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Profiling UK university spin-outs

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EXECUTIVE SUMMARY

Background

This report presents the results of a comprehensive survey of UK university spin-out businesses. While various academic studies have examined *university spin-outs (*USOs*)* these have largely focused on a small sample of businesses, often within certain universities. These are useful and insightful studies in contributing to our understanding of the antecedents and determinants of USO success. They have not however provided a comprehensive overview of the characteristics of this population.

In the development of appropriate and effective interventions to support USOs, it is essential to understand their corporate characteristics. Yet, detailed and current evidence on the USO population is limited. Basic data exists on the number of USOs, the sectors in which they operate, their financial performance, number of employees and equity investment [1]. However, more detailed information is lacking relating to the how these businesses were formed, the financial and business support received, the business models they pursue, characteristics of the founding teams, intellectual property strategies etc.

In an effort to enhance our understanding of this sector, a database of 1044 active USOs was compiled from individual university records and internet searches, *and* matched to a published list of UK university spin-outs[2]. Telephone interviews were conducted with USOs and a final sample of 350 was achieved. Non-response bias was tested for and weights were constructed to ensure that the findings were representative of the UK population of USOs.

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University Spin-outs (USOs) are defined as 'new ventures that are dependent upon licensing or assignment of [an] institution's intellectual property for initiation'[3]. It is argued[4] that in recent years there has been a shift in emphasis from exploitation of university IP through licensing models to a focus on spin-out activity. However, the perception remains that research commercialization through spin-outs will tend to occur, only when other routes such as licensing have been exhausted[5].

The main findings of our survey are as follows:

- On average there is a two year time lag between development of the technology on which the business is based and the spin-out being formed. For a third of USOs this time lag is shorter at just under a year between technology development and commercialisation.

- USOs adopt a range of business models. The dominant business model, adopted by two-thirds of USOs was developing technology with a view to sale. This involved the development of technology, product and/or service which the USO was seeking to commercialise. In only a small proportion of these USOs (c.7 per cent) are consultancy services also provided to support customers in their adoption of the technology. Therefore most technology that is developed and sold is independent of other support services from the spin-out. A fifth of USOs develop technology that they then seek to further develop and commercialise in collaboration with other organisations, typically incumbent businesses. Only 14 per cent of USOs were engaged solely in providing consultancy or contract research activities.

- The average USO generates £190,000 in sales and as might be expected, older businesses have higher levels of sales.

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- A significant share (almost a third) of USOs were not generating revenue at the time of our survey. These are not newly established businesses, as might be anticipated, but rather businesses that have existed for on average of 7 years, and are focused on selling their technology.

- For a small proportion of USOs (7 per cent) that had previously been trading, these businesses were no longer generating sales. The main reason for this was that previous technology had been sold and no further demand existed (or a competitive alternative had been introduced to the market). The USO had not undertaken any innovation in their technology or the market they were serving.

- USOs are generating around half of their revenue from non-UK markets. This share is higher for Northern Ireland and Scottish USOs with no significant relationship found between the USO age and the share of sales to export (non-UK) markets.

- On average USOs employ 4 highly educated employees, with almost all (93 per cent) having a degree level qualification or higher. Employment growth in USOs is very mixed with gains in some being counteracted by losses in others since 2011. There is no straight-forward explanation for this with sales growth/losses not related to the age of the USO, the business model adopted or share of export sales.

Founders

- The majority of USOs have a founding team typically comprising 3 individuals, with only 12.5 per cent being established by only one founder.

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- Rates of female academic entrepreneurship compare favourably to corporate rates, however less positively, where females are involved they are mainly part of a team and not the main founder. In those USOs where a female is the main founder (8.3 per cent of all USOs), the founding teams are smaller.

- The main founder of USOs are approximately 47 years of age. While these founders have spent most of their career in academia (on average 17 years) almost three-fifths of them had previously worked in industry (for an average of 2 years) and a small proportion (6 per cent) could be described as serial entrepreneurs having previously founded 3 or more USOs[6].

- As might be anticipated, academic founders have considerable technology expertise with over 40 per cent of first founders and almost 30 per cent of second founders reporting previous patent awards (on average 3 patents). Founders with commercial career experience were significantly more likely to have received prior patent awards.

- In general the second founder had slightly longer industry work experience (4 years) and less in academia (10 years). Therefore, for the majority of USOs it is not the case that there is no commercial business expertise in the founding team. However, the share of USOs with no commercial business expertise among its two main founders remains substantial at 25 per cent.

- For the majority of academic founders there are likely to be significant tensions between time commitments to university academic work and work associated with the USO. Only a quarter of primary founders were fully committed to the USO with the

average time commitment to the USO being 20 per cent. This time commitment was lower again for the second founder at 10 per cent.

Finance

- Average investment varies significantly according to the business model of the USO. Consultancy based USOs require the lowest level of financial investment at c. £0.8m. This contrasts with USOs formed to develop technology with a view to alliances with other businesses, where average investment was £3.9m.

- The rounds of funding received by USOs also differed according to their business model. USOs formed to produce consumer products received significantly fewer rounds of funding than USOs formed as OEMs.

- Public sector financial support was received by a significant proportion of USOs. Local/Regional financial support had been received by a larger proportion of USOs (38.7 per cent) than National support (28.0 per cent). English USOs were the least likely to receive local/regional financial support with USOs formed in Northern Ireland and Scotland being significantly more likely to receive local/regional support.

- USO's business model also influenced their probability of receiving financial support. For example, USOs formed to develop technology with a view to sale were more likely to receive local/regional financial support. USOs formed as OEMs were more likely to receive national and EU financial support.

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- On average, USO founders hold the highest proportion of equity in the businesses at formation. VC's account for a relatively small share of equity at formation, however where a change in the distribution of equity occurs in USOs then this is reflected in declining founder (and university) shares and an increase in VC share. 'Others' also increase their equity share in USOs over time, and it is likely that this is captured by other businesses, who may be forming strategic joint ventures or alliances with the spin-out.

- The distribution of equity across the different USO business models at the period when the business is formed is quite similar. Exceptions to this are for OEM USOs where universities hold a slightly higher share of equity. Similarly, VC's hold a higher share of equity in USOs seeking to sell their technology.

Incubation and Support

- The assumption that USOs develop IP in the lab and seek to develop and exploit this in a university incubator are unsupported by the evidence. Only a quarter of all USOs located at any stage of their development in their University's incubation facility. For 63 per cent of all USOs, at no stage in their formation or development were they located in an incubator, whether or not this was owned by their university. Indeed, for over 27 per cent of USOs the businesses emerged from universities without an incubation facility.

- Of those USOs locating in their University's incubator, over half entered the incubator in the same year as they were formed. Of those which reported having entered and left an incubator, on average their tenancy had been for 4 years.

- Some variation is evident in the propensity to locate in an incubator across the USO business models. USOs with technology which they were seeking to develop collaboratively with incumbent businesses, as well as OEMs were more likely to locate in an incubator.

- On average, there were 15 other businesses located in incubation facilities alongside the USO with approximately one-third of these being spin-in businesses.

- The favourable location and flexibility of leasing terms were the two most commonly cited reasons for locating in a university incubator. Less frequently identified were the reputation and image of the incubator, availability of professional support, opportunities to network, mentoring support and company reviews and recommendations.

- Only a fifth of USOs reported having been located at any stage of their development on a science park. Welsh USOs were significantly less likely to locate on a science park. It is difficult to determine based on the evidence if this reflects the preferences of the Welsh USOs or the provision of science park facilities.

- UK Universities attempt to support their USOs in a number of ways. The most frequently cited forms of university support were business planning and formation of the business as well as IP advice. Seed capital investment was received by just under a third of USOs, yet of those in receipt of it the majority found it important or very important to their development. Some variation was evident across the USO business models in the nature of support received.

- Some forms of support which USOs reported having received from their universities such as support with recruitment or business skills development were not rated highly by the USOs as being important to their development.

Intellectual Property

- While it is clear that patents are the most common mechanism used by USOs to protect their intellectual property, various other methods are also used including trademarks, employee non-disclosure agreements, confidentiality agreements and trade secrets etc.

- On average, USOs are applying four forms of IP protection. As USOs increase their sales in non-UK markets this corresponds with a broadening of their mechanisms used to protect their intellectual property.

- The USO business model has a significant effect on the IP protection mechanisms used by the business. For example, USOs developing technology with a view to sale are more likely to use patents, copyrights and trade secrets than other USOs. In contrast, OEM USOs are more likely to use exclusivity agreements and employee non-disclosure agreements to protect their IP.

INTRODUCTION

Research Objective

Government efforts in the UK to strengthen university-business collaboration and the economic contribution of academic research continue. Initiative such as the Higher Education Innovation Fund (HEIF) along with other initiatives [7] have been very successful in increasing knowledge transfer activities. Yet as the House of Commons Business, Innovation and Skills Committee concluded: 'Care is required to ensure that new initiatives add value to the existing system, rather than creating unnecessary complexity' (p.3), and therefore 'If the UK is to have a coherent innovation strategy, it is vital that there is a UK wide picture of the capacity, capability and coherence of local innovation ecosystems' (p.23)[8].

The main objective of this study therefore, is to complement existing academic literature by profiling the current characteristics of the UK university spin-out sector.

In this report we present detailed and current evidence on the USO population. To date only rudimentary data exists on the number of USOs, the sectors in which they are operating, their financial performance and equity investment[9]. However, more detailed information is lacking relating to the how these businesses were formed, the financial and business support received, the business models they pursue, the characteristics of the founding teams, intellectual property strategies etc. Where this type of information has been collected, it has been collated by academics focusing on small samples of businesses, often within certain universities. These are useful and insightful studies in contributing to our understanding of the antecedents and determinants of USO success. They have not however provided a comprehensive overview of the characteristics of this population.

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This report presents the initial findings of a survey of all UK university spin-out businesses. A database of 1044 active USOs was compiled from individual university records and internet searches, matched to a published list of UK university spin-outs[10]. Telephone interviews lasting approximately 30 minutes were conducted with USOs and a final sample of 350 USOs was achieved. Non-response bias was tested for and weights were constructed to ensure that the findings were representative of the population of USOs. Further details pertaining to research method and data analysis are available in the appendix.

Policy Environment

It is widely recognised that the University sector has experienced mounting pressure in recent years to demonstrate societal and economic impact. Almost 20 years ago, in 1998, the UK Government White Paper (DTI, Dec.1998, Cm 4176) on building a knowledge-driven economy emphasised the important role of Universities in knowledge generation and exploitation and the intricate link between these activities. Yet, the translation of theoretical knowledge into inventions and subsequently the commercialisation of these in innovation was, and remains, extremely challenging. One of the reasons for this is market failure in the commercialisation process meaning that the societal and economic benefit arising from public sector investment in research is at a sub-optimal level.

In an effort to address market failure and in particular to increase engagement between Universities and businesses, the Higher Education Reach-out to Business and the Community Fund (HEROBC) was established in the late 1990s, the purpose being to 'provide a platform of core funding to help [Universities] to put into practice organizational and structural arrangements to develop and implement strategic approaches to their relations with business, and to assist in activity to improve the transfer of knowledge and skills' (HEFCE, 2000, p.4)[11]. This was followed by further

government papers and in 2002 by proposals to ensure the long-term sustainability of university research and efforts to encourage greater collaboration between universities and the business sector through increased investment in knowledge transfer activities.

The Government's Science and Innovation Investment Framework 2004-2014 (July 2004)[12] therefore committed to further develop and expand third stream funding in UK Universities[13]: 'Over the next ten years, it is critical that the levels of business engagement with the science base increase, to realise fully the economic potential of the outputs of our scientists and engineers to turn basic and strategic research into successful new products and services, and to engage more fully with business'. Annually around £160m is currently allocated through HEIF to English HEIs to 'maintain and build capacity and capability to work with business and other external organisations'[14] as well as to support the commercialisation of intellectual property (IP) through licensing and spin-outs. The perceived success of HEIF has led to the recommendation for HEIF to be increased to £250m per annum beyond 2016[15].

So has policy intervention in the commercialisation of academic research been effective? In general, the view is that it has had a significant effect on the scale and scope of university-business collaboration. The Lambert Review in 2003 and later Government reviews of university-business collaboration concluded that government funding for knowledge transfer activities had been important in changing the culture among universities. It is suggested that universities have had to become ambidextrous in balancing the pursuit of academic research with a commercialisation agenda[16]. For academics this has translated into a 'dual cognitive approach to academic science' where knowledge creation is combined with opportunities to protect and commercialise research.

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The appropriateness of academic publications as a channel of transferring knowledge to a non-academic audience has been questioned in recent years. Certainly evidence on the use of business innovation and patent protection in academia estimates that 'at least half the new products based on university patents would not have been developed if the results had been put in the public domain without patent protection," (EU, 2004, p.11)[17], [18]. At the same time, some argue that the shift in emphasis from open science to patents and licenses has now progressed to a declining reliance on patenting as the primary means of commercialising research and instead there has been a growing emphasis on, and rates of, university spin-out activity. In a relatively short time frame universities have moved from an 'open science' approach to knowledge to that of a 'licensing model' and more recently to an 'innovation and entrepreneurial model' of knowledge sharing. University spin-outs (USOs) represent one of a number of mechanisms through which university research and technology can have an economic impact.

The increasing policy prioritisation of university commercialisation, and of spin-out activity specifically, has been accompanied by an extensive literature on the determinants and consequences of spin-out activity. However, statistics on USO survival, growth and revenues have been discouraging. UK figures suggested that three in ten USOs ceased trading[19], and a case study of a US university incubator revealed that 52 per cent of tenant firms failed and that higher-growth firms, while performing better in the early stages, were more likely to fail[20]. What is more, numerous studies highlight that surviving USOs typically have either no growth or lower growth than other new technology-based firms[21] and that increasing rates of spin-out activity have been driven not by preceding role models of high-growth, profitable USO (which are extremely rare), but by the "rhetoric of aspiration"[22], with the benefits of USO for their regions and parent institutions have been assumed but rarely proven.

These factors, along with the fact that the commercialisation of university technology is now such a high priority of public investment, provide a strong justification for critical research into the UK university spin-out landscape.

UK UNIVERSITY SPIN-OUTS: A PROFILE

In the early 2000s only 21 per cent of US university technology transfer offices explicitly mentioned new firm creation in their mission statements[23] and only 52 per cent of UK universities spun out any firms in 2005[24]. More recently, increasing rates of USO formation have been reported with a growth rate in the UK of 46 percent between 2008 and 2011, or an average annual increase of 15.3 percent[25]. At the same time, concerns have been raised about the low growth rates of USOs, the cost-benefit to universities from supporting these firms[26], and the regional and national externalities they generate[27].

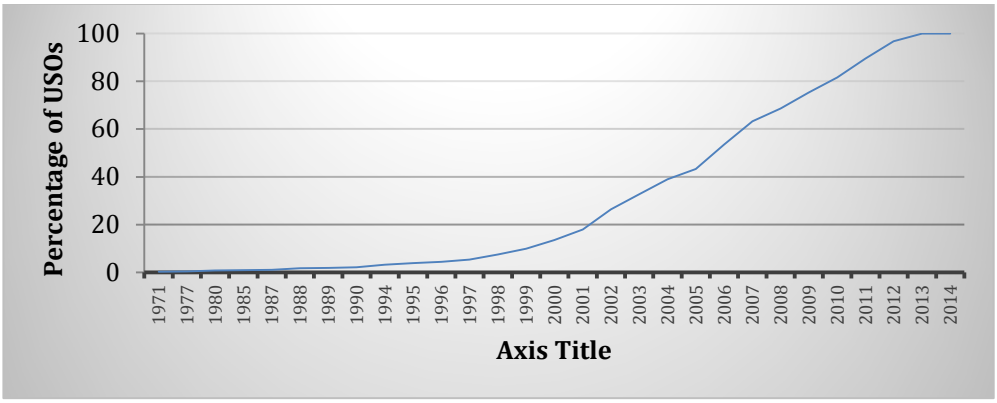
In an effort to better understand the nature of USOs we begin in this chapter by profiling their underlying characteristics. This includes an assessment of the age profile of USOs and consideration of the period of time required between technology development (or identification of the opportunity to exploit a technology) and the point of business formation. We also profile the business model adopted by USOs along with an indication of their business performance, as assessed in terms of sales revenue and employment. The extent to which these businesses are trading internationally is examined in terms of the share of sales to markets outside of the UK. The period following the 2008 recession has presented challenging trading conditions for all businesses and in light of this we consider the reported growth rates of USOs in the recent 2011-2014 period. The chapter concludes by considering the human resources available in the businesses as assessed through employees' educational attainment.

How Old Is the Stock of UK University Spin-outs?

In 2014, three-quarters of all UK university spin-outs (USOs) were formed since 2002, half formed since 2006, and a quarter of all USOs were formed since 2010 (Figure 2.1). These figures are consistent with academic studies[28] and data for the UK[29] suggesting that the rate of University Spin-out formation increased by 46 per cent, or an average annual increase of 15.3 per cent between 2008 (160 USOs) and 2011 (233 USOs)[30]. The implication of this is that the average age of live USOs is 9 years[31].

The formation of the spin-out business occurs as part of the spin-out process. While it might be assumed that commercialization occurs in a linear way with the technical development arising from research and then the exploitation of this through the incorporation of a business, the reality is much more complex. It is true that for 90.9 per cent of all USOs, technological development preceded business formation and is the basis on which the firm currently trades. On average, technological development occurs 2.0 years prior to the formation of the business. Despite criticisms that university academics and technology transfer processes are often misaligned with market opportunities in being slow to respond, the findings from our survey suggest that this is not supported in terms of the commercialization of technology. Indeed, for approximately a third (33.2 per cent) of USOs the time lag between technology development and business formation was short – being less than one year.

Figure 2.1 Formation year of current USOs (Cumulative percentage)



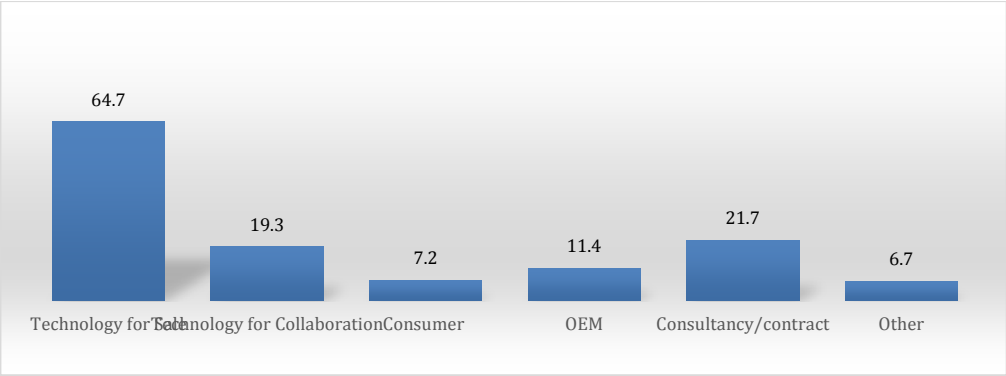
What Business Model Do University Spin-outs Adopt?

USOs were asked to identify their business model across 6 broad categories. These included: (i) developing technology with a view to sale; (ii) developing technology with a view to alliance with incumbent organisation; (iii) consumer product producer; (iv) original equipment manufacturer[32]; (v) provider of consultancy or contract research; and, (vi) other (which was then described by the respondent). Approximately three-quarters (77.3 per cent) of USOs, identified that they had one business model with an additional 17.4 per cent stated that the firm were following two of these models.

The dominant business model was the development of technology with a view to sale (Figure 2.2). This suggests the complementary nature of university-developed technology, requiring external organisations to embed the technology in their products and access the final customer. Other research has also identified that university spin-outs tend to develop and seek to commercialise narrower technology than that developed by corporate spin-outs. This, they propose, may constrain growth rates of the spin-out with the development of broader technologies positively associated with higher growth rates[33].

Of the 21.7 per cent of firms involved in consultancy or contract research services, a third of these firms were providing this as a complement to the sale of technology. In the remainder of cases where consultancy or contract research services were provided, these were the sole activity of the business.

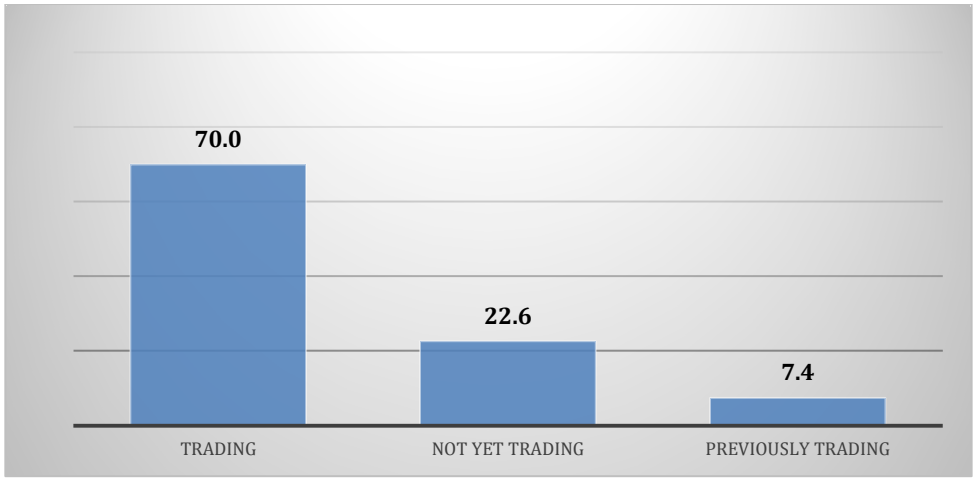
Figure 2.2 Business model reported by USOs (Percentage)



What Sales Do UK University Spin-outs Generate and How Many Do They Employ?

All USOs respnding to the survey were asked whether or not they were currently generating revenue and if so, the value of revenue generated from sales of products or services in the last financial year (2012/13). Just under three-quarters (69.5 per cent) of USOs are generating revenue. Of those not generating revenue the majority of these firms had not commenced trading however for 26 USOs, trading had occurred previously (Figure 2.3). It might be assumed that those which had never traded (79 USOs) were newly founded and were awaiting contracts. However, on closer inspection it appears that these were not newly founded firms, with only 9 of the 79 having been formed in the previous 2 years. On average these firms had been established for 7 years[34], with the majority of them having developed technology with a view to sale[35].

Figure 2.3 Trading status of USOs (Percentage)



Of the 69.5 per cent of USOs who were trading, average revenue from the sale of products or services in 2012/13 was £190,000[36]. As anticipated, firms established for a longer period of time are generating higher revenue (x^2=.277, p=.000). USOs producing consumer goods had significantly higher sales than those with other business models (p=.117, sig=.044).

In What Markets Do UK University Spin-outs Trade?

In relation to the market destination of sales, on average, 50.0 per cent were made outside of the UK market[37]. Disaggregating this by UK countries, some variation is evident with English firms having the lowest average share of sales outside the UK (49.63 per cent) followed by Wales (54.1 per cent), Scotland (56.1 per cent) and Northern Ireland where exports outside the UK market account for the highest share of total sales (66.3 per cent).

It is possible that the firm's business model may also affect the propensity to trade outside the UK. However no significant relationship was found, with the exception of firms engaged in providing consultancy services. For

these firms, sales to export markets is significantly lower reflecting a higher dependence on the UK market[38]. Further, while firms that were trading longer had significantly higher sales, this is not translated into higher export sales. In other words, there is little evidence to suggest that spin-out firms once formed, begin trading in the national market and over time as they build up experience, begin to penetrate foreign markets.

Have University Spin-outs Grown Over The Past Few Years?

On average USOs have 4 employees[39] (mean 10.0, sd=16.9). Aggregating this across all USOs suggests national employment of c. 4,176 employees[40].

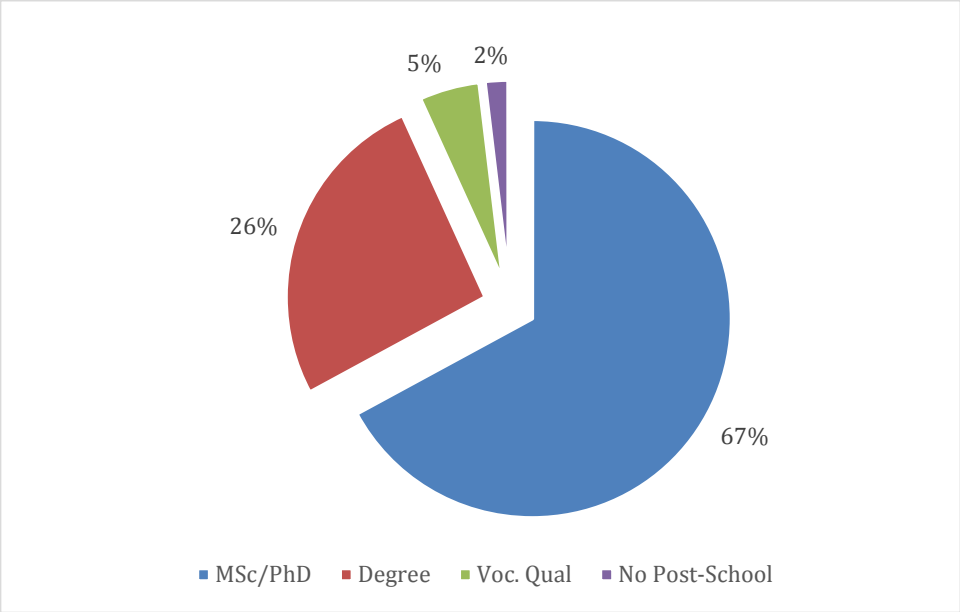
Employment growth was very low over the 3 year period 2011-2014, with gains in some USOs largely cancelled out by losses in others. Overall, 23.8 per cent of USOs reported contractions in employment over the period while 35.1 per cent had stable employment and only 41.1 per cent experienced employment growth.

For those USOs reporting contractions in employment over the period, on average this equated to a contraction of half (50.0 per cent) of their workforce (sd=34.8 per cent). Of the proportion that did record employment growth, these percentage levels were quite high at an average of 66.6 per cent growth although it should be noted that many of these USOs were starting from a very low base in 2011, often with only a few employees.

Comparing those USOs that experienced employment contractions with those reporting employment growth over the 2011 to 2014 period, no significant difference was found by business model, age[41] or share of sales outside the UK.

Across the USO sector employees are highly educated: 93.2 per cent of all employees were educated to at least degree level and 67.1 per cent had qualifications at a Master's or PhD level (Figure 2.4).

Figure 2.4 USO employees by educational attainment (percentage of all employees)



USO FOUNDERS

What Are The Characteristics Of The Founding Team?

On average, USOs have 3 founders[42] with a relatively small proportion of USOs (12.5 per cent) being started with only one founder. Based on a UK population of spin-outs in 2014 of 1044, this equates to 3132 founders. Comparing this to the number of academic staff (FTE) reported for all UK Universities in 2012/13 suggests a founder share of 1.7 per cent of all academic staff being involved in university spin-outs[43].

What Is The Gender Balance In The Founding Teams?

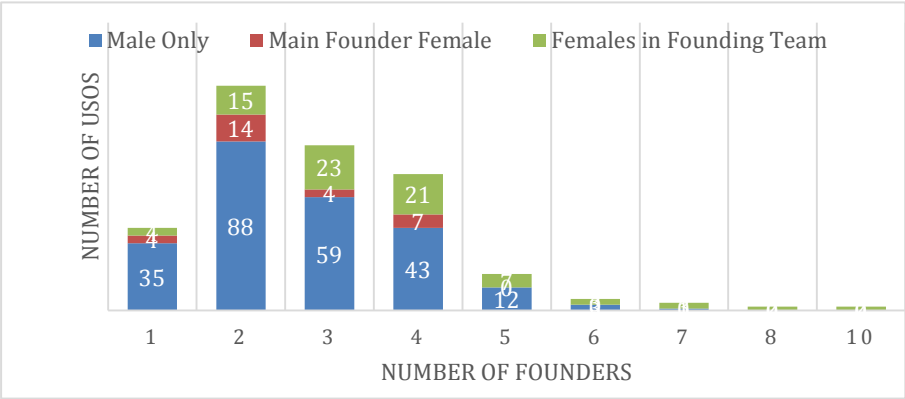
Female involvement in founding USOs was high in comparison to levels of female representation on corporate boards and entrepreneurship levels. In our sample of USOs, almost a third (31.4 per cent reported that a female had been involved in founding the spin-out. This rate of female entrepreneurship compares favourably to 20.4 per cent of FTSE 100 companies with females on their corporate boards[44] and to a much lower rate of female directors on Fast Track 100 companies[45].

At the same time, in our survey we asked respondents to profile each of the main founders of the USO in terms of shareholding: up to a maximum of three. Drawing on this information we find that females were significantly less likely to be the main founder in terms of the majority shareholding: accounting for 8.3 per cent of all USOs and therefore males were the most significant founder for 91.7 per cent of USOs. This finding echoes findings of the Global Entrepreneurship Monitor which highlighted that female graduates in the UK were 'particularly poor at starting their own businesses rather than working for someone else' with the study placing UK females as 17th out of 17 countries in terms of the willingness of females to take risks in the workplace[46].

Two points are important to emphasise in terms of female involvement in founding USOs (Figure 3.1):

1. As the number of founders in a USO increases, so too does the probability of a female being involved in the founding team.
2. Where a female is the main founder, then the founding team tends to be smaller[47].

Figure 3.1 USO founders by gender: The role of Females (number of USOs)



What Are The Personal Characteristics Of University UK Spin-out Founders?

In terms of the age at which individuals form USOs, this appears to be slightly higher than that found for other start-up businesses. Average age of spin-out entrepreneurs was 47.0 years[48] which is almost 10 years older than the average entrepreneur, estimated to be in their late 30's[49]. The second founder[50] of USOs was on average slightly younger than the first founder at 43.0 years[51], although again this remains above the average for all start-up businesses.

In other studies of start-up businesses, entrepreneurial age has been found to be a less significant determinant of success than the previous startup and industry experience. Indeed a number of studies have suggested that university spin-out firms perform less well than corporate spin-out firms[52]. One of the reasons for this may be better commercial networks and knowledge of the industry by corporate entrepreneurs as compared to academic entrepreneurs. In addition, academic entrepreneurs may have weaker entrepreneurial skills to run a business than corporate entrepreneurs[53].

In our sample of USOs, the founders' educational attainment mirrored that of the employees, with the majority having Master's or PhD level qualifications. Indeed, 93.7 per cent of the primary founders of these USOs had a Masters or PhD qualification with 83.4 per cent of second founders having this level of attainment also.

Do Founders Have Prior Industry Experience?

For both first and second founders, approximately 57 per cent had previously worked in industry. On average, the first founder had spent a slightly shorter period in industry (2.0 years) than the second founder (4.0 years)[54]. Looking at this in terms of years spent in academia/research, Founder 1 had spent longer at 17.0 years as compared to Founder 2 who had spent an average of 10.0 years prior to founding the university spin-out firm[55].

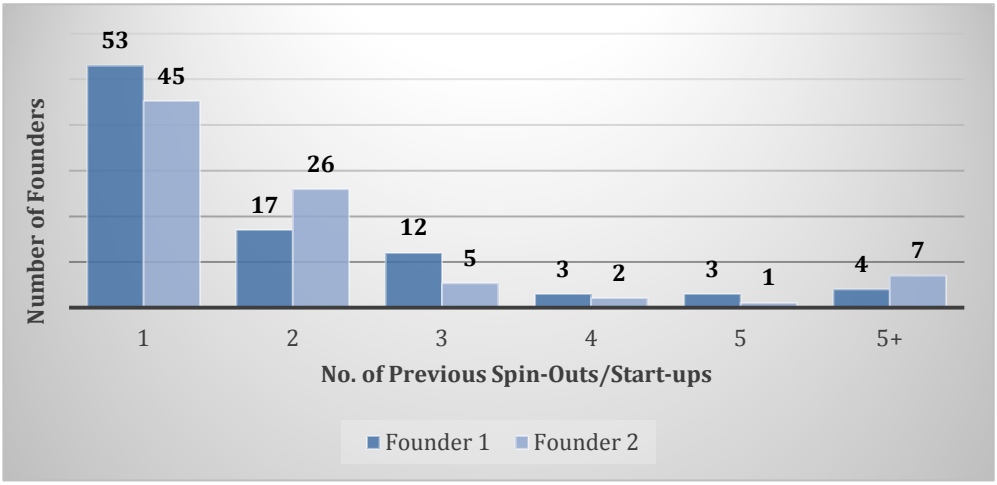
These findings suggest that, for approximately three-quarters of USOs, contrary to what is often assumed of academic entrepreneurs and the wider founding team, these founders had a cumulative background in industry of 16.2 years[56]. At the same time, it is the case that for a quarter (24.7 per cent) of USOs their two main founders had no commercial work experience prior to founding the firm.

As might be anticipated, founders have an extensive academic and research background which is likely to be resulting in novel technologies which are new to the world, yet narrowly focused and therefore requiring complementary assets and expertise to commercialise.

Do Founders Have Previous Experience Of Commercialisation Activities?

In addition to the commercial background of founders we sought to determine the proportion which had been involved in other spin-out ventures prior to the one under investigation. Of first founders i.e. those with the majority shareholding, 27.5 per cent had previously been involved in a spin-out or start-up business. This proportion was similar for second founders at 28.4 per cent, i.e. those founders identified as having the second largest shareholding at inception of the business. For both dominant founders, involvement in prior entrepreneurial endeavours had typically been with one (or two) other spin-out/start-ups (Figure 3.2). The proportion of serial entrepreneurs was relatively small with 6.3 per cent of all first founders having been involved in 3 or more spin-out/start-ups (4.9 per cent of second founders).

Figure 3.2 Number of founders previously involved in spin-out/start-up activity



In addition to prior entrepreneurial activity it was also interesting to determine founder's prior experience in terms of the disclosure of inventions and patenting. Substantial debate in the academic literature has

focused on the relationship between patenting and publishing. In particular, this has centred on notions of the substitutability of patenting and publishing with the former representing efforts by the academic or university to protect knowledge while the later characterises an open science model with knowledge sharing.

In general, empirical findings have not identified a conflict between publishing and patenting, but instead a complementary relationship between the two. For example, Azoulay et al. (2009)[57] and Stephan et al (2007)[58] identify a positive relationship between patenting and publishing. Further, Agarwal and Henderson (2002)[59] in studying academics at MIT found that the publications of academics having engaged in patenting were more highly cited than for those academics with no patents.

Based on our sample of USOs, 41.1 per cent of primary founders had previously been awarded a patent. This proportion was lower for second founders with only 27.1 per cent having been awarded a patent. Of those primary founders with prior patenting experience, on average these individuals had been awarded 3 patents[60], a similar number to the second founders where again the average number of prior patents was 3[61]. This suggests that USOs primary founders are more likely to have prior patenting experience than additional founders, however little difference is found between founders where they do have a background in patenting.

Data for prior invention disclosures was similar to that for patents with the primary founder being slightly more likely (23 per cent of founders) to have experience of this than the second founder (16.0 per cent of second founders).

In this study we find a strong positive correlation between founder's prior patenting experience and prior entrepreneurial activity ($x^2=107.19$, $df=4$, $p=.000$). This relationship holds for both primary and second founder

suggesting a technology and commercial awareness among these individuals. It should be noted however that the majority of USO founders had neither patenting nor prior entrepreneurial experience before founding the current spin-out.

How Much Time To Founders Commit To The Spin-out?

For academic entrepreneurs there can be a tension between delivering research and teaching activities while attempting to spin-out a new venture. 25.1 per cent of primary founders were committing 100 per cent of their time to the spin-out, however for the remainder this was not the case.

On average, primary founders are committing 20.0 per cent of their time to the spin-out[62] with this percentage being slightly slower for the second founders at 10.0 per cent[63]. One of the reasons for this time allocation could be the business model of the spin-out. For example, if the business model is to develop technology with a view to sale of this technology then the time commitment might be lower than where consultancy/contract research or seeking to identify suitable collaborative partners to further develop the technology dominates. However, no significant difference was found between the percentage of time allocated by the founders and the business model being pursued.

Personal characteristics such as educational qualifications, gender and their prior involvement in a spin-out/start-up were all found to have no significant effect on the proportion of time committed to the spin-out. However, what did appear to have a significant effect on time commitment was the age of the entrepreneur and the length of time that they had worked in industry or academia.

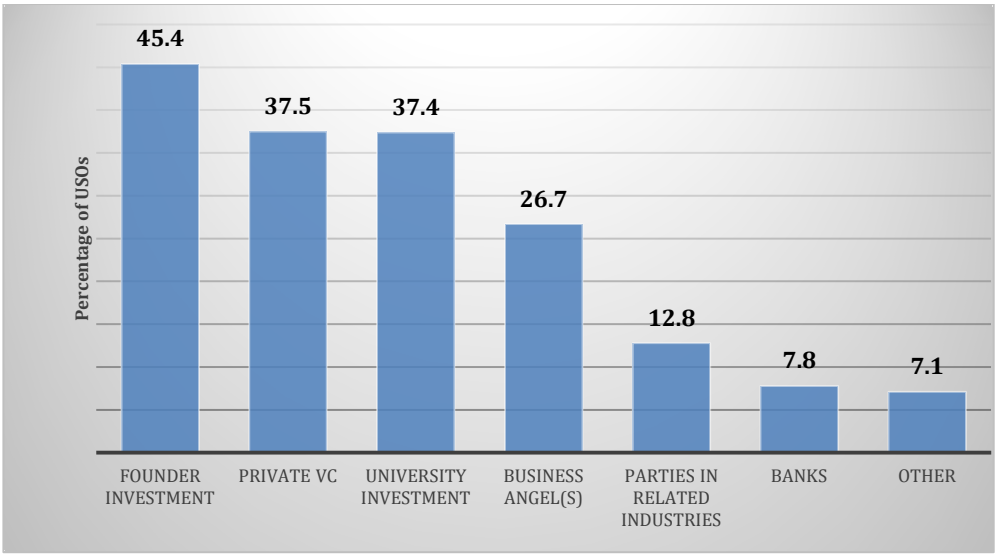
Older founders committed a significantly lower proportion of their time to the USO than younger founders (r=-.187, Std error=.052, p=.001). The institutional context of prior experience also effected the time commitment of founders with those having more years in industry now devoting a significantly larger share of their time to the spin out (r=.175, Std error=.058, p=.001). Similarly founders having spent more years in academia/research were committing a significantly lower share of their time to the spin-out (r=-.363, Std Error=.047, p=.000). This suggests that older founders who have been in academia for many years commit a significantly lower proportion of their time to a spin-out firm (even when they are the primary founder) than individuals who are younger and/or have more years of prior commercial work experience. The implication of this is that the tensions that arise in balancing research, teaching and academic entrepreneurship are exacerbated for more senior (typically older) academics with less commercial work experience. It is this profile rather than the nature of the spin-out being formed that influences the time that they are able to commit to developing and growing the venture.

FINANCE

Where Do UK University Spin-out's Get Funding From?

USOs received investment from a variety of sources. The most common source of investment was from the founders (45.4 per cent of USOs), with a similar proportion reporting investment from private VCs (37.5 per cent) and their host University (37.4 per cent). Business Angel investment was recorded in 27 per cent of spin-outs with investment from other organisations in the industry or banks being much less common (at 12.8 per cent and 7.8 per cent of spin-outs respectively) (Figure 4.1).

Figure 4.1 Percentage of USOs having received finance by source



How Much Investment Do They Receive?

In relation to total investment, this equated to an average of £300,000 per spin-out firm[64]. As might be anticipated, there was a significant positive correlation between the amount of investment received by a spin-out and its age, with older firms having received significantly larger amounts (r=.18, Std error=.040, p=.041).

In general, differences in the amount of investment received were not evident by the business model of the spin-out, with the exception of consultancy/contract research spin-outs and to a less statistically significant extent, spin-outs developing technology to be further developed and exploited through an alliance with other businesses. In the case of consultancy/contract research spin-outs, investment was significant lower than for other spin-outs at £0.8m, while for spin-outs developing technology and seeking alliances for development, investment was higher (albeit weakly significant) at £3.9m.

Table 4.1 Average investment in spin-out firms by business model (£)

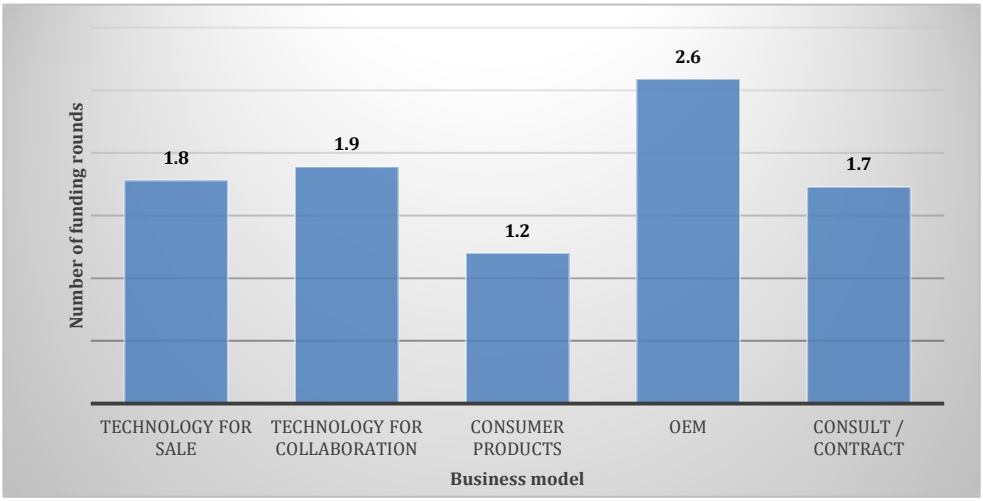
	Investment to date	t	p
	£ Mean		
Technology with a view to sale	2,683,812	-.240	.811
Technology for collaborative development by incumbent	3,902,041	-1.749	.081
Consumer product producer	3.309,156	-.450	.653
Original Equipment Manufacturer	2,541,792	.082	.935
Consultancy/Contract research	866,963	2.593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

In terms of receipt of investment, founders indicated the number of rounds of funding that they had received. On average, this equated to 2 funding rounds. However, for many USOs they had received multiple funding rounds, although this may be partly explained by the age of the USO with older businesses having received more funding rounds (x^2=.141, p=.008).

Some variation was also evident in the number of funding rounds received by USOs reflecting their business model (Figure 4.2). Of note, USOs concerned with producing consumer products had significantly fewer funding rounds (1.2 as compared to 1.8 for non-consumer products USOs; t=2.178 p=.036), and OEM USOs had significantly more funding rounds than others (2.6 as compared to 1.6; t=-2.806 p=.005).

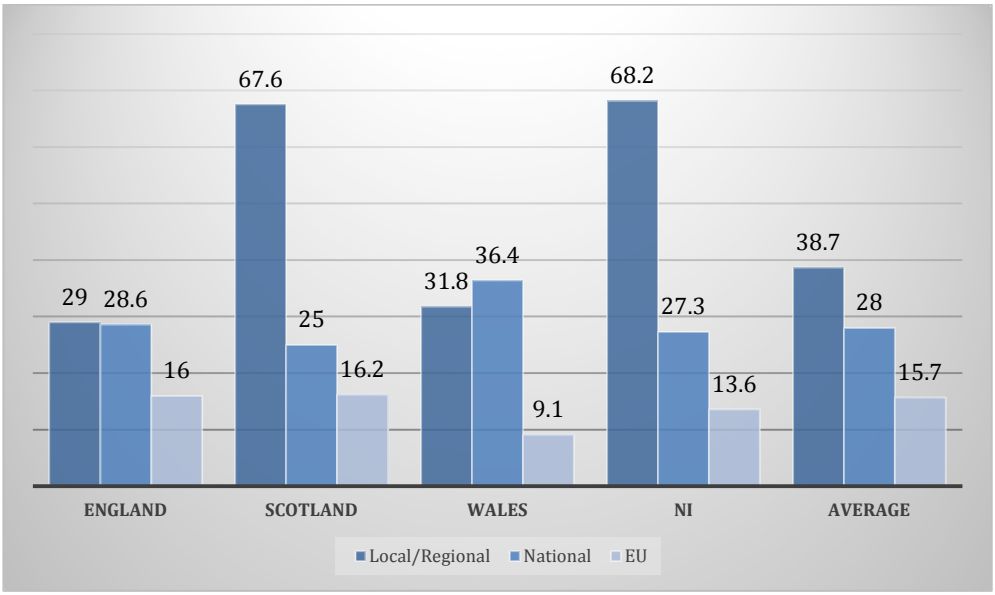
Figure 4.2 Average number of funding rounds for USOs according to their business model



Do Spin-outs Receive Public Sector Support?

In addition to the private (and university) sources of investment, spin-out firms may also receive financial support from the public sector[65]. On average 38.7 per cent of USOs reported having received local/regional financial support, 28.0 per cent received national support and 15.7 per cent reported having received EU financial support (Figure 4.3)[66]. Some variation is evident across the UK however, with English spin-out firms significantly less likely to receive local/regional financial support (t=11.12, p=.000). In contrast, Scottish and Northern Ireland spin-outs were significantly more likely to receive local/regional financial support (t=-10.186, p=.000 for Scotland and t=-4.284, p=.000 for Northern Ireland). No statistically significant differences were found in the propensity of Welsh spin-outs to receive public financial support. Therefore, while overall there is commonality in access to and receipt of national and EU funding sources for USOs, significant variation is evident in Scotland and Northern Ireland in terms of higher receipt of local/regional support.

Figure 4.3 Share of USOs reporting receipt of public financial support by UK region



Variation in the receipt of public financial support is also found across the business models (Table 4.2)[67]. For example, local and/or regional financial support is more likely to be received by spin-outs developing technology with a view to sale, and OEM spin-outs. Receipt of financial support from National sources is significantly more likely for OEM spin-outs and consumer product producers.

In terms of EU support, only spin-outs founded on technology with a view to sale and 'Other' spin-out business models display no significant relationship with receipt of EU financial support. For those spin-outs seeking to sell their technology there may be a lack of desire to collaborate with other organisations (in comparison for example, with technology for collaborative development). This may constrain their eligibility for EU funding, given that many of the programmes are directed at collaborative consortium.

Table 4.2 Receipt of Public Financial Support by USO Business Model (Percentage)

	Local /Regional		National		EU	
Technology with a view to sale	41.59	***	28.61		16.05	
Technology for collaborative development by incumbent	37.62		32.18		22.28	**
Consumer product producer	36.00		29.33	**	25.33	**
Original Equipment Manufacturer	47.06	**	41.18	***	31.09	***
Consultancy/Contract research	36.12		26.43		22.91	**
Other	35.21		28.57		8.57	

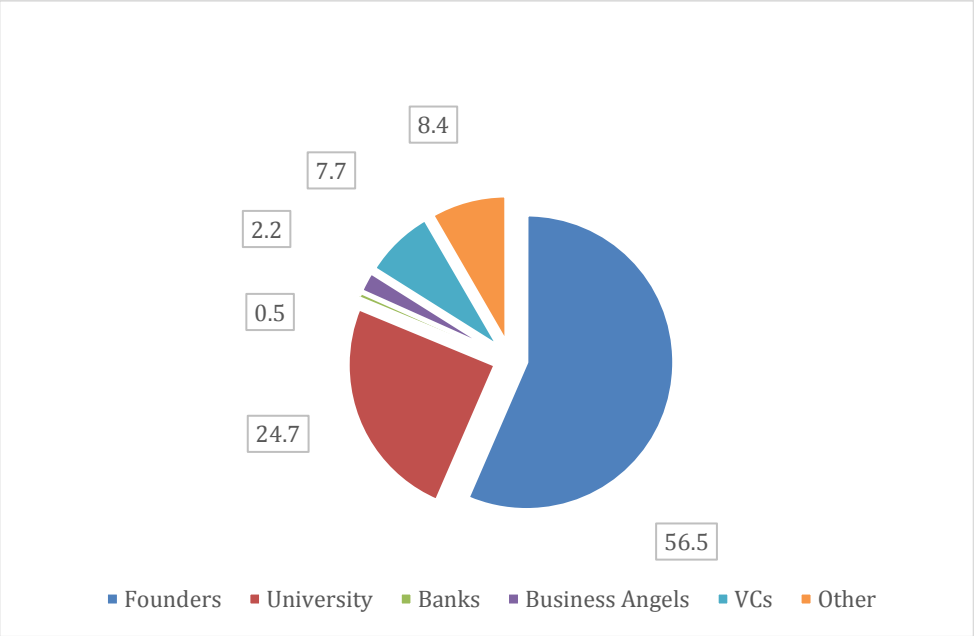
Note: Significance is assessed in relation to each form of public financial support e.g. local/region etc. Each business model is tested against all others. For example, in the case of receipt of local/regional financial support, spin-outs based on technology with a view to sale, were significantly more likely than all other spin-out business models to receive this form of support.
Significance levels denoted as follows: * 10%; ** 5%; *** 1%.

What Is The Equity Profile and Does This Change Over Time?

In our survey of USOs, the distribution of equity was measured not only in 2014 when the survey was conducted, but also when the business was formed. This distinction is important given that 48.6 per cent of all USOs reported a change in the distribution of equity since their formation.

At the point when spin-outs are formed, on average founders own 56.5 per cent (sd=30.9) of equity with 24.7 per cent (sd=23.4) belonging to the host University (Figure 4.4). Financial providers own a relatively small share of the overall equity at this stage of development, with VC's accounting for 7.7 per cent, (sd=16.7) followed by business angels at 2.2 per cent (sd=8.4) and to a much lesser extent, banks at 0.5 per cent (sd=4.7).

Figure 4.4 Average distribution of spin-out equity at formation (Percentage)



In most cases, the allocation of equity at formation does not differ markedly by business model pursued by the spin-out, with a few exceptions (Table 4.3).

- ***Founders' equity***: The equity share belonging to founders remained similar across all USOs, irrespective of their business model.

- ***University equity***: average equity share was significantly higher among spin-outs established as an OEM.

- ***Bank equity***: Banks account for a very low share of overall equity in USOs, however this share is significantly lower where the spin-out is providing consultancy or contract research activities.

- ***Business Angels' equity***: Similar to Banks, overall, business angels account for a relatively small share of equity with this tending not to vary very much across the different USO business models. One exception is for consultancy or contract research activities, where business angels (along with the banks) have a significantly lower equity share.

- ***VC equity***: This is found to be significantly lower for consultancy or contract research USOs and higher for those USOs with technology for which they are seeking to sell to a third party.

Table 4.3 Equity distribution at foundation across the business models (Mean Percentage)

	Technology with a view to sale	Technology for collaborative development	Consumer product producer	OEM	Consultancy / Contract Research	Other
Founders	56.30	57.08	51.72	50.29	61.43	50.08
University	23.86	28.94	33.18	32.86 *	29.39	23.33
Banks	0.22	0.00	1.45	1.88	0.00 *	0.23
Business Angels	2.42	2.34	2.47	3.25	1.15 *	0.23 ***
Venture Capital	9.12 **	6.58	8.62	3.37	2.53 ***	8.59
Other	8.07	5.06	2.56 **	8.35	5.51	17.54

Note: Significance levels denoted as follows: * 10%; ** 5%; *** 1%.

For those USOs reporting a change in their equity from what was agreed at foundation, we find that this is significantly related to age as well as the share of equity held by the founders at formation. For example the average age of USOs reporting an equity change was 11.0 years as compared to an average age of 8.2 years for those USOs without any

change to the distribution of equity (t=4.63 p=.000). In addition, USOs which proceeded to have an equity change, on average had significantly higher shares of equity allocated to founders (60.7 per cent) when the spin-out was formed compared to those USOs having no equity change (founder equity averaging 52.6 per cent).

Where the equity distribution changed, founders' equity declined by approximately 20 per cent and university equity somewhat less: by around 12 per cent (Table 4.4). This was counteracted with an increase in the equity share allocated to Venture Capitalists by almost 12 per cent and other investors – by almost 17 per cent - and to a lesser extent by business angels whose average share increased by approximately 3 per cent (Table 4.4).

Table 4.4 Equity distribution at formation of Spin-outs and in 2014

	Equity at formation	Equity at formation	Equity 2014	Equity at formation &
	All USOs	USOs with equity Change N=170	USOs with equity Change N=170	USOs No equity change
	%	%	%	%
Founders	56.5	60.7	40.3	52.6
University	24.7	23.6	11.8	25.8
Banks	0.5	0.6	0.6	0.3
Business Angel	2.2	2.5	5.4	2.0
Venture Capital	7.7	6.7	18.6	8.7
Other	8.4	5.9	22.7	10.7
Total	100.0	100.0	99.3	100.0

INCUBATION AND SUPPORT

One institutional approach to support the formation and growth of USOs has been through incubators. Incubation has evolved significantly over the past 30 years from 'helping companies survive their formative years (decreasing downside risk) to one of adding value to companies (increasing upside advantage)[68]. Yet, given the large capital and recurrent investment required to establish and run an incubator and data on the weak growth performance of many university spin-out companies, assumptions about the appropriateness and effectiveness of incubation and other forms of support provided to spin-outs are being re-evaluated.

Do UK University Spin-outs Have Access to an Incubator, And Use It?

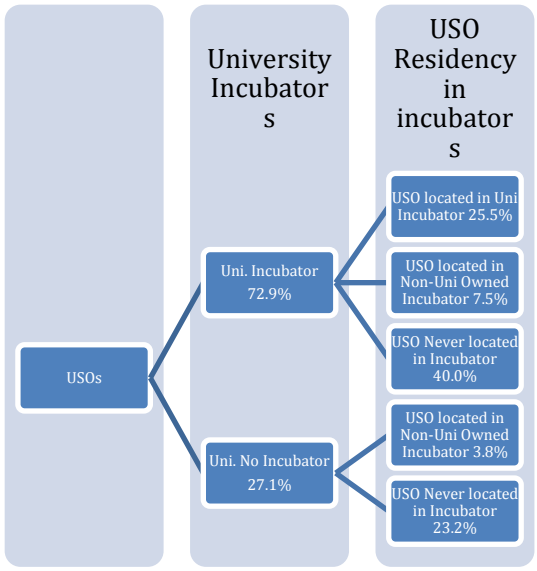
While over half (58 percent) of UK universities and specialist colleges in 2011 had an on-campus university incubator (UI) 30 percent of UK universities with technology transfer offices had no involvement in any business incubators or science parks, whether on- or off- campus, and 22 per cent of UK universities reporting spin-out activity undertook this in the absence of a UI (HESA, 2012).

This infrastructural provision is mirrored in our survey, with 27.1 per cent of USOs stating that their University did not have an incubator facility (Figure 5.1). For the majority of these USOs they were never located in an incubator – including non-university owned incubators i.e. those owned privately or by other public sector organisations. For a small minority of USOs originating from Universities with no incubator provision 3.7 per cent), tenancy was secured in a non-University owned incubator facility.

In the absence of an incubator it is possible for Universities to provide other forms of support, and we return to this later in this section. Here we consider in more detail the characteristics of those USOs that did have

access to a University incubator and the reasons cited for locating there.

Figure 5.1 Residency of USOs in incubator facilities



Just under two-thirds (72.9 per cent) of USOs reported that their universities owned incubator facilities. The presence of an incubator did not automatically lead to USOs locating there. Indeed only 25.4 per cent of all USOs located in their University's incubator. In other words, including only those USOs whose university owned an incubation facility, approximately a third of USOs located in the University incubator with the remaining two-thirds either locating in a non-University owned incubator or never locating in an incubator (Figure 5.1).

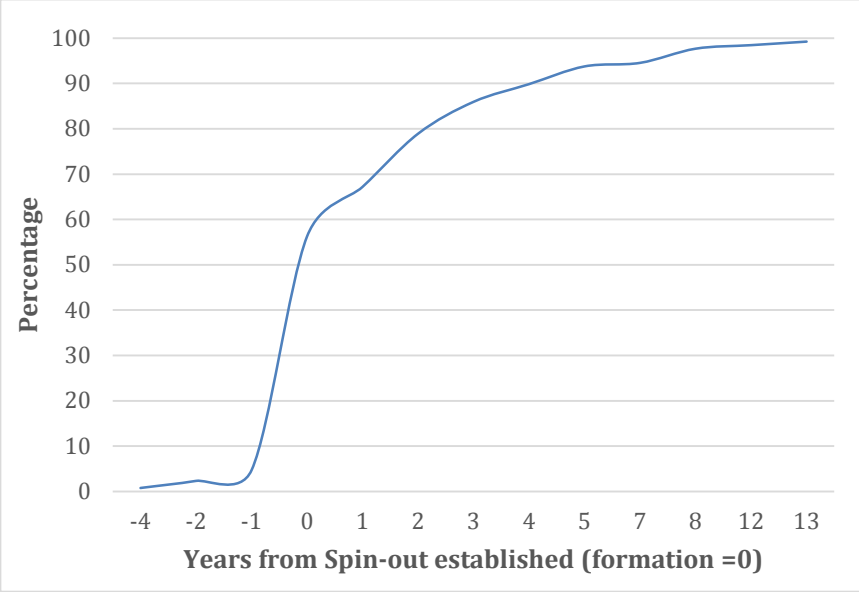
One of the reasons for this appears to be the USO's business model with this effecting the propensity to locate in an incubator. Those USOs formed with technology that it was seeking to develop through collaboration with an incumbent business, as well as OEMs were significantly more likely to locate in an incubator[69]. For those USOs locating in an incubator, on average these incubators hosted 15 other firms (sd=15.81) and around a

third of these were spin-in businesses (sd=32.77) i.e. not having originated from the host University.

At What Stage of Development Do Spin-outs Enter an Incubator?

Half (56.3 per cent) of USOs enter the incubator in the same year as the business is legally formed with the propensity to enter an incubator declining after the business has been established for 3-4 years. This supports the notion that spin-outs face specific problems associated with the 'liability of newness' which incubators attempt to address[70]. Indeed, a small proportion (4.7 per cent) locate in the incubator prior to their legal formation, with this period ranging from 1 to 4 years.

Figure 5.2 Cumulative percentage of USOs located in an incubator by age of business at entry

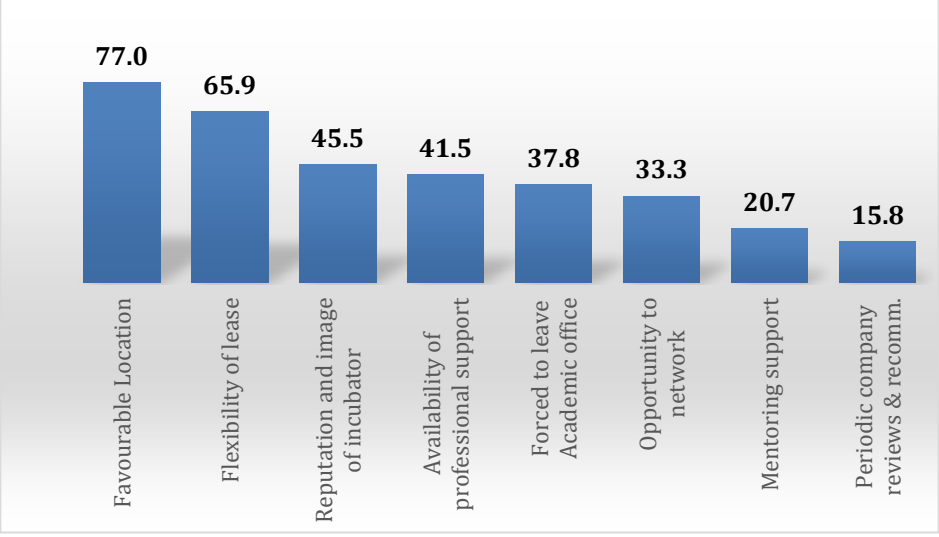


Given the high capital and operational investment in incubators and the emergence of alternative ways of supporting USOs [71], it is critically important to understand the additionality that incubators generate for USOs[72].

USOs identified how important a range of factors were in their decision to locate in an incubator (Figure 5.3). The most common reason was the favourable location provided by the incubator (cited by 77.0 per cent) followed by the flexibility of leasing terms (65.9 per cent). The remaining reasons for incubator location – including the reputation and image of the incubator, availability of professional support, opportunity to network, mentoring support and company reviews and recommendations - were identified by less than half of the USOs.

It is interesting to note that for a significant proportion of USOs who entered an incubator (37.8 per cent) this decision was prompted by the university requiring them to leave their academic offices.

Figure 5.3 USO decisions to locate in an incubator (percentage)



Based on our sample, of those USOs reporting tenancy in an incubator at some stage of their development, 42.2 per cent were still resident in the incubator at the time of interview with the remainder having graduated.

Of those businesses that had left the incubator, on average they stayed for 4.0 years (sd=3.35) before graduating. Of course it must be remembered that this refers to successful graduations whereby the USO relocated out of the incubator and continued to operate. It is also possible that some USOs entered the incubator but subsequently closed and were therefore not captured in the survey.

Do Spin-outs Locate in Science Parks?

In addition to residency in an incubation facility, spin-outs were also asked about whether or not they had ever been located on a science park. This is of particular interest as a science park may substitute for a lack of incubator provision by the University. Indeed, as outlined above, a small proportion (16.0 per cent) of USOs with no University incubator still proceeded to locate in an incubator[73]. Further, even for those USOs with access to University-owned incubators, 10.0 per cent located in incubators that were not owned by their University[74].

On average, only 22.1 per cent of all USOs had located at any time in their development on a Science Park with this proportion being at the lower end for USOs with a University incubator and slightly higher for those without a University incubator. The propensity to locate in a Science Park was not however statistically significant between these two groups. In other words, originating from a university that provided incubation facilities was not significantly related to whether or not the spin-out located on a science park.

In addition no statistically significant relationship was found between the USO's business model i.e. technology with a view to sale, technology for collaborative development etc. and the propensity to be located in a science park. Some regional variations were apparent across the UK, with Welsh spin-outs being the significantly less likely to locate in a Science Park (4.0 per cent reporting a Science Park location), with similar shares being reported in Scotland (19.2 per cent), Northern Ireland (23.4 per cent) and England (23.6 per cent).

What Support Do Universities Provide to Their Spin-outs?

Providing incubation facilities is one of many ways that Universities can support their USOs. For example, support may be provided prior to the USO being formally established through providing advice on IP, assistance with business planning and the legal requirements of business formation. As the business is formed further support may be provided through providing training to academic entrepreneurs in terms of their business skills and as already discussed, in providing office premises typically located on-campus and support services in terms of administrative support.

As finance is constrained in the business formation period, Universities may also provide support to USOs by providing seed-capital investment and/or facilitating relationships with external financial providers i.e. business angels, venture capitalists, government grants and subsidies and banks.

In addition, on-going support may be provided to the USO in terms of advice on recruitment and employment issues as well as innovation advice and support as USOs strive to improve and develop their technology and markets.

The findings of our survey suggest that this support is not provided or accessed extensively by the USOs (Figure 5.4). Just under half of all USOs reported having received support from their university in the initial stages of formation, associated with establishing the business (45.4 per cent) and issues associated with the protection of intellectual property (43.1 per cent). To a much lesser extent had training support been provided to USOs targeted at developing their business skills (24.0 per cent), further innovation of their products and/or services (19.9 per cent) or issues associated with recruitment and employment issues (19.1 per cent).

Around a third of USOs reported having received seed-capital investment from their university or assistance in accessing grants or other forms of seed funding. Support in accessing VCs was slightly less common with only a quarter of USOs have received this assistance and a minority (3.7 per cent) of USOs having been helped to access finance through the banks.

Some variation was evident in the extent to which these support services were accessed by the USOs, reflecting their business model. USOs concerned with technology development with a view to its sale or technology which was to be developed in collaboration with other incumbent companies were significantly more likely to receive support in accessing grants or other sources of seed funding (t=-2.102, p=.036 and t=-1.956, P=.051 respectively). In addition, those USOs seeking collaborative development and exploitation with incumbent firms were also more likely to receive support in accessing angel or VC funding (t=-3.456, p=.001) as well as availing of an incubator location (t=-1.825, p=.069).

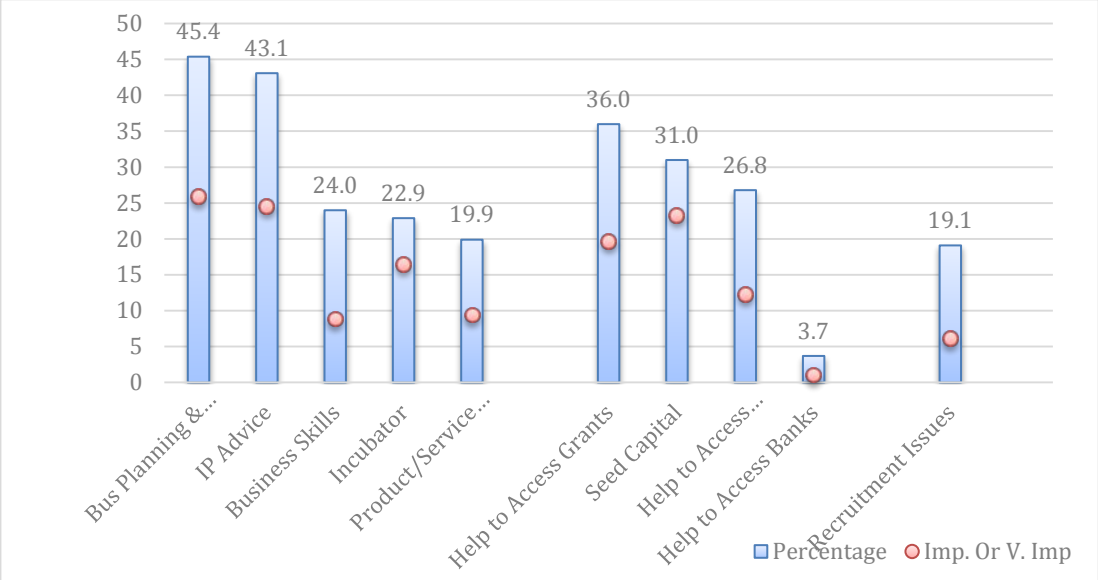
USOs concerned with producing a consumer product were significantly more likely to receive incubation support (t=-1.712, p=.088) and along with OEM's were also more likely to have help with raising bank finance (t=-

3.215, p=.001 and t=-3.762, p=.000 respectively).

OEM's were also more likely to be provided with advice on recruiting staff and other human resource issues (t=-2.487, p=.013), but less likely to receive innovation advice (t=1.668, p=.096). Finally, USOs formed to provide consultancy or contract research services were more likely than any other USOs to get support in the business planning and formation stage (t=-2.132, p=.035).

The profile of support – as determined from a demand side in terms of USO's access of these support services – was similar across the UK regions. The only exception to this being for Northern Ireland where USOs were more likely to be receiving support to access bank finance (x2=.187, p=.000) and in receiving seed capital investment from their university (x2=.107, p=.045).

Figure 5.4 Proportion of USOs receiving various forms of support from their University and the proportion stating that this was important or very important to their development



Beyond accessing these various forms of University support, the findings also highlight how important USOs perceived this to be, to their development (Figure 5.4). In other words, for those USOs receiving support along each of the dimensions, they were asked to rate the importance of these to their development on a scale of 1 (unimportant) to 5 (very important). The following discussion reports the proportion of USOs stating that each of the services were important or very important.

The form of support received by USOs which the greatest proportion identified as being important to their development was seed capital investment from their university. Although less than a third (30.9%) of USOs received this support, 75% of these firms stated that it was important to their development. Similarly, despite only 37.1% of USOs receiving help to access grants and other seed funding, over half of these USOs stated that this was important to their development.

The other support service that was most valued by USOs was IP advice with over half of those receiving the support, stating that this was important to their development. It is interesting to note that despite less than 20% of USOs receiving advice for subsequent innovation efforts, almost half of these USOs stated that this was important to their development.

These figures suggest that there is substantial opportunity for universities to provide support to USOs. Although the likelihood of USOs receiving support is higher for some activities than for others, these figures also emphasize the value of these activities as perceived by the firms.

INTELLECTUAL PROPERTY PROTECTION

Many of the definitions of university spin-outs (USOs) emphasise novelty in technology as the basic rubric on which the firm is formed. This technology is then transferred from the university (or organisation) where the

intellectual property was created as part of the USO formation process. For example Lockett and Wright (2005, 1044-1045) define USOs as "new ventures that are dependent upon licensing or assignment of [an] institution's intellectual property for initiation" (Lockett and Wright 2005, 1044-1045)[75].

The range of intellectual property mechanisms used by USOs is not well documented. As a result, this has led to a focus on patents and licenses with less attention being paid to other legally-binding forms including trademarks, copyrights, trade secrets, confidentiality agreements etc. and other practices through which competitive advantage is derived including employee non-disclosure agreements (NDAs), exclusivity in distribution channels and superior lead times etc.

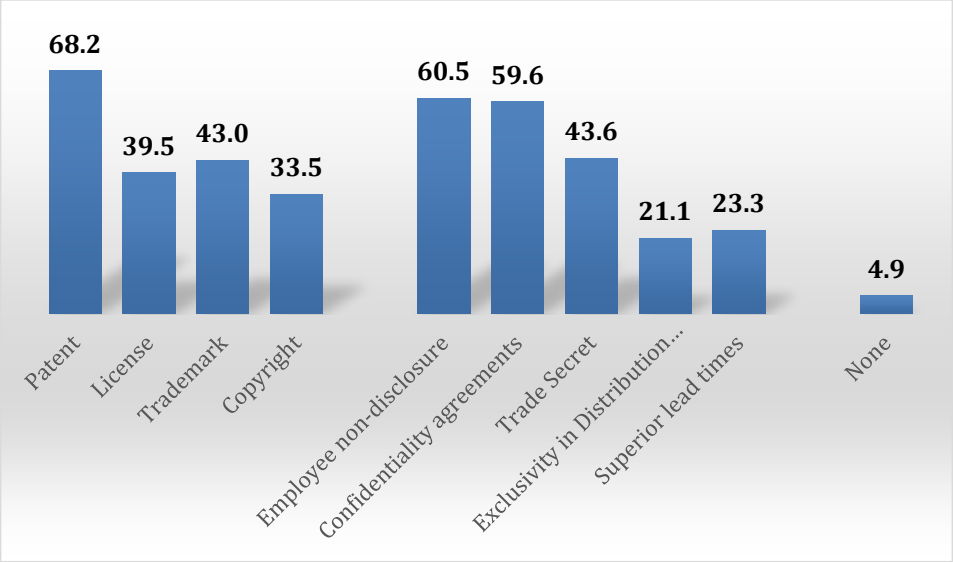
In this chapter we briefly consider the range of mechanisms used by USOs for IP protection. First, we profile the extent to which IP protection is used by USOs and the mechanisms applied. We then consider if a relationship exists between the USO's business model and the mechanisms of IP protection adopted by the USO. This is based on the proposition that the nature of the technology and the method by which it is being commercialised, will be related directly to the preferred mechanism(s) of IP protection.

How Do UK University Spin-outs Protect Their Intellectual Property?

From our survey of USOs we find that patents are used widely (68.2 per cent of USOs) and are the most common mechanism for protecting IP. The use of licenses was reported by almost 40 per cent of USOs and for most of these businesses (73.9 per cent), they also owned a patent. Employee NDAs and confidentiality agreements were reported by over half of USOs and indeed, these mechanisms were more commonly cited than the traditional mechanisms of licenses, trademarks, copyright and trade

secrets. In only a small proportion of USOs, none of the intellectual property mechanisms listed were used (4.9 per cent). Our findings therefore support conceptualisations of USOs as having intellectual property (and the transfer of this from the university) as an essential component of the business.

Figure 6.1 Percentage of USOs using each of the mechanisms to protect their intellectual property



On average USOs reported using 4.0 mechanisms to protect their IP[76] (Figure 6.1) however for 16.5 per cent of USOs, 7 or more mechanisms were used. It is plausible that as USOs develop over time with changes in their technology and markets, this might be reflected in the adoption of a broader IP protection portfolio. However, no evidence was found to support this, as measured in terms of USO age, yet there is evidence that as firms increase their share of total sales made to markets outside the UK, this is associated with a significant increase in the IP mechanisms being employed (r=301.05, p=.015).

Our survey findings demonstrate the breath of IP mechanisms used by USOs, with the implication of this being that one-dimensional conceptualisations of approaches to IP should be avoided. How USOs approach IP protection is complex and multi-faceted, and significant gaps exist in our understanding of the mix of IP protection forms that USOs choose, the determinants of these choices and how the portfolio of IP protection changes over time in response to market or technological conditions.

It is likely that an important determinant of USO's use of the different IP protection methods relates to its business model and underlying technology. Indeed, analysis of the data highlights a number of significant differences as outlined below:

Technology with a view to sale:

More likely to use:

Patents: 74.3 per cent compared to 57.1 per cent; x2=11.151, p=.001

Copyrights: 36.9 per cent compared to 27.1 per cent; x2=3.711, p=.054

Trade Secrets: 48.1per cent compared to 35.3 per cent; x2=5.123, p=.024

Technology with a view to alliance

More likely to use:

Patents: 78.0 per cent compared to 65.9 per cent; x2=3.633, p=.057

Confidentiality

Agreements: 70.6 per cent compared to 56.9 per cent; x2=4.270, p=.039

Less likely to use:

Copyrights: 23.7 per cent compared to 35.8 per cent; x2=3.716, p=.054

Trade Secrets: 39.5 per cent compared to 43.8 per cent; x2=11.330, p=.001

Original Equipment Manufacturer

More likely to use:

Exclusivity: 34.8 per cent compared to 19.4 per cent; x2=5.201, p=.023

Employee

NDA: 74.2 per cent compared to 58.7 per cent; x2=3.937, p=.047

Consultancy

More likely to use:

Leadtimes: 31.0 per cent compared to 21.1 per cent; x2=3.595, p=.058

Less likely to use:

Patents: 46.0 per cent compared to 74.4 per cent; x2=22.159, p=.000

Trademarks: 33.3 per cent compared to 45.7 per cent; x2=3.934, p=.047

Copyright: 23.9 per cent compared to 36.1 per cent; x2=4.142, p=.042

Consumer Product Producer

Less likely to use:

Trade Secrets: 21.1 per cent compared to 45.3 per cent; x2=6.015, p=.014

Confidentiality

Agreements: 42.2 per cent compared to 60.9 per cent; x2=3.463, p=.063

Employee

NDA: 40.7 per cent compared to 62.0 per cent; x2=4.715, p=.030

FINAL REMARKS

The motivation for this study was the lack of systematic evidence on the profile of spin-out businesses from UK Universities. Despite a slight fall in the rate of USO formation in the past few years, the annual rate of spin-out activity from UK universities increased markedly over the 2008 to 2011 period. Yet, there has been limited evidence on the characteristics of these businesses meaning that efforts to support these businesses have been poorly informed.

With the purpose of enhancing our understanding of the characteristics of USOs in the UK, a telephone-based survey of USOs was conducted. Drawing on the UK population of 1,056 active university spin-out firms, the survey was conducted between February and April 2014 and a response rate of 33.1 per cent obtained, equivalent to 350 spin-out businesses.

USO Stock: Approximately a quarter of the current stock of USOs were formed since 2010. From a university perspective, growth in spin-out rates will have implications for the **resources** required to support these

businesses through the business formation process. Further, a higher volume of spin-outs will also accentuate demands on university technology transfer and commercialisation offices for the types of support required at the early stages of formation, including assisting in the protection of IP, identification of appropriate external organisations and brokering of these relationships, increased financial investment in spin-out businesses where investment is made in return for an equity stake etc.

TTO Role in IP Protection and boundary-spanning: Intellectual property protection is critically important for USOs given the dominance of technology development which is then sold. University technology transfer and commercialisation offices have an important role to play in supporting the **protection of intellectual property**. In addition, with a fifth of USOs seeking to exploit their technology collaboratively with other organisations technology transfer offices need to have sufficient breadth of expertise across industry sectors and depth of network ties to identify appropriate firms and in the contractual (often licensing) requirements of collaborative agreements. These technology transfer employees must act as **boundary-spanners** between academic spin-outs and incumbent businesses.

Support for USOs beyond start-up: Universities tend to concentrate support on the spin-out pre- and early-formation stage. These findings suggest that support is also needed at later stages in further innovation and technology/market development. A significant proportion of legally formed USOs were not generating revenue and for an additional 7 per cent of USOs prior trading had ceased due to changing customer demands or the development of similar or enhanced technology by competitors. This suggests that support for USOs needs to ensure that it goes beyond legal formation and assists in the **commercialisation and subsequent innovation** activities of the business.

Disparities in USO growth rates: measuring USO growth in terms of employment produces a very mixed picture with some growing since 2011 and others contracting. There is no obvious and straight-forward explanation for this with sales growth/losses not related to the age of the USO, the business model adopted or share of export sales. While much academic research has sought to examine the determinants of USO formation perhaps less well understood is the differential growth rates across the USO population. This is an area that warrants further research.

Founding teams: Our findings on the profile of the founding team suggests that University policies and efforts to encourage the identification of inventions, their disclosure, protection and exploitation, may need to be designed around **research teams rather than just individuals**. In addition, the findings raise questions surrounding the **lower propensity of females to form USOs**. Are there specific efforts that Universities could implement to foster female academic entrepreneurship? Of course the findings also raise further questions relating to the effect of the size of the founding team on performance of the USO, if this is enhanced by female involvement in the founding team or if female-led USOs under or over-perform relative to male-led USOs?

Characteristics of 'academic founders': The notion that the founders of USOs are mature academics with no prior commercial experience is clearly inaccurate for the majority of businesses. While for most founders the period of commercial experience was relatively short (2 years), at the same time it suggests that **commercial work experience** may be increasing the propensity of academics to identify business opportunities and take the necessary steps to protect their intellectual property. In addition a significant proportion of founders had prior patenting or business formation experience. Despite the lack of prior evidence, it is likely that this reflects increasing experiential learning by academics in these technological and

business oriented practices. If this is the case then it is probable that this will continue to translate into increasing rates of USO formation.

Strengthening the commercial skills of founding teams: It is encouraging that for the majority of USOs the founders had some (although often limited) commercial business experience prior to forming the business. More worrying is the fact that for 25 per cent of USOs the two main founders had no commercial business experience. Clearly these USOs require commercial skills whether provided through the TTO or by extending the founding team to include commercial partners. If this is provided through the TTO then there are resource implications as staff are committed to business development of specific USOs. In addition, as the USO develops the business skills required will also evolve with implications again, for the knowledge and expertise of TTO staff and their ongoing involvement in the business where changes occur in the USO-University relationship (often evident in a reduction in equity). Ultimately, for Universities and TTOs, a priority in those USOs with limited or no prior commercial experience will be attempts to support **capability development of the entrepreneurial teams**.

Juggling time between business and academia: USOs are often criticised for failing to become credible, sustainable and grow. Yet, based on the time-commitment of the first and second founders this failure is unsurprising. For example, only a quarter of primary founders were fully committed to the USO with the average time commitment to the USO being 20 per cent. This time commitment was lower again for the second founder at 10 per cent. Universities may benefit from considering how they can best support the development of these businesses, not only in terms of the advice, support and seed-capital investment that they can provide or indeed of the incentives to academics in terms of promotion and pay, but perhaps crucially in terms of the relief that they provide to academics in

performing non-USO activities such as teaching, administration and additional research support for ongoing research projects. **No successful new venture can be established on the effort of 1-day per week, and USOs are no exception to this**.

Financial investment in USOs varies markedly: The average investment in USOs differed substantially across the cohort of USOs. Consultancy based USOs reported having received £300k however for USOs developing technology with a view to commercialisation through alliances with other businesses, average investment was £3.9m. As USO formation rates increase this may pose significant investment challenges for universities and other financial providers both in the total amount of investment and the number of funding rounds required, both of which will vary according to the USO's business model. This suggests that **a standard approach to investment in USOs is inappropriate**. Instead, decisions on the amount of investment (often seed-capital) and follow-on funding or support to secure additional funding need to be tailored to the individual needs of the USO.

USO receipt of public financial support: Public sources of financial support are used by a significant proportion of USOs. At the same time, all USOs are not equally as likely to receive such support. Instead, variations in the propensity to receive public sector financial support are found across business models and also across the UK. More specifically, OEM USOs are significantly more likely to receive public financial support from local/regional, national and EU sources, whereas consultancy/contract research USOs are less likely. In addition, variation in receipt of public financial support according to business model also suggests that the type of support provided at a local/regional level may vary to that at National and EU levels. In turn, different forms of support (e.g. local v's EU) may be more suited to some USOs than others e.g. USOs formed with technology

with a view to sale were more likely to receive local/regional support.

Further analysis is required to determine if this financial support has a positive effect on USO development, however if this is the case then issues related to supply (particularly in English LEPs) need to be investigated further. It is possible that national forms of public support may substitute (rather than complement) for local/regional support. Again this is an issue which is not fully understood and on which further research would be useful.

Distribution of equity in USOs: The distribution of equity is dynamic and changes as USOs grow. However this occurs over a number of years often reflecting USO requirements for additional investment. VCs account for approximately 8 per cent of USO equity at formation. Where there is a change in the distribution of equity then VC involvement increases markedly. This suggests that University's entrepreneurial ecosystem should include VCs to engage in the formation stage of USOs rather than perceiving VC investment solely to finance business development and growth. Business angel equity in USOs is relatively low and could be a source of finance and support which is further developed by USOs and their host university.

The role of incubators in the spin-off process: The value of incubation has been discussed elsewhere and while the benefits and disadvantages of incubation are debated, the findings presented in this report point to the use of incubation facilities by USOs. It is interesting however that even where incubation facilities are offered by universities, these are often not used by USOs. In other words, **the presence of a university incubator does not necessarily lead to a USO becoming a tenant**. Conversely, the absence of a university incubator does not appear to act as a detriment to USO formation. Again, it must be reiterated that further research is required to be able to determine the effect of having access to an incubator

facility on rates of USO formation.

Universities encouraging staff to leave academic offices/labs: Where incubators are used by USOs, given the proportion of businesses entering during the formation stage, this suggests that incubators are perceived as being most beneficial in helping businesses overcome the liability of newness. This may be particularly relevant for some USO business models. However, it may also reflect university policies which restrict access by academic entrepreneurs to their academic office/lab facilities. Almost 40 per cent of USOs who had located in an incubator had been requested to leave their academic offices by the University. This may be interpreted as the **University 'pushing' USOs out of academic offices** with a view that they were conducting activity outside the scope of the buildings, or it could be an attempt by Universities to provide incubation facilities that **'pull' USOs into a more appropriate and supportive environment**. The reality is likely to be a combination of both 'push' and 'pull' mechanisms.

Reasons for locating in University Incubators: As incubation models evolve the emphasis has focused more on the supportive role of incubators and less on the advantages of geographical proximity to the University and subsidised office space. What our findings suggest however, is that the most commonly cited reasons for locating in an incubator remain the infrastructural elements of location and cost of office space. This does not imply that broader support activities are not valued by USOs, but it may suggest that there is a lack of awareness by USOs of the added-value support that incubators can provide. It may also imply that incubators are struggling to convey to academic entrepreneurs the wider portfolio of support services that they offer and positively influence USOs location decision.

Provision and uptake of support services from Universities: A wide range of support services to USOs are provided across the HEI sector. There appears to be considerable variability both in the supply of these services across the population of HEIs as well as the demand for these services from USOs. Further research is required to investigate why this is the case and if the absence of support services has a negative effect on USO development. In addition, there is also a need for greater understanding of how these services contribute to their development of USOs at different stages of the spin-out process.

Intellectual property protection is more than patents: Narrow conceptualisations of intellectual property, particularly in terms of patents should be avoided. As highlighted throughout this report, USOs follow different business models and this directly effects the form of intellectual property protection that is most appropriate for them. The implication of this is that while universities need to continue to provide support for USOs in encouraging disclosures, evaluating inventions and submitting patent applications, support for USOs in using other formal or informal mechanisms should also be supported. The majority of USOs apply more than one form of IP protection suggesting that businesses need to be aware of how these different IP protection mechanisms complement each other. In other words, USOs are likely to require a portfolio of IP protection mechanisms and this portfolio will change over time in response to product/service or process innovation, entry and expansion into new markets, changes in the supply chain etc.

APPENDIX

Research Method

A list of all active UK University spin-out businesses was compiled through an extensive internet search of all UK HEIs and matched with the publicly available list of UK Spin-outs as provided by Spinouts UK. This database contained information on the registered business name, registered business address where available, University from which business originated, CEO and other senior management involved in the business, business email contact, CEO email contact, telephone number and fax number. An initial email was sent to all contacts to inform them of the impending research and to encourage participation. Research was conducted by means of a telephone survey with interviewing for the main survey conducted between 10th February and 15th April 2014, with a pilot taking place on 6th February. Fieldwork was conducted by members of the Millward Brown Ulster Telephone Interviewer Panel.

At the outset, a total contact database of 1,056 was acquired, but due to initial responses to the email invitation the database was reduced to 1,044 before fieldwork commenced. It became evident during the pilot that many of the telephone numbers and email address were outdated, which then initiated a data collection exercise, often referring to search engines and utilising research assistants to obtain correct contact information.

Another crucial component of the survey was to ensure each interview was conducted with the most appropriate person within the business – in this case, the named person who was involved in the formation and development of the business. As a result, we included a confirmation question at the outset of the questionnaire to ensure each interview was channelled correctly; failing this the interview was aborted with the particular business contact, appropriate details were acquired and placed

back into the system for re-contact at a later stage.

Throughout the fieldwork period, in excess of 1000 emails were sent to potential respondents, inviting them to take part in the study and setting up appointments for them to do so. Reminder emails were sent out every week, and while success rates declined towards the end of the fieldwork period, responses were achieved from 350 businesses as outlined in Table A1.

Table A1 Study sample and response rate

	A	B	C	D	E		
	Population N	Population %	Respondents N	Respondents % of Region	Respondents % of Sample	Establishment Weight	Relative Establishment Weight
England	763	72.8	238	31.2	68.0	3.206	1.0707
Scotland	213	20.3	68	31.9	19.4	3.13	1.0453
Wales	25	2.4	22	88.0	6.3	1.136	0.38
Northern Ireland	47	4.5	22	46.8	6.3	2.136	0.7133
Total	1048	100.0	350	n/a	100.0		

Note: Establishment weights are applied when calculating data for USOs in the UK countries. Relative establishment weights are applied when calculating national data.
Establishment weights are calculated as Col.A/Col.C
Relative establishment weights are calculated as Col.B/Col.E

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[8] House of Commons (2014) report by the House of Commons Business, Innovation and Skills Committee on Business-University Collaboration, HC 249.
http://www.publications.parliament.uk/pa/cm201415/cmselect/cmbis/249/249.pdf

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[31] Median value reported in text. Mean value is 9.6 years with Std Dev of 5.5 years.

[32] Original equipment manufacturers (OEMs), are defined as businesses producing a part or subsystem used in another businesses' end product.

[33] Zhara et al (2007)

[34] Median value reported in text. Mean value is 7.34 years with Std Dev of 4.36 years.

[35] 61 of the 79 USOs who had never generated revenue, based their business model on the development of technology with a view to sale.

[36] Median value reported in text. Mean value is £968,619 with Std Dev of £2.31m.

[37] Median value reported in text. Mean value is 52.1 per cent with Std Dev of 34.9 per cent.

[38] For consultancy-based spin-outs, average sales to non-UK markets equate 45.0 per cent compared to 55.4 per cent for the remaining firms (t=2.012, p=.045).

[39] Employment is calculated in terms of full time equivalent employees.

[40] This value is calculated as the median*identified population.

[41] 67 of respondent USOs were formed in 2011 or later. For an additional 27 USOs employment data was unavailable for 2011.

[42] Median value reported in text. Mean value is 2.91 years with Std dev of 1.43 years.

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[47] Where males are the main founder then the founding team has on average 3.0 members (sd=1.44) as compared to female-led USOs where the founding team is comprised of 2.0 members (sd=1.02).

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[51] Median value reported in text. Mean value is 43.83 years with Std dev of 10.65 years.

[52] C.f. Zhara et al (2007), Wennberger et al (2011) and Clarysse et al (2011).

[53] C.f. Vohora et al (2004).

[54] Median values are reported in the text. Mean years commercial work experience for Founder 1 was 7.41 (sd=10.41) and for Founder 2 was 9.19 years (sd=11.58).

[55] For founder 1 mean years of academic/research experience was 17.9 years (sd=12.18) and for founder 2 was 12.97 (sd=11.79).

[56] Median values are reported in the text. Mean cumulative years of commercial work experience for founder 1 and founder 2 was 22.52 years (sd=17.36).

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[61] Median value reported in the text. Mean number of patent awards for those having previously received a patent, 6.43, sd=8.88**.**

[62] Median value reported in the text. Mean time commitment to the spin-out is 38.27 per cent sd=40.2 per cent.

[63] Median value reported in the text. Mean time commitment to the spin-out is 31.67 per cent sd=39.5 per cent.

[64] Median value reported in the text. Mean investment was higher at £2,623,309 sd=£6,386,602.

[65] This may include financial support via tax credits or deductions, grants, subsidised loans and loan guarantees. Excluded from the analysis is research and other innovation activities that are conducted entirely for the public sector under contract.

[66] Note that percentages do not necessarily round to 100 per cent as spin-outs may have indicated that they had received more than one form of support e.g. local/regional and EU etc.

[67] Technology with a view to sale and receipt of local/regional support (x2=7.038, p=.008).

OEM spin-out and receipt of local/regional support (x2=4.008, p=.045); receipt of national support (x2=11.646, p=.001) and EU financial support (x2=22.839, p=.000).

Technology for collaborative development and receipt of EU support (x2=8.009, p=.005).

Consumer product producer and receipt of EU financial support (x2=5.599, p=.018).

Consultancy or contract research and receipt of EU financial support (x2=11.208, p=.001).

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[72] Bruneel, J., Ratinho, T., Clarysse, B. and Groen, A. (2012) 'The Evolution of Business Incubators: Comparing Demand and Supply of Business Incubation Services Across Different Incubator Generations.' *Technovation*, 32 (2), 110-121

[73] 16.0 per cent relates to the sample of all USOs whose University did not own or run an incubator. The value of 3.8 per cent quote in Figure X.X relates to the share of the total sample of USOs.

[74] Again this percentage relates to the share of USOs whose Universities owned an incubator but they choose to locate in a non-University owned incubator. The value of 7.5 per cent referred to in Figure X.X is relative to the total USO sample.

[75] Lockett, A. and Wright, M. (2005) Resources, capabilities, risk capital and the creation of university spin-out companies. Research Policy. 34. 7. 1043-1057.

[76] Median value reported in text. Mean value is 3.9 mechanisms with Std Dev of 2.4.

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