends in the average size of investment deals in university spinouts, 2011 – 2018
Source: author's analysis of Beauhurst database



6.4 Scale of investment in spinouts in different sectors and stage of development

The Beauhurst database also allows us to explore the patterns of investments in USOs by the sector of application of the USO product or service. Based on their sector categories, the top 25 sectors (by number of USOs formed) are shown in Table 16. For each sector the total amount of investment secured over the period 2011 – 2018 is provided, along with the average amount secured per USO at each stage of their development. This gives some insights into the significant variations in financing requirements of USOs targeting different sectors of the economy.

Of the top 25 sectors, those developing products or services in pharmaceuticals; research tools and reagents; analytics, insight and tools; and materials technologies; chips and processors; clean energy generation; security services; and consumer electronics are investment heavy, with average investments per USO exceeding £10 million. Investments rapidly rise to excesses of £30 million in the growth stage. By contrast the average investment secured per USO developing mobile products and mobile apps, healthcare products, software-as-a-service, and other business and professional services, is many times lower than USOs targeting the former set of sectors.

Table 16 Scale of investments in USOs, by sector and stage of investment
Source: author's analysis of Beauhurst database

Top 25 sectors by number of USOs formed	Number of USOs	Total funds invested (£000s)	Investments (£000s) per company by stage of company evolution				
			Total	Seed	Venture	Growth	Established
Pharmaceuticals	139	2,068,336	14,880	5,059	19,040	41,674	
Research tools/reagents	124	1,777,846	14,337	3,008	11,939	52,117	
Other technology/ip-based businesses	116	564,105	4,863	1,578	6,344	12,260	4,257
Other software	78	600,982	7,705	1,572	6,576	29,025	2,718
Clinical diagnostics	74	340,465	4,601	1,546	5,339	8,321	
Software-as-a-service (saas)	61	228,190	3,741	1,009	3,014	18,681	3,000
Analytics, insight, tools	59	696,968	11,813	1,363	5,221	56,781	1,012
Medical devices	57	306,226	5,372	1,456	5,973	31,409	
Other manufacturing and engineering	50	307,209	6,144	1,078	6,696	14,477	4,067
Materials technology	49	531,282	10,842	2,821	4,648	39,835	7,633
Other hardware	48	339,527	7,073	533	6,178	21,712	2,101
Mobile	41	78,840	1,923	659	3,164		
Other cleantech	37	209,273	5,656	995	6,733	10,368	
Mobile apps	31	43,979	1,419	613	2,843		
Nanotechnology	30	173,081	5,769	1,670	4,459	18,779	7,720
Medical instrumentation	27	143,709	5,323	1,396	5,997	6,585	303
Other business and professional services for businesses	24	82,523	3,438	3,868	2,680		394
Healthcare products	22	43,536	1,979	719	3,087	3,162	
Chips and processors	20	340,158	17,008	1,337	4,606	53,146	7,720
Security services (physical and virtual)	19	234,811	12,358	991	9,076	86,792	
Clean energy generation	19	277,802	14,621	1,534	11,389	20,295	
Semiconductors	19	143,419	7,548	5,556	2,324	14,961	7,720
Internet platform	18	120,340	6,686	470	4,891	21,827	2,101
Consumer electronics	16	383,352	23,959	2,289	8,052	50,302	
Energy reduction technology	16	59,775	3,736	876	4,612	7,062	

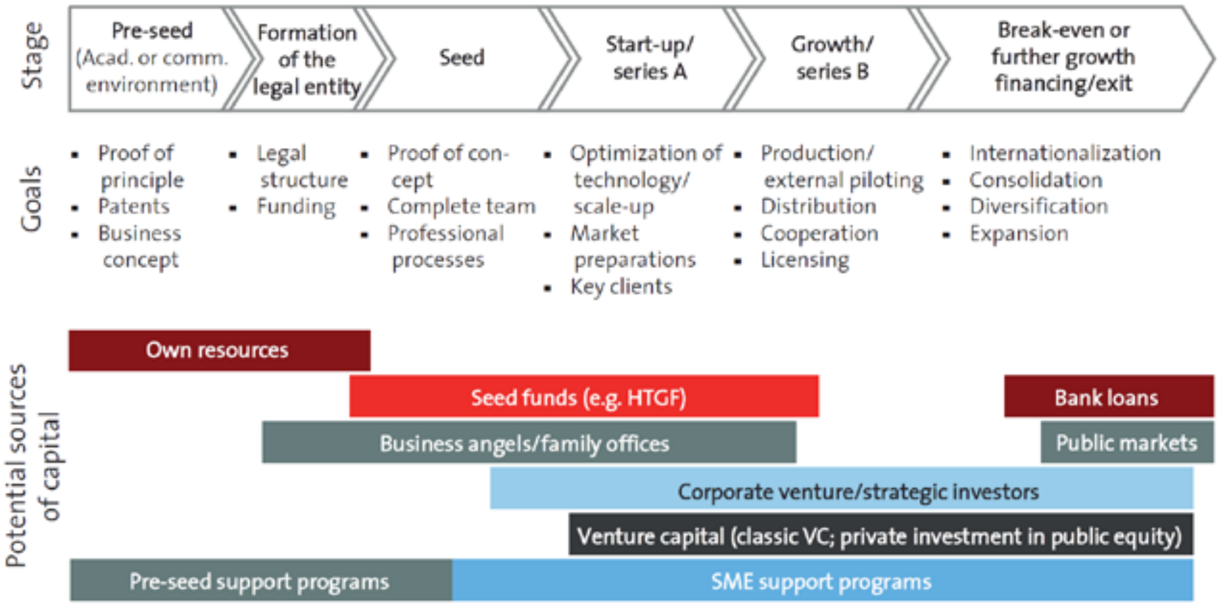
Note: USOs can be categorised into multiple sectors. Investments are counted in full in each sector identified rather than making assumptions about proportion of investments relevant to each sector. As such the total amount of investments should ***not*** be compared to the total amounts invested overall and will exceed this number.

7 The funding landscape for university spinout development

University spinouts seek investments from a variety of sources to support their commercial development (Connell and Probert, 2010; Hewitt-Dundas, 2015; Rittershaus, 2016). Rittershaus (2016) show that USOs draw on different types of capital financing as they move through the various stages of company development (Figure 17).

In this section I explore the types of organisations investing in USOs and how these patterns are changing. In addition I examine the scale of available capital from three key sources of finance for USOs: the established venture capital sector; the emergent role of corporate venture capital; and the role of Innovate UK, the UK's innovation funding agency.

Figure 17 Stages of financing and typical sources of capital for chemistry-related start-up companies
Source: Rittershaus (2016)



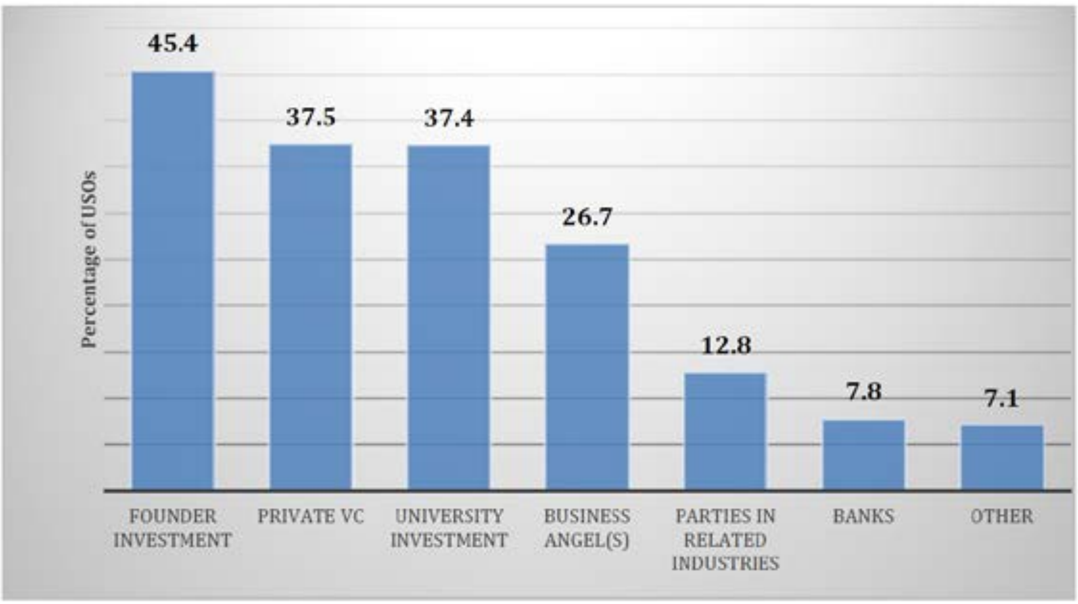
7.1 Types of investors in university spinouts

An analysis of the Beauhurst data reveals the variety of investors in USOs. Table 17 presents the involvement of different types of investors based on the number deals they are involved in. It also explores how the scale of involvement by different types of investors varies by the stage of USO development. It suggests that, overall, private equity and venture capital investors are the most active, followed by business angels and angel networks, and commercialisation companies. Universities are also heavily involved in seed and venture stage investment deals, as are devolved governments and local/regional governments, while corporate investors are more active during venture and growth stage deals. This pattern of involvement by different investors is broadly consistent with the evidence compiled by Hewitt-Dundas (2015) (Figure 18).

Table 17 Involvement of different types of investors in USO investment deals, by stage of company development (percent of deals of each type)
Source: author's analysis of the Beauhurst database

Investor type	Total	Stage of company development at point of deal			
		Seed	Venture	Growth	Established
Private Equity and Venture Capital	29	18	35	58	33
Commercialisation Company	18	15	21	26	14
Business Angels / Angel Networks	18	14	24	13	4.8
University	10	11	11	4.3	0
Devolved Government	9.1	7.5	11	8.2	10
Corporate	7.2	3.2	7.4	24	0
Local and Regional Government	5.1	4.3	6.0	5.2	0
Crowd funding	3.2	2.7	4.1	2.2	0
Central Government	2.1	1.2	3.3	2.2	0
Private Investment Vehicle	1.6	0.8	2.8	0.9	4.8
Charity/Not-for-profit company	1.3	0.6	2.0	2.2	0
Asset Management	1.1	0.3	1.2	4.3	0
Family Office	0.8	0.3	1.3	1.7	0
Accelerator	0.7	1.2	0.2	0	0
Specialist Lender	0.2	0	0.3	0.4	0
Bank	0.1	0	0.1	0.4	0
Research Council	0.1	0.1	0.1	0	0
Merchant Bank	0.1	0	0.2	0	0
Investor type not known	*70*	*70*	*71*	*69*	*81*
Total	100	100	100	100	100
Number of deals	*2,136*	*1,023*	*860*	*232*	*21*

Figure 18 Percentage of USOs having received finance by source
Source: Hewitt-Dundas (2015) based on survey of UK USOs



7.1.1 Most active investors

The Beauhurst database allows us to go further and identify the most active investors of different types based on the number of deals each investor is involved with. Unfortunately it is not possible to identify the amount each investor invests in particular deals.

The analysis below attempts to account for the ownership of different funds by the same organisation (for example the multiple funds managed by Parkwalk, Northstar Ventures, the IP Group, Scottish Enterprise, and a number of universities) as well as the mergers and acquisitions of funds by organisations (in particular the acquisition by the IP Group of Fusion IP in 2014, Parkwalk in early 2017, and Touchstone Innovations in late 2017).

Table 18 Top 15 most active investors investing in USOs over period 2011 – 2018
Source: author's analysis of the Beauhurst database

Rank	Investor	Investor type	Number of deals
1	IP Group	Commercialisation Company	157
2	Scottish Enterprise	Devolved Government	141
3	Business Angel(s)	Business Angels / Angel Networks	135
4	University of Cambridge	University	84
5	Parkwalk (pre-2017)	Commercialisation Company	73
6	Touchstone Innovations (pre-2018)	Commercialisation Company	64
7	Mercia Fund Managers	Private Equity and Venture Capital	58
8	Management participation	(no value)	48
9	Archangels	Business Angels / Angel Networks	41
10	Start Up and Early Stage Capital	Devolved Government	40
11	SyndicateRoom	Crowd funding	39
12	Oxford Sciences Innovation	Commercialisation Company	33
13	The North West Fund	Local and Regional Government	30
14	Woodford Investment Management	Private Equity and Venture Capital	29
15	24Haymarket	Business Angels / Angel Networks	25

Overall, as of 2018, the most active investors in USOs included the IP Group, Touchstone Innovations (now owned by the IP Group), Parkwalk (also now owned by the IP Group), and Oxford Sciences Innovation (a commercialisation company specifically linked to the University of Oxford). Scottish Enterprise – which set up the Scottish Investment Bank and the Scottish Co-Investment Fund – and Mercia Fund Managers which is focused primarily on investing in innovative SMEs in the UK regions are also active investors. The University of Cambridge is the most active university in terms of investing in spinouts.

It was not possible to say anything on the role of different investors in USO deals (for example as lead investor or co-investor). Future work might find it insightful to explore trends in investors based on whether or not they are willing to lead USO deals.

7.1.2 Trends in investors in university spinouts

Figure 19 explores how the scale of investments in USOs being made by different investor types has changed over the period 2011-13 to 2016-18. It highlights the increases in investment activity across all investor types. Those with the greatest rates of increase include from private equity and venture capital, and commercialisation companies and universities. Deals involving corporate investors increased by 49% from an average of 16 per annum in 2011-13 to 24 per annum over the period 2016-18. Also striking is the emergence of crowd funding as a source of financing for USOs.

Figure 19 Average number of deals by investor type over period 2011 – 2013 and 2016 – 2018
Source: author's analysis of Beauhurst data

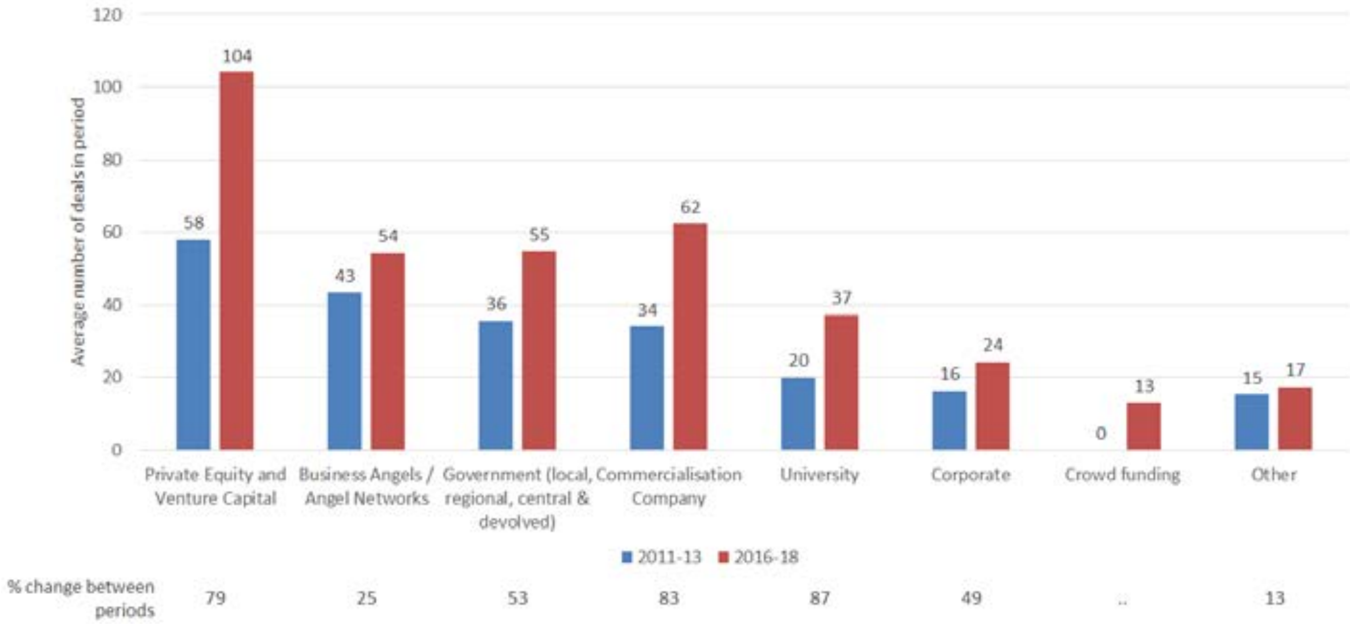


Figure 20 Involvement of investor types (where known) in deals over period 2011 – 2013 and 2016 – 2018 (proportion of deals)
Source: author's analysis of Beauhurst data

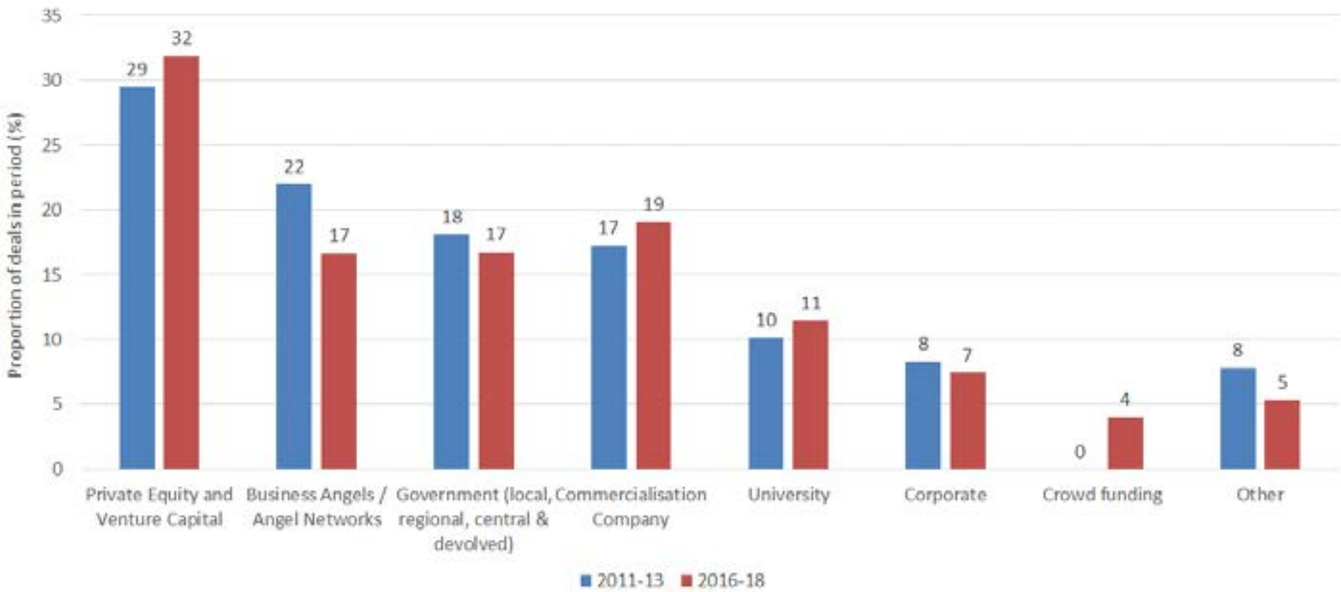


Figure 20 explores whether the patterns of particular investor types in USO deals has changed over time and examines the proportion of deals involving a particular type of investor. Note here that multiple investor types can invest in the same deal. This figure builds on Figure 19 and shows that the patterns of investors involved in USO deals has remained roughly similar over time. Private equity and venture capitalists are a little more likely to be involved in USO deals as are commercialisation companies and universities, while business angels and angel networks are less likely. As a proportion of total deals, government investors (including UK central, devolved nations and local government agencies), and corporate investors are a little less likely to be involved in USO deals.

What the aggregate analysis in Figure 20 masks, however, is the changing concentration of individual investors in USO deals. Figure 21 shows that, on average the top five investors in USOs in are involved in an increasing share of all USO deals: in 2017-18 they invested in 36% of deals compared with 26% in 2011-12. Thus, while the top investors draw from different types, within each type of investor activity is highly concentrated in a relatively small number of investors. Similar trends are evident at the seed and venture stages (Figure 21). By comparison, the proportion of growth stage deals involving the top five investors has decreased over this period suggesting more investors are now involved in this stage.

Figure 21 Proportion of deals top five investors are involved in over the period 2011 – 2012 and 2017 – 2018 (percentage)
Source: author's analysis of Beauhurst data

	2011 - 12		2017 - 18	
	Proportion of deals involving top 5 investors	Total number of deals	Proportion of deals involving top 5 investors	Total number of deals
All deals	26	378	36	674
Seed	24	190	32	320
Venture	33	153	44	273
Growth	53	34	39	70

While more detailed tables information on trends at the investor level could not be published due to conditions of accessing and reporting on Beauhurst data, the following results emerged from the analysis of how the proportion of deals the most active investors are involved in has changed over the period 2011-12 to 2017-18. In particular:

- The IP Group increased its involvement in USO deals between 2011 and 2018 although this was is due to its acquisition of other investors, and in particular increased activity through Parkwalk. By comparison, activity by the core group dropped significantly in the past few years.
- Scottish Enterprise is now a significant investor in the USOs largely due to the creation of its investment arm, the Scottish Investment Bank. It focuses on USO activity in Scotland
- The University of Cambridge has also seen the proportion of deals it is involved with grow significantly over the period, particularly at the seed stage
- Oxford Sciences Innovation (a commercialisation company which raised £600 million to invest in IP developed by the University of Oxford and in which both IP Group and Woodford Investment Management are shareholders) has emerged as an active investor in both seed and venture stage USOs
- The crowdfunding platform, SyndicateRoom has also emerged as an active investor in seed stage USOs
- In terms of growth stage investments, the rise of corporate investors BP Ventures and ESB Novusmodus (linked to the Irish State Utility company, ESB) is striking as is the significant decline in investments by the asset management company Invesco Perpetual

7.2 Private equity and venture capital activity in the UK

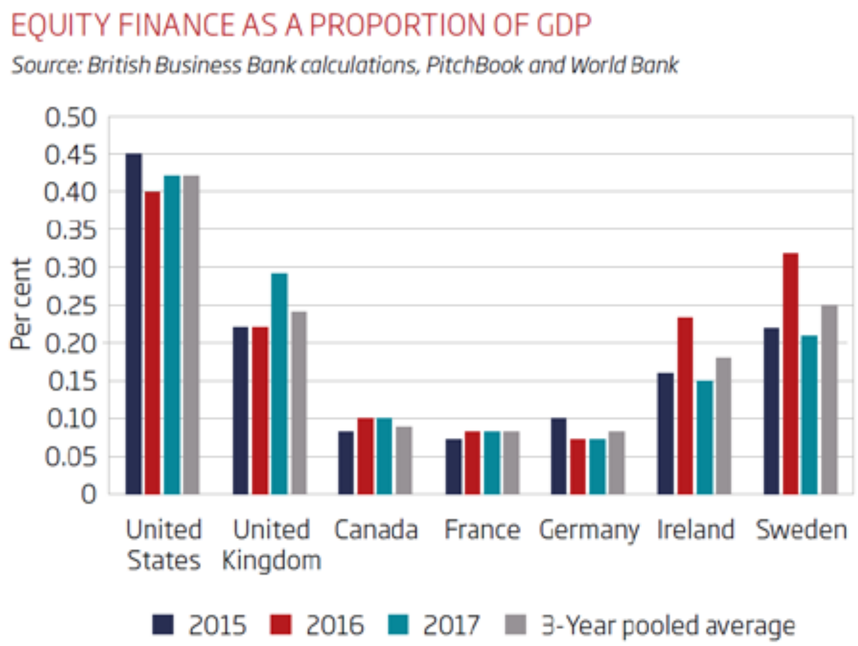
This section turns to the strength, scale and trends in the equity finance landscape in the UK.

7.2.1 Equity finance trends in the UK

A recent report by the British Business Bank on the state of finance markets for small businesses in the UK (British Business Bank, 2019a) shows that equity finance into small companies in UK has increased rapidly over period 2011-2017. It finds that equity finance is increasingly clustered, both globally into specific countries. In addition, within countries equity finance is clustered within specific regions.

The British Business Bank report also shows that the UK has been closing the gap in terms of the availability of equity finance, once the size of the economy is controlled for (Figure 22). It shows that in 2017 the US had an equity investment to GDP ratio of 0.42% (0.45% in 2015) compared with ratio in UK of 0.29% (0.22% in 2015). A comparison of the number of deals normalised by GDP shows that this is now slightly higher in the UK compared with the US. Comparisons with key European countries suggests equity investment to GDP ratio was substantially higher in the UK with the exception of Sweden which has seen an active investment cluster emerge in recent years.

Figure 22 Equity finance as a proportion of GDP
Source: British Business Bank (2019a)



Comparing the data available on equity deals in USOs from Beauhurst with information in the British Business Bank report on the number of equity deals in the UK shows that in 2017 just over 1 in 5 equity deals made in the UK were with university spinouts Table 19.

Table 19 Proportion of equity finance deals in UK secured by USOs
Sources: British Business Bank (2019a), author's analysis of Beauhurst

	2015	2016	2017
USO equity deals in UK	306	350	324
Number of equity deals in UK	1,692	1,470	1,458
USO deals as % total equity deals	18	24	22

A 2017 report by the British Private Equity and Venture Capital Association (BVCA) on the state of the venture capital (VC) market explored key trends in VC investments in the UK by stage (not limited to USOs). It shows that at the seed stage both the number of companies securing VC investments and the overall amount invested has increased between 2015 and 2017. By contrast, investments at the start-up stage have fallen. Other early stage investments have grown as have those at the later stage venture. Overall the amount of VC investment in the UK is estimated to have increased from £345 million in 2015 to £463 million in 2017.

Figure 23 UK investment by financing stage
Source: BVCA (2017)

Financing stage	Number of companies			% of companies			Amount invested (£m)			% of amount invested		
	2017	2016	2015	2017	2016	2015	2017	2016	2015	2017	2016	2015
Seed	60	49	19	7	6	2	46	15	16	0	0	0
Start-up	54	50	76	6	7	9	58	47	83	1	1	1
Other early stage	202	145	179	24	19	22	207	112	126	2	2	2
Later stage venture	72	68	59	8	9	7	150	72	119	1	1	2
Bridge equity financing	8	5	5	1	1	1	3	17	2	0	0	0
Total venture capital	396	317	338	47	42	41	463	262	345	4	4	6

7.2.2 British Business Bank Enterprise Capital Funds

The British Business Bank (BBB) was set up in 2014 to improve the availability of finance and related services to small companies operating in the UK at all stages of their development, including starting up, scaling up and staying ahead[2]. A particular focus is on businesses that are start-ups, high growth, or simply viable but underfunded. BBB is owned by the British Government but is independently managed. It does not lend or invest directly in companies, but rather works with partners such as banks, leasing companies, venture capital funds, and web-based platforms) to channel their investments and lending.

One programme set up by the BBB of particular relevance to USOs is the Enterprise Capital Funds (ECFs). This is designed to leverage public and private funds to co-invest in high growth businesses (British Business Bank, 2019b). The aim is to increase the supply of equity to these types of companies and lower the barriers to entry for fund managers looking to operating in the venture capital market. The most recent report on the ECF claims that over £1.2 billion has been committed since its inception, with the BBB contributing almost £700 million (British Business Bank, 2019b).

Interpreting these figures needs caution however. Mark White from UK Innovation and Science Seed Fund notes that headline numbers often suggest a misleadingly positive picture, for two principal reasons. Firstly, the figure of £700m is not an annual figure but represents the total commitment to funds with typically 10 year lives. The second is that not all of these funds will be invested at seed stage. It would be instructive for future research to explore the extent to which USOs benefit from these funds as they progress through the various stages of company development from seed to venture to growth.

7.2.3 Corporate venture capital

Corporate venture capital (CVC) – a term which captures a wide variety of equity investments made by corporations into high growth, high potential private businesses – emerged in the 1960s. It has evolved considerably since then with current forms much more flexible than in previous waves with CVCs adopting much more tailored and individualised approaches that are more closely aligned with their parent corporation's objectives. In addition they typically take a longer term view on investments that balance both strategic and financial objectives (BVCA, 2013).

BVCA (2013) highlight two key objectives of CVCs: developing the strategic capabilities of their parent corporations; and providing a source of financial return for them. The report also highlights a significant variety of CVC funds in operation not least in terms of their purpose, structure and how they measure success (Figure 24).

2 https://www.british-business-bank.co.uk/what-the-british-business-bank-does/, accessed on 14th May 2019

Figure 24 Differences in the types of corporate venture capital
Source: BVCA (2013)

	Corporate/Direct Investment (Balance Sheet)	Internal Dedicated Fund (GP Model)	External Fund (LP Model)
Purpose	Gain direct business and technology experience in emerging areas	Emerging business and technology with more autonomy for step out options	Develop internal VC capabilities whilst gaining market awareness and understanding
Structure	Direct investment, funding each deal, closely related to business divisions and future business opportunities	Corporate acts as LP in a 100% captive fund. Greater fund autonomy	GP external firm LP corporate part investor Decision on investment GP in fund parameters
Talent	Internal corporate talent	Mixture of external VC hired and internal corporate talent	Experienced VCs and potential secondees from corporate
Success measures	Measurement of direct strategic inputs	Primarily financial with a level of strategic exposure	Predominantly ROI
Examples	BP, Bosch, Panasonic	Unilever Ventures, Reed Elsevier Ventures, Bloomberg Beta	Siemens Venture Capital (SVC), Physic (Unilever)

Corporate venture capital, whilst in some ways similar to venture capital funding it differs is some fundamental ways (BVCA, 2013). In particular private venture capital is typically a 'singular pursuit' making investments based on the sole objective of financial return and hold committed capital in a fund for 10 years. By contrast, CVC typically assess performance both on financial and strategic metrics and can take a longer term perspective.

In terms of trends in CVC, CB Insights – a market intelligence firm – finds increasing activity globally both in terms of the number of deals and the amounts invested, with corporates investing both directly off the balance sheet as well as through CVCs. As of 2018, the UK had been securing a growing share of global CVC investments (23% in 2018 up from 16% in 2013). Globally, the trend is towards more CVC investment at seed stage of companies (CB Insights, 2018).

In the UK, CB Insights find an upward trend of CVC investment from $0.3 billion across 31 deals in 2013 to $1.7 billion across 121 deals in 2018 (Figure 25). When analysed by stage of investment, they find that 21% of deals in 2018 were at the seed stage, down from a high of 33% of deals in 2015. Overall 45% of deals were in early stage companies in 2018 (seed + Series A).

Figure 25 Annualised disclosed corporate venture capital funding to the UK, 2013 - 2018
Source: CB Insights (2018)

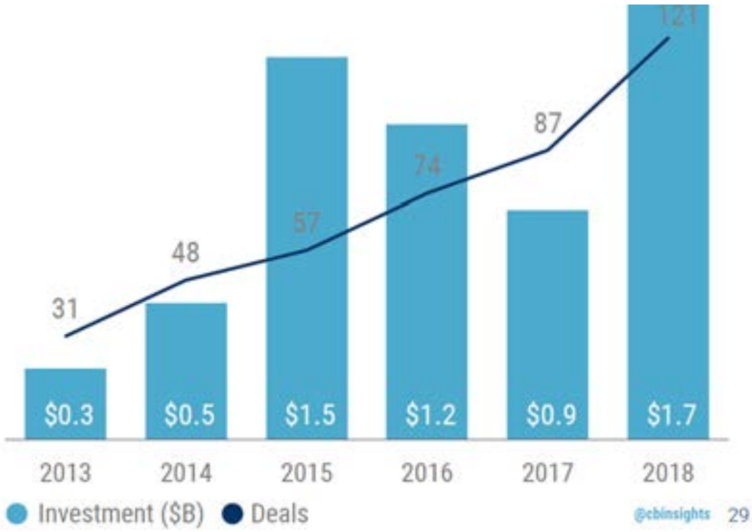


Figure 26 Annual corporate venture capital share by stage, 2013 - 2018
Source: CB Insights (2018)

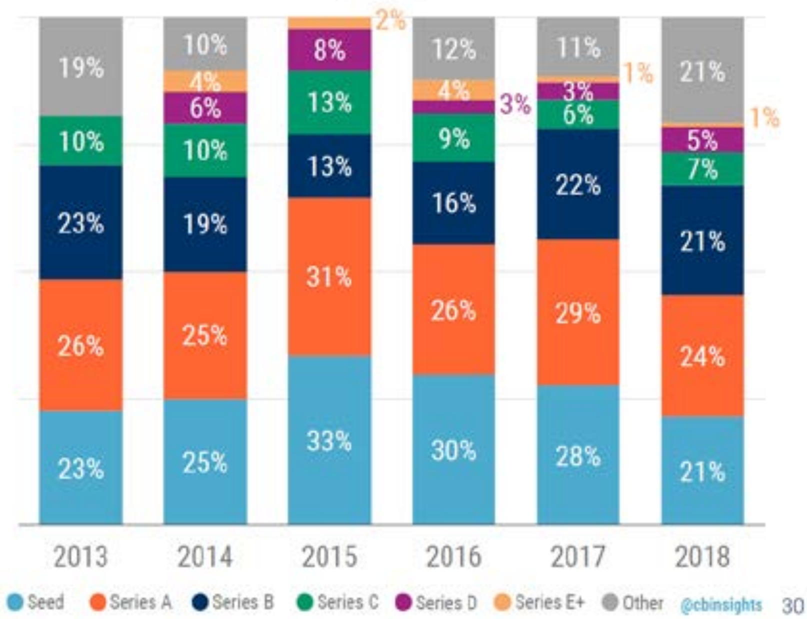


Table 20 Proportion of corporate venture capital deals made with university spinouts
Source: author's analysis of Beauhurst, CB Insights (2018)

	2013	2014	2015	2016	2017	2018
USO deals involving corporates	14	20	11	23	25	25
Number CVC deals	31	48	57	74	87	121
USO deals involving corporates as % of total CVC deals	45	42	19	31	29	21

Table 20 compares the number of USO deals identified in the Beauhurst data as having corporate involvement with the number of CVC deals in the UK. It suggests that in 2018, 21% of CVC deals were with USOs, down from 29% in 2017. Note that caution should be taken with this analysis and finding as the data are drawn from different data sources and it is very hard to compare the quality and consistency of data sources.

7.3 Innovate UK funding and university spinouts

Innovate UK, part of UK Research and Innovation, is the UK's innovation agency, providing public support to businesses "to develop and realise the potential of new ideas, including those from the UK's world-class research base"[3]. Furthermore, recent research by Beauhurst of the performance of high growth companies in their dataset suggests that those that have benefited directly from Innovate UK funding performance better across a range of company growth and development metrics than those that have not[4].

Innovate UK funding should therefore, in principle, be a valuable source for the development of USOs emerging from universities. This sub-section examines the extent to which their funding programmes are being exploited by USOs. To do this, the companies identified in the USO database were linked to the publicly available information on Innovate UK projects which includes the company, university and other participants involved. This process resulted in 801 of the 3,074 USOs identified in the USO database being matched to an organisation involved in an Innovate UK grant. This implies approximately 26% of USOs have been involved in some form of Innovate UK grant, securing £357.9 million over the period 2011 – 2018 (Table 21).

Table 21 Involvement of USOs in Innovate UK funding programmes between 2011 – 2018
Sources: author's analysis of the USO database, publicly available Innovate UK project data available at https://www.gov.uk/government/publications/innovate-uk-funded-projects (accessed in April 2019)

Innovate UK programme	Number of companies receiving Innovate UK funding between 2011 – 2018			Total funding received by USOs (£000s)	Funding per USO (£000s)
	USOs	All companies	Proportion of USOs in all companies		
Collaborative R&D	476	5,572	8.5	216,800	455
Feasibility Studies	352	2,995	11.8	34,800	99
GRD Proof of Concept	104	724	14.4	11,300	109
Vouchers	99	2,982	3.3	500	5
GRD Development of Prototype	97	682	14.2	20,700	213
EU-Funded	75	438	17.1	15,800	211
GRD Proof of Market	63	542	11.6	1,600	25
Knowledge Transfer Partnership	41	507	8.1	4,700	115
Small Business Research Initiative	36	442	8.1	15,600	433
BIS-Funded Programmes	34	593	5.7	26,300	774
Investment Accelerator	20	36	55.6	1,800	90
Study	16	127	12.6	4,500	281
Launchpad	16	113	14.2	1,400	88
Other	51	586	8.7	2,100	41
Any Innovate UK programme	801	9,805	8.2	357,900	447

3 https://www.gov.uk/government/organisations/innovate-uk/about, accessed on 14th May 2019
4 https://about.beauhurst.com/blog/innovate-uk-grants-equity-accelerators/, accessed on 10th July 2019

Table 21 also shows which programmes are accessed most by USOs. Most frequently used are collaborative R&D grants, feasibility studies, grants for R&D (GRD), in particular those focused on developing proof of concept and on prototype development, and innovation vouchers.

The table also examines the extent to which particular programmes reach USOs by comparing the number of companies involved in projects within a particular programme that are USOs to the total number of companies involved in that programme. It suggests that over 55% of companies participating in the new Investment Accelerator programme are USOs, while 14% of those accessing GRD (proof of concept and prototype development) are USOs. By contrast, just 8% of companies securing Knowledge Transfer Partnership (which help businesses to access knowledge, technologies and skills that reside in the UK's university base), and just 3% of companies receiving innovation vouchers are USOs.

7.4 University spinouts and the Enterprise Investment Scheme

Two key investment schemes operated by the UK government to encourage investments in young, small companies are the Enterprise Investment Scheme (created in 1994), and the Seed Enterprise Investment Scheme (SEIS) designed to focus more specifically on investing in start-ups. These schemes work by providing various tax reliefs on investments for qualifying companies.

Beauhurst have attempted to identify deals that are likely to qualify for EIS/SEIS. An analysis of this information suggests that between 2011 and 2014 around 84-85% of USOs received EIS/SEIS investments Table 22. However in recent years this has dropped to around 70%.

Comparing the number of USOs likely receiving EIS/SEIS investments to the number of companies in general receiving these tax reliefs has remained relatively stable at around 6% Table 22.

Table 22 Involvement of USOs in Enterprise Investment Scheme funding, 2011 – 2018
Source: author's analysis of Beauhurst database, analysis of HMRC (2018)

Year	Number of USOs		Share USOs receiving EIS funding	Number of companies receiving EIS funding	USOs as share of companies receiving EIS (%)
	Raised EIS funds in year	No EIS funds raised in year			
2011	129	24	84	2,025	6.4
2012	157	31	84	2,680	5.9
2013	166	30	85	2,475	6.7
2014	197	41	83	2,845	6.9
2015	210	59	78	3,380	6.2
2016	202	75	73	3,545	5.7
2017	215	95	69	3,470	6.2
2018	202	89	69		

8 Assessment of UK university spinout performance

This section explores the performance of UK universities in generating spinouts. Insights from evaluation methods suggest that assessments of performance need to go beyond 'activity' measures such as the volume of spinouts produced by a university, even controlling for structural differences between institutions such as the scale and type of research undertaken. Performance assessments should be outcomes-based, or at minimum demonstrate progression towards positive outcomes. Given the available data in databases such as HEBCI and Beauhurst, possible performance metrics could include:

- The amount of investment raised by universities, controlling for structural differences between institutions, and the types of products or services being commercialised. This would give an indication of belief by investors in the potential of the technology or idea.
- The turnover and employment generated by the spinout companies. This perhaps gets closest to the direct impacts of the spinout companies emerging from a university. One key challenge here is the significant difficulty in acquiring accurate data on these variables. Arguably a more robust measure of performance of this type would be an appropriate measure of growth in the value of IP-based startups – this accepts that many early stage companies may take a number of years before generating turnover let alone profits.
- The proportion of university spinouts making progress towards a successful outcome, either becoming an established, growth company, or has made a successful exit through an initial public offering (IPO) or acquisition (this was not explored in this data annex due to time constraints).
- The five-year survival rates of spinouts compared with non-university technology- or knowledge-intensive startups. This recognises that many spinouts will survive for at least three years from incorporation date as they are being actively supported and nurtured during these early years by investors.
- The returns to university-focused investment funds compared with other venture funds. Such an analysis was undertaken by Cambridge Enterprise (the TTO of the University of Cambridge). It suggests that, based on the paper value of their funds (the money returned to investors plus the fund's unrealised investments, divided by the money paid-in to the fund) was 3.55 times the paid-in value, placing it 10th in Pitchbook's list of 'big hitters'[5]. Further studies of this kind could be instructive in better understanding the performance of USOs compared with IP-based startups from non-academic origins. In addition, studies could further examine why such performance differences exist, as well as performance differences between different university-focused investment funds.

Table 23 Key university spinout performance metrics for different types of universities
Source: HEBCI surveys 2003/04 – 2017/18

HEI type	External investment raised (£000s)			Turnover of active firms (£000s)			Employment of active firms		
	Total raised	Total per USO	Total raised	Average for all active firms	Average per USO	Average for all active firms	Average for all active firms	Average per USO	Average for all active firms
	2016 - 18	2016 - 18	2008 – 10*	2016 - 18	2016 - 18	2004_06	2016 - 18	2016 - 18	2004_06
Largest 6 research intensive HEIs	2,048,400	10,725	1,085,600	526,400	943	129,900	6,600	12	3,300
Other research intensive HEIs	1,474,500	8,378	1,687,600	1,162,600	1,451	362,700	12,200	15	11,100
Smaller medium research intensive HEIs	176,400	1,896	55,900	137,800	490	63,600	2,300	8	600
Less research intensive HEIs	33,500	201	64,400	171,300	566	88,900	1,800	6	1,100
Specialist STEM HEIs	14,800	927	82,100	12,600	941	10,100	100	9	200
Specialist arts, social science and other HEIs	24,600	702	1,900	19,700	657	6,500	300	9	0
Total	3,772,200	22,829	2,977,500	2,030,300	1,022	661,700	23,300	12	16,500

* Note: earliest data available for external investment in HEBCI is for 2008.

Table 23 presents possible performance metrics for different types of universities in generating USOs, focusing on the scale of external investment raised by USOs, and the average turnover and employment per USO for active firms over the period 2016 – 18. It suggests that USOs emerging from the largest six research universities raise the most external investment to support their commercial development. USOs emerging from other research intensive universities that are currently active generated, on average, the most turnover per firm (£1.5 million), with those emerging from the largest six research universities generating £1.1 million per firm (based on an analysis of the HEBCI database). By contrast, USOs emerging from other types of universities secure less external investment and generate less turnover per firm.

5 Reported in a blog by Dr Anne Dobrée (Head of Seed Funds, Cambridge Enterprise) "Money returned from investments? We're global number one", found at https://www.enterprise.cam.ac.uk/money-returned-from-investments-were-global-number-one/, accessed on 11th July 2019.

An alternative performance metric for examining university USO performance is looking at the survival rates of their new ventures. By matching the USOs identified through Beauhurst, Spinouts UK and Gateway to Research with information from a company accounts driven database, it was possible to determine the current status of each USO. USOs were categorised into three core categories: active, zombie (including those dormant and dormant in default), and dead (including those in administration, in default, in liquidation, or dissolved). From this data I calculated the five year survival rate of USOs formed in 2014. This is shown in Table 24. It suggests that, overall, 76% of USOs formed in 2014 survived five years. This increased to 82% of USOs emerging from the largest six research universities.

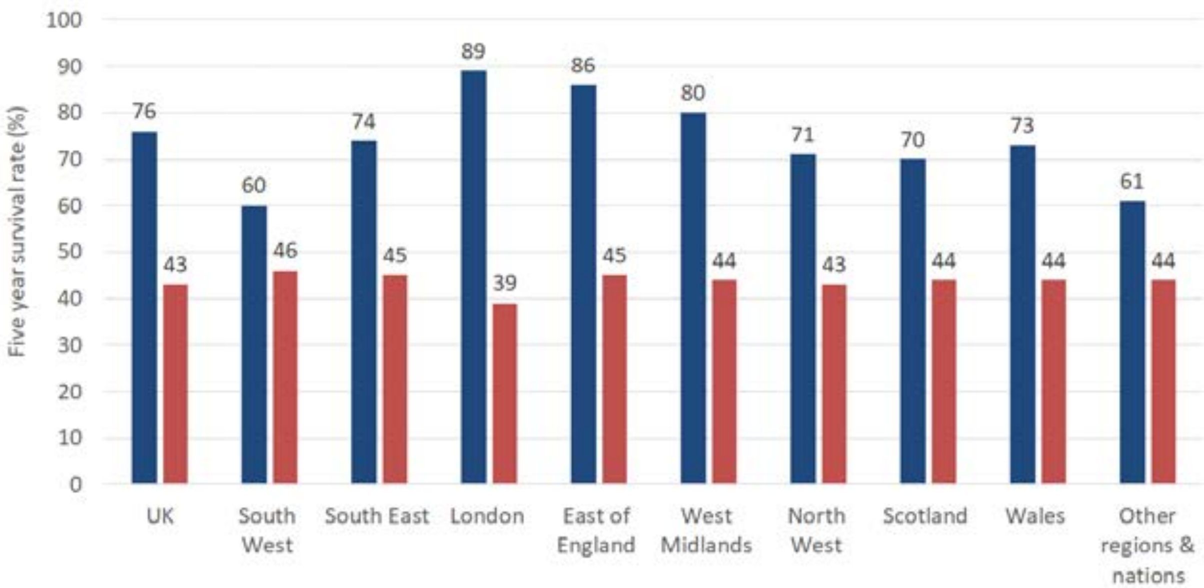
Table 24 Five year survival rates for USOs incorporated in 2014
Source: author's analysis of the USO database including Beauhurst, Spinouts UK and Gateway to Research

HEI type	Number of USOs formed in 2014	Number of USOs currently active	5-year survival rate
Largest 6 research universities	73	60	82.2
Other large research intensive universities	70	50	71.4
Other HEIs (including specialists)	31	22	71.0
All HEIs	174	132	75.9

It is also instructive to compare the overall five-year survival rate of USOs to that of other types of companies. The UK Office for National Statistics (ONS) provides estimates of the five-year survival rate for the general population of new enterprises formed in 2012. It estimates that 43% of firms survive for this period Figure 27. This figure also provides the five-year survival for USOs and the general population of new enterprises by region. It shows some variation in the survival of USOs with those emerging from London- and East of England-based universities exhibiting the highest survival rates.

However, one has to be cautious with comparisons of the survival rates of USOs against the general population of new enterprises as they will exhibit significant structural differences in the types of companies being created. Helmers and Rogers (2010) estimate the five year survival rate for IP-active startups in the UK (formed in 2001) at just over 80%. This suggests that USOs perform similarly to other IP-based startups. They also find significant heterogeneity in this rate between different industrial sectors.

Figure 27 Five year survival rates of USOs (incorporated in 2014) and general business population (incorporated in 2012), by region



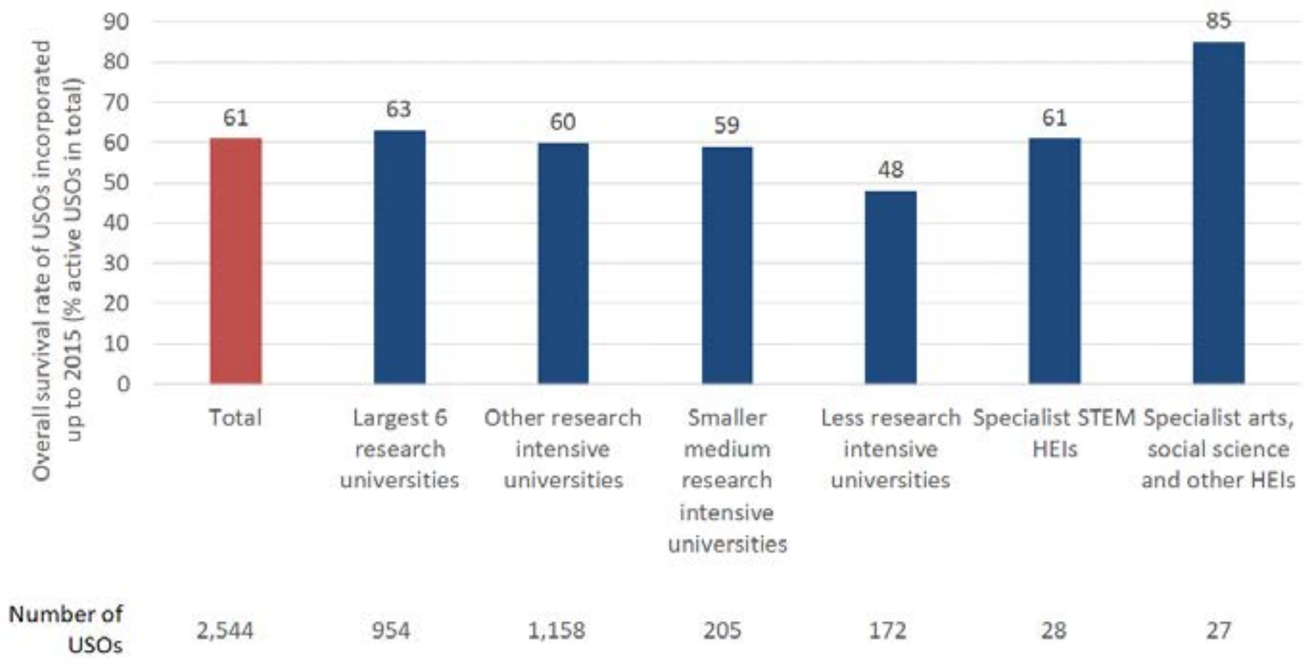
I also examined the overall survival of USOs identified by each of the databases that underpinned my consolidated USO database. Limiting the dataset to companies incorporated up until 2015, I found significant differences in the overall survival rates between data sources (Table 25). For the consolidated USO database, the overall survival rate is 61%. By comparison, 88% of USOs identified in the Beauhurst database were still active in 2018. For those USOs identified by Gateway to Research, this rate is 75%, while for Spinouts UK this rate drops to 60%. This further points to the potential biases inherent in any single micro-level data source.

Table 25 Overall survival rates for USOs incorporated up to 2015: comparison of data sources
Source: author's analysis of the USO database, Beauhurst, Spinouts UK and Gateway to Research

Company status	USO database	Beauhurst	Spinouts UK	Gateway to Research
Survival rate (% companies active)	61	88	60	75
Number of companies	2,591	624	2,324	4,26

Figure 28 presents the proportion of USOs that have emerged from different types of universities up until 2015 that are remain active. It shows that there is some limited variation in overall survival rates between the more research intensive groups (63% for the largest six research universities; 60% for other research intensive universities; and 59% for smaller, medium research intensive universities). This drops to 48% for less research intensive universities.

Figure 28 Survival rates of USOs incorporated up to 2015, by type of HEI
Source: author's analysis of the USO database, Beauhurst, Spinouts UK and Gateway to Research



9 International comparisons in university spinout performance

The UK is frequently compared in its spinout activity and performance to the US, and in particular to specific universities, namely Stanford and MIT. This section attempts to examine how the UK compares with the US. Such comparisons are very difficult for a number of reasons. First, the innovation systems of the two countries are very different with different industrial structures, scales and focus of R&D activity, and absorptive capacities of companies for external R&D (Hughes and Mina, 2012; Ulrichsen et al., 2014). Second, while data on university spinout activity exists is more extensive than for other forms of knowledge exchange, the definitions used in the national surveys to collect these data can be different making comparisons less accurate. International comparisons must therefore be interpreted with some caution.

9.1 Country-level comparisons of commercialisation activity in the US and UK

With the above caveats in mind, Table 26 provides a comparison of the UK and US on various metrics related to commercialisation. It suggests that, once the scale of research activity in each nation is taken into account that the US on average generates slightly more spinouts, but rather considerably more IP income. The UK secures slightly more industrial sponsored research income as a share of total research income compared with the US.

Table 26 Commercialisation activity for the US and UK, 2014-15 and 2015-16

Source: BEIS et al. (2017)

Metric	USA (AUTM)	UK (HE-BCI and HESA finance record)
	FY 2015	AY 2015-16
Total research resource (£M)	39,620	7,845
IP income including sale of shares in spin-offs (£M)	1,224	176
IP income as percentage of total research resource	3.1	2.2
Spin-off companies formed	946	168
Spin-offs per £100 million research resource	2.4	2.1
Patents granted	6,124	1,219
Patents granted per £100 million research resource)	15	16
Industrial contribution (£M)	2,961	603
% industrial research	7.47	7.69
US cashed-in equity/UK sale of spin-off shares (£M)	45	36

Note: ‘FY’ = ‘Financial year’; ‘AY’ = ‘Academic year’; ‘IP’ = ‘intellectual property’.

Figure 29 Most frequently cited countries by experts of the universities that have created/supported the world's most successful technology innovation ecosystems
Source: Graham (2014)

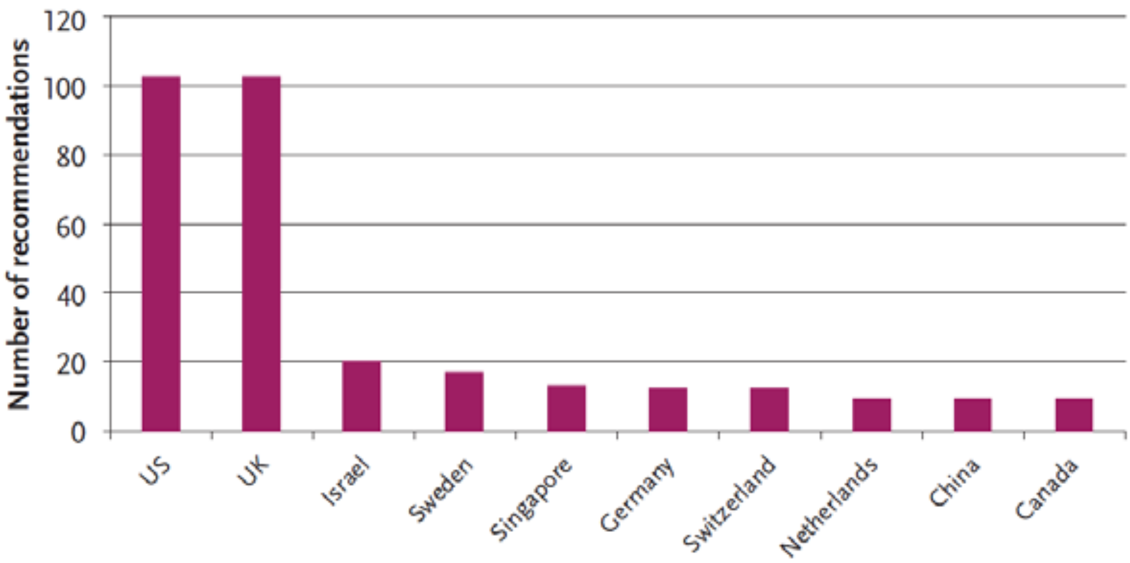
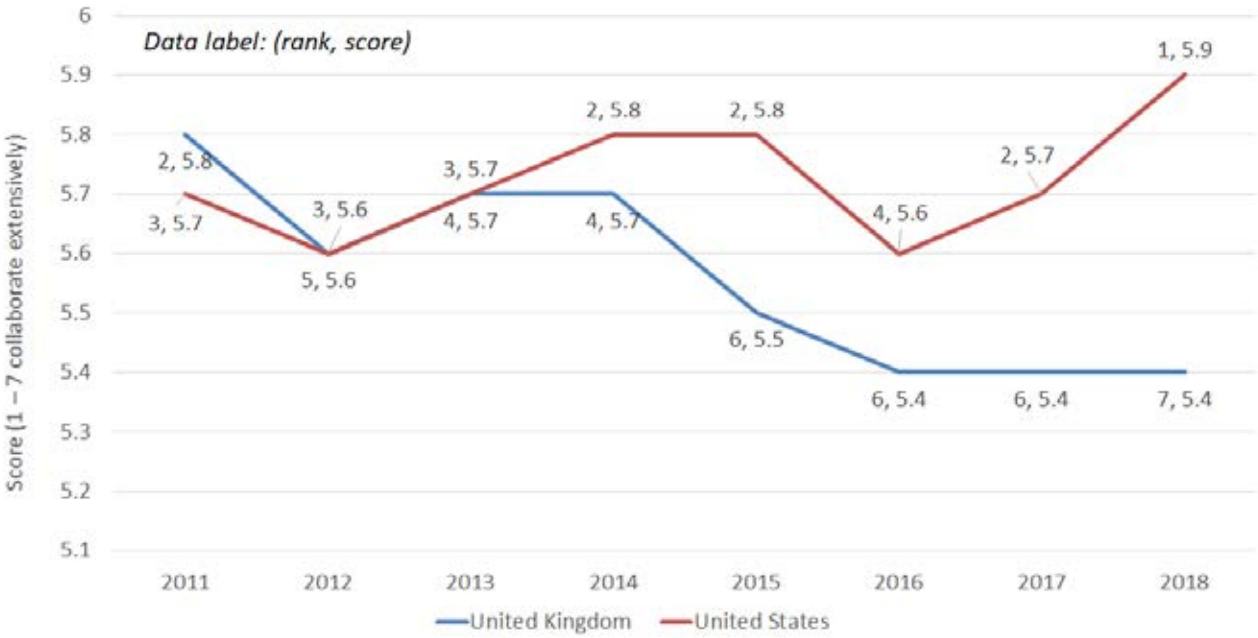


Figure 7. The most frequently cited countries in response to the question '*Which universities would you identify as having created/supported the world's most successful technology innovation ecosystems?*', with the results adjusted for country of residence of the interviewee.

Another way of comparing the university spinout landscape and performance between US and UK is to look at expert judgements on the strength of the contributions of universities to generating successful entrepreneurial ecosystems. Graham (2014) – in her study of the factors driving successful university-based entrepreneurial ecosystems – found that most experts saw the UK and US at similar levels of success, and far ahead of other nations, even once the country of residence of the interviewee was taken into account (i.e. the experts could not recommend areas in their own country).

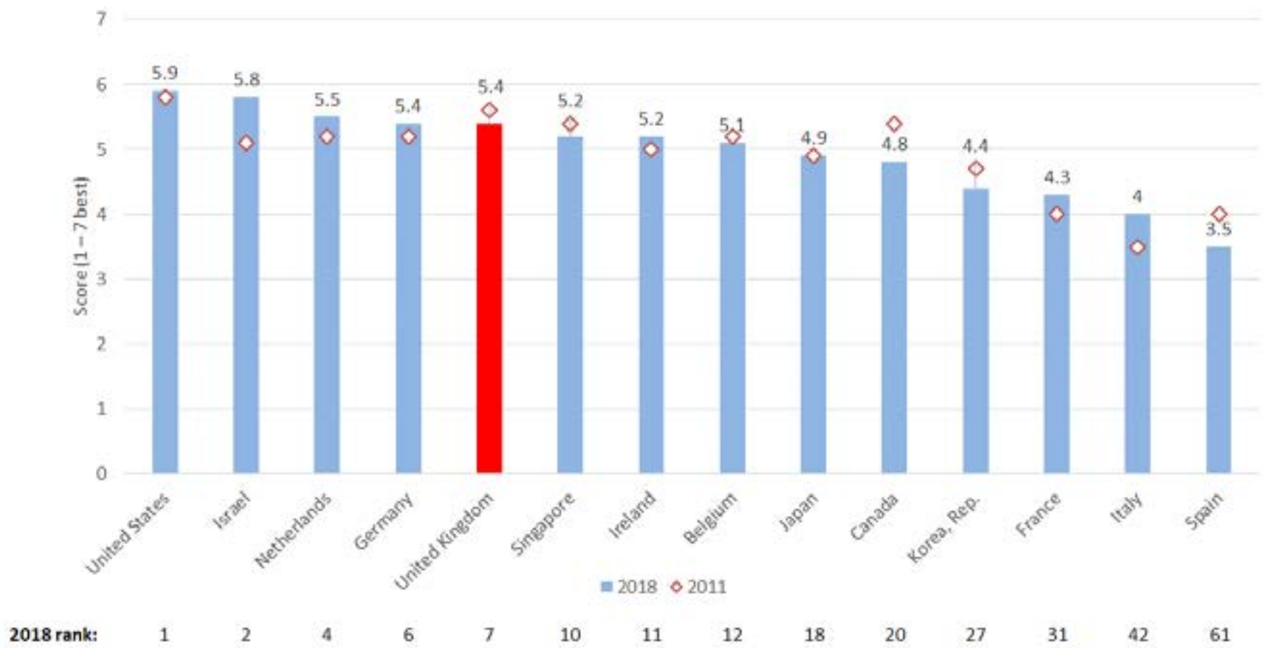
Another source of evidence on the comparative strength of different countries on various dimensions of innovation and competitiveness is from the World Economic Forum (WEF) Global Competitiveness reports. These compile a wealth of data from both secondary sources and from a survey of the opinions of executives from around the world. One of the dimensions examined is the strength of university-business collaborations. While not specifically focused on the commercialisation of knowledge through USOs, it does give a sense of how well universities partner with industry to exchange and commercialise knowledge. On this metric the UK has consistently ranked within the top 10 since 2011 as has the United States (Figure 30). However, compared with the US which has seen both its rank and score, on a scale from 1 (do not collaborate at all) to 7 (collaborative extensively), increase over this period, the UK has experienced a modest decline. It is now ranked behind Israel, Netherlands and Germany.

Figure 30 Strength of university-industry collaborations in R&D for the United Kingdom and United States (score 1 – 7 best)
Source: World Economic Forum Executive Opinion Survey, Global Competitiveness Report 2018 edition and 2010-11 edition



Question: In your country, to what extent do business and universities collaborate on research and development (R&D)? [1 = do not collaborate at all; 7 = collaborate extensively]

Figure 31 Strength of university-industry collaborations in R&D (score 1 – 7 best)
Source: World Economic Forum Executive Opinion Survey, Global Competitiveness Report 2018 edition and 2010-11 edition



Question: In your country, to what extent do business and universities collaborate on research and development (R&D)? [1 = do not collaborate at all; 7 = collaborate extensively]

Another dimension examined by the WEF Global Competitiveness Report is the strength of the entrepreneurial culture in a nation. On this composite metric, the UK ranks 7th, again behind, among others, the United States, and Germany (Figure 32). On venture capital availability, the UK ranks 11th (Figure 33) while on financing for SMEs it ranks much lower at 22nd (Figure 34).

Figure 32 Entrepreneurial culture (composite indicator)

Source: World Economic Forum Executive Opinion Survey, Global Competitiveness Report 2018 edition and 2013-14 edition (2012-13 data)

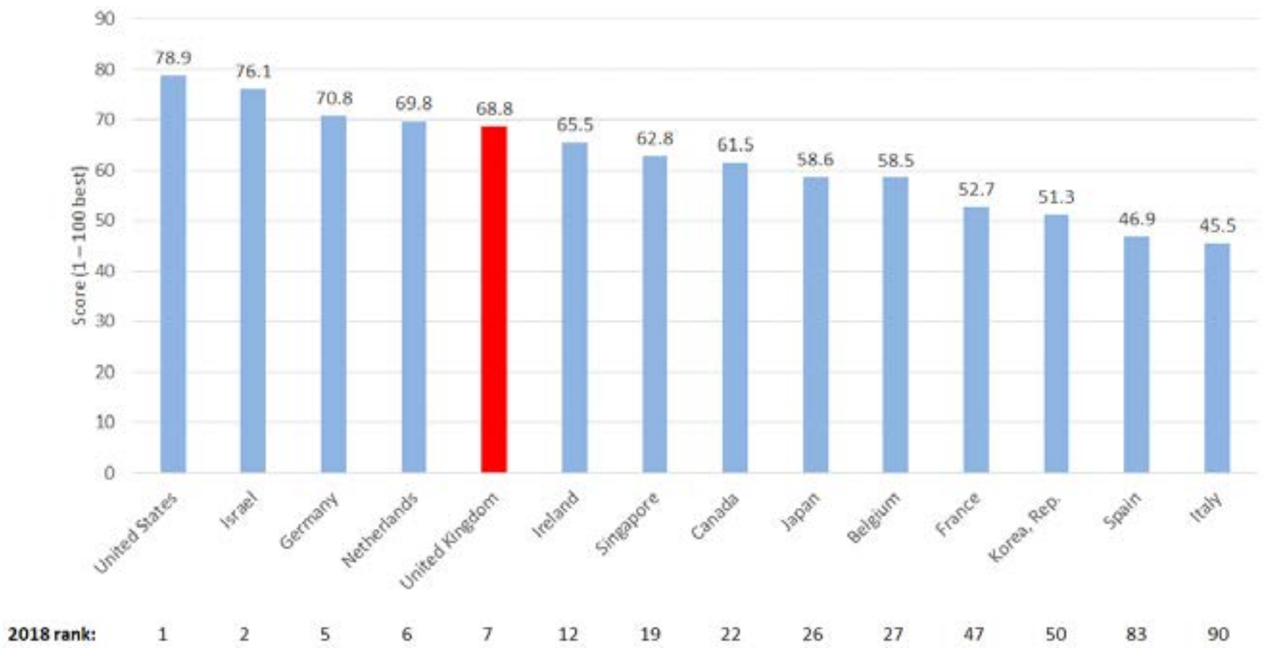
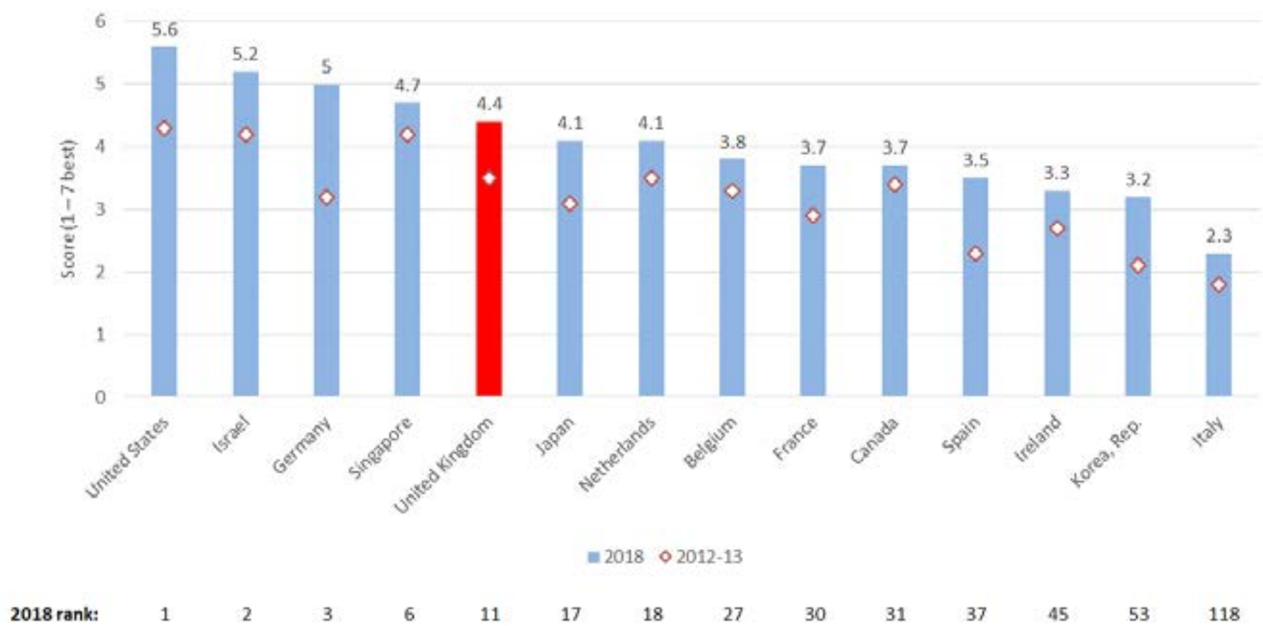


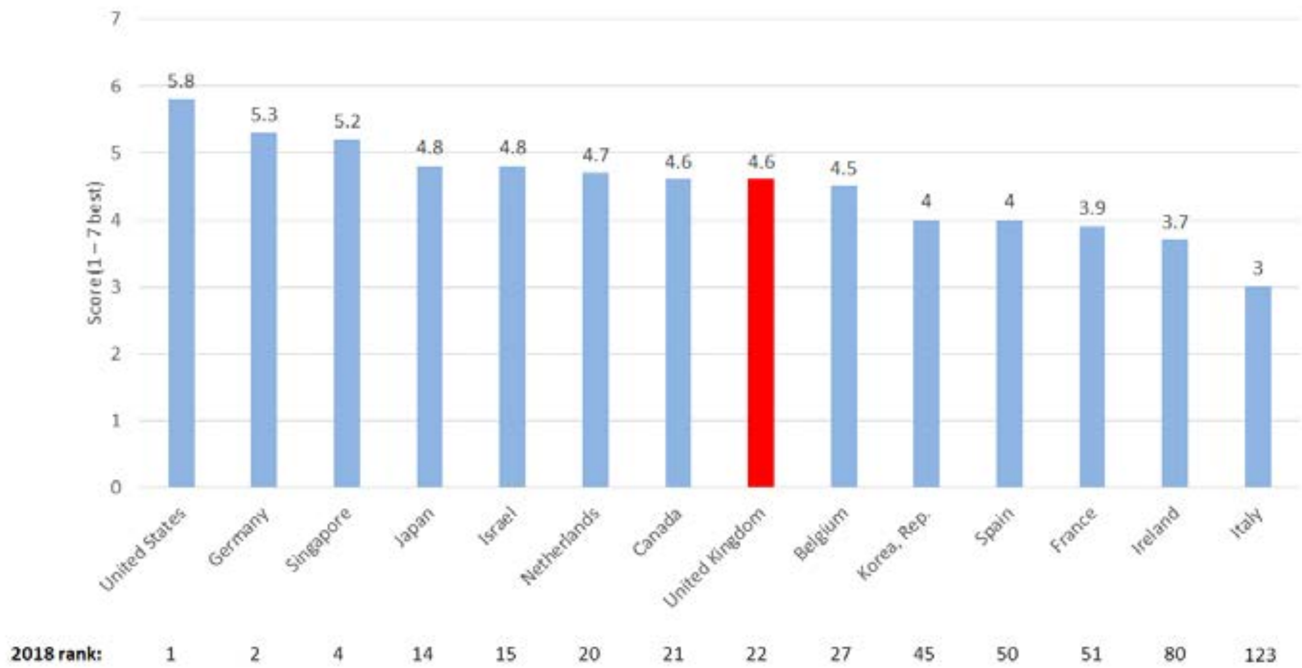
Figure 33 Venture capital availability

Source: World Economic Forum Executive Opinion Survey, Global Competitiveness Report 2018 edition and 2013-14 edition (2012-13 data)



Question: In your country, how easy is it for start-up entrepreneurs with innovative but risky projects to obtain equity funding? [1 = extremely difficult; 7 = extremely easy]

Figure 34 Financing of SMEs
Source: World Economic Forum Executive Opinion Survey, Global Competitiveness Report 2018 edition



Question: In your country, to what extent can small- and medium-sized enterprises (SMEs) access finance they need for their business operations through the financial sector? [1 = not at all; 7 = to a great extent]

9.2 University-level comparisons of commercialisation activity in the US and UK

Country level comparisons, however, typically mask significant variations in the performance of individual universities within each nation. This section presents comparisons of the US and UK at the university level.

Starting with the 2014 Graham study of university-based entrepreneurial ecosystems, perhaps unsurprisingly, experts around the world frequently cited MIT and Stanford as the universities having created most successful entrepreneurial ecosystems. Following these institutions, the Universities of Cambridge and Oxford, and Imperial College London were next in the ranking, and above universities based in other (non-US) nations.

Figure 35 Most frequently cited universities perceived by experts as having created / supported the world's most successful technology innovation ecosystems
Source: Graham (2014)

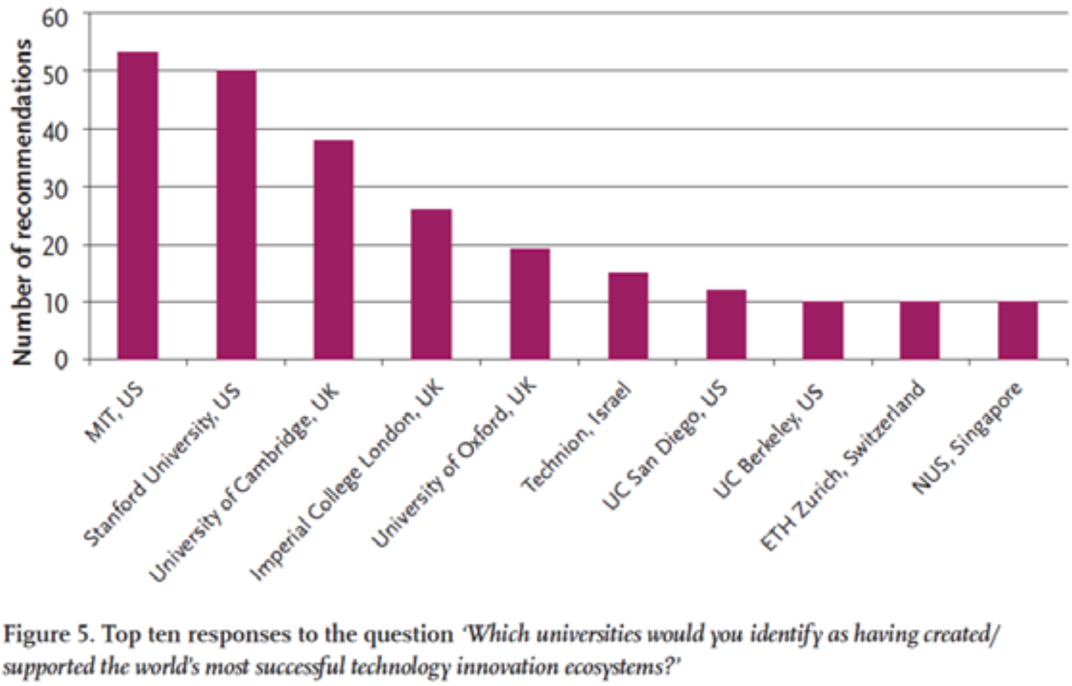
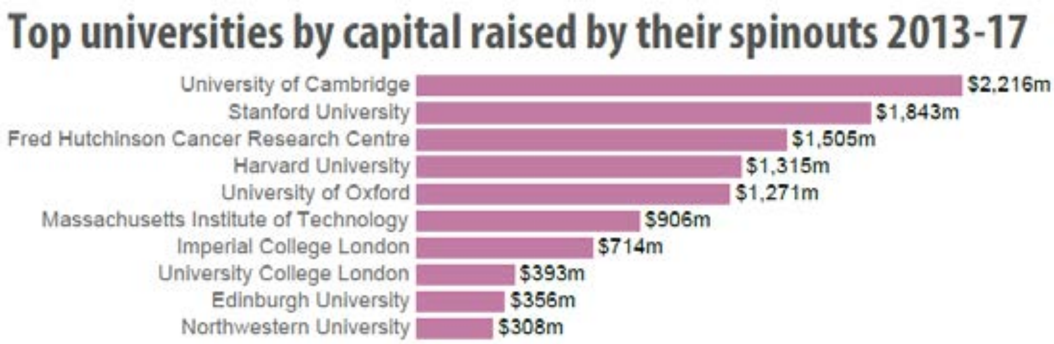


Figure 36 Top universities globally by capital raised by, and number of deals in, their spinouts, 2013 – 2017
Source: Global University Venturing 2013-17 Data Review



Another key proxy for the performance of universities in generating successful spinouts is to look at the number of USO deals secured and the amount of capital raised[6]. Global University Venturing[7] collects data on the number of deals and amounts invested for different universities around the world. Their data review 2013-2017 presents the top ten universities globally in terms of these metrics (Figure 36). This shows that leading UK universities compete well with their US counterparts with five institutions in the top ten for the amount of capital raised. Looking at the average deal size where possible using data in this figure, the leading UK universities raised somewhat less capital per deal than leading US universities.

Looking at the average amount of capital raised per deal for selected US and UK universities in the top ten (based on amount of capital raised), the University of Cambridge performs in line with leading US universities. The University of Oxford and Imperial College London raised slightly less per deal than leading US universities. Note that it is not possible from the data available to adjust for sector or technology differences which could explain some of these differences.

Table 27 Average deal size for selected US and UK universities in the top ten globally by amount of capital raised
Source: author's analysis of the Global University Venturing Data Review 2013 – 17

University	Amount of capital raised 2013 - 17	Number of deals 2013 - 17	Average capital raised per deal 2013 - 17
Harvard University	1315	26	51
Massachusetts Institute of Technology	906	37	24
University of Cambridge	2216	102	22
Stanford University	1843	96	19
Imperial College London	714	47	15
University of Oxford	1271	94	14

All of the above assessments of differences between nations and universities are on specific metrics of USO activity or an indicator of performance (such as the amount of venture capital funding raised into a university's spinouts). Such comparisons do not control for different influencing factors. Various academic studies have attempted to assess the performance of universities in generating USOs, controlling for a range of such factors (Chapple et al., 2005; Ho et al., 2014; Siegel et al., 2008). Many of these studies attempt to estimate where universities are located relative to a 'frontier' of most efficient universities (such as stochastic frontier analysis or data envelope analysis).

Siegel et al. (2008) in particular explores the comparative efficiency of UK and US universities in generating university spinouts controlling for various factors. Their analysis suggests that the US is the more efficient than the UK in generating USOs. However, two important caveats should be noted. The first is that the key measure of performance is the volume of USO activity. Section 8 discussed the significant drawbacks of such a metric. The second is that the data feeding into their model is from the early 2000s. During this period the UK was still professionalising its technology transfer system of support within universities. It would be prudent to repeat this type of analysis using up-to-date data to explore whether their results still hold true.

6 This should be adjusted for the sectors of USOs given that investment requirements will depend in part of the type of technology being commercialised. However this was not possible with the data available.

7 https://globaluniversityventuring.com/

10 Factors influencing university spinout performance

The main focus of the technical annex is an empirical analyses of the landscape of university spinout activity and insights into performance. Before concluding the annex, this section presents what is known about the many factors that shape university spinout activity and performance. This topic has been the subject of many academic papers over the past two decades (see e.g. Hayter et al., 2018; O'Shea et al., 2007; Perkmann et al., 2013; Rothaermel et al., 2007). The recent systematic literature review on this topic by Hayter et al. (2018) captures many of the key factors including: characteristics of academic entrepreneurs; human capital; social networks; entrepreneurial environment; financial resources; scientific, technical, and product characteristics; academic entrepreneurship support programs; and university management and policies (Figure 37). Within each of these categories a number of different factors have been explored. These are highlighted in Table 28.

Figure 37 Key factors shaping university spinout outcomes
Source: Hayter et al. (2018)

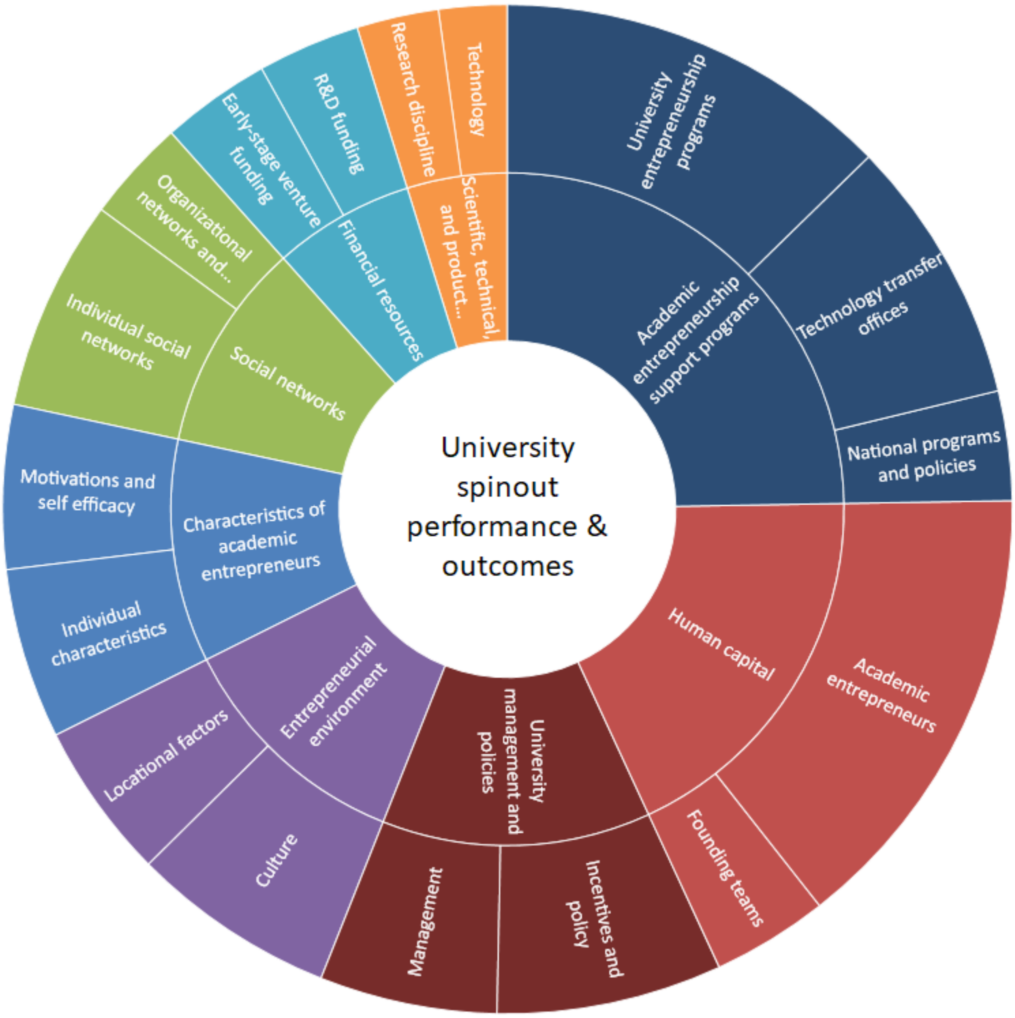


Table 28 Factors influencing the commercialisation process (spinouts and technology licensing)

Category	Factors	Sources
The strength of the research base	- Importance of the strength of the research base, particularly in science, engineering and health. It is from this base that IP with commercial potential emerges, and feeds the pipeline for commercialisation activity.	(Haeussler and Colyvas, 2011; O'Shea et al., 2007; Perkmann et al., 2013; Zucker et al., 1998)
Academic founder & team characteristics	- Prior entrepreneurial experience / working with business - Strong social networks with investor community / companies decrease probability of failure - Strong social networks with parent university provide important infrastructure and expertise. However, overly strong ties can retard graduation from an incubator - Motivation and commitment to spin-out - Entrepreneurial and business knowledge o Management knowledge o Knowledge of product development and production o Knowledge of markets and customers - Scientific excellence - Team complementarities and heterogeneity - Willingness to evolve team as needs change - Willingness to include 'surrogate' (external) entrepreneurs in leadership positions alongside academics linked to more successful spin-outs	(Druilhe and Garnsey, 2004; Ensley and Hmieleski, 2005; Franklin et al., 2001; Grandi and Grimaldi, 2003; Hayter, 2013; Johansson et al., 2005; Perkmann et al., 2013; Rothaermel and Thursby, 2005; Shah and Pahnke, 2014; Shane, 2004; Shane and Stuart, 2002; Siegel and Wright, 2015)
Technology transfer office (TTO) capabilities and resources	- Overall TTO resources and scale – TTOs often struggle with a lack of financial and human resources - Cumulative experience in commercialisation - Organisational structure and processes of TTOs affects information processing capacity, coordination capability across units and incentive alignment across units and across stakeholders - Capabilities of staff (marketing, scientific and technological, negotiation skills) and experience including in negotiations - Ability to attract suitable staff (compensation practices) found to be important - Access to outside resources (e.g. legal expertise). Evidence that commercialisation performance is related to expenditure on external IP protection - Technology/sector specialisation of TTOs - Internal commercialisation processes and practices including selecting appropriate route to market - Ability to develop proposals that meet relevant investor selection criteria (investor readiness) - Bureaucracy involved in commercialisation processes - Flexibility over terms and conditions in commercialisation processes - Understanding of business and product development by TTO staff (leads to more flexibility and trust and promotes willingness of inventors and investors to work with TTO) - Ability of TTO staff to translate technical and business jargon across university-business interface	(Bercovitz et al., 2001; Breznitz, 2014; Feldman et al., 2002; Lockett and Wright, 2005; Markman et al., 2005; McMillan, 2016; O'Shea et al., 2007; Owen-Smith and Powell, 2001; Shane, 2004; Siegel et al., 2003b; Thursby et al., 2001; Wright et al., 2006)

Table 28 (… continued)

Category	Factors	Sources
University entrepreneurship programs	- Variety of support programmes such as business plan competitions; hackathons; industry research centres; early-stage seed funds; proof-of-concept centres; incubators; Science parks. Play roles in providing physical space, technical and financial resources, access to important networks, and coaching to academic entrepreneurs. - Seed funds particularly important as venture capitalists do not invest (sufficiently) in very early stage companies. They also provide important signalling to outside investors, support the development of an entrepreneurial culture within the university, and strengthen networks with regional stakeholders - Proof-of-concept centres have emerged as a promising support mechanism combining entrepreneurship education, mentoring, networking, and technology development services, often in combination with modest levels of funding to support entrepreneurial activities. Hayter and Link (2015) find that universities with such centres produce more spinouts - Business plan competitions encourage students and faculty to think in terms of market demand and the steps that their business must take to respond	(Boh et al., 2016; Hayter et al., 2018; Hayter and Link, 2015; Jefferson et al., 2017; Mustar and Wright, 2010; Rasmussen et al., 2006; Wright et al., 2006)
University policies, incentives and culture	- Faculty reward systems found to be particularly important in shaping commercialisation performance, including royalty distribution and incentives for disclosing inventions - Equity distribution policies and practices/guidelines – some evidence by Lockett et al. (2003) based on 57 UK universities that successful universities always take equity stakes in spin-out companies - IPR ownership and preferred method of commercialisation (e.g. exclusive/non-exclusive licensing, spin-outs) - Other policies can be important for encouraging academics to engage in commercialisation, including tenure policies and protecting and encouraging junior faculty to engage, policies around leave of absence, and permitted uses of university resources - Research collaborations terms e.g. over background / foreground IP - Culture and perceived legitimacy of commercialisation amongst academics - Clarity of university mission and vision for university management of IP, and commitment of leadership to commercialisation (emphasized in both major UK (McMillan, 2016)and US (Merrill and Mazza, 2010) reviews) - Alignment of incentives across different university offices (e.g. TTOs, research contracts) and academics	(Bercovitz and Feldman, 2008; Breznitz, 2014; Chapple et al., 2005; Clark, 1998; Di Gregorio and Shane, 2003; Link and Siegel, 2005; Lockett et al., 2003; Lockett and Wright, 2005; McMillan, 2016; Merrill and Mazza, 2010; O'Shea et al., 2007; Siegel et al., 2003b, 2003a; Siegel and Phan, 2005; Thursby and Kemp, 2002)
Investor capabilities and policies	- Experience with investing in university spin-outs - Informational gap (e.g. understanding of investing in USOs, understanding of technology) - Availability of suitable investors (VCs, banks, business angels etc.) - Investor policies not to invest in particular technologies / sectors	(Wright et al., 2006)

Table 28 (... continued)

Category	Factors	Sources

External local environment of university	- Availability and access to capital
	  o At the pre-seed stage capital to help develop university inventions to point where they become of interest to investors. This also provides a signal to investors that technology has been through some prior screening. Wright et al. (2006) highlight the challenges perceived by TTOs both in securing funding to develop prototypes as well as for develop the necessary market validation, IPR due diligence, and business plans, all of which are critical for developing investor-ready proposals
	  o At the seed stage capital e.g. venture capital providing risk capital and operational assistance / business angel
	- Social networks between universities, inventors & investors
	  o Networks, communications and cooperation between different institutions in local area
	  o Strong local investor community – social ties between investors & inventors allow investors to gain access to private information and reduce costs of monitoring new ventures.
	  o Active involvement of investor community in local entrepreneurial network facilitates linking of new ventures to networks of managers, suppliers and customers
	- Industrial composition, absorptive capacity and local labour markets
	  o Nature and maturity of local industries
	  o Absorptive capacity of industry for university generated IP
	  o Strength of the regional innovation system that combines learning with upstream and downstream innovation capability, and strong entrepreneurial culture
	  o Availability of skilled labour available to new companies
	- Availability of entrepreneurial infrastructure and supporting organisations
	  o Availability of, and access to entrepreneurial infrastructure (e.g. incubators, science parks, accelerators) is likely to facilitate university spin-outs… These are more likely in high technology clusters, which will also tend to have pools of experienced managers, customers and suppliers, investors etc.
	  o Availability of support organisations / innovation infrastructure providing assistance to prospective entrepreneurs
	- Rigidities of the academic labour market
	  o Ability of academics to change institution or move between industry and academia - makes it harder for academics to move to leverage resources elsewhere (e.g. financial, complementary technologies, human capital including management expertise)… tied to what is available locally. Also if can't take leave of absence, makes it harder to invest time in exploiting technologies
		(Breznitz, 2014; Etzkowitz, 2008; Friedman and Silberman, 2003; Gulbrandsen and Smeby, 2005; Lester, 2005; McMillan, 2016; O'Shea et al., 2007; Rothaermel et al., 2007; Saxenian, 1996; Shane, 2004; Wright et al., 2006)

The role of investor experience

The role of investor experience in influencing the outcomes of the USO process was explored by Wright et al., (2006). They examined the reasons why venture capitalists rejected investment proposals, comparing investors with experience in investing in university spin-outs with investors that do not.

Table 29 Key differences in reasons for rejecting proposals between university spin-out investors and non-university spin-out investors

Source: authors' survey of venture capital firms. Note: respondents scored each factor as: 1, "unimportant"; 2, "not very important"; 3, "quite important"; 4, "important"; 5, "very important". A Mann–Whitney test was performed to analyse the differences between spin-out and non-spin-out investors.

** 5% significance level.*

*** 1% significance level.*

**** 0.1 significance level.*

 # 10% significance level.

Reasons for rejecting proposals	Combined score	Non-spin-out investors	Spin-out investors
Size of potential market for applications of the technology	4.2***	4.6	3.9
Stage of development of the product/service	4.1**	4.7	3.6
Availability of a prototype/test data to demonstrate proof of concept	3.5**	4.6	2.8
Difficulty in identifying key decision makers	3.4#	4.1	3
Lack of formalised university technology transfer procedures	3.3*	3.9	2.8
Requirement for service development to support customers who will use the product/service	3.0*	3.7	2.4
Concerns over co-investing with public sector funds	2.9*	3.7	2.4
Concerns over co-investing with universities	2.8*	3.4	2.3
Joint ownership of the IPR with universities	2.6**	4	1.9

They find a variety of important similarities and differences in the reasons for rejection (Table 29):

- Both experienced USO investors and non-USO investors looked for the following in proposals from universities for investment:
  - o Strong patent protection
  - o Skills of the entrepreneurial team
  - o Clear route to market for the technology
  - o Investor policies not to invest in certain sectors
  - o Familiarity with certain technological markets
  - o Difficulties raising finance for certain sectors
- However, there were a number of critical differences between experienced USO investors and non-USO investors (see table below for details). These included:
  - o Size of the potential market: Non-USO investors place greater emphasis on the size of the potential market when considering investment proposals. The difficulty many universities have in commercialising disruptive technologies emerging from basic research is that of identifying markets in which to apply the technology and estimating the level of demand. By contrast, USO investors on the contrary seem to be more concerned about the economic viability of the venture and find the estimated time to break-even a major point of importance.
  - o Ownership of IPR: Joint ownership is much more important for non-USO investors as they feel uncomfortable investing in USOs when IP is licensed compared with being assigned in return for an equity share in the company. Some of these investors believe that separation is required to develop the spin-out without interference. Non-USO investors believe universities wish to retain ownership and control over IP without sharing in any of the risks involved in its development

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- Working prototypes/proof of concept: Non-USO investors also placed greater importance on prototypes in order to assess viability of technology while USO investors may invest at earlier stages and work with the USO to achieve proof of concept.
- Availability of a professional management team: Non-USO investors put much more emphasis on having professional management team in place before the investment is made
- Difficulties in identifying key decision makers in university and lack of formalised university technology transfer procedures also significant source of discouragement for non-USO investors

They also find that few VCs had strong and relevant technological backgrounds which potentially limiting their understanding of the technologies emerging from university research. This places an important focus on the ability of academic entrepreneurs in being able to translate their inventions into commercial propositions in terms that investors will understand. Indeed, Wright et al. (2006) argue that a key area where universities and their TTOs can provide support to academic entrepreneurs is helping them develop investments pitches that are 'investor ready' – i.e. that focus on providing key information that targets the investment criteria of investors.

Evidence on the importance and performance of university technology transfer offices

A wide range of competences and skills are required to support the commercialisation process (e.g. technology assessments, patent searches, marketing, patent law, IP issues, management and entrepreneurial support) (Shane, 2004). Many of these are unlikely to be possessed by an academic entrepreneur but must nevertheless be accessed during the process either from their technology transfer office or, if they have the choice, they can attempt to go it alone or contract these services from other organisations (as well as meeting the costs themselves).

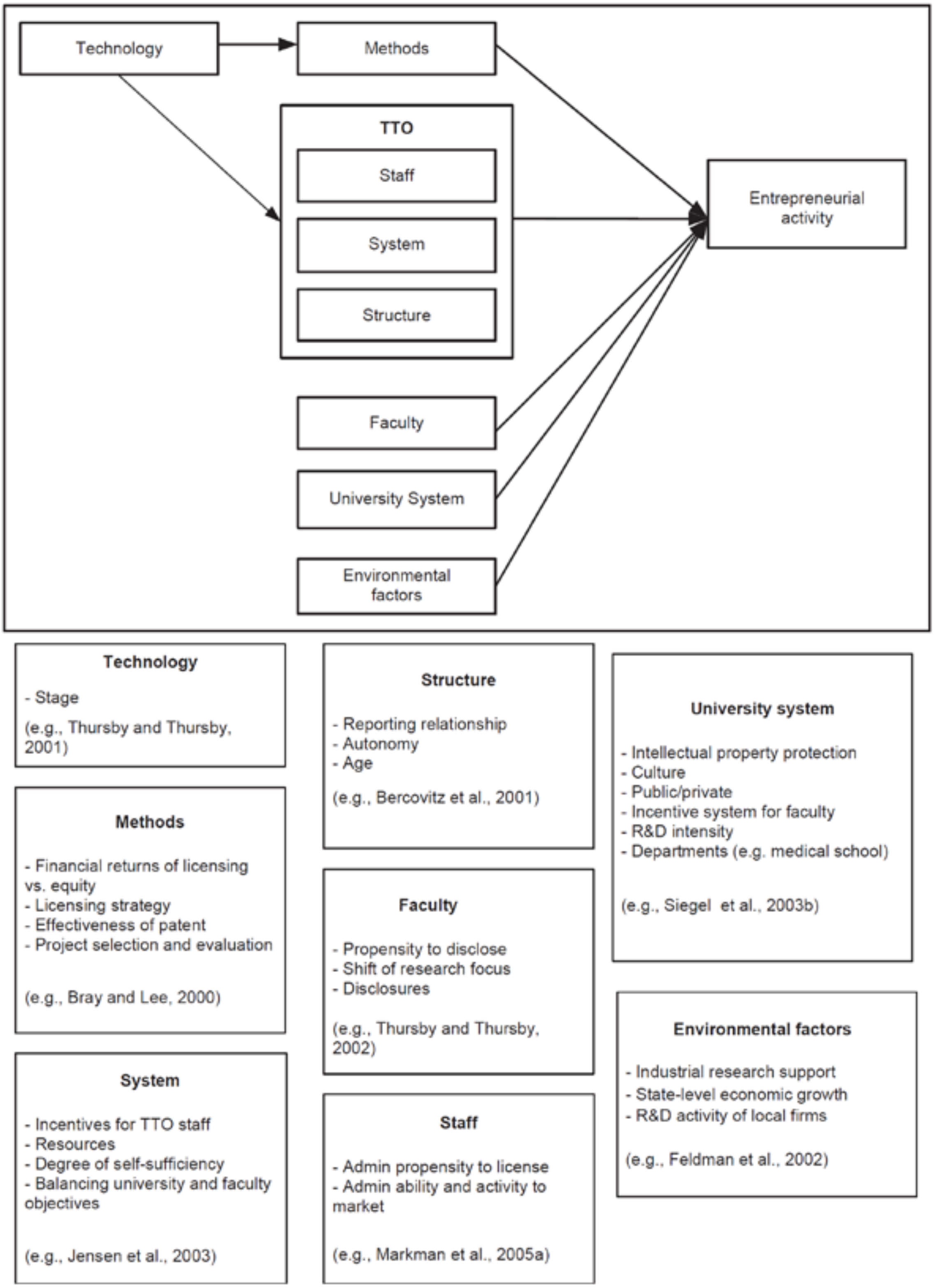
Most scholars consider TTOs to be an important element of the technology transfer ecosystem (Fernández-Alles et al., 2015; Fini et al., 2011; Galán-Muros et al., 2017; Hsu et al., 2007; Jefferson et al., 2017; Perkmann et al., 2013). In addition, scholars have found that many factors shape their performance (Hayter et al., 2018; Rothaermel et al., 2007). Key factors are captured in the systematic literature review by Rothaermel et al. (2007) (Figure 38)

Owen-Smith and Powell (2001) found that well-managed TTOs in the right entrepreneurial university and environment can operate smoothly with considerable success. Indeed, if there are significant market failures preventing academic entry, and the TTO has skills to relieve these obstacles, then there should be greater likelihood of success compared with a scenario where academics have to overcome these obstacles on their own. However, Kenney and Patton (2009) note that while some TTOs – particularly those at larger, entrepreneurial minded and research intensive universities able to invest in developing these services – are able to operate smoothly and develop strong, positive reputations, it is very easy for a badly managed TTO to cause significant damage to the process. They also argue that TTOs that focus on becoming a "service" organisation to support the spinout process are more likely to be successful.

No one-size-fits-all models for technology transfer

Lastly, a key finding in the academic and practitioner literatures on the organisation of university technology transfer activities and support is that there is no one-size-fits-all approach (Allen and O'Shea, 2014; Baglieri et al., 2018; McMillan, 2016; Schoen et al., 2014). There are too many variables that shape the appropriate business model for technology transfer for a particular university, not least the type of technologies emerging from its research; the scale of the university and IP pipeline; the university's strategy towards commercialisation; the entrepreneurial history of the university and current internal technology transfer capabilities; access to investment capital and the strength of its local entrepreneurial ecosystem; etc. Schoen et al. (2014) – in exploring the 'bewildering' diversity of TTOs across Europe – argue that these types of structural factors need to be taken into account when analysing the performance of different universities in generating spinouts and commercialising technologies.

Figure 38 Key factors shaping the productivity of technology transfer offices
Source: Rothaermel et al. (2007)



11 Summary of key findings

This technical note provides insights into the nature and scale of USO activity emerging from UK universities and the involvement of investors in the commercialisation process and the development of these companies. It also explores key trends in the wider investment landscape for USO development and reflects on how one might assess performance of UK universities in generating USOs that move beyond volume measures.

Most USOs *formed based on intellectual property generated within the university* emerge from attempts to commercialise new technologies or ideas resulting from research projects. Choices have to be made as to the most appropriate pathway for commercialisation which could include, for example patenting and licensing the IP to an existing company, or forming a new venture to continue its commercial development and application. Given the origins of the IP at the heart of USO formation in research, it is to be expected that the majority of such companies will emerge from the more research intensive universities. This is not to say that other universities do not undertake valuable entrepreneurial activities leading to new companies being formed by staff and students. However, these wider types of companies are not the focus of this report.

Underpinning the technical note is an analysis of a number of datasets including data provided by Beauhurst on the investment deals into university spinouts; the UK's Higher Education Business and Community Interaction (HEBCI) survey which provides university-level information on the nature and scale of spinoff activity and the investments they secure to foster their development; and a database of individual USOs linked to some key basic company information (year of incorporation and industrial activity) built by the author bringing together different data sources including Beauhurst, Spinouts UK (now part of Beauhurst) and Gateway to Research.

Key findings emerging from the analyses are highlighted below.

Types of USO

Different types of companies emerge from universities. These can be categorised along different dimensions such as the business model to get IP to market; the sector of the product or service being commercialised through the USO; and the ownership models for the IP. These have implications for the scale of investment required, support available, and challenges faced.

Volume and concentration of USO activity

Approximately 3000 IP-based spinouts have been created by UK universities over the period 2003 – 2018. Just over half of these companies emerged from higher research intensive HEIs. A further 1,000 academic staff start-ups emerged over this period. The largest 6 research universities generated by far the most USOs per institution compared to other groups of universities.

In terms of trends, UK universities have been generating USOs in broadly similar numbers over the period 2003 – 2018 albeit with some tentative evidence of cyclicality in these trends.

Investments into USOs

Over the period 2011 – 2018, IP-based USOs secured approximately £8.86 billion in external investments to support their development. Since 2008, the amount of external investment raised has increased substantially in real terms (from approximately £991 million in 2008 to £1.5 billion in 2018), with some evidence of cyclicality, particularly for IP-based spinouts where universities retain ownership of the IP.

At a more granular level, analysis of Beauhurst data (which captures primarily equity-based investment deals into USOs secured from 2011 onwards, although companies themselves may have been formed prior to this date) suggests that investments have grown in USOs at all stages (seed, venture and growth) over the period 2011 – 2018.

Investments secured into USOs are even more concentrated that the numbers of companies formed. The largest six research universities secured almost half of the external investments recorded in HEBCI over the period 2011 – 18, compared to generating 16% of USOs. Together with other research intensive universities they generated approximately half of USOs but secured around 95% of external investments. In addition, the analysis shows that these the average amount invested per USO is much larger in these research intensive universities compared with other institutions. This may reflect in part the types of products and services being commercialised but may also reflect their ability to access external finance.

Types of investors into university spinouts

Private equity and venture capital investors are the most common type of investor in USOs. Business angels, commercialisation companies (such as the IP group), and universities are also frequent investors. The analysis of investor types also highlighted the role of the devolved governments, and local and regional governments as investors in USOs, particularly in the seed and venture stages. By contrast, corporate investors are relatively more common at the growth stage than in other stages.

The analysis of investors also revealed a growing concentration of deals in USOs within a small number of investors, particularly at the seed and venture stages. The top 5 investors (based on number of deals in USOs) were involved in 32% of seed stage deals in USOs over the period 2017-18 and 44% of venture stage deals. This is up from 24% and 33% respectively for the period 2011-12. This raises an important question as to whether this trend is positive for the UK system of nurturing USOs. On the one hand it could reflect a maturing of the investor market and the accumulation of experience in investing in these types of companies (which were historically out of many investor's comfort zones). On the other hand too much concentration could decrease the resilience of the system as it becomes more exposed to the effects of key changes in a particular investor (e.g. change in geographical focus of investments out of the UK; change in investor appetite for risk and involvement in USOs etc.).

The technical note also explored the role of Innovate UK in supporting the development of USOs. Their mission is to provide public support for businesses to develop and realise the potential of new ideas, including those emerging from the research base. As such they should, in principle be a source of support for USOs as they seek to develop and commercialise their new technologies and ideas. By linking the dataset of USOs at the company level to information on the recipients of Innovate UK funding, the analysis found that 26% had received some form of support. Of the 800 companies benefiting from Innovate UK funding, almost 60% were involved in a collaborative R&D grant and 44% received a grant to support feasibility studies. The new investment accelerator programme –although relatively small compared with other programmes – was by far the most likely to engage with USOs, with 56% of recipients of this type of support by a spinout. What is not clear from this analysis is what 'good' should look like in terms of how Innovate UK supports USOs: should we expect many more USOs to benefit from their funding? Are their funding programmes appropriately designed to enable USOs to benefit from them?

Trends in wider investment landscape

The technical note also explored trends in the wider venture capital investment landscape in the UK. It found that the UK is slowly closing the gap in the amount of equity finance as a percentage of GDP compared with the US. Compared to Germany, France and Canada, over the period 2015 – 2017, the UK invested significantly more through equity finance once the scale of the economy is taken into account. A detailed analysis by the British Private Equity and Venture Capital Association also shows that, over this period, VC investments at the seed stage, other early stages, and later stages of company development have grown substantially, although have fallen at the start-up stage.

A key trend in VC funding both globally and nationally is the rise of corporate venture capital (CVC). Whilst in some ways similar to traditional private VC funding, it differs in key respects. In particular while private venture capital typically pursue a singular objective to maximise financial returns and hold committed capital in a fund for 10 years, CVC investments typically assess performance both on financial and strategic objectives and can take a longer term perspective. Evidence generated by CB Insights suggests a significant rise in CVC activity in the UK. In addition, as of 2018 the UK has been securing a greater proportion of global CVC investments. Importantly, for USOs, the global trend is towards more CVC investments at the seed stage of companies. The analysis of investor types in USOs over the period 2011 – 2018 suggests that corporate investors are now involved in more deals, although they do not appear to be becoming relatively more important than other forms of capital.

Assessing university performance in generating USOs
Assessments of university performance in generating USOs need to move beyond measures of activity – i.e. the volume of spinouts produced. A number of alternative measures are suggested in this data annex that attempt to move towards more 'trajectory' or outcomes measures of performance.These include:

- The ability of a universities USOs in raising external investment, *controlling for sectoral/technological variations*
- The time taken for companies to progress towards an exit or becoming established in the marketplace, *controlling for sectoral/technological variations*
- Survival rates of USOs, *controlling for sectoral/ technological variations*.
- Appropriate measures of growth in the value of USOs (i.e. accepting that many early stage companies may take a number of years before generating turnover let alone profits, *controlling for sectoral/technological variations*
- Comparison of returns to investment for university-focused funds vs other venture funds

The ability to generate USOs is also driven by the strength of the entrepreneurial ecosystem in which the university is linked into (note this does not necessarily have to be geographically proximate to the particular university). As such, comparative assessments of the strength of the ecosystems within which universities are inserted can be instructive in informing an understanding of the likelihood of successful development of USOs.

International comparisons of USO activity and performance

International benchmarking of USO activity and performance at both the national level and university level can provide valuable insights into the strength and weaknesses of the UK university system in generating USOs and where it needs to be strengthened. However, such comparisons are typically very challenging as data is frequently not collected in the same way or to the same definitions. In addition, the structure of the industrial and entrepreneurial ecosystems in different countries can be very different which result in different decisions being made on appropriate commercialisation pathways, or types of support required. Nevertheless, and recognising these caveats, some useful comparisons can be made. The evidence suggest that:

- UK has five universities in the top 10 globally when ranked in terms of the amount of venture capital raised over period 2013 – 2017.
- On key metrics such as the volume of spinouts generated per £research income in the year 2015/16, the UK did not perform quite as well as the US but it is a similar order of magnitude once the size of the research base is taken into account.
- The UK compares favourably against US in terms of strength of entrepreneurial ecosystem at the national level and the amount of capital raised to invest in USOs. Key UK locations identified as globally competitive entrepreneurial locations in a 2014 study included Cambridge, London and Oxford
- On the general availability of venture capital for start-up firms (including USOs), the UK still lags behind the US although appears to be closing the gap.

Overall, the technical note suggests an overall strengthening of UK universities in generating spinouts that are able to secure increasing amounts of external investments. And while there are some weaknesses in the system, leading UK universities compare well with their US counterparts in generating USOs valued by the market.

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