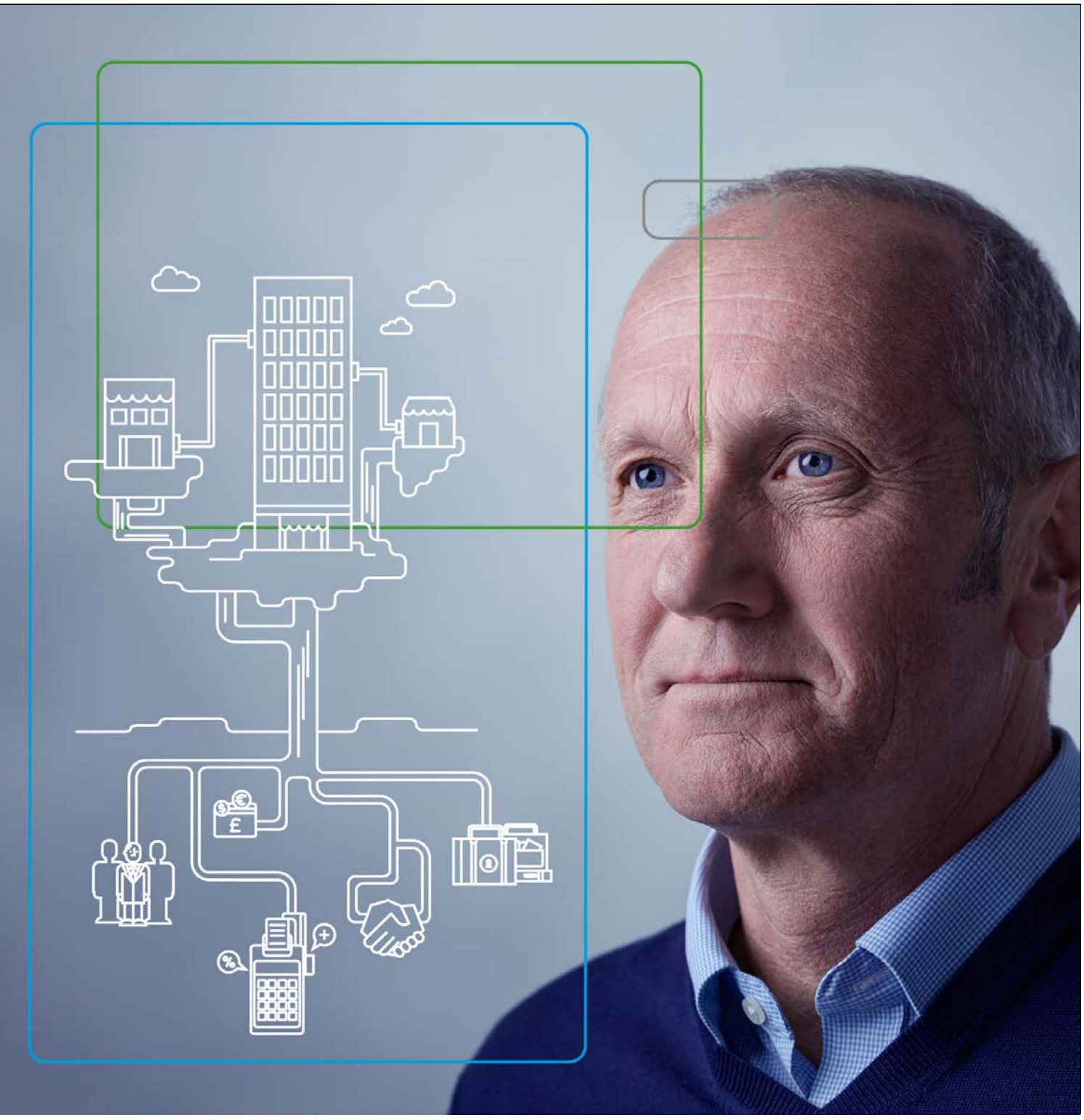

A REPORT FOR THE DEPARTMENT FOR BUSINESS, ENERGY, AND INDUSTRIAL STRATEGY (BEIS)

PREPARED BY RSM PACEC LTD

Research into issues around the commercialisation of university IP

February 2018

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The project team comprised Jenny Irwin (Project Director), Matt Rooke (Project Manager), Bernard Fischer, Jasmeet Phagoora, Theo Read, Tricia Rowland, Aldabra Stoddart, and Stephanie Wright of RSM PACEC. Our project advisors were Rod Spires, Professor Alan Hughes, Professor Tom Stephenson, Tomas Coates Ulrichsen, and Patrick Farrant.

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1 EXECUTIVE SUMMARY

Research into issues around the commercialisation of university IP

1.1 Introduction

"Knowledge exchange" involves a range of activities that universities undertake to engage with the business community and the wider public, such as research collaborations, research carried out under contract, consultancy arrangements, student placements, sharing of physical resources, and community events. "Commercialisation" in particular results when university intellectual property (IP) is used to create products and services for the general market. The focus of this research is on two specific types of commercialisation transaction: licensing the use of university IP to an external company or "spinning-out" a new company to develop and exploit university IP.

This research aims to increase understanding of how this aspect of the knowledge exchange and commercialisation system is currently functioning, identify where there are issues that prevent opportunities from being realised, and suggest potential improvements. The research programme incorporated a literature review, extensive surveys of universities, spin-outs, external businesses that have licensed university IP, and investors (collectively referred to as the "stakeholder groups"), and detailed case studies. The methodological approach was:

i To validate, and refine as appropriate, a proposed model of Knowledge Exchange and Commercialisation (KEC), including Influencing Factors, Transaction Types and Transaction Stages;

ii To apply this model to increase understanding of how different factors influence the development of knowledge exchange policies and practices, and how certain factors create complexity or barriers leading to problems in practice; and

iii To explore how and where improvements might be made to KEC practice (in both universities and business), governance or leadership, including the role of improved information in increasing understanding and overcoming barriers to collaboration.

Overall, the research concludes that current approaches taken to commercialising university IP are **working reasonably well and that the steps taken by participants have improved outcomes over time**. Stakeholders have nonetheless highlighted a number of specific constraints and barriers where there is **potentially scope to do more**.

1.2 Factors influencing commercialisation

The research used a theoretical model to identify and investigate a wide range of potential **influencing factors** on commercialisation that affect the amount and type of activity undertaken. Initial evidence on these influencing factors was gathered from a literature review. Appendices B and C present the findings of the literature review and discuss this model in detail, including commentary on the refinements that were implemented to the model during the research.

The model was used to provide a discussion framework for a series of in-depth **qualitative telephone surveys, which comprised the principal form of research** for this project. In total, there were 138 interviews with representatives from 35 HEIs (c. 3-5 per HEI, typically including senior management and TTO staff); 291 interviews with businesses, charities and spin-outs; and 20 interviews with investors. The (non spin-out) businesses surveyed all had experience of licensing (or seeking to license) IP from universities, along with some charities; investors surveyed (and some charities) had experience of investing in spin-outs.

The research aimed to triangulate the views and perspectives of the different participants in the commercialisation process. Survey respondents were asked to name the most important influencing factors at each stage of the commercialisation process, and whether these had a positive or negative influence; that is, as helpful to the commercialisation process or as a constraint on commercialisation.

The overall view of survey respondents in each stakeholder group was that the most influential factor on the early stages of the commercialisation process is the **skills and experience of university commercialisation staff** (the

Technology Transfer Office, or TTO). The experiences of businesses vary considerably, and they were roughly equally likely to view TTO skills as a positive or negative influence. Universities tended to rate the skills of their staff positively, but believed commercialisation to be held back by a lack of staff resources and financial resources for commercialisation.

Overall, the key positive and negative influences on commercialisation, as identified and ranked by the stakeholder groups in the survey, were as follows:

Top positive influencing factors

- **Universities:** The Research Excellence Framework (REF) and wider impact agenda; the aims, central leadership and strategic direction of the university; the local ecosystem.
- **Spin-outs**: The role of individual academics; the local ecosystem; government and Research Councils (funding and regulations).
- **Other businesses**: Company central management and strategic direction; financial resources for R&D; IP commercialisation skills and experience of company staff*.
- **Investors:** Quality of science/invention; commercial skills of university TTOs*; commercially-minded academic inventor.

Top negative influencing factors:

- **Universities:** Staff resource levels; financial resource levels, role of individual academics.
- **Spin-outs:** Skills and experience of the university TTO*, university staff resource levels*, university regulations and governance.
- **Other businesses**: University IP/commercial skills and experience*, university awareness of IP commercialisation opportunities, government and Research Councils (funding and regulations), internal R&D/IP resource levels.
- **Investors:** Timing of opportunities (early filing of patents), commercial skills of university TTOs* where weak.

Factors marked with an **asterisk (*)** attracted mixed views across the survey respondents as to whether they were positive or negative. For some they were positive. For others, they were negative depending on circumstances and specific transactions.

Based on survey feedback and the literature review, six **key themes** which group and describe the factors influencing commercialisation were identified:

1 Skills and resources to devote to commercialisation;

2 Leadership and management;

3 Interpersonal relationships and networks;

4 Local economic conditions;

5 Funding and incentives for commercialisation and investment; and

6 Availability of information.

The key findings are set out under these themes below.

1.2.1 Skills and resources for commercialisation (Chapter 4)

The **Literature Review** identified the scale and quality of support available through the technology transfer infrastructure within universities as key influencing factors, including the capabilities of both TTO staff and academic inventors.

Our **survey** found that:

- The skills and resources available to universities and businesses to undertake commercialisation, in particular the skills and resources of university TTOs, seemed to be viewed as the most significant influences on the early stages of the commercialisation process.

- Overall, universities are generally positive about the skills and experience of their TTOs, and those most active in commercialisation are much more positive about the influence of their TTOs than less active institutions (see 4.1.2). However, universities believed commercialisation to be held back by a lack of capacity, including both staff resources (48% negative) and financial resources (33% negative) for commercialisation.

- The businesses and investors interviewed had varying experiences of working with universities (some very positive), but sometimes they perceived a lack of skills and experience. This was more often seen to be the case where the universities they worked with had traditionally been less active in commercialisation and in areas where the innovation ecosystem was less well developed. This perception contrasts somewhat with the university's own perspective that they are constrained by resources. Businesses typically had a positive view of their own internal skills and resources, although some reported specific gaps in staff resource levels (not finance) and a few lacked internal skills and experience.

- University commercialisation professionals (the TTO staff) also perceived a lack of experience in their negotiating partners, noting the need to manage the expectations of academics, businesses, and investors – some of whom may have less experience of commercialising university IP. Although respondents mainly commented on skills and experience within universities, we also heard evidence that early-stage companies face particular skills and resource issues in bridging the well-researched "valley of death".

Potential improvements: Skills and resource issues within universities are already being addressed via a number of government funding mechanisms. These include capacity-building support for HEIs as institutions via Higher Education Innovation Funding (HEIF), where the Government announced in the November 2017 Industrial Strategy White Paper that it will commit to raising this to £250m a year by 2021. Other Government mechanisms include funding for individual research groups via e.g. Impact Accelerator Accounts and Research Council Follow-on Funds, and schemes to support people and skills e.g. CASE Studentships and Innovation Fellowships. Local and regional university partnerships have been emerging over a number of years to share expertise and facilities; some of these partnerships have recently received allocations of direct funding from the new Connecting Capability Fund (CCF) through a competitive process, and the next round of funding from this fund will support the creation of new commercialisation partnerships.

All stakeholders agree that skills, training and experience are important; this points to scope to improve business and investor as well as university capabilities. Suggestions for further improvements include:

- Increasing KE funding such as HEIF (since the interviews were undertaken the Government announced an increase in funding for HEIF in the Industrial Strategy) and considering how to target additional funding towards developing the skills necessary to identify commercialisation opportunities and work with spin-outs, licensees and investors to negotiate deals that would increase the frequency and quality of commercialisation. The key skills were seen as negotiating skills and the ability to understand businesses and their needs.

- Provision of more training across universities, businesses and investors (including through organisations such as PraxisAuril) and guidance on how skills could be developed and the sources of support available.

- Increasing the transfer of skills and expertise between participants in existing schemes such as CCF, the Knowledge Transfer Network (KTN), Knowledge Transfer Partnerships (KTPs), KE inter-university collaborative activity and other schemes.

- Explore the extent to which the universities with more established commercialisation capabilities can be incentivised to partner with and advise the less experienced ones.

A brokerage-type solution suggested in the case study of the University of Nottingham (section 10.4) would be to partner spin-outs with established players in their marketplaces, who can provide cash resources and access to experience, perhaps in return for a limited equity stake or revenue sharing agreement.

1.2.2 Leadership and management (Chapter 5)

The **literature review** identified clarity of mission and visible commitment of leadership for universities, the administrative processes in both universities and businesses, the selection criteria for advancing technology and projects and making decisions regarding the appropriate route to market (spin-outs or licensing), and the experiences, capabilities and policies of investors and businesses, as key influencing factors on commercialisation.

Our **survey** found that:

- University central leadership and management are viewed as among the strongest positive influences on the overall level of commercialisation. However, their influence on the specific phases of commercialisation depends on the policies and support functions that the universities provide as a result of the strategic direction and allocation of resources, not least because of the demands on academic time to fulfil teaching and research functions.

- A number of universities, especially the more research-intensive institutions, have specific policies that encourage academics to spend time on commercialisation and incorporate it within university career structures. However, there are barriers to universities taking this approach, such as the nature of academic career paths and the need to balance teaching and research priorities. Commercialising existing IP is also only one route to impact; other forms of collaboration with business such as collaborative and contract research are also priorities.

- The effectiveness of TTOs was viewed as variable by businesses and investors, with the most commercialisation-active universities generally viewed most positively, and effectiveness was sometimes thought to depend on the personal networks of a few key individuals in TTOs.

- The central policy driver for commercialisation activity in universities is the Research Excellence Framework (REF) and its impact agenda.

Our research also looked specifically at a set of interrelated **financial issues around spin-out and licensing processes** highlighted by the literature review, including concerns or disputes over the level of equity shares, royalties, or license fees, establishing the “proper value” for technology, and complexities and related delays in spin-out and warranty processes. On these issues, our survey found that:

- More university respondents thought there were issues over equity shares compared to spin-outs (including academics), other businesses and investors. They occurred especially at the start of the spin-out process. However, the problems were not seen as significant and only existed “to some extent”. Issues could usually be dealt with through negotiation.

- Generally, it was recognised by investors and spin-outs that universities merited some share of the equity to help incentivise them and ultimately contribute to covering their costs for creating the IP. Returns for universities also helped resource their TTO activities to bring forward opportunities and support academic entrepreneurs in commercialising their technology. Just 10% of spin-outs said that the issues related to equity shares were large (see section 5.2.2).

- In terms of establishing the proper value for technology there could “to some extent” be issues for all participants with around a half of the universities, spin-outs, businesses and investors citing this. Establishing the proper value can be difficult because it is dependent on coming to a view on what the longer-term returns could be for commercialising the technology compared to the costs involved, which is difficult due to the long timescale typically involved in bringing new technologies to market. Valuation was usually resolved in negotiations based on expense, comparisons with the trends in equity value and revenue for other similar technologies and benchmarking data (held by the more research-intensive and active universities).

- The royalties aspect of spin-outs and licensing appeared to be more of a problem for university interviewees with 60% raising it as an issue compared to around a quarter of spin-out interviewees and business participants (see section 5.2.2). The negotiating process usually resolved the issues assisted by an increase in the information that was now available on royalties based on other IP and technology. The information covered deals at the outset, and later as commercialisation developed. This information provided greater clarity which helped participants reach agreement.

- Complexities and delays associated with processes to set up spin-outs were raised as issues "to some extent" by half the universities and some three quarters of spin-out respondents – see section 5.2.2. It was recognised that different parties had different priorities (such as the pressure to publish, for academics and universities, which is a major focus of academic time). However, adjustments were being made to ensure that technology could "get to market" more quickly, particularly by universities with more established commercialisation capabilities. These adjustments, included, for example, universities taking steps to streamline processes and communicate them more clearly, more flexible approaches to negotiations, and delegating decision-making to experienced specialists.

- Providing warranties can be an issue "to some extent" and contribute to delays for four in ten university respondents and a third of spin-outs and other business interviewees (see section 5.2.2). Universities were willing to give limited warranties on a minority of occasions, but were more likely to offer a trade-off by taking fewer shares or lower royalty payments. Usually issues could be dealt with through negotiations.

Potential improvements: Respondents suggested all parties could potentially benefit from improved guidance, more information on historic/benchmark royalties, licence fees, or IP valuations, and greater encouragement for universities to publish their standard IP policies. Respondents also suggested that there was scope for universities to develop or strengthen specific policies on commercialisation, which could include:

- Ensuring that academics have sufficient time and incentives to commercialise opportunities, and increasing recognition of these activities in remuneration/rewards and career progression. This could include offering greater number of shares in spin-outs, higher royalty payments, and remuneration for commercialisation-focussed activity.

- Streamlining commercialisation processes in both universities and businesses to reduce bureaucracy and ensure that deals can be struck more quickly.

- Improved dissemination of information on university practices for spin-outs/licensing issues covering equity distribution, IP values, royalties and warranties. This reflects a recommendation of the McMillan group on clarity of university policies. Measures to improve dissemination could include the production of standard "deal sheets" that outline the university approach and policies, with an explanation of why universities seek the terms they do. The university rationale reflects their charitable status and associated legal duties[1], their institutional mission and accountability for use of public funding that they receive for research, and the McMillan review also clearly states that universities undertake technology transfer as part of their mission to deliver impact for society.

The University of Manchester case study (10.5) is an example of an institution, as with the other more active ones, that publicises its general approach to commercialisation and outline policies in order to raise awareness of its commercialisation activity and hopefully streamline the negotiating process. Generally, the spin-outs and other businesses saw this approach as useful as it speeds up the process of commercialisation and helps all parties understand what to expect.

1.2.3 Interpersonal relationships and networks (Chapter 6)

The **literature review** identified factors relating to interpersonal relationships and access to networks as influential on the amount and nature of commercialisation: this included the professional networks available to academic inventors in particular, but also broader networks between academics, TTOs, businesses, and investors in a specific location.

Our survey found that:

[1] The McMillan Review of good practice in technology transfer (2016) commented that "generally the law points toward universities maximising income from technology transfer and commercialisation in order to reinvest resources into teaching and research, as the means to deliver public benefit".

- Businesses and investors tend to locate commercialisation opportunities through networks and interpersonal relationships, rather than more formal sources such as government-provided services, specialist firms and websites, or consultants. Universities develop and maintain relationships with industrial partners as a spur to activity, and are reliant upon networks to locate people to manage spin-outs and provide business and entrepreneurial acumen. Investors use their own networks to influence the composition and skills of management teams and provide mentoring.

- Negotiations are perceived as an important test of the strength of the relationships between an academic inventor, companies, and investors. As mentioned in the existing literature[2], this is recognised to be important to the long-term success of commercialisation, as an ability to form strong working relationships can help ensure further positive outcomes later such as follow-on licencing deals, research collaborations, or consultancy relationships. These would also benefit the parent university.

- A corollary finding to the importance of interpersonal relationships is that incentive schemes such as tax reliefs should be carefully designed to avoid "perverse incentives" to end relationships, such as time-bound reinvestment relief.

Our case study of Imperial College London (section 10.6) includes an interview with a Royal Academy of Engineering Enterprise Fellow who benefited from mentorship and access via networks to expertise and contacts in potential markets provided through the Fellowship. These were considered to be crucial for the establishment of a spin-out, and in developing the academic's own commercial expertise and potential to grow the business or develop more commercialisable IP in future. Programmes such as the Fellowship schemes and ICURe, which combine mentoring with financial support and the entrepreneurship education, are resource-intensive. However, the implications, based on the views of respondents, are that they have long-term benefits beyond the initial establishment of a spin-out.

Potential improvements: Interpersonal relationships and networks are difficult to influence directly, although the HEI KE strategies required by HEFCE for HEIF funding include requirements for university-to-university collaboration and monitoring of funding allocations used for networking events. Respondents suggested:

- Encouraging more information provision and shared experiences through networking and events for all those involved in commercialisation.

1.2.4 Local economic conditions (Chapter 7)

The **literature review** identified several influencing factors connected to the university's local environment, including access to investment, the strength of networks between academics and investors, the absorptive capacity of local businesses, and the availability of infrastructure and services to support the commercialisation process.

All stakeholder groups said that their local economic conditions had, on balance, a positive influence on their commercialisation activity, regardless of the level of commercialisation activity in some areas. Despite this, many stakeholders considered there to be constraints to commercialisation in their areas where economic activity – especially in the high-tech sectors – was less advanced. Factors that influenced activities included the strength of the local research base and innovation ecosystem, the presence and interest of relevant businesses and investment partners, and regionally-specific funding support that would assist growth and development.

The Oxford-Cambridge-London "Golden Triangle" is the area with the highest concentration of activity, reflecting a concentration of research-intensive universities with nationally-recognised research specialisms, a history of commercial activity which has helped to develop the ecosystem and build the experience and skills of TTOs, and the wider economic environment including the concentration of investment capital around London. This has led to considerable advantages, network benefits and economies of scale for universities, high-tech businesses, and investors in the area.

Potential improvements: It is a conclusion of the research team and expert advisors that incentivising collaboration has strong potential to help less established universities start to realise the scale advantages that the most successful universities have. This is already starting to be implemented via the Science and Innovation Audits (SIAs), which are bringing together local consortia of universities, businesses, and LEPs, and also the CCF, which will facilitate

2 Examples are provided in Table 29 of the detailed literature review in appendix B.

university-university collaboration in commercialisation and may allow smaller or less-experienced universities to benefit from extended networks and the sharing of best practices.

Additional suggestions included:

- Increasing funding (either through additional place-based funding streams, or reprioritising existing funding streams) towards areas where innovation ecosystems are less well developed. This could be informed by Science and Innovation Audits.

In the Industrial Strategy White Paper, published in November 2017, the Government announced a new £115m Strength in Places Fund, which will support areas to build on their science and innovation strengths and develop stronger local networks.

1.2.5 Funding and investment (Chapter 8)

The **Literature Review** identified availability and access to pre-seed and seed-stage capital as a key influencing factor (which depended upon local context /availability of investors).

Our survey found that:

- The current policy environment (including grant funding, tax incentives, and access to investment) was generally recognised by interviewees as favourable. However, there was scope to increase the availability of funding - which interviewees argued need not require an overall increase in the amount of funding if it could be targeted more effectively at a local level or at specific stages of commercialisation.

- All stakeholder groups saw the major funding gaps to be at the earliest stages of technology development – Proof of Concept (POC) and Proof of Market (POM), followed by seed funding for spin-outs. This stage can be seen as a challenge because HEIs are being required to "de-risk" opportunities before companies and investors are prepared to get involved.

- There is also a perceived lack of funding for scaling-up successful businesses.

Potential improvements: Suggestions included:

- Increasing the availability of Proof of Concept/Market and Accelerator funds, and considering selective direct funding (perhaps targeted towards specific locations or technologies) for universities to test the investment readiness of technology and carry out feasibility studies.

- Increasing the availability of, and access to, equity investment, including through developing stronger investment networks, exploring funding vehicles to bring university, government, and investor funds together, and further tax incentives.

- Increased funding to support universities on cost and maintenance of patents.

- Exploring how to stimulate other sources of longer-term funding such as AIM

Since our research concluded, the Government has published its response to the Patient Capital Review, which sets out proposals on many of the issues raised by our interviewees. These include the establishment of a new £2.5bn Investment Fund to be incubated within the British Business Bank and doubling the annual allowance for people investing in knowledge-intensive companies through the Enterprise Investment Scheme (EIS) and the annual investment those companies can receive through EIS and the Venture Capital Trust (VCT) schemes.

1.2.6 Availability of information (Chapter 9)

The **literature review** identified potential issues related to the availability of information on opportunities for commercialisation; availability of best practices and guidance; transparency in university IP policies; and transparency in examples of transactions. These issues also featured in the survey research.

Our survey found that:

- There is a marked contrast between universities and businesses in their views on the availability of information about commercialisation opportunities. This is particularly evident in their views on information specifically available for businesses, to the extent that 30% of spin-outs and 41% of licensees, and most investors, said that provision of information for businesses was "not effective", compared to just 6% of universities.

- A substantial proportion of the respondents in the university and business communities said that government could facilitate greater transparency over how universities, businesses, and investors approach commercialisation. However, there was no clear agreement over the feasibility and nature of any government approach to this: there are difficulties associated with revealing potentially commercially sensitive information, and there are already commercial databases showing transactions in some sectors (such as life sciences). Nevertheless, it is clear that smaller, less commercialisation-active universities and businesses have much to gain from improved access to information on opportunities and transactions, as they can lack experience.

The 'Konfer' platform provided by NCUB was mentioned by a few respondents as a potential solution, though one at an early stage of development with further refinement needed to surface the required data results. At the time of our research this platform was in 'alpha' testing; Konfer was officially launched in November 2017 with an updated design following feedback from universities and business.

Potential improvements: Suggestions included:

- Improving online information on commercialisation opportunities, including considering providing more detailed information on commercialisation opportunities and contacts through Konfer, Gateway to Research, and universities' own websites.

- Exploring how the interface and interaction between universities, businesses and investors can be strengthened to increase awareness of specific commercialisation opportunities, build relationships, and increase understanding of best practice. This could involve utilising existing networks (such as the Knowledge Transfer Network), or potentially through additional regionally or technologically focused fora, perhaps convened by Government or research and innovation funding bodies.

- Using (existing or additional) KE funding to allow university staff to work more closely together to ensure early identification of IP with commercialisation potential.

1.3 Conclusions

The evidence from the overall research indicates that approaches taken to knowledge exchange and the commercialisation of university intellectual property are **working reasonably well and that the steps taken by the participants have improved the outcomes over time**. The amount of income universities derive from IP is rising, and is doing so more rapidly than KE income in general.[3] A number of universities are establishing commercialisation companies and investment funds to increase their support for spin-outs and licensing, and specialist external investors are setting up regional teams to increase their access to IP from research-intensive universities located outside London and the South East. There are also new policy developments, including increased funding and support via HEIF and the CCF, greater incentives for universities and academics to focus on the impact of their research in the REF, and improved capacity, skills and good practice models in universities.

However, stakeholders have highlighted several specific constraints, barriers and pinch-points. These issues are complex, and reflect the different aims, motivations, objectives and interests of the participants involved in the negotiations (for example, the charitable constitution and research/engagement missions of universities, and the commercial imperatives of their business and investment partners). The government and the various participants in the commercialisation process are already acting to address these perceived barriers where they have the ability to do so, but **there is potentially scope to do more.**

All stakeholders perceive the **skills and experience of university commercialisation staff** (the TTO) as one of the most influential factors on the commercialisation process. Universities report that they are resource-constrained in

[3] According to Higher Education – Business Community Interaction Survey data, trend annual growth in income from IP averaged 8.6% over the period 2003/4 to 2015/16; collaborative research, contract research, and consultancy income averaged 4-5% trend annual growth over the same period.

terms of finances and availability of staff; the perception of external businesses and investors is that TTO staff lack necessary skills, rather than resources. There are also key issues created by a lack of **critical mass** and conditions in the **local economy**: activity is concentrated in a small number of highly-successful institutions that benefit from access to investment, local business networks, and their own resources and policies based on years of successful commercialisation. The **REF** is the single most important driver of commercialisation activity identified by university interviewees but individual academics have competing priorities (between teaching, research and commercialisation activities) which universities need to manage carefully through their internal processes.

The **negotiation stage** of the commercialisation model is viewed as the point where problems are most likely to arise, and the universities, businesses, and investors report difficulties with negotiation on equity shares, royalties, and technology valuations. There is some evidence that the effect of these issues on total commercialisation is not substantial. **Difficulties in negotiations are reported by all participants, suggesting that the difficulties arise because there is something of value to both sides to negotiate over and there is no particular intrinsic bias to one side or the other.** These difficulties are reinforced by the difference in constitutions, motives, and strategic objectives between publicly-funded research universities and private companies and investors. The magnitude of these difficulties is reported as "to some extent" rather than "to a great extent" in almost all cases, and the qualitative comments from survey respondents suggest that issues can be resolved over time at the negotiation stage. The share of potential transactions reported by universities as having failed is relatively low, at around 20%, and among these will be some opportunities that are rejected by investors on the grounds that they are seen as unlikely to generate a return – it should not be assumed that *all* opportunities brought forward will be judged as investment-ready by the market.

The survey does suggest that there are some problems with **expectation management** on both sides (particularly with less commercially-experienced university IP teams, or external businesses/investors who have not previously interacted with universities on these types of transactions). This points to a requirement for further training, guidance on practices and/or case studies that help reduce complexity[4] for all participants in the commercialisation process, and a need for **greater transparency on university policies,** in broad terms, to streamline the negotiation process and help manage expectations among partners.

The interviewees in the research, reflecting all types of participants, did not suggest how the issues expressed above could be addressed. Nevertheless, the implication was that government (and HE and research funding bodies) had a role to help co-ordinate activities, alongside action from universities and best practice groups working with businesses and investors.

A core finding of the research is the diversity of opinions on the constraints and pinch points experienced by the survey respondents. The appropriate policy responses need to take this into account in terms of the flexibility that they offer their beneficiaries and the focus of their intended impact, for example by geographical region, subject specialism, or commercialisation maturity. As we discuss in chapter 10, recent policy developments such as the SIAs, the CCF, the encouragement built into HEIF funding strategies to stimulate and monitor collaboration, and the Research Council Accelerator funds, seem to be well-targeted on the resourcing, networking, informational and local economic constraints identified. As a result, the rate of growth in IP income may continue to outpace the rate of growth in KEC income overall.

[4] Several Government studies highlight the requirement for more information and guidance to help resolve issues between the types of participants and reduce the complexity. Note the Dowling, UK-IRC and Lambert reports.

2 METHODOLOGY

2.1 Overview of work programme

2.1.1 Project inception

The assignment commenced with a formal Project Initiation Meeting with the Steering Group at BEIS on 8th February 2017. The output of this stage was a Project Initiation Document (PID) which set out content and scope.

2.1.2 Review of existing literature

A review of the policy and academic literature relating to commercialisation was led by Tomas Coates Ulrichsen, who is a Research Fellow at the Centre for Science, Technology and Innovation Policy of the University of Cambridge. This review was to ensure that the work reflects the full breadth of existing information dealing with the topic of barriers to KE commercialisation available from academic, industrial, and government sources. It has been used in the refinement of the KEC transaction model, in preparation of the survey instruments and briefing note for interviewers, and the key findings and detailed supporting evidence are set out in Appendices B and C.

2.1.3 Review of the KEC Transaction model

The proposed KEC model was developed by BEIS in association with representatives of PraxisUnico and was provided to the project team along with the initial invitation to tender. It is outlined in section 3.1 (page 16) in full form. The KEC model was reviewed by our project team and discussed at a workshop with BEIS staff, the project team (including our panel of experts), and representatives from PraxisUnico, AURIL and NCUB. It was decided to focus the research on just two of the many KEC "transaction types" – IP licensing, and spin-out formation. A key project aim is to test whether licensing and spin-out activities have more pronounced barriers to collaboration than other types of transaction. It was also decided that the survey instruments would directly reflect the KEC model as produced by BEIS, as it was deemed to be appropriate in its structure, but that the instruments would include questions to verify the components within each of the transaction stages and add more if suggested by the interviewees.

2.1.4 Review of policy

After the workshop, it was decided that the survey research needed to account for the views of respondents on potential policy responses to the challenges and barriers identified. In addition to open questions on how changes to policy could help, the survey included a section seeking views on broad categories of potential policy responses such as 'information' and 'incentives'. The research team were aware that they did not wish to bias the response by leading the participants into certain policy avenues with their questions; or worse, to the accusation of suggesting, or even being perceived to be "offering", policy interventions which would not come to fruition. To provide a window within which potential policy approaches of most potential use to BEIS could be discussed freely, the project team conducted a review of current and developing policy and, in close consultation with the BEIS project team, developed a framework of potential policy responses that could be discussed in the round, and a set of questions to spur discussions on these, to be included in the survey discussions.

2.1.5 Telephone surveys

The primary research for this project was driven by a set of in-depth qualitative and quantitative telephone surveys. A set of research instruments was designed and piloted by the research team, with input from BEIS. Each research instrument was customised for each type of KEC participant, but with many common questions to allow perceptions of different stages of the KEC process to be compared between groups. The target groups were:

- Sector networks / representative organisations;
- Universities;
- Businesses (IP licensees and spin-outs) and charities; and
- Investors.

The research instruments were discussed at the KEC transaction model workshop referred to above and were subsequently reviewed by our panel of experts. We piloted the questionnaires for businesses and universities (the largest sub-groups) with a representative selection of respondents before rolling them out for the population at large.

The structure of the KEC transaction model, and a summary of the questionnaire topics, were circulated to respondents before each telephone interview, so that they would be familiar with the framework and the terminology used.

The overall structure of the questionnaires was as follows (with customisations for each class within this structure):

- Characteristics of respondent and organisation;
- Importance of KEC influencing factors: using definitions from KEC model;
- For spin-outs and IP licences:
  - How the transaction inputs were assembled and how difficult it was to do so;
  - Ease of transaction negotiations;
  - Issues with post-transaction management, using the KEC model types;
  - Lessons learned for organisational policy, impacts on future KEC.
- Overall opinions on best management of KEC, most significant barriers to KEC in general, and implications for government policy.

The interviews were recorded where permission to do so was granted. The responses were entered into a database. Qualitative answers were coded to identify common groups of responses.

Representative groups

The interview stage commenced with discussions with sector networks and representative organisations. These interviews helped to shape the final design of the questionnaire alongside the survey pilot. The qualitative findings are also reflected in the conclusions to this report, which include a synthesis prepared by the research team of the key barriers and policy responses from all stakeholders, and the insights of the representative groups have helped to clarify this process.

Universities

A quota sample was prepared of 35[5] HEIs to be interviewed, which is representative by English region, Scotland, Wales, and Northern Ireland. To stratify the survey, a cluster analysis was undertaken using data on the strength of the research/knowledge base of the institution (disciplinary focus and type of research), and the scale of commercialisation activity as measured by HE-BCI data. Notes on the clustering and sample selection can be found in Appendix A.

Multiple interviews per institution have been conducted to reflect the fact that institutions can have multiple disciplinary specialisms with differing approaches to KEC. Larger institutions may also have quasi-independent IP exploitation companies which have been consulted in addition to academics. Ultimately, 36 universities were represented among 138 interviews (typically 3–5 per institution, depending upon size) – the initial target was 120–140. The appropriate members of staff for interview were PVCs or Directors of Enterprise/Research, directors of relevant support offices (TTOs, external exploitation companies, corporate liaison offices, etc.) and facilities (e.g. incubators, innovation centres, and science parks), and, where appropriate, faculty-based support.

[5] Part of a long list of 40 institutions. 36 institutions were ultimately interviewed as the initial suitability of one institution had been questioned and interviews were conducted with a substitute from the long list.

As part of the interviews with universities, contact details for engaged businesses, charities, spin-outs and investors were requested in order to provide further interviews that the university interviewee said would be of particular use. These fed into the other interview groups.

Businesses & charities (including spin-outs)

We have prepared a sample of businesses using a mixed methodology. We have obtained contact details of businesses (including licensees and spin-outs) directly from universities and representative organisations, so as to pre-select the most KEC-active businesses which have long-standing collaborations with universities, those which have negotiated complex IP and licensing arrangements, and those that universities believe may have experienced significant difficulties in managing these transactions (as understood from the university perspective). Nonetheless, this sample may be biased towards businesses that have had the most successful relationships with universities. Therefore, we supplemented the list sourced from universities in two ways: by a mass mailout to businesses inviting them to participate in a survey if they have engaged with a university to access IP for commercialisation (or tried and failed); and a sample drawn from a national database of spin-out companies (available from spinouts.co.uk).

The report is based on interviews with 291 businesses, charities, and spin-outs (including university spin-out management as well as the business management team). A target of 290 was set as part of the project specification at the "invitation to tender" stage of research commission, as this constitutes a large enough sample to be able to carry out quantitative analysis of responses.

Investors

Respondents to the university and business surveys were asked for details of investors in their spin-out companies, and for other local investors and organisations such as business angels. We have carried out 20 such interviews – due to the small sample size and their largely qualitative nature, these are not quantitatively assessed to a great degree in the research but qualitative findings are presented throughout the evidence base.

Case studies

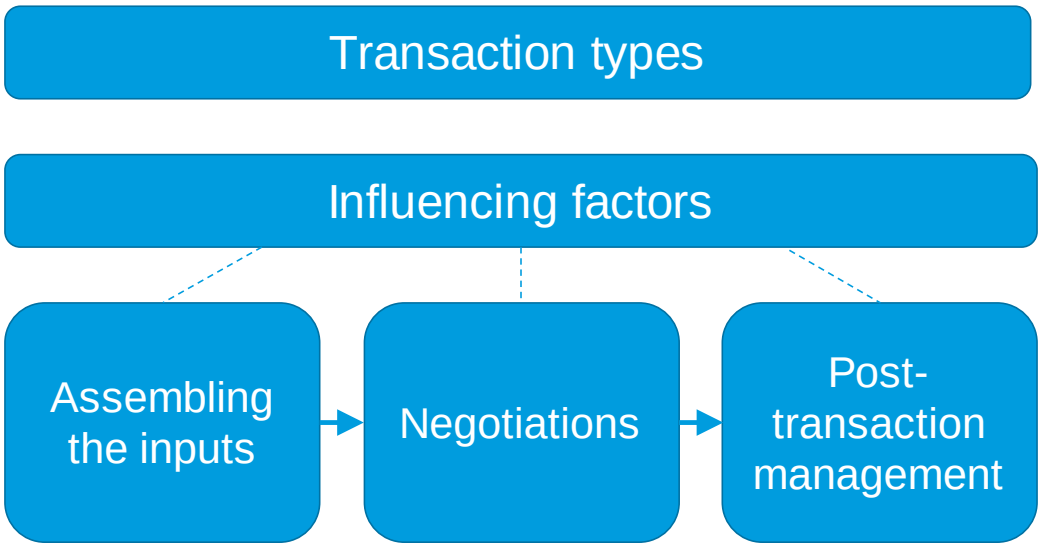
Case studies of interactions between participants in specific commercialisation transactions were developed. These have been designed to show the full range of commercialisation activities, and are not limited to the most successful commercialising universities.

Six case studies have been developed for English institutions which focus on the result of a single KEC interaction such as the licensing of IP or the formation of a spin-out company, supported by general information about the institution. The case studies provide insights into barriers to commercialisation from all sides of the interactions, and are referred to in the thematic survey analysis chapters. There are also three case studies of general commercialisation activity in institutions from the devolved administrations (which have their own KE funding and support infrastructure).

3 KEY ELEMENTS IN COMMERCIALISATION PROCESS

3.1 Influencing factors and transaction inputs

As part of the research, our project team developed a KEC transaction model, consisting of the factors influencing the type and amount of KEC, the KEC transaction types, and a three-stage process of assembling the necessary inputs for a transaction, the negotiations, and post-transaction management.



We have classified the influencing factors in the model into five main groups:

- **Internal factors relating to the Higher Education Institution or businesses**: including regulations and governance, leadership and strategic direction, strength of a commercialisable research base, and awareness of potential commercialisation opportunities;
- **Internal factors concerning skills and resources:** the role of individual academics, the staff and financial resources levels for commercialisation, skills and experience relating to IP, use of good practice guidance, and communication between industry, universities, and sector representative bodies;
- **Local or regional external factors:** the strength of local economic activity, the local innovation and investment ecosystem, the presence of significant local competition;
- **National external factors:** government and research funding bodies and their rules and regulations, the Research Excellence Framework, the interface with supply and demand from UK businesses and universities, and national competition; and
- **International external factors:** the interface with supply and demand from multinational companies and international universities.

We have also developed a classification of the various phases of establishing the transaction inputs:

- **Establishment of roles, responsibilities and priorities for:** the university, the lead academic inventor, business partners, and the relationship to funding terms;
- **Planning of:** project delivery, business planning, market research, risk analysis, and securing a suitable management team;
- **IP management:** due diligence, protection, warranties, valuation, field of use;

- **Finance:** equity sharing allocations, value of royalties, payment milestones, forms of external finance; and
- **Regulation, compliance, and advice:** external professional advice on points of law, regulatory compliance, finance, university and company policies.

3.2 Framework for primary research to assess views on policy

An exploratory framework was developed to enable the research to assess the current state of government support for commercialisation **as perceived by participants,** including guidance for universities and businesses on best practice in commercialisation, policies to govern and incentivise commercialisation, provision of information to businesses, universities, and investors, and ways in which policy responses could be developed to any barriers discovered.

The framework consists of a set of potential **barriers** to commercialisation, and **potential policy approaches** to alleviate them.

This framework is based upon the literature review, in particular the reports from government committees and reviews, initial external scoping interviews, previous PACEC studies, and discussion with BEIS on potential policy approaches for evaluation.

The survey research has been designed to test which policy approaches the respondents would find particularly useful. However, the feasibility of implementing these is not a direct subject of the research and would need to be tested along with, for example, responsibilities, costs, timescales and priorities. **It is important to note that the potential barriers to investigate were agreed with BEIS, to frame the survey discussions, and to ensure that the research gathered stakeholder views on these issues and on a broad range of potential policy approaches.**

The potential policy approaches are set out in detail in Appendix D. They were organised into broad groups for investigation in the survey:

- Specific financial issues for commercialisation such as equity shares, royalties, licence fees, valuing technology, warranties etc.;
- Availability of information;
- Effectiveness of current policies to incentivise activity;
- Funding constraints; and
- Transparency of licensing and spin-out agreements.

3.3 Presentation of findings by key themes

The results of the survey research are presented below in a set of chapters investigating key themes of the research, and are drawn together with the rest of the findings in the chapter on conclusions and suggested potential policy approaches.

The key themes which have emerged from the research, based on the quantitative investigation of the influencing factors on commercialisation, are as follows:

- Skills and resources to devote to commercialisation (Chapter 4);
- Leadership and management – strategic policy vs bureaucracy (Chapter 5);
- Interpersonal relationships and networks (Chapter 6);
- Local economic conditions (Chapter 7);
- Funding and investment (Chapter 8); and

- Availability of information (Chapter 9).

Within each chapter, there are sections showing how opinions on the relevant influencing factors vary between the groups of interviewees (university respondents, spin-outs, licensees, and investors), how the factors come into play at the various stages of the commercialisation model, and potential policy approaches that were suggested by the survey respondents to address any perceived constraints.

4 SKILLS AND RESOURCES

This chapter covers the different perspectives on skills and resources among the different stakeholders (businesses as well as universities), their relative importance at different stages in the commercialisation process, and the potential policy responses. These are grouped into three areas under the "skills and resources" theme:

1 Roles, capacity and skills of university technology transfer offices

2 Academic capacity, resources, and incentives to commercialise

3 Capacity and skills of businesses (licensees and spin-outs)

These areas are covered in sequence below.

4.1 Roles, capacity and skills of university technology transfer offices

4.1.1 Existing evidence from the literature review

Some potential barriers to commercialisation, identified by the literature review, involved the capacity of technology transfer office (TTO) staff to deal with potentially difficult negotiations with the funders of original research over terms and conditions (in the public and private sectors), and potentially difficult negotiations when commercialising IP with academics/inventors, spin-out businesses and investors, and companies that license IP.[6]

The levels of experience of staff in the universities and their TTOs, and their technical and business development capabilities, were central to negotiations. This was the case not just for the mechanisms, such as spin-outs and licensing, but the different stages of the commercialisation approach and model to be applied by individual universities. Skills, experience, capacity and resources influenced the approach, the choice of mechanisms, decisions on the inputs and the critical transaction details, the ability to negotiate with partners, and post-transaction management. In this context, some of the barriers highlighted that required appropriate skills to deal with them[7,8] were:

- Difficulties in finding suitable partners to commercialise IP for both spin-outs and licensing. These would include, for example, investors and other businesses;
- Aligning the aims of universities and companies;
- Negotiating the contractual terms (given university regulations, investor and business requirements) that dealt with the complexities of the different stages of commercialisation; and
- The level of resources available and time available to the universities, academics and partners.

In those universities where TTOs were less well established, the business development and entrepreneurial capabilities of TTO (and university) staff were also seen by some interviewees as an issue. This was linked to the ability to bring together a sufficiently entrepreneurial team from internal resources to manage spin-outs when capacity was constrained. Skills in this context included business planning, product development, marketing, recruitment and understanding of the factors necessary to successfully grow the spin-out businesses. These skills issues were also relevant to licensing transactions.

[6] See Table 29 in the detailed literature review in Appendix C.
[7] Shane S, 2004. Academic Entrepreneurship: University Spinoffs and Wealth Creation, *Edward Elgar Publishing Ltd*; UNICO, 2006a. Practical Guides: Commercialisation Agreements: Spin-out Transactions, *UNICO*; McMillan T, 2016. University Knowledge Exchange (KE) Framework: good practice in technology transfer, by the McMillan group, *HEFCE.*
[8] PACEC 2012-2016. The effectiveness and role of HEFCE/OSI. Third stream funding; The value of university spin-outs; The non-monetised benefits of knowledge exchange. *HEFCE.*

4.1.2 Influencing factors by stakeholder group

Almost all the university interviewees (96%) stated that they organised their support for IP commercialisation centrally, typically through a dedicated TTO or enterprise unit. Some institutions support this unit by maintaining staff in the main departments which generate IP. In a minority of cases, the more research-intensive universities have set up investment companies that manage the commercialisation process and invest in spin-outs. This approach is becoming more popular and is heavily reflected in the case study research: the case studies of the Universities of Oxford, Manchester, and Edinburgh, Queen's University Belfast, and Imperial College London set out examples of mature IP commercialisation companies and how they operate, while the University of Nottingham is currently in the process of setting up such a company to manage its spin-out support. The advantages include independence, a clear mission for seeking returns for the university, and the potential to offer market rates for experienced staff.

All stakeholders highlighted that university TTO staff are key to the commercialisation process. The full set of tables outlining the factors influencing commercialisation of university IP (positively or negatively) is found in Appendix E.

Over three quarters of **university** respondents said that their internal skills and resources were a negative influencing factor on commercialisation – more than any other factor. Almost half (48%) of university interviewees said this was due to a lack of **staff** resources, and 33% were held back by **financial** resources. There were mixed views on the skills and experience of university internal IP teams or TTOs[9], these were viewed as "negative" or "strongly negative" by 10% of university respondents, but "positive" or "strongly positive" by 37% (which makes it one of the most important positive influences overall). The general picture that emerges is of institutions that rate the individuals in their commercialisation support facilities highly but are under-resourced. However, it is also clear that the perceived skills and resources of individual institutions vary greatly.

A critical source of this variation was the level of commercialisation activity at each institution, as measured by the cluster analysis carried out when designing the university sample. As the table below shows, the most active universities are much more positive about the influence that their internal skills and resources have on their commercialisation activity. One notable finding is that while all university clusters contain examples of institutions who view the skills and experience of their TTO as a "strongly positive" influence on their commercialisation (42% in the top 2 clusters, 15% in cluster 3, 29% in cluster 4), virtually all responses of "strongly positive" under **resourcing**, whether in terms of staff or finance, are given by universities in the top 2 clusters. The most substantial negative factor reported is that 57% of universities in the 3rd cluster, and 55% in the 4th cluster, state that their available staff resources have a negative influence on their commercialisation activity. These institutions undertake relatively little commercialisation at present, and may have lower overall potential for activity than those that currently dominate commercialisation activity, so the absolute amount of additional economic activity that could be generated if these resources were increased may be relatively small; nevertheless, this is evidence of a gap between the additional employment and economic value that are currently being generated by the UK commercialisation environment, and what could potentially be achieved.

[9] The survey questions were phrased in more general terms to ask about the "University IP Team" – having established that in almost all cases this refers to a technology transfer office or TTO, TTO will be used for the remainder of the report.

Table 1: Views on internal skills and resources by university commercialisation cluster

Influencing factor	Strongly negative	Negative	Positive	Strongly positive
Skills and experience of the internal IP team / TTO				
Cluster 1+2 (high)	6	3	3	42
Cluster 3 (moderate)	5	0	15	15
Cluster 4 (low)	5	11	8	29
University resource levels – staff				
Cluster 1+2 (high)	12	21	6	27
Cluster 3 (moderate)	26	31	10	3
Cluster 4 (low)	21	32	5	3
University resource levels – finance				
Cluster 1+2 (high)	3	18	9	33
Cluster 3 (moderate)	18	21	8	0
Cluster 4 (low)	8	29	0	3

Source: interviews with universities

University spin-outs were less negative about the skills and resources available to their parent universities than the universities themselves. As they are examples of successful transactions, the spin-outs may have a positive bias towards the universities' level of commercialisation support. A positive view of the skills and experience of the university's internal IP team was held by 35% of the spin-outs, while 27% were negative, thus making this factor the most commonly identified as negative but also one of the most likely to be viewed as positive. The "net" position (+8% positive) is less significant than the fact that over half of the respondents stated that these skills had an influence on their commercialisation (more than any other factor), and that experiences varied very widely between individual cases. When assessing the staff resources available to their parent universities, 28% of spin-outs were positive as opposed to 18% negative. Their opinions of financial resource levels followed a similar pattern, with 21% seeing them as a positive factor, 7% negative.

In qualitative responses, **businesses and investors** suggested that TTOs were generally seen as dependent on a few key individuals and lacking in overall resource. Nearly all the **businesses** who offered an opinion on TTO skills said that real-world business experience was an issue. They linked this issue to a perceived tendency to employ academics, and to have a high turnover of junior staff. A government service to support TTOs in assessing IP proposals was suggested by some (unprompted) when discussing this constraint. Almost one third of the **investors** stated that they were more interested in the quality of the IP on offer than the skills of the support team; however, they did suggest that quality of the TTO may vary. One investor suggested (unprompted) that forums and meetings between academics and investors would be useful so TTOs are well informed on how attractive a project may be to an investor.

The overall picture as perceived by universities is that they have skilled people working to support commercialisation but that they are not sufficient in number to meet demand. They are also constrained by financial resources (which typically share a common budget with IP management costs, such as patent portfolios). This is reflected to an extent by the responses from other stakeholders, who have widely varying experiences but often perceive a lack of skills and experience. This perception may indicate that there is a genuine problem with university skills, or that university resource constraints are preventing them from devoting sufficient time and attention to engagement with businesses and investors. The resource constraint is particularly commonly reported among the universities with lowest current commercialisation activity.

4.1.3 Importance of TTO skills and resources at each stage of commercialisation

University respondents said that their skills were among the most positive influencing factors on the choice and scale of activity at the stage of **assembling the inputs** for commercialisation. For **preparing to spin-out** a company,

university skills were regarded as a positive factor in 27% of cases (the second most common response, behind university priorities), and negative for 13%. The equivalent statistics for **preparing a licencing agreement** were 54% positive and 6% negative. This perhaps reflects the view (from the literature review and these interviews) that licensing is generally simpler than creating a spin-out, by its nature as a time-bound transaction that can be codified by standard procedures, as opposed to the task of creating and managing a company with the potential to grow and develop revenues.

The responses from **spin-outs** themselves painted a broadly similar mixed picture, with university commercialisation skills seen as a positive by 32% but negative by 27%. Spin-outs from universities in higher IP commercialisation clusters were more satisfied with their TTO skills, but this was not a strong effect. There was no meaningful difference between spin-outs from different clusters.

In qualitative follow-up discussions, some university participants mentioned the need for an improvement of skills in their TTOs. The comments made suggest that a TTO works better when it consists of a professional group of people with commercial and business experience. There is a corresponding assessment from **businesses** that universities have insufficient commercial skills and experience at their disposal, with one comment being that "*they're ex-university people rather than ex-commercial people".* An **investor** highlighted the lack of commercial skills, explaining that TTOs often assume they need to bring in an external CEO straight away when this may not always be the case. Two investors questioned whether TTOs' were appropriately incentivised towards commercialisation: for instance, they may be more inclined to generate impact from research in broader terms, rather than specifically focussing on realising commercial value. . Many universities have moved in the direction of hiring commercially skilled staff, but there is a related issue that it can be difficult to attract experienced business people under university salary structures. This is less of an issue for the larger universities and specifically for those with independent knowledge exchange companies that are not bound by university pay scales.

TTO respondents said that managing the expectations of academics and businesses was a crucial part of the process of engagement. This is particularly the case for **assembling the inputs** required to start a spin-out and impressing upon the academics the requirements for **managing the spin-out** after the IP transaction, in terms of the amount of time and resource required, the potential time period before significant impact and commercial returns might be expected, and the potential disjunction between the apparent interest or usefulness of a technology and the actual existing market for a product based upon it. Section 4.2 deals with academic skills directly but it must be borne in mind that the support and training that TTOs can offer is essential to building these.

Early stage spin-outs are much more sensitive than universities to any delays in negotiation, as they may not be adequately resourced to cover costs while waiting for agreement to be reached over IP. This issue will be returned to below under Section 4.3 on business capacity to commercialise, but it is relevant here as university preparedness is identified as a source of these delays. Some of our spin-out participants suggested their university lacked the resources to process documentation more quickly, while others suggested that the source of the issue was the 'to-ing and fro-ing' between the different legal teams acting for the university, investors and the company itself.

Based on the relative frequency by which they are identified as an influencing factor, and the qualitative comments on constraints, the evidence shows that TTO inputs are most important at the **assembling inputs** stage of commercialisation. They have a role to play in leading the **negotiations** on the university side, though there are fewer specific issues identified in the research at this stage, and this stage of the transaction is typically viewed as procedural, where policies are more important than individual skills for the most part. TTO skills are less important in the **post-transaction management** stages of running spin-outs as the company is taken forward by the assigned management team – however, assembling that management team in the first place is amongst the TTO's main responsibilities in the spin-out process. This is particularly the case if the spin-out grows and takes on further investment, thus diluting the university's equity stake and reducing its oversight responsibilities. At this stage, business management skills become much more important; these are dealt with later in this chapter.

4.1.4 Summary and emerging conclusions

The skills and resources available to university TTOs are viewed as crucial drivers to commercialisation by all parties. These include the number of available staff and their funding, and the specialist skills and sector expertise they possess.

TTOs are seen as important to support, and manage the expectations of, academics, businesses, and investors who may not have experience of IP transactions – as such, improving their resources and skill levels is fundamental to the capacity and culture of universities to commercialise.

There is a need for a critical mass of activity for commercialisation units to be most effective, which suggests a strong incentive for universities to pool technology transfer resources. There is real pressure on TTOs to have a wide range of skills but also to be experts on specific sectors where possible, and to maintain strong connections with academics and business (drawing upon real-world business experience where possible), and there is an argument to spread that load between groups of universities by information sharing and (for smaller institutions) pooling of resources. This suggestion is made explicitly in the case study research with Aston University (section 10.10). The benefits of collaboration would go beyond simple cost savings – they could lead to more streamlined processes, access to a wider business base through a range of entry points, and the ability to access and fund more specialised individuals drawn from across the partner universities.

Universities are already forming partnerships to improve their research activities, and the Connecting Capability Fund (CCF) is providing money for groups of universities to improve specific elements of their commercialisation offer. For example, the existing enterprise collaboration between the universities of Bath, Exeter, Southampton and Surrey (SETsquared) was awarded a CCF grant in October 2017 to assist commercialisation with small businesses in four key technology sectors, and the Universities of Manchester, Leeds, and Sheffield have a CCF award to develop their Northern Triangle Initiative Company to expand their shared IP pipeline, set up a regionally-focused financial vehicle for commercialisation supported by significant private finance (a target of £350m), and strengthen the local entrepreneurial ecosystem.

4.2 Academic capacity, resources, and incentives to commercialise

4.2.1 Existing evidence – the literature and policy reviews

The **literature review** identified a set of "influencing factors" and potential constraints that were commonly referred to as affecting the commercialisation process for academics as the originators of IP, and colleagues who provide support for them.[10] These factors cut across the type of transactions that academics may seek to be involved in (i.e. spin-outs and licensing agreements), how they input to the process, the negotiations and the management of the spin-out or licence agreement. They influence their time available and capacity (given other responsibilities), the extent to which they have the appropriate skills, and the incentives influencing their choices of commercialisation routes and engagement.

In many ways, the capabilities of the academics as the originators of potential IP (and spin-outs) mirror those of the TTO staff, as shown above, with respect to the early and subsequent stages of commercialisation. The exceptions are that the academics are more knowledgeable about the science and research that underpins the IP and its application whereas the TTO staff tend to have more direct experience in the process of commercialisation itself.

At the outset, it is recognised that the academics have other responsibilities in the universities besides knowledge exchange and the commercialisation of IP. These include their role in research (and potential publishing) and their teaching responsibilities. Increasingly, these different responsibilities can be linked. These roles can influence the capacity that the academics have to engage in commercialisation in all the stages.

In terms of the stages of commercialisation, the initial skills required by the academics that influence their involvement and impact relate to their ability to negotiate their share of returns on IP they have been involved in generating, especially where different funders are included with their respective terms and conditions.[11] There is also the contractual relationship between the academics themselves and the universities. Subsequently skills are required for dealing with barriers identified in the literature. These include finding suitable partners (with the TTO staff) and the extent to which academics engage in the wider research infrastructure and networks, the adjustments required to orientate themselves to business partners (their requirements and culture), the ability to participate in negotiations on

[10] Druilhe and Garnsey, 2004. Do Academic Spin-Outs Differ and Does it Matter?, *The Journal of Technology Transfer, page:269-285, volume:29, issue:3*; see also footnote 7, page 19, and further references in Table 29 in the literature review in Appendix B.

[11] Gregson G, 2011. Investment negotiation between academic entrepreneurs and private equity investors: examining factors affecting investment deal outcomes, *Frontiers of Entrepreneurship Research, volume:31, issue:1;* N = 33.

contracts and terms and conditions (which may cover the value of IP, their equity share, their accessibility for spin-outs and licensees, and their contractual freedom to operate and publish). There are also requirements for entrepreneurial skills, and the ability to contribute to the growth of spin-outs and the management team.

Successful negotiation of returns on their IP, and engaging with partners, can help incentivise the academics and motivate them to contribute to spin-out development or engagement with a licensee, or to pursue further commercialisation. Other factors relate to how the university can directly incentivise the academics through simplifying processes and limiting bureaucracy to help enable academic involvement in commercialisation, provide rewards and recognition, and develop an entrepreneurial and commercialisation-focused culture.

4.2.2 Influencing factors by stakeholder group

A minority of **universities** (14%) said that establishing the role of individual academics was a strongly positive influence on commercialisation; however, 8% found this "strongly negative" and 16% "negative", making it one of the most negatively-perceived influencing factors (behind issues of resourcing).

There is potentially a related factor here in that the **balance of priorities** within the university (between teaching, research, and commercialisation, for example) is seen as negative by 11% of the universities but positive by 32%, suggesting that it is a significant influencing factor which universities are able to manage to greatly differing extents. This was often related to the time available to academics given their teaching and research commitments and career aims.

The incentives provided by universities to motivate academic commercialisation are driven by national policy. The university view is that government policy is currently at least partly effective (55%) or very effective (15%) in incentivising them to commercialise. The REF impact framework in particular is the primary motivator of commercialisation activity as reported by universities (seen as a "strongly positive" influence by 41% and "positive" by 10%), although there is some mild dissent from spin-outs (strongly positive 23%; positive, 5%; negative, 5%).

There is more that could be done. While the REF has certainly encouraged individual academics to commercialise, and promotes the concepts of impact and practical application of research, there is an ongoing issue with how academics devote their time to the pressures of teaching and publication as well as impact: it is perceived by academic and business respondents alike that academics are insufficiently incentivised to engage with commercialisation through opportunities for promotion or career progression.

The previous section on the skills and resources available to universities to support commercialisation established that there were substantial differences between the institutions carrying out high levels of commercialisation and those less active (using the cluster analysis developed for this project). The distinction is much less clear when considering the establishment of roles of individual academics, and the balance of university priorities which influences their activity. It seems that the potential for an academic inventor to influence a spin-out or licensing agreement based on IP they have generated is broadly similar regardless of the institution, and the factors that influence the balance of activity at a university are universal, driven as they are by incentives to publish and government policy on excellent research and teaching.

Table 2: Views on academic roles and university priorities by university commercialisation cluster

	Very negative	Negative	Positive	Very positive
Role of individual academics				
Cluster 1+2 (high)	12	9	0	15
Cluster 3 (moderate)	5	23	5	5
Cluster 4 (low)	8	16	5	18
University balance of priorities				
Cluster 1+2 (high)	15	3	3	24
Cluster 3 (moderate)	0	10	15	15
Cluster 4 (low)	5	3	8	29

In qualitative comments, some of the less commercially-experienced universities were keen to emphasise that the general level of awareness of the potential for commercialisation was not strong within the university and it was a struggle to promote this information to all staff. There was a view amongst many university interviewees that there were a range of potential commercial opportunities that were not identified and brought forward to TTOs. This issue concerns the general awareness among academics of the potential for commercialisation and the support available for this, and the capacity of TTOs to maintain contact with research departments to identify commercialisable technology. Two of the **investors** perceived the role of individual academics as an influential factor on the decision to engage with the university, particularly their commitment and commercial acumen. One investor commented *"A great invention with a commercially minded academic is more attractive than an invention alone".*

In contrast to university academics, the **spin-outs** reported that the roles played by individual academics had an overall positive influence on commercialisation, alongside university leadership and priorities, and awareness of IP commercialisation opportunities.

There are a small number of resource-intensive, competitively allocated academic entrepreneurship support packages (e.g. ICURe, Royal Academy of Engineering Enterprise Fellowships) that include training or mentoring and access to networking. Our case study of Imperial College London includes an interview with a RAE Enterprise Fellow that highlights the ways in which this support was useful: direct financial support is important but the mentorship, and access via networks to expertise and contacts in potential markets provided through the Fellowship, were considered to be crucial for the establishment of a spin-out and in developing the academic's own commercial expertise and potential to grow the business or develop more commercialisable IP in the future.

4.2.3 Importance of academic input at each stage of commercialisation

At the stage of **establishing inputs to form a spin-out**, **university interviewees** said that defining the roles of individual academics (shareholding, management, and access) were the most common negative influencing factors (21% negative, 10% strongly negative - although 10% saw this as strongly positive, confirming that experiences differ greatly between respondents). The lead academic's requirements were viewed as "negative" by 14% of university respondents and "strongly negative" by 10% - although a further 10% viewed them as a strongly positive influence.

In contrast, the spin-outs themselves saw the individual academics as positive drivers for activity. In qualitative follow-up discussions, they did sometimes cite a lack of alignment between the university and the company at the set-up stage: this included such issues as differing priorities on both sides, clashes of personality, and the ability of academics to commit time to their spin-out alongside their other university responsibilities.

It is possible that there is a specific bias which explains the contrast in opinion between spin-outs and universities. The spin-outs that were interviewed were largely examples of successful transactions that may have benefited from academic input. The universities, on the other hand, will be aware of academics that they have tried and failed to encourage to commercialise as well as their successes. This bias is informative as it is evidence of a **gap** between the current levels of commercialisation and what could be achieved if other academics could be incentivised to pursue commercialisation more actively.

Universities were likely to report problems with obtaining academic approval or agreement to the use of IP (or facilitate its use with their technical knowledge) at the **negotiation** stage – in fact, it was the second most commonly-cited problem by universities at negotiations (16%) with only the general procedural barrier of establishing Heads of Agreement (28%) more commonly mentioned. However, **spin-outs** were relatively unlikely to see this as a problem (only 3%) – they were much more likely to have difficulties with the mechanics of negotiation such as establishing positions (39%), points of agreement and divergence (24%), or executing final documents (20%) for which universities have experience, established policies, and access to support.

The discrepancy between universities and spin-outs on the benefits of academic input reflects a difference in perspective between them: spin-outs will be thinking about the role of the specific academic inventors of their successfully-commercialised IP, whereas university TTOs will have in mind examples of unsuccessful negotiations and academics who have not engaged with them. This may indicate that there remains potentially commercialisable IP within universities that is being held back by lack of academic participation: however, if academics and their research departments are focused on pure research or other forms of KE, or impact, it may not be for TTOs to intervene.

Investors report concerns about securing a suitable management team at the **negotiation** and **post-transaction management** stages. Some reported issues when an academic transitions into a management team, based on their probable lack of commercial experience, although investors did mention that they provide mentoring. Commercial expertise varies across academics, two of the investors commented independently that their ability is "lower than they think". Another issue surrounding academics is potential conflicts of interest between an academic who wants to maintain an academic career and wants to also be part of the company. However, investors did report that an academic inventor who was motivated to work to grow a spin-out company was potentially a useful asset. The **universities** themselves did report in qualitative discussions that the impetus towards following a spin-out route to commercialisation can flow from the individual academics involved in a particular research project - if they are commercially-minded or motivated to see impact from their research.

A specific area of conflict between universities and businesses arises when academics seek to publish findings that could have commercial value and that a current or prospective industrial partner would wish to keep confidential. Businesses were much more likely than universities to regard this as a problem (61% of universities thought it rarely or never caused issues, as against 33% of spin-outs and 20% of licensees), but few respondents regarded it as a frequent or significant problem – please see the table below for the full statistics.

Table 3: Views on early academic publication of commercially useful findings

	Universities	Spin-outs	Licensees
Universities seek to publish - and that is frequently or significantly an issue	4	13	0
Universities seek to publish - and it is an issue to some extent or on occasion	35	53	60
Universities seek to publish - but that rarely or never causes issues	61	33	20
Universities don't typically seek to publish	0	0	20

In qualitative discussions, businesses and investors usually accepted that there was a requirement for academics to publish, linked to their career progression and the ongoing need to be able to attract research funding, and were experienced in accommodating these requirements by negotiating small delays in publication or arranging protection of the IP – hence its status as a problem "to some extent" rather than a serious problem for the most part.

Issues related to publication of research results typically arise at the earlier stages of **assembling the inputs** to a spin-out, as the negotiations would set out terms of ownership and use of IP, and scope for further development. The imperative to publish may prevent some transactions from ever taking place, as the IP is made public before the prospect of entering into an agreement with a business partner.

4.2.4 Summary and emerging conclusions

It seems that there may be an issue with academic priorities and demands on their time which can be traced back to the institutional role of universities, as well as the balance between incentives and policies to encourage commercialisation, other forms of impact, and excellent research as an end in itself, at both national and university level. This dynamic is not correlated with the current level of commercialisation (as measured by the cluster analysis) - it is a feature of the national policy environment. Although the REF impact agenda is highly influential, it covers a wide range of forms of impact and is not a specific policy driver for commercialisation in its own right. The REF is designed to incentivise HEIs to think about the translation of their knowledge into impact, but it is for HEIs to decide the most appropriate forms for knowledge diffusion in their specific contexts. A greater focus on commercialisation as a subset of impact could be achieved by specific university policies on impact through commercialisation. The case studies of Oxford (Section 10.8) and Imperial College (10.6) show examples of policies on academic staff ownership of IP, time allocated to development of commercialisation opportunities, and university protection and exploitation of IP.

Should universities have an ambition to increase the scale of commercialisation activity, then they could readdress their knowledge exchange and impact policies to reprioritise how academics spend their time, provide greater incorporation of commercialisation within university career structures, or create policies to permit academics to spend more time working with spin-outs. This would be particularly attractive to investors if the support was targeted at

commercially-minded academics – identifying these is a TTO function, but one which needs to be appropriately resourced to maintain contacts with research departments.

There are a small number of resource-intensive, competitively allocated academic entrepreneurship support packages (e.g. ICURe, Royal Academy of Engineering Enterprise Fellowships) that include training and access to networking, and are well-regarded by participants. The Imperial College case study (section 10.6) provides an example of this.

4.3 Capacity and skills of businesses (licensees and spin-outs) and investors

4.3.1 Existing evidence from the literature review

The role of businesses (including investors) in the commercialisation process with universities varies according to whether they are involved in spin-outs (including their set up) and in licensing (within, or outside, a spin-out – which is the more frequent form of engagement). It is also influenced by the stage the spin-out is at from the negotiations on start-up/seed and early stages through to the negotiations on consolidation and growth as commercialisation matures. IP rights, their value, the field of use of technology and equity shares are relevant at all stages.

The literature indicates that university spin-outs are typically different from other types of high-technology start-ups and attempt to commercialise very different types of technology (at relatively early stages). Their resource requirements are different (not just in terms of investment but the skills of staff and the roles of academics).[12] The commercial knowledge, experiences and culture of founders in university spin-outs are different compared to other high-tech firms. Some of the skills required include the ability to:

- Negotiate with universities and academics on a range of issues (e.g., IP value, equity distribution, access to academics, royalties, warranties, etc.);
- Build a suitable management team that can exploit the IP (which can often be at early stage) and successfully engage with academics, university TTO staff and investors[13];
- Manage more long-term investment to take the IP through the stages to test it, develop products and successfully develop markets and revenue streams;
- Secure several rounds of funding as the IP and the spin-outs go through the commercialisation process and agree the equity shares and reward systems; and
- To manage the financial restructuring and linked to the previous point, manage the investor requirement to secure a return through dividends, equity shares, disposals and potential exit.

It is argued that the issues faced with respect to university spin-outs/licensing can increase the risk for business partners compared to other high-tech firms. While universities and businesses can come to compromises and adjust their standard practices to alleviate these, some of them may be inherent to universities and their culture.

4.3.2 Influencing factors by stakeholder group

The most common positive influencing factors for **licensees** in respect of internal business factors were found particularly within the company's own management and strategic direction. However, the skills and experience of company staff to access and commercialise IP, and the internal resources to allocate to R&D (both in terms of provision of staff and finance), were also viewed as positive influences on commercialisation within the survey sample.

Universities, and their **spin-outs**, report that they have difficulties to some extent with assembling a management team for a spin-out, recruiting staff, developing skills, entering the market and managing growth. At the **assembling inputs** stage, this is reported as a problem by 9% of university respondents and 8% of spin-outs. This implies that there is a lack of business skills within spin-outs at their earliest stage of growth.

[12] Druilhe and Garnsey, 2004. Do Academic Spin-Outs Differ and Does it Matter?, *The Journal of Technology Transfer, page:269-285, volume:29, issue:3*;
Shane S, 2004. Academic Entrepreneurship: University Spinoffs and Wealth Creation, *Edward Elgar Publishing Ltd;*
Wright et al, 2006. University spin-out companies and venture capital*, Research Policy, page:481-501, volume:35, issue:4*

[13] Wright et al, 2006; ibid.

Other businesses were generally positive about their capacity to communicate with universities, and specifically their ability to interface with universities at the research stage; these were seen as broadly positive influential factors. This emerges from the skills and resources that businesses have available to maintain connections with university research departments, seek and negotiate collaborative arrangements that can lead to the development of IP, and also from the networks of individual academics that they have access to (see also section 6 on interpersonal relationships and networks); it is also a generally positive comment on university openness to research collaboration). However, some businesses reported specific gaps in staff resource levels (not finance) and a few lacked internal skills and experience.

The investors were generally confident in their own levels of management expertise; however, over half of the investor respondents mentioned the importance of having an appropriately skilled and experienced management team in place within the spin-outs that they invest in. Those that did mention this often said that they assist the spin-outs in finding the right team, and by providing mentoring.

4.3.3 Importance of business capacity and skills at each stage of commercialisation

The major business development issues as reported by the university staff were: the appointment of a management team and assignment of roles; recruitment of staff and development of their skills; and market entry and growth.

After their establishment, some spin-outs had had difficulty attracting VC funding. This is partly a reflection of the skills and resources that spin-outs have at their disposal to seek investment. However, there are local factors, as the VC technology investment community is concentrated in the "Golden Triangle" between London, Oxford and Cambridge (see chapter 7 on local economic conditions). Non-specialist VCs are said to expect a return on investment too quickly, which doesn't suit high-technology start-ups (where extra research and development can be needed and timescales are naturally longer, particularly in life sciences).

Aside from funding and investment, the most commonly raised issue by the spin-outs at the **post-transaction management** stage was **recruitment of specialist management and operational staff** (as the company grows). A key component that causes a problem for universities is the ability to find operational staff with the required skill set to recruit into a spin-out. Half of the universities that made qualitative comments on this phase of development mentioned bringing in the right skills into the spin-out company. Recruiting both technical staff and management is important for business growth **after negotiations**.

Establishing the strength of the business management team is a priority for **investors** by the **negotiation stage**, for those involved at the seed stage of spin-out creation, and persists into **post-transaction management** for additional rounds of investment. One suggestion was for universities to offer resource to support academics and make legal resource available, although investors also stated that they provide mentoring for spin-out management teams along with providing access to their own networks of advisors and potential team members.

A specific potential solution to skills and resource issues for early-stage companies is suggested in the case study research with the University of Nottingham (section 10.4). High-tech start-ups require considerable experience to develop technology and grow their business, but money for salaries is hard to come by when a company is at an early stage. This is a risk for the first staff working for the new company, and even though they can be founder shareholders there is considerable dilution of their equity if investment is secured at the point that the company's revenue potential is more established. One approach to spread risk would be a service to be partner spin-outs with established players in their marketplaces who can provide cash resources and access to experience, perhaps in return for a limited equity stake or a revenue sharing agreement.

Another route for intervention, suggested in the case study research with the University of York (section 10.7), would be an increase in the provision of Knowledge Transfer Partnerships (KTP), which support UK-based businesses to engage with an HE or FE institution or RTO, and a graduate, to provide academic expertise. The application requirements include a need to demonstrate that the business lacked skills which would be addressed by input from the UK knowledge base, would not replace what could be achieved by external consultants, and would be clearly additional to what may occur without the KTP. These are difficult and time-consuming to evidence for a start-up, but a potential policy approach would be to provide greater flexibility for spin-out applicants.

4.3.4 Summary and emerging conclusions

Issues of skills and resourcing cut across the various stakeholder groups and stages of commercialisation; from assembling the IP in the first place and developing it to the point of being an investable opportunity, through the handling of the negotiations, to recruiting and retaining skilled staff to grow and develop spin-out companies.

Universities, and their **spin-outs**, report that they have difficulties with assembling a management team for a spin-out, recruiting staff, developing skills, entering the market and managing growth. As such, the difficulties the skills and capacity issues they identified were internal, rather than perceived weaknesses in the skills of external businesses and investors. The spin-outs from the higher IP commercialisation clusters were slightly more likely (18%) to report difficulties in assembling a management team, and in recruiting staff and developing skills (32%), but were less likely (8%) to report difficulties in assembling a board. The higher IP commercialisation universities were more likely (45%) than lower (19%) to report difficulties in assembling the board and management team for spin-outs. Only universities in clusters 3 and 4 reported problems finding staff and developing skills.

Having the right management team in place for any commercialisation project is important for all stakeholders – assembling appropriately-skilled teams requires experience and a network of potential partners, which is easier for more commercially-experienced universities, and those located near clusters of investors (the “Golden Triangle” – see the case studies of Imperial College London and the University of Oxford in chapter 10) or areas of high-tech business growth.

4.4 Chapter conclusions

Universities are **resource-constrained** in terms of the numbers and skills of staff to support commercialisation, the available time for commercialisation activity, and funding for staff and to invest in IP to take commercialisation forward. They do however rate the skills of the support staff they are able to fund very positively. **Businesses and investors** suggested that TTOs were generally seen as dependent on a few key individuals and lacking in overall resource. It is a struggle to maintain IP, business development, research and innovation teams all with the necessary skills or experience to drive commercialisation activity forward. Until a critical mass of successful commercialisation activity and concomitant returns on investment can be developed, this will remain an issue outside the largest commercialising universities.

The issues of critical mass and the importance of networks suggest a strong incentive for universities to pool technology transfer resources. There is real pressure on TTOs to have a wide range of skills but also to be experts on specific sectors where possible, and to maintain strong connections with academics and business (drawing upon real-world business experience where possible), and there is an argument to spread that load between groups of universities. This is already occurring to an extent via local and regional university partnerships, the partnership working encouraged by producing Science and Innovation Audits (SIAs), which map out regional knowledge resources and strengths, and funding for collaborative partnerships between universities that have recently become available through the CCF: these developments should be monitored closely.

Individual academic inventors are viewed internally and externally to the universities (by businesses and investors alike) as potentially important drivers for commercialisation but they have time constraints and competing priorities, despite the influence of the REF and the development of university strategies to drive KE and commercialisation. The issue therefore arises of the interaction between the REF impact agenda and other policies driving academic behaviour. Research and teaching career paths are well-established, and universities may not have consistently chosen to incentivise academic staff so that they are able to prioritise and commit to commercialisation and spin-out development – but this may be a less significant concern than the general level of funding for maintenance of skilled TTOs and the maintenance of patent portfolios outside the top few most successful commercialising universities. Commercialising universities have policies which permit their academics to take on consultancy work for spin-outs as part of their allotted time, or arrange for their research time commitments to be bought out so that they can work directly with spin-outs; the case studies with Oxford and Imperial give examples of these.

Another issue is that the REF covers a wide range of forms of impact and is not a specific policy driver for commercialisation in its own right. Indeed, it could be thought of as the policy influence in the absence of any other mechanisms, rather than an incentivising driver of commercialisation in particular.

The issues of academic priorities could be addressed at the university level by university policies to recognise and incentivise impact through commercialisation and permit flexibility in the use of academic time to work for spin-outs.

The case studies of Oxford (Section 10.8) and Imperial College (10.6) show examples where these are in place in the most successful commercialising universities. The REF is designed to incentivise HEIs to think about the translation of their knowledge into impact, but it is for HEIs to decide the most appropriate forms for knowledge diffusion in their specific contexts. A greater focus on commercialisation as a subset of impact could be achieved by specific university policies on impact through commercialisation, in cases where individual universities judge that this would achieve greater economic and societal impact than other forms of KE, or fits their strategic aims. If commercialisation is a university strategic priority, then the current support and incentive structure (e.g. REF and HEIF) is in place to facilitate that.

There are other aspects of university management and policies to consider. Spin-out businesses often complained about university bureaucracy and IP policy. Specific comments were made about the effectiveness of TTOs as brokers and intermediaries, which varied from institution to institution and typically depended on the personal networks of a few key individuals. There was also a focus on levels of funding, in terms of maintaining an IP portfolio as well as funding research and development. These points are addressed in separate thematic sections: on leadership, management, and bureaucracy (chapter 5); funding and incentives (chapter 8); and interpersonal relationships and networks (chapter 6).

5 LEADERSHIP AND MANAGEMENT

This chapter covers the different perspectives on leadership and management among the different stakeholders, their relative importance at different stages in the commercialisation process, and the potential policy responses. These are grouped into three areas under the "skills and resources" theme:

1 University leadership

2 IP policies, equity sharing, royalties and their negotiation

3 Spin-out growth management / skills within commercialisation projects

These areas are covered in sequence below.

5.1 University leadership

5.1.1 Existing evidence from the literature review

The leadership and management arrangements in place for universities, and their partners, to encourage and assist the commercialisation of IP are critical to success for spin-outs and licensing. The issues arise at two main levels; the aims, strategic policies and priorities of the universities that influence their activities and determine inputs and secondly, the operational issues when negotiating with partners over spin-outs and licensing.

Universities have legal duties as regulated charities to protect their IP assets and use them to pursue their charitable objectives, typically by reinvesting commercialisation income into teaching and research. The literature provides further insights into the aims, priorities and strategies of universities. It suggests that HEIs typically develop their aims and priorities for commercialisation through a combination of their overall missions and objectives and their practical experiences of seeking collaboration and exchanging knowledge with a range of partners, that their approaches to spin-out and licensing are also linked to central government funding for innovation.[14] The universities' aims then typically provide a framework for the governance of these mechanisms, and the resourcing of activity through the appointment of dedicated technology transfer staff. This framework also influences the degree of academic engagement commercialisation of IP which is considered to be increasingly important.[15]

Specific operational issues highlighted by the literature include:

- when specific deals are being considered for commercialisation, decisions to seek IP protection, and determining IP ownership (including establishing whether the inventor (or academic) has made a material use of university facilities in creating inventions).[16]
- skills and experience required for negotiations to set up and grow spin-outs and license IP to help achieve the aims of universities and partners. It has been important here to recognise that spin-outs are very different from other high-tech companies in terms of their commercial knowledge, technologies and resource requirements.[17]

Barriers to commercialisation that could arise from the approach to leadership and management at the strategic and operational levels include those related to the clarity of mission, the orientation of the university (its policies and practices for partners), the resources and capabilities, the time available especially for academics (and incentives), the rules and contractual terms[18] and the processes and potential associated bureaucracy.

[14] PACEC, 2015; see footnote 8, page 19.
[15] Hughes and Kitson, 2012. Pathways to impact and the strategic role of universities: new evidence on the breadth and depth of university knowledge exchange in the UK and the factors constraining its development. *Cambridge journal of economics, page:723–750, volume:36, issue:3*.
[16] Shane S, 2004; UNICO, 2006a; and McMillan T, 2016; see footnote 7, page 19.
[17] Wright et al, 2006; see footnote 12, page 27.
[18] Dowling A, 2015. The Dowling Review of Business-University Research Collaborations. *The Department of Business, Innovation & Skills*.

5.1.2 Views on university leadership and management by stakeholder group

The survey research on the factors influencing commercialisation strongly reinforces the findings of the literature review on the importance of strategic leadership from the universities. The university respondents were more likely to regard their central leadership and strategic direction as having a positive influence on their commercialisation activities than any other factor; they were seen as a "strongly positive" influence by 41% of universities and "positive" by a further 11%, with only 6% seeing the influence as negative.

The same question was asked of spin-outs (concerning the leadership of their parent university): 20% reported it as "strongly positive" and a further 19% as "positive". This makes it one of the more positive internal influencing factors in the perceptions of the spin-outs, but slightly less so than the role of individual academics. Again, 10% of the respondents saw the influence as negative.

University regulations and guidance were thought to be less important than leadership and strategic direction, but overall 24% of university interviewees thought these had a positive impact, and only 1% thought the impact was negative (although where the impact was thought to be negative it was classed as strongly negative). Spin-outs were more likely than universities to think university regulations and guidance were a significant factor; 27% thought it was a positive influence and 11% thought it was negative.

Licensees (who may have commercialisation relationships with multiple universities) were not asked these questions, but were instead asked about the importance of their company's central management and strategic direction. Around a quarter (24%) regarded this as a "strongly positive" influence, and 5% as "positive", making this the most significantly positive influencing factor apart from the opportunities in the local economic activity ecosystem.

Spin-outs tended to think the university's commercialisable research base was a strong factor (32% positive, zero negative). Universities themselves were slightly less likely to cite the strength of their research as a positive driver, with 26% saying the strength of their research base was a positive factor and 3% saying it was strongly negative. This is likely to be because successful spin-outs typically come from universities which have strong research bases, and so there is an observation bias.

Investors did not comment specifically on the goals and leadership of universities in particular, but when asked to discuss the influences on their engagement with universities for the purpose of commercialising IP in general, they rated the quality of the research base primarily, and secondarily the skills and experience of the university TTOs. The initial question was unprompted, leaving investors to suggest the most influential factors themselves; they did not comment specifically on the strategic goals or leadership of the universities, concentrating instead on their outputs and the interface with business.

One of the ways in which universities can influence activity through central leadership is through the establishment of priorities for the different activities required of academics as part of their roles (such as teaching, research, and knowledge exchange including commercialisation). As explored in the earlier chapter on academic roles, views on the relative balance of priorities within each university as a driver of commercialisation vary: 32% of university respondents thought that the balance of priorities within their institution had a positive influence on commercialisation, but 11% felt that it was a negative influence (i.e. that commercialisation was not given sufficient focus). Unlike many of the drivers of commercialisation activity, there was little difference between universities by their level of commercialisation activity (as measured by the cluster analysis). Among the spin-outs, 20% thought the university's balance of priorities had a favourable influence, and 4% thought it was negative. Licensees had more mixed opinions, with 19% seeing the university's balance of priorities as a positive factor and 15% seeing it as negative.

Factors that influence the prioritisation of commercialisation for academics, ultimately, are primarily external (incentives to publish and government policy on research and teaching excellence). Universities can influence commercialisation in other ways by establishing support for academic staff (e.g. via TTOs and/or exploitation companies), and by setting out policies on KE in general, academic staff ownership and development of IP, and university protection and exploitation of IP. The case studies of Oxford (Section 10.8) and Imperial College (10.6) show examples of commercialisation policies from the institutions in the top 4 universities by level of activity.

5.1.3 The influence of university leadership and management by stage of commercialisation

The research did not directly investigate how the role of university leadership and management varied by stage of commercialisation. Respondents were however asked about the factors influencing the stages of **assembling the**

inputs for the spin-out and licensing commercialisation routes. The broad group of factors pertaining to the establishment of roles, responsibilities, and priorities was viewed as the most positively influential broad group by universities. Specifically, "university priorities" was the most commonly-reported positive influencing factor of all for preparing **spin-outs** (with 26% of universities rating these "strongly positive") and even more so for **licensing** (40% "strongly positive"). This reflects the finding from section 4.1.3 that universities view their skills to be a strong positive influence on assembling the inputs for a spin-out, and a very strong positive for licensing; there seems to be agreement that universities are appropriately prioritising the two routes to commercialisation and have the skills to support them **once the decision to commercialise has been made** – business frustrations with TTO engagement may be more likely in cases where the route to commercialisation is less clear, or if they are engaging with a university without knowing in advance if there is a specific technology that would be of use to them (e.g. they are contacting their local university to explore a potential relationship with a particular faculty).

A potential negative influence on commercialisation would be any perception of excessive bureaucracy leading to delays in activity. Although the quantitative responses of spin-outs on the influence of university central management and strategy were broadly positive, as set out above, the qualitative discussions did focus on the delays and complications introduced by university bureaucracy. There was one specific comment about the relationship between TTO functions and individual departments which pertains to university and departmental culture:

"There's little the commercialisation office can do with culture in different departments – you can affect it a little bit but it needs to come from Dean level downwards."

Among the relatively low number of spin-out participants that expressed reservations about central management, the respondents were most likely to identify the different priorities of the university as a problem. There was particular tension between **IP protection** and **publishing requirements**, and the universities proceeded **slowly** by commercial standards. The **cost of IP protection** was prohibitive in some cases, particularly in the "valley of death" before the company starts to generate revenue from sales.

Spin-outs and early stage companies are particularly sensitive to delays at the **negotiation** stage as they may not have the revenue to cover costs while waiting for transactions to be completed so that their value can be realised. The spin-outs that gave qualitative comments on university management typically considered the slow pace and overall length of time taken by the **negotiations** to have been an issue at this stage of the commercialisation process. This is not something that came across at all as prominently in our discussions with our university participants, perhaps indicating differing expectations on both sides.

"The timescales are too slow. Six months is a lifetime for a start-up – we have payroll to consider."

As to the source of these delays, some of our spin-out participants suggested their university lacked the resources to process documentation more quickly, while others suggested that the source of the issue was the 'to-ing and fro-ing' between the different legal teams acting for the university, investors and the company itself. The latter issue of co-ordination reflects more directly upon the management skills of universities.

The management skills and teams required for individual spin-outs, particularly in the **post-transaction management** stage, are considered separately within the "Skills and resources" section (chapter 4).

5.1.4 Emerging conclusions

The strategic direction and leadership of universities influences the prioritisation that academics give to commercialisation, and the levels of resource that are available to support commercialisation. University leadership is one of the main influences on academics and spin-outs, but not on investors.

As such, it is not surprising that these are viewed as among the strongest positive influences on the overall **level** of commercialisation. Their influence on the specific phases of commercialisation depends, however, on the policies and support functions that the universities provide due to their strategic direction and allocation of resources. For instance, the University of Edinburgh uses a centralised TTO, Edinburgh Research and Innovation Ltd, which provides support for spin-outs, licensing of IP and consultancy. The University of Nottingham is planning for a subsidiary, Nottingham Technology Ventures, which will specifically provide support to spin-out businesses. More details can be found in the case studies in Section 10.

5.2 IP policies, equity sharing, royalties and their negotiation

5.2.1 Existing evidence from the literature review

Part of the leadership function of a university regarding commercialisation includes setting out the policies for dealing with IP, equity and royalties. The literature review highlights that these are often contentious issues. Both commercialisation and research contracting typically involve potentially difficult *negotiations* over terms and conditions, not least the ownership of intellectual property and the distribution of any resulting monetary benefits.

Common features identified surrounding IP management by the literature review included the valuation and assignation of IP. Businesses and investors often seem to feel that universities tend to overvalue their IP. Agreeing on the value of IP during collaborative research negotiations can be particularly difficult as the IP is not yet generated[19,20]. As such agreements can build university-business collaborations and lead directly to commercialisation of IP through subsequent spin-out formation or licensing, any perception of risk when valuing IP at the research stage can provide a constraint on future commercialisation activity.

Negotiation delays tend to arise on managing IP and technology transfer, and there is not clear evidence as to why the delays arise.[21] However, evidence has shown that participation of academics in the licencing process is associated with a greater speed of commercialisation.

Finally, research has found that variation exists in approaches to negotiating equity shares from universities, with some universities having a willingness to negotiate and others not (in roughly equal proportions so far as the research is able to distinguish).[22]

5.2.2 Influencing factors by stakeholder group

The research examined five specific commercialisation issues with a common question format on the extent of the perceived problem:

- **Concerns or disputes over the level of royalties or licence fees**
- **Concerns or disputes over the level of equity shares taken by different parties in spin-outs**
- **Establishing the "proper value" for technology in spin-outs and/or licensing agreements**
- **The complexity of the spin-out process, and any related delays**
- **There is complexity and delay in providing warranties on the technology**

The table below summarises the quantitative findings from universities and businesses on the specific commercialisation issues that were investigated. The "all businesses" column includes some responses from external businesses that had invested in spin-outs or had begun trading as spin-outs before becoming licensees in the wider market.

[19] Bruneel et al, 2010. Investigating the factors that diminish the barriers to university–industry collaboration. *Research Policy 39, 858–868*.

[20] Saraga, P, 2007. Streamlining University/Business Collaborative Research Negotiations, An Independent Report to the "Funders' Forum" of the Department for Innovation Universities and Skills. *Department of Innovation Universities and Skills*.

[21] Science and Technology Committee, 2017. Managing intellectual property and technology transfer: tenth report of session 2016-17 (No. HC 755). *UK House of Commons Science and Technology Select Committee*.

[22] Wong, et al, 2015. Keys to the kingdom. *Nature Biotechnology, page:232–236, volume:33, issue:3* – however, see caveats on this research in the detailed literature review in Appendix C, as it is based largely on the **stated terms** in university policies rather than **actual terms** agreed during negotiations.

Table 4: Interviewees' views on five specific issues for commercialisation

	% of all respondents perceiving a problem to at least "some extent"		
Commercialisation issues	**Universities**	**Spin-outs**	**All businesses**
Concerns or disputes over the level of equity shares	68	35	n/a
Concerns or disputes over the level of royalties or licence fees	60	26	24
Establishing the "proper value" for technology	52	52	48
The complexity of the spin-out process, and related delays	45	74	n/a
Complexity and delay in providing warranties on the technology	42	35	36

Source: Interviews with universities, spin-outs, and IP licensees

Two-thirds (68%) of university respondents said that concerns over equity shares had created issues for commercialisation in their experience – but only ever to "some extent", rather than a "large extent". A third of spin-outs (35%) and overall businesses (30%) had issues over equity – but only 12% of businesses in general said that these issues were "large". The investors provided some qualitative information on their perception of university equity shares as high: one investor commented that an equity range at 50 – 60% for a university is out of proportion to the value provided to spin-outs and described this high share stake as "egregious".

Concerns over equity were particularly likely to arise in the early stages of the spin-out process. The universities argue that they tended to take a flexible approach to the allocations (while seeking to cover elements of their costs), were keen to incentivise the participants and ensure that IP could, in the end, bring benefits to society at large. As second and additional rounds of investment were made university shares (as with their role in the company) typically become diluted (sometimes on a pro rata basis with academics) with investors taking a higher proportion.[23] It was stated by a small number of universities that some external restrictions meant they sought to take less than 25% of equity – for example, EU regulations on state aid for businesses and their own charitable status. Business respondents were aware of this to some degree, and also of other thresholds on equity shares which would affect their classification as SMEs and restrict access to certain forms of support (for example, to qualify for relief under SEIS an investor must not hold more than a 30% stake in the company in which they invest).

Correspondingly, investors perceive universities taking an initial 50 – 60% equity share as high, which could hinder entrepreneurs/investors coming on board, despite the views expressed above by universities that they were prepared to be flexible; one investor said, *"founders who have a low share at the start leave no room for investors."* Investors also thought that there is inconsistency over equity allocations amongst universities, a suggestion was to publish information on all licensing and spin-out deals, therefore sharing information on equity shares and other elements such as royalty rates.

Over half of university participants (60%) said that disputes over the level of royalties or license fees had created issues for commercialisation in their experience – again, to "some extent". Once more, a minority of spin-outs (26%) and overall businesses (24%) stated the concerns over royalties and/or licence fees – 9% of businesses said that the issues were "large". Investors had little to say regarding licence fees and royalties, however, one commented on the TTOs taking a large equity stake alongside royalties meaning a bigger pay off for the university.

With regard to establishing the proper value of IP and technology, while over half of the spin-outs regarded IP valuation to be a problem, only 12% had deemed these issues to be "large". Around half of university participants (52%) said that this had been an issue: 48% "to some extent", 4% to "a large extent". Some 48% of all businesses said that establishing proper value was an issue to some extent. Usually issues were resolved based on experience,

[23] Our case study research on Swansea University includes details of funding streams that are designed to ensure that all participants are incentivised to develop a successful business, and methods to generate societal benefits (such as "giving away" IP if the monetary benefit is low and/or the route to commercialisation unclear).

reference to examples of the increase in share values and revenue, and benchmark data that was available (often held by the more research-intensive and active universities). The negotiations usually resolved the issues.

According to 45% of university respondents, the complexity of the **spin-out** process, and related delays, had created issues for commercialisation to some extent. However, the majority of spin-out companies (74%) said that delays and the complex process were perceived as a problem. Two thirds of all businesses deemed this to be a problem and 9% thought that this was an issue to a "large extent". A large amount of spin-out companies often commented the process was long and the university may take a while to respond. Investors' comments included some issues over the time taken to spin out due to the low technology readiness level (TRL) – that is, the early stage of development of the technology and difficulties with assessing value and finding a route to market - and specific areas of negotiation which are discussed in the following subsection. Spin-out participants and those with licences are keen to develop technologies and "get to market" to improve the chances of success and revenue, and ensure that technology is not overtaken.

Lastly, complexity or delay in providing warranties[24] on technology had created issues for commercialisation in the experience of 42% of our university participants (to some extent). Similarly, 35% and 36% of both spin-out and business respondents respectively stated delay and complexities on warranties is a problem with 9% reporting that this problem was "large". A minority of investors (unprompted) suggested that they do not typically ask universities for warranties as they recognised that universities are not normally willing to give them, due to the generally untested nature of the technology.

The overall results for the five specific issues investigated in the survey research show that there are very few cases in which these specific commercialisation issues were viewed as substantial or insurmountable barriers in the general case. They are viewed as issues "to some extent", not "a large extent". In the qualitative discussions around these points it was frequently stated that all these issues could be successfully negotiated to the satisfaction of the participants.

There was information and data available which provided guidance and benchmarks which could help inform decisions on issues such as valuing IP, extracting proper value, and royalties. However, the larger institutions with greater commercialisation activity were better able to draw on their own experience as a benchmark. (See section 9 on availability of information). Universities tended not to provide warranties on early stage technology and these could in some cases be traded off against higher equity shares / lower prices for investors.

5.2.3 Importance at each stage of commercialisation

Respondents were asked to assess the most influential factors in the choice of commercialisation through a spin-out or IP licence, whether these affected the commercialisation activity positively or negatively. These factors broadly fall into the category of IP management and finance; IP policy, licensing terms and equity shares; these are commonly mentioned during certain stages of commercialisation from all types of stakeholders.

Assembling inputs

This section deals with the process of assembling the various inputs that are needed to enter a formal licence negotiation or spin-out creation, as perceived by the universities and businesses in our survey.

[24] "Warranties" here refer to assurances that a particular technology will behave in a certain way and produce reliable, replicable outputs, which given the early stage of development, can be difficult for a university to make.

Table 5: Specific factors influencing the spin-out process

	% of all respondents					
	Universities			Spin-outs		
Specific influencing factors	Negative	Positive	Net pos	Negative	Positive	Net pos
Value of royalties	13	3	-10	10	9	-1
University IP warranties	13	6	-7	4	6	2
IP valuation and price setting	9	11	2	17	12	-5
Equity sharing allocations	15	13	2	19	17	-2
IP ownership and protection/ patents	12	26	12	28	14	-14

Source: Surveys of universities and spin-outs

At the "assembling inputs" stage, valuations of royalties are seen as a negative factor by universities (6% "negative", 7% "strongly negative"), as were issues surrounding IP warranties (3% "negative", 10% "strongly negative"). Spin-outs have slightly more positive views on these issues overall, and identified the problems as arising from issues of IP ownership and protection, broader considerations of roles, responsibilities, and priorities, and from regulation, compliance, and advice.

Our spin-out participants were somewhat split regarding the equity share their university sought to take in the company, although there was a balance towards a positive influence. This reflects findings from the literature review regarding the variation in equity shares. Some said that the equity stake the university sought was excessive: for some, this created problems in later investment rounds, as well as problems with regard to the incentives for academic founders to remain involved with the company. This reflects to a degree the responses of our university participants, a number of whom considered equity shares to be a typically contentious point. Some of our spin-out participants were successfully able to negotiate down the university's share, though many said that the university's high starting point produced difficulties.

"There's room for negotiation and we managed to change the share - what we got is the maximum that they have given. Despite that, we were still unhappy with the arrangement. 50/50 is unfair to start with, and the deal isn't that far off 50%."

However, some of our spin-out participants did consider the university's equity share to be reasonable, finding in their experience it either compared favourably with other spin-outs or was fairly commercially realistic. The comments reflect a wide variety of experiences depending upon each case. One spin-out respondent in particular said it had been useful in their case for them to have had a prior awareness of the terms the university would seek.

The subject of equity sharing allocation was brought up as a key influencing factor, unprompted, by approximately half of the investors interviewed, suggesting that it is a significant issue for the group as a whole. Most of these investors believed it to be a negative influence during the 'assembling inputs' stage. For instance, one investor mentioned they had three opportunities fail due to not being able to reach an agreement over equity allocation, others believed that equity sharing allocations sometimes take a long time to agree. Correspondingly, overvaluing IP is perceived by investors as a general problem and investors tend to feel that both academics and other university staff can have a slightly unrealistic expectation regarding value. One investor said that if the valuation is widely out of its range, then they would not even consider negotiation. Similarly, the commonest observation for spin-outs and businesses was that they felt that some universities systematically over-estimated the importance and valuation of the IP. The more research-intensive universities usually had in-house databases which gave valuations realised from a range of technologies (these transactions effectively define the market price, but will include instances where their investors had felt that the valuation was inflated but who struck a deal if alternatives were limited). These could be agreed upon in the negotiations. IP valuation could act as a constraint to a degree, along with how proper value was extracted for the university in terms of the return on the resources invested and the contribution to further research and teaching in line with the institution's charitable obligations. Warranties posed more of an issue, linked to due diligence: the universities tended not to give warranties as they could become liabilities and did not reflect their rules. They said that warranties were an unreasonable requirement for IP that could be at a very early stage of development – it was incumbent upon the spin-out or licensee to turn it into a marketable product or service. Universities did not tend to have strong views on the extent to which their IP management policies were a positive or negative influence on commercialisation relative to the other key factors identified in the research. The majority of university respondents noted that the university has an IP policy or process that tends to be followed.

While the overall business position as reflected by the quantitative findings reflects a pragmatic approach to dealing with academics and their obligations to publish, some individual businesses did highlight the tension between publication and IP protection in their qualitative remarks, for example: *"In our view, if you've got an idea patent all the way and protect. Whereas universities get praised on publishing journals and so on. The two are incompatible. If you expose what you've got it loses the value. […] They want to publish but then they want to exploit; the two are mutually exclusive, you can't protect something that has been published."* Patenting is seen as a significant cost. *"Some universities are surprised how intensive patent protecting can be."* Publication could sometimes be seen as a bonus, as long as it didn't conflict with IP protection. *"That's fine – publication is advertising for us."* However, the tension between publication timescales and patenting timescales was a source of frustration. Investors did not view publication as a particular issue.

Several business respondents commented that the universities tended to operate very slowly, by commercial standards. *"We have the experience that in the time it takes to get a licensing agreement done, particularly with multiple universities, which we dread, our priorities can change. If it takes a year to happen we might not be interested because the environment has changed."*

Negotiations

The agreement of licensing terms could pose similar problems to the approach to negotiating equity shares, depending to an extent upon the type of university. Some universities with less commercial experience would ask for a larger stake than potential partners were willing to accept, while universities with more commercial expertise tended to reach agreement more rapidly. A few investors mentioned clauses that have potential to cause difficulty in a few cases, for instance an anti-dilution clause that doesn't dilute stakes until milestones have been reached. Investors also noted that assignation of the IP takes time to negotiate and is negotiation can often be difficult. One investor simplified their terms and conditions documents and decided to negotiate deals that fit the needs of projects.

These issues are rarely impassable barriers to commercialisation, and they have to be seen as part of the negotiating context where participants are able to be flexible. There was generally a view across all stakeholder groups that the negotiating context would resolve any issues, and at the negotiating stage it was understandable that the participants would firmly set out their aims for negotiation.

As with the set-up phase, some of our spin-out, business and investor participants considered the slow pace and overall length of time taken by the negotiations to have been an issue. This is not something that came across at all as prominently in our discussions with our university participants, perhaps indicating differing expectations on both sides.

5.2.4 Summary and emerging conclusions

A general view from businesses and investors is that universities can be slow throughout the commercialisation process. Universities (68%) were more likely than businesses (30%) to perceive problems over the levels of equity shares, or royalties and licence fees (60% vs 24%). Businesses were as likely as universities (both around 50%) to perceive difficulties with valuing technology in that they felt that universities tended to over-estimate the valuation of their IP. All parties were equally likely to perceive problems with warranties – however, a small minority of businesses viewed these as "large" problems, which no universities did.

There was a difference in perception on several factors relating to IP management. Spin-outs and external businesses with knowledge of the spin-out process, identified the complexity of the spin-out process (and related delay) as an issue to at least some extent in around two thirds of cases, though rarely (9% of businesses) to a large extent. However, this was not such a common problem for universities (under half of respondents). This indicates a general difference in perception between universities and both investors and businesses. Similarly, universities and businesses differed in opinion to the extent that establishing IP ownership was an issue, with universities having an overall net positive response and businesses experiencing an overall net negative response (reflecting that universities typically have initial ownership of the IP in these transactions unless the businesses were involved in a collaborative research agreement of some kind).

Despite the small differences of opinion of the relative significance of these issues, it is clear that many parties felt they could potentially benefit from improved guidance, more information on historic/benchmark royalties or licence fees, and potentially an arm's length negotiation resolution service; these suggestions were made proactively by survey respondents in their qualitative comments. Perhaps surprisingly, universities were more concerned about equity shares, royalties, and licence fees than their business partners, and considered that providing information in advance

on their standard approach to negotiating equity shares could help to facilitate a smooth negotiating process, particularly when widening their potential market to companies with a limited experience of dealing with university IP. See Chapter 9 on availability of information for evidence and policy suggestions in these areas.

Businesses were no more likely to view early publication of research as a problem than universities, with both acknowledging that it was a core part of academic roles that had the potential to present challenges in the context of maximising commercialisation activity, at least to some extent, if not discussed in advance. This finding is not linked back to any particular ongoing policy developments – there is a natural tension between academics who have a requirement to publish and businesses seeking competitive advantage. There is perhaps scope to alleviate the issue by developing guidance on what academics and businesses can do to overcome or accommodate these tensions, backed up by case studies and practice notes provided by the institutions to allow businesses and universities to manage the issue. The TTOs are a key point of liaison to ensure that academics are not publishing research without checking whether it would impact on potential commercialisation and keeping potential business partners informed of ongoing research.

5.3 Business management / Skills within commercialisation projects

5.3.1 Existing evidence from the literature review

According to the **literature review,** key business management challenges in the commercialisation process include the search for potential investors and licensees, continuing to develop technology and products post spin-out, and development of entrepreneurial capabilities on the journey to market and sustainability. There is a "search" process required to find potential partners and investors to take the IP forward towards commercial application (Shane 2004; UNICO 2006a). This process is difficult as many university inventions are not yet at a stage that is of interest to industry. The technologies are often embryonic and may not have reached the prototype stage let alone demonstrated manufacturability and practicality in the market, and so represent high risk investments (Pressman et al. 1995; Shane 2004). This is an issue for universities at the "assembling inputs" stage and spin-outs in "post-transaction management" – but the resources available to spin-outs are much less, and these issues stretch the business management skills and resources available to early-stage spin-outs.

University IP, at the point where it is licensed by an external company or used to form a spin-out, typically requires significant technological and product development challenges to be addressed in order to develop a commercially viable product. Shane (2004) highlights the nature of further technology and product development work typically required. The scale of further work - and the **ability of the founders to successfully deliver this** – is a key part of the consideration of whether or not to invest in a spin-out. Again, this crucially depends on the business management and commercialisation skills of the spin-out team.

Research has also shown that the participation of academics in the licensing process is associated with both greater speed of commercialisation and higher royalties (Markman et al. 2005; Shane 2004). The academic holds significant tacit knowledge about the potential applications and benefits of the IP they have generated. Given this, close dialogue between the academic, the TTO, and potential investors can help increase understanding of the potential value of the IP. Therefore, there is a substantial role for academic inventors in contributing to the technical direction of a spin-out business.

5.3.2 Influencing factors by stakeholder group

The most common positive influencing factors for **licensees** in respect of internal business factors were found particularly within the company's own management and strategic direction.

Universities, and their **spin-outs**, report that they have difficulties with assembling a management team for a spin-out, recruiting staff, developing skills, entering the market and managing growth. Over half the investors also mention the importance of having a management team in place and those that did mention this often assist in finding the right team and mentoring. Mentoring is identified as a key benefit for entrepreneurial academics in the case study on Imperial College London (see section 10.6).

The final influencing factor identified in the literature review was the potential influencing role of the academic inventor on the success of a spin-out or licence (by providing their specialist knowledge of the IP and contributing to the development of the spin-out by working for them part-time or full-time). There were varying opinions among the universities, with 18% viewing the establishment of roles for individual academics as a positive influence but 24% as

negative. However, spin-outs viewed the role of individual academics as the most common *positive* influencing factor (20% positive, 24% strongly positive). There is a bias here in that all spin-outs are examples of successfully-concluded transactions and many will have involved the academic inventors, but even so the contrast is striking between the views of the spin-out staff and the university staff. Also, the interpretation of the question may extend to the role of TTOs to encourage academics to commercialise in the first place, which would explain the difference between universities and spin-outs. The spin-out interviews always concerned commercialisation that *had already happened,* while university staff were considering the commercialisation opportunities that may be being missed in their institutions, and difficulty in establishing specific roles for busy academics in the past, and therefore reporting a constraint on activity.

The overall view that establishing the role of individual academics is a potential constraint on activity does not seem to differ between the most and least active commercialising universities. High-activity universities are roughly as likely as the others to see the role of individual academics as either a positive factor or a *negative* one. It seems that the potential for an academic inventor to influence a spin-out or licensing agreement with their IP, and the views on how challenging it is to establish such roles, are broadly similar regardless of the nature of the institution – see the table below. This is doubtless linked to the wide range of competing demands upon academic time that are imposed by teaching and research responsibilities, and the universities' internal balance of priorities.

Table 6: Views on academic roles by university commercialisation cluster

	Very negative	Negative	Positive	Very positive
Role of individual academics				
Cluster 1+2 (high)	12	9	0	15
Cluster 3 (moderate)	5	23	5	5
Cluster 4 (low)	8	16	5	18

5.3.3 Importance of business management at each stage of commercialisation

The major business development issues as reported by the university staff when considering the establishment of a spin-out were: the appointment of a management team and assignment of roles; recruitment of staff and development of their skills; and market entry and growth.

Many **spin-outs** considered that the **spin-out set-up** and **negotiation** processes could have proceeded much more quickly if the university had been more responsive or the process (which is partly defined by university policies and procedures) had been less complex. **Early stage spin-outs** are much more sensitive than universities to any delays in **negotiation**, as they often are not adequately resourced to cover costs while waiting for agreement to be reached over IP.

Aside from funding and investment, the most commonly raised issue by our spin-out participants at the **post-transaction management** stage was **recruitment**, although our respondents provided a mixed picture; many said recruitment had been a particularly difficult issue when growing their business, while a sizeable minority had had a far more positive experience on this front. Other prominent business issues raised by our spin-outs included **technology or product development** and **access to premises**, with many making use of university incubator spaces.

Establishing the strength of the business management team is a priority for investors by the **negotiation stage**, for those involved at the seed stage of spin-out creation, and persists into **post-transaction management** for additional rounds of investment. Investors stated that they provide mentoring for spin-out management teams and also provide access to their own networks of advisors and potential team members. Investors see it as critical to add members to a management team with a commercial background by the post-transaction management stage as they can drive company performance.

5.3.4 Summary and emerging conclusions

Establishing the roles of academics in assembling the inputs for a spin-out is viewed as a positive influence by the spin-outs themselves but negatively by university staff. This discrepancy can be explained by the fact that all spin-outs are examples of successful commercialisation, but university staff responses include an assessment of opportunities

that are being missed because it has not been possible to motivate or involve the academic inventors. The differences of opinion between spin-outs and university staff have been used in this report to shed some light on difference between potential and actual activity – in this case, the discrepancy would appear to be evidence of a substantial level of commercialisation opportunities that are being "missed" in that research considerations (or alternative routes to business engagement such as consultancy or contract research) are being favoured.

Having the right management team in place for any commercialisation project is important for all stakeholders – assembling these teams requires experience and a network of potential partners, which is easier for more commercially-experienced universities, and those located near clusters of investors (the "Golden Triangle") or areas of high-tech business growth. Investors are aware of this and are willing to contribute to the development of management teams. The case study of Imperial College London refers to a spin-out from a "Golden Triangle" institution with access to considerable investment and networking resources, backed up by a fellowship with the Royal Academy of Engineering (see section 10.6). Small licensee (or potential licensee) businesses and pre-revenue spin-outs are badly affected by delays in the commercialisation process (which can be due to lack of expertise/ capacity to deal with IP and/ or negotiations).

These issues concern location and recruitment of specific people for specific tasks, and a recurring theme is the importance of **interpersonal relationships and networks** in this process. Investors, universities and their TTOs have greater resources and access to these than spin-outs, who are partly dependent on leveraging their relationships with their parent university (at early stage when the institution is more involved with the spin-out), investors or business partners. These networks are the subject of the next chapter.

6 INTERPERSONAL RELATIONSHIPS AND NETWORKS

This chapter covers the different perspectives on the value of interpersonal relationships and networks among the different stakeholders, their relative importance at different stages in the commercialisation process, and the potential policy responses. For the most part, it is based on qualitative responses to questions – it was not one of the influencing factors tested as part of the evaluation of the commercialisation model. It is therefore telling that it has emerged as a significant issue from the research, a finding which highlights how critical "softer" factors, not easily captured by a theoretical process model, are to the success of commercialisation processes in practice.

6.1.1 Existing evidence from the literature review

The common factors influencing commercialisation that were identified by the literature review included:

- Social networks with investor communities;
- Social networks within local regions;
- Pre-existing relationships between universities and companies; and
- The ability to find the right partner.

A strong social network with an investor community is likely to decrease probability of failure for the academic founder; this is important during the commercialisation process.[25] It is key for the academic founders and management team of a spin-out to have strong links with the university, as the networks and resources available to the university may be helpful in accessing infrastructure and expertise. The literature highlights the need for social networks within local communities, social ties between investors and inventors, and active involvement from investor communities in local entrepreneurial networks[26]. This will facilitate links for new ventures and to people such as managers and customers.

A further influence highlighted is the pre-existing relationship that exists between universities and businesses, this is identified as significant to securing financing. Prior relationships between businesses and companies (provided that these have been viewed as mutually satisfactory) help to build trust between both parties and can influence the terms that are agreed through future contract negotiations, and the speed of the process of establishing these.

In summary, the literature review identified factors relating to interpersonal relationships and access to networks: social networks between academics and investors particularly, but also academic inventors and networks in a particular location.

[25] See Table 29 in the detailed literature review in Appendix B

[26] Breznitz, S M, 2014. The Fountain of Knowledge: The Role of Universities in Economic Development, *Stanford University Press*;
Etzkowitz. H, 2008. The Triple Helix: University-Industry-Government Innovation in Action, *Routledge*;
Friedman and Silberman, 2003. University Technology Transfer: Do Incentives, Management, and Location Matter*?, The Journal of Technology Transfer, page:17-30, volume:28, issue:1*;
Gulbrandsen and Smeby, 2005. Industry funding and university professors' research performance, *Research Policy, page:932-950, volume:34, issue:6*;
Lester, R, 2005. Universities, innovation, and the competitiveness of local economies, A summary Report from the Local Innovation Systems Project: Phase I. Massachusetts Institute of Technology, Industrial Performance Center, Working Paper Series;
McMillan T, 2016; see footnote 7, page 19;
O'Shea et al, 2007. Delineating the anatomy of an entrepreneurial university: the Massachusetts Institute of Technology experience, *R&D Management, page:1–16, volume:37*;
Rothaermel et al, 2007. University entrepreneurship: a taxonomy of the literature, *Industrial and Corporate Change, page:691-791, volume:1*;
Saxenian, A, 1996. Regional Advantage: Culture and Competition in Silicon Valley and Route 128, *Harvard University Press*;
Shane S, 2004. Academic Entrepreneurship: University Spinoffs and Wealth Creation, *Edward Elgar Publishing Ltd*;
Wright et al, 2006. University spin-out companies and venture capital, *Research Policy, page:481-501, volume:35*, issue:4.

6.1.2 Influencing factors by stakeholder group

Universities tended on balance to think that communication between industry, universities, and sector bodies was a positive factor for commercialisation (22%, compared with 3% thinking it was negative). Spin-outs were more mixed (17% positive; 6% negative), as were licensees (17% positive; 12% negative). The interface between universities and business demand (for example, terms of collaborative research, etc., leading to generation of IP) was seen as a positive factor by 23% of universities (and as a negative by just 3%), and by 13% of spin-outs (zero negative). Licensees were similarly positive about the interface with universities at the research stage (12% positive, compared with 2% negative). These factors are among the more commonly-cited **external** factors by survey respondents, reflecting the literature review findings on their importance (though less so than internal factors such as skills and resources, and external factors relating to government policy and local economic conditions).

The influence of interpersonal relationships and networks clearly has a similar effect to the availability of information, and the local economic context, which were tested in the research using quantitative questions and are discussed in other thematic sections of this report. However, there was a recurring theme in the qualitative follow-up questions relating to opportunities that would not have arisen, and transactions that would not have taken place, were it not for the ability to draw on close working relationships or associations, or even chance encounters (an example of which is highlighted in the case study for the University of Aston).

The business and investor survey respondents were asked a set of questions, with comparable pre-coded responses, about the sources they use to access IP or find investment opportunities, respectively. The table below shows the responses given, with those most relevant to networks and interpersonal relationships highlighted. The most important sources for businesses and investors alike were contacts within HEIs, conferences, trade fairs, exhibitions, and networks or associations. More formal sources such as the government or public research institutions, trade and technical press, online databases and websites, and private sector sources such as commercial labs and consultants were less significant.

Table 7: Sources of information on IP/knowledge (businesses) or investment opportunities (investors) used

Sources of IP/knowledge/investment opportunities used	Businesses	Investors
Contacts in Higher Education Institutions	**82%***	**39%**
University technology transfer/commercialisation units		**50%**
Conferences, trade fairs, exhibitions	**40%**	**11%**
Professional and industry networks and associations	**26%**	**22%**
Within your firm or group	26%	22%
Government or public research institutions	22%	22%
Other businesses	**0%**	**28%**
Trade and technical press, computer databases	17%	6%
Technical standards or standard setting bodies	17%	n/a
Other investors	**n/a**	**17%**
Clients or customers	**13%**	**n/a**
Commercial labs and private R&D enterprises	13%	n/a
Suppliers of equipment, materials, services or software	**9%**	**n/a**
Investment opportunity websites	n/a	6%
Consultants	4%	0%

** Businesses were asked about HEI contacts in general; investors distinguished between TTO and other contacts.*

Some spin-out companies had personal connections with investors, and those that did tended to have pre-existing relationships with high net-worth individuals rather than Venture Capitalist or business angels. Other key relationships were with university mentors or contacts within their college. Several of the universities mentioned the broad range of relationships that they have with industrial partners as a spur to activity (although these require effort to develop and

maintain). Business respondents reported in qualitative comments that university-business interactions are often built on pre-existing personal relationships. As investigated in the chapter on information availability, a potential policy response suggested by businesses was the provision of a neutral forum to help facilitate more interactions.

A small number of spin-out participants had participated in enterprise fellowships organised either by universities or industry bodies, and had found these to be hugely helpful in supporting them in establishing their own companies. The case study of Imperial College London includes an interview with an enterprise fellow of the Royal Academy of Engineering, who had found the mentorship and access to commercial contacts enabled by the fellowship to be particularly useful. This also supported the development of their own commercial expertise.

Three of the investor respondents independently commented that universities were not promoting their opportunities as well as they could, which is why most of what they do find is through personal relationships with the TTO and key academics. Investors typically go down two routes to find investment opportunities, the first being that academics and universities approach them with an idea or the second being that they reach out to see what investment opportunities are available.

One investor commented:

"*We see very little from the UK, rather than waiting for them to come to us we go to them"*

A suggestion from the investor stakeholders was to introduce a forum and meetings in which academics can present work to investors in a relaxed environment, so investors can begin thinking about future investment.

Of the businesses, 40% stated they attend conferences, trade fairs and exhibitions whereas only 11% of investors did. A similar proportion of investors (22%) and businesses (26%) stated that they used professional industry networks and associations. Those investors that were specific to a region mentioned that the majority of their opportunities come from knowing the latest news in the area through either word of mouth, or personal connections in their area:

"A lot of it comes from just being part of a cluster, knowing who's doing things and what's going on, and some of it comes through some of the incubator facilities."

The innovation ecosystem, in particular locations, meant that universities are working with local partners across a range of KE activities to develop partnerships between businesses and investors which could lead to commercialisation, including provision of facilities, collaborative research, and allowing access to student/graduate talent via placements.

6.1.3 Stage of commercialisation

All university spin-outs gain access to the academic, business and investor networks available to the university (which should be administered via the TTO support). The strength of the TTO's networks and the local economic and innovation ecosystem are therefore available to the spin-out. This is highly relevant at the stage of **assembling the inputs** for a transaction, influences the **negotiations** (by having assembled the most appropriate team and any initial external investment), and is fundamental at the **post-transaction management** when seeking markets, partners, and future investment, and assessing competitors.

By contrast, **licensing** deals require an inventor and a business partner to locate each other and are therefore highly reliant on information on opportunities – which is frequently located by consulting networks of associates or attending industry gatherings, conferences, and networking events. Access to information through networks is therefore fundamental to **assembling the inputs** in the first place.

It was reported in qualitative comments by universities and businesses that negotiations were dependent on the interpersonal relationships of the people involved and how they "got on". This was a critical factor that ensured positive outcomes later in the process of **managing a spin-out** or maintaining a university-to-business relationship through an **IP licence** and onto potential further engagement.

As well as being able to secure favourable terms, **negotiations** are perceived as an important test of the strength of the relationships between an academic inventor, companies, and investors. As mentioned in the existing literature[27], this is recognised to be important to the long-term success of commercialisation, as an ability to form strong working relationships can help ensure further positive outcomes later on such as follow-on licencing deals, research collaborations, or consultancy relationships. These would also benefit the parent university.

Over half the investors mentioned the importance of having a management team in place and those that did mention this often assist in finding the right team and mentoring. Appointing the first Board and finding facilities were not usually issues for universities. The more research-intensive universities had extensive networks and contacts (including databases) from which the management and technical teams could be drawn.

6.1.4 Summary and emerging conclusions

The sources of information that businesses and investors use to locate opportunities are highly skewed towards those emerging from networks and interpersonal relationships rather than formal or private sector sources such as government, specialist firms and websites, or consultants. All stakeholders broadly agree that universities could do more to promote their commercialisable IP and opportunities for licencing – a key finding of the research. Often communication between businesses and universities is based on pre-existing relationships, and therefore there is a need to improve and increase communication channels. There also appears to be scope to increase awareness and use of existing information channels such as Innovate UK's Knowledge Transfer Network.

A corollary finding to the importance of interpersonal relationships, which is relevant to the discussion of funding and incentives for commercialisation and investment in chapter 8, is that incentive schemes such as tax reliefs should be carefully designed to avoid "perverse incentives" to end relationships, such as time-bound reinvestment relief.

The most successful commercialising universities have large inbuilt advantages due to their scale and experience, and the policy question is how to recreate this for developing institutions. Introducing more forums and exposure to more networks for universities may help both businesses and investors become aware of the opportunities that do exist, alongside creating more relationships within industry – chapter 9 on availability of information shows that there are no clearly favoured ways that this could be implemented, but there is widespread demand for some form of assistance. A common finding from the sections on **local economic conditions** and **availability of information** is that the most effective policy remedies may not lie in centrally-provided national information resources, but rather to incentivise universities to share knowledge and resources through local and regional partnerships such as LEPs, SIAs, university groups, the Knowledge Transfer Network, regionally-allocated funding, and schemes such as the CCF. These options could provide similar benefits to a centrally-directed service, with the advantage of a greater focus on local economic conditions and specific university specialisms.

[27] Examples are provided in Table 29 of the detailed literature review in appendix B

7 LOCAL ECONOMIC CONDITIONS

This chapter covers the different perspectives on local economic conditions and their relevance at stages in the commercialisation process among different stakeholders.

7.1.1 Existing evidence from the literature review

The **literature review** identified a range of influences impacting on commercialisation connected to the university's local environment. These cut across many of the other themes referenced in this document (such as funding and incentives for commercialisation, interpersonal relationships and networking), but are set out below in full.

Availability and access to capital at pre-seed and seed stages. At the **pre-seed** stage, capital is required to help develop university inventions to point where they become of interest to investors. Investment at this stage also provides a signal to investors that technology has been through some prior screening. Wright et al. (2006)[28] highlight the challenges perceived by TTOs both in securing funding to develop prototypes as well as for developing the necessary market validation, IPR due diligence, and business plans, all of which are critical for developing investor-ready proposals. At the **seed** stage, spin-outs require risk capital accompanied by operational assistance via VCs and business angels.

Social networks between universities, inventors and investors: this is the subject of its own thematic chapter in this research, but the areas of particular interest emerging from the literature review are the importance of:

- Networks, communications and cooperation between different institutions in a local area;
- Strong local investor community – social ties between investors and inventors allow investors to gain access to private information and reduce costs of monitoring new ventures; and
- Active involvement of investor community in local entrepreneurial network facilitates linking of new ventures to networks of managers, suppliers and customers.

Industrial composition, absorptive capacity and local labour markets. Activity is influenced by the nature and maturity of local industrial clusters, and the capacity that they have to absorb university generated IP, and the availability of skilled labour (particularly for new companies). There is also an issue with the strength of the regional innovation system as a whole, which combines learning with upstream and downstream innovation capability, and strong entrepreneurial culture

The availability of, and access to, **entrepreneurial infrastructure** (e.g. incubators, science parks, accelerators) is likely to facilitate university spin-outs. These are more likely in high technology clusters, which will also tend to have pools of experienced managers, customers and suppliers, investors etc. Related to this (and often co-located with these) are **support organisations** and innovation infrastructure providing assistance to prospective entrepreneurs.

Finally, the rigidities of the **academic labour market** affect the ability of academics to change institution or move between industry and academia). If academic entrepreneurs are tied to markets and support that are available locally, they may be constrained in activity.

7.1.2 Local economic conditions by stakeholder group

All stakeholder groups said that their local economic conditions had, on balance, a positive influence on their commercialisation activity. While university respondents were more likely than others to report a negative influence (19%), this was still far outweighed by the share that said that the local economic environment was a positive / "strongly positive" influence (49%). The table below sets out the relative frequency with which the stakeholders identified local and regional factors as a positive or negative influence.

[28] Wright et al, 2006; see footnote 12, page 27.

Table 8 Views of stakeholders on the influence of local factors in general

	% of all respondents			
Broad group of influencing factors	**Strongly negative**	**Negative**	**Positive**	**Strongly positive**
Universities	5	14	16	33
Spin-outs	0	3	17	19
Other businesses	0	5	12	24

The qualitative follow-up questions did however reveal some areas of slight concern on the influence of specific aspects of the **local or regional factors,** which varied around the country. Many of the universities took the view that there was a problem with regional access to investment and funding for knowledge exchange – a view particularly common among participants from Wales (where HEIF monies to fund and catalyse knowledge exchange and commercialisation are not available). It was also commonly acknowledged that the amount of potential commercialisation activity, the availability and interest of external business and investment partners, and of funding, varied around the UK, and in particular that outside the South East (and the "Golden Triangle" between London, Oxford, and Cambridge) the level of potential business interaction dipped significantly. Approximately one third of investors have a regional focus, and of those investors that do not, although they typically follow the quality of science for investment opportunities, it was noted that the strengths are typically in the South East, and the "Golden Triangle" in particular.

In response, regional universities are working with local partners across a range of KE activities to develop partnerships between businesses and investors which could lead to commercialisation, including provision of facilities, collaborative research, and allowing access to student/graduate talent via placements. Many report strong involvement with their Local Enterprise Partnerships such as board membership.

The Aston University case study reports several ways in which the institution is working with partnerships. It uses the Midlands Innovation group of universities to share opportunities and best practice, intends to use the Midlands Engine Science and Innovation Audit[29] to identify and share research excellence and to also provide an investment fund. Aston is currently involved with a CCF[30] bid with the Midlands Innovation group of universities, and is enthusiastic about this Fund's potential to form deeper relationships between institutions.

The table below shows that local economic conditions are reported as a positive influence by all universities, regardless of their level of commercialisation. Those that are more active commercially rate the local economic situation as having a more positive influence on their work, related to the availability of investment and the sectoral distribution, commercialisation awareness and absorptive capacity of local businesses. Virtually no respondents identified local competition (with other institutions) as an influencing factor.

The level of awareness within universities of businesses that were seeking IP and commercialisation opportunities was rather greater for the more active institutions (30% positive/ strongly positive) than the medium and low activity clusters, who nevertheless also saw this as a slight net positive for them.

[29] Regional consortia of LEPs, district councils, universities etc have been invited to submit bids for Government funding to prepare Science and Innovation Audits (SIAs). Initially these take the form of research documents which are mapping regional innovation assets and economic conditions, and these will be used in the allocation of further funding for development.

[30] The Connecting Capability Fund (CCF) was announced in April 2017. £100m of funding has been allocated to support university collaboration in research commercialisation. It aims to share good practice and capacity internally across the higher education sector, forge external technological, industrial and regional partnerships, and deliver the Government's industrial strategy priorities. The majority of the funding (£85m) is to be allocated by a competitive bid process across two funding rounds: the first call, for up to £20 million, closed in July 2017, and the second round of up to £65m will complete early in 2018.

Table 9: Views of universities on specific local and regional influencing factors, by level of commercialisation activity

	% of all respondents			
Specific local and regional influencing factors	**Strongly negative**	**Negative**	**Positive**	**Strongly positive**
Local economic activity ecosystem:				
- Cluster 1&2 (high)	3	15	**15**	**48**
- Cluster 3 (medium)	3	15	**5**	**33**
- Cluster 4 (low)	8	13	**29**	**21**
Significant local competition				
- Cluster 1&2 (high)	0	0	0	0
- Cluster 3 (medium)	0	3	0	3
- Cluster 4 (low)	0	0	0	3
Awareness of businesses seeking opportunities				
- Cluster 1&2 (high)	0	0	**6**	**24**
- Cluster 3 (medium)	0	5	3	8
- Cluster 4 (low)	0	3	0	11

The thematic chapter on funding and investment for commercialisation (chapter 8) provides further evidence on demand from businesses and universities for **regionally-focused funding** to stimulate activity, connect institutions, and help to build the critical mass of activity that the "Golden Triangle" currently benefits from. The majority of spin-outs who made qualitative comments about regional issues said that this sort of funding would be beneficial; however, they were also exposed to more general local business constraints such as availability of premises, facilities, and business support. Support of this kind can be provided by universities, for example, provision of premises onsite or access to Science/Innovation Parks closely aligned with universities; the Business Schools of institutions can also provide basic business support. Areas mentioned as having a particularly supportive environment were Cambridge, Aberdeen, and Manchester.

As set out in Table 8 at the beginning of this chapter, local factors in general were viewed as positive influences in their university commercialisation interactions by **spin-outs** (36%) and **licensees** (58%). Local factors are particularly important for **licensing** as universities and licensees need to locate each other to carry out a transaction. Spin-outs can be formed by a university wherever it is, although local factors are still important as the process can be made easier by local support networks and the spin-out requires access to markets.

The strengths and advantages of "Golden Triangle" universities were consistently identified by respondents in qualitative discussions (by "Golden Triangle" institutions themselves, their competitors, and their collaborators), including their ability to meet a range of business needs in finance, access to skills, and the quality of TTOs

The **investor** perspective is interesting in that they are seeking a return which is driven primarily by the quality of the science on offer, supported by the quality of individual TTOs. For this reason, the larger investment groups (such as IP Group and Mercia) have formed regional teams to develop relationships with institutions based on the strength of their TTOs and research base. They would be able to use existing regional funds (including co-investment) to help stimulate activity, but access to regional funding is not the primary attraction; rather it is to expand access to commercialisable IP and the potential of making a return. They are aware that a critical mass of investment and activity will improve the quality of scientific offers and potential returns in an area, and are willing to work with universities to develop their commercialisation skills, and to incentivise and encourage universities to work together if that improves the quality of investable opportunities and helps develop the local institutional culture towards bringing more technology forward.

The investors from Scotland that were interviewed tended to be very positive about funding and local economic activity. Scottish Enterprise are seen as having several effective programmes that help spin-out activity, high-tech investment (in the form of the Scottish Investment Bank's funding "ladder" of schemes such as the Scottish Seed Fund, Co-investment Fund, and Venture Fund), and business support and investment readiness in general. The universities of Scotland (as can be seen from the cluster analysis) are disproportionately represented at higher levels of IP income and activity.

7.1.3 Importance of local economic activity at each stage of commercialisation

The interview discussions highlighted that local economic conditions are significant at all stages of commercialisation. Their influence is accounted for in the transactional model and is set out by stage below.

In **assembling the inputs for commercialisation,** the key regional factors identified are access to information, opportunities, and pre-seed funding to develop investable opportunities. The level of potential activity is dependent on the presence of strong industrial clusters and research-intensive universities in an area. This is an issue for universities in commercialisation whether preparing to start **spin-outs** (where the issues will be access to resources and potential partners for the entrepreneurial team) or to **licence IP.** In the latter case, universities outside the "Golden Triangle" and other commercialisation clusters may find it more difficult to locate a potential licensee; licensees can be located anywhere in the world, but the presence of local high-tech clusters and access to networks and information makes the search easier.

Issues relating to information on opportunities and best practice are being addressed by the formation of formal and informal partnerships between universities, and initiatives such as the SIAs to identify (and market) clusters of commercialisable research strength and high-tech industries and to help access funding from different sources. Additional information and specific suggestions for potential actions by government can be found in the thematic chapter on **availability of information (chapter 9).**

The **negotiation** stage is less influenced by local and regional factors. The information from investors provided in this section of the research (and in the earlier section on **skills and resources** (chapter 4) suggests that although there are local clusters of commercialisation and business activity, the success or otherwise of negotiations depends upon the quality of the science and the skills and experience of the negotiating parties.

It is at the **post-transaction management** stage of commercialisation that access to finance, and other elements of business support, become crucial to **spin-outs** as they seek to grow, develop their products, services, and markets, and access further rounds of investment. The thematic section on **finance and incentives for commercialisation** deals with the constraints that spin-out companies face as they grow.

Local factors are less of an issue for **licences** at this point as the transaction has been made and the partners are known to each other – the continued success of the partnership and any follow-on licensing, collaborative research, or consultancy depends on the skills and relationship management of the participants rather than access to any additional local resources.

7.1.4 Summary and emerging conclusions

Local economic conditions are seen as a positive influence in commercialisation activity by all stakeholder groups, but particularly universities and licensees. This is true of universities of all levels of commercialisation activity, as measured by the cluster analysis – however, the universities in the highest commercialisation cluster have the highest opinions of their local economic activity ecosystems and are much more likely to have positive views of local business awareness of commercialisation (30% in the highest clusters, 11% in the lowest).

The Oxford-Cambridge-London "Golden Triangle" is the area with the highest concentration of activity. The factors driving this are:

- Research-intensive universities with nationally-recognised research specialisms; broad IP portfolio;
- Economies of scale that permit large TTOs with a wide range of specialists;
- Local innovation ecosystems with strong indigenous business activity and availability of investment; strong local networks of technology entrepreneurs and serial CEOs to assist in assembling an effective management team;

- History of commercial activity: catalogues of past deals that provide useful benchmarking information, and sufficient income / evidence of success to be able to resource their own investment funds in partnership with local investors; and

- Organisational experience: well-refined policies to streamline the negotiations and to free up academic time to pursue commercialisation opportunities.

These characteristics of the “Golden Triangle” environment reinforce each other and are partly based on a history of success: as a result, they are difficult to replicate for universities and businesses in other areas. They could be addressed directly to some extent by regionally-directed funding, training in commercialisation skills, guidance, and case studies. However, support for university to university collaboration to share resources and develop specialisms, such as offered by the CCF (which many responding universities were bidding for at the time of interview), may unlock greater activity by allowing smaller universities to benefit from extended networks and permitting them to build specialist experience in their sectors of strength, rather than having to cover all areas with limited resources – this has the further impact of incentivising a higher level of activity and begins to address many of the other constraints already mentioned.

8 FUNDING AND INCENTIVES FOR COMMERCIALISATION AND INVESTMENT

This chapter covers stakeholders' perspectives on the amount and type of funding available to finance commercialisation, their relative importance at different stages in the commercialisation process, and the potential policy responses.

8.1.1 Existing evidence from the literature review.

The **literature review** identified availability and access to **seed-stage capital** for spin-outs as an influencing factor. The availability of capital depended to some extent upon local context and availability of investors, but was also a national issue and affected business as they grow.

The funding and investment to support the **establishment and growth of spin-outs** in particular is a key issue. It also arises for licensing, but usually the amount of investment required is not so great. One reason for this is that the technology may be at a later stage and requires less development while it is more obvious what its field of use and application will be and whether there is a market for this with a suitable return.

There are a range of different public sector funders involved in financing research, which are crucial to the creation of IP that can ultimately be commercialised.[31] They include Research Councils and other government agencies (where each have their own conditions for funding). Some basic research is supported by businesses, and in some cases this may be incentivised by a collaborative research grant with the public sector.[32] A key factor, however, in funding commercialisation can be the regional economy and the availability of investors/ funds to support research and subsequent commercialisation – this is **external investment**, although it can be incentivised by government through **co-investment** or indirectly through **tax incentives**.

University spin-outs compared to other high technology start-ups differ and have different research technologies that require higher resource and funding requirements.[33] The characteristics of university spin-outs (as listed below) indicates that higher levels and more focussed funding is required. This influences both universities, academics (as founders of IP and technology), businesses and critically investors, the initial financial inputs at the negotiating stages and the subsequent rounds of funding required by spin-outs as they move from the seed/early stage to growth and maturity.

Some of these characteristics of university spin-outs compared to other high-tech start-ups include:-

- Longer term investment horizons that require higher levels of funding at different stages and a recognition that the required rate of return will take longer to materialise;
- The need for several rounds of funding as the technology is explored, tested, validated and applied to products and services. This has implications for the equity distribution, role of investors and control of the spin-outs;
- The greater variability in returns which are largely a function of the uncertainty over the IP and technology, its investment readiness and ultimate pay off; and
- Generally, the university spin-outs require greater funding to set up appropriate management teams, resource complex negotiations, manage financial difficulties and the financial restructuring that can accompany it.

Funding availability is also linked to other issues that arise in the literature. For example, there is difficulty in finding private sector investors because of the high risk of funding embryonic technologies in spin-outs.[34], [35].

The funding gap for university spin-outs on the supply side arises primarily at the seed and early stages of spin-outs when the uncertainties are greatest about likely success and consequent rates of return. This funding gap relates to

[31] 2015/16. HEBCIS data for university annual returns, which shows the funders. *HESA/HEFCE.*
[32] PACEC, 2013. The evaluation of collaborative research and development programmes. *Innovate UK*.
[33] Druilhe and Garnsey, 2004; Shane S, 2004; Wright et al 2006; see footnote 12, page 27.
[34] Wright et al, 2006; ibid.
[35] McMillan T, 2014; see footnote footnote 7, page 19

- A shortage of information or information failure on investment opportunities and the abilities of spin-out owners/managers
- The relatively high cost of due diligence and transactions which restricts investment
- The perception of risk and excessive risk aversion which prevents investments
- Low returns and yields on high tech companies
- Larger deals limit risk exposure.[36] [37]

Evidence from spin-outs on the demand side shows that access to finance both equity and loans was identified by one in five businesses as a main constraint to their start-up and growth (and for most it was significant). This resulted in cash flow issues for over a third.[38]

Research by Mason and Harrison (2013) indicated that following the financial crisis in 2008-10 there were significant declines in venture capital which can affect spin-outs. Equivalent information on business angel investment is less relative, but indications are that investment through business angel networks shows that it has held up to some extent, possibly because of increased demand (though increasing trends in start-ups) and government support (e.g., SEIS and EIS schemes). There is a continued emphasis on investing in tech sectors but with a shift towards more established and larger businesses which is likely to have an impact on the supply of finance spin-outs. Co-investing has become more significant in recent years that has encouraged angel investors to participate in much bigger investments and the larger firms.[39]

Over the past ten to twelve years, while the number of university spin-outs per annum has been at a lower level in since a peak of activity in 2010, the value of investment in spin-outs has been rising significantly over the period since 2013, implying that some spin-outs (and the more mature ones in particular) are attracting more investment.[40] But the qualitative evidence highlights that there are still issues in accessing finance.

These issues can be alleviated to some degree by grant funding from government sources. In particular, the Impact Accelerator Accounts and various proof of concept (POC) and proof of market funds allow the application and marketability and investment readiness of IP to be explored and co-investment funds (with investors) help to alleviate risk and spread it. Other British Business Bank interventions in equity investment include VC Catalyst (support for VC funds seeking to make investments of over £5m) and Enterprise Capital Funds (making investments of up to £5m in early stage, high growth firms), and the Business Angel Co-fund which invests alongside syndicates of business angels.

Since the conclusion of this research, the Government has published its response to the Patient Capital Review[41], which sets out proposals on many of the issues raised by respondents to the survey research. These include the establishment of a new £2.5bn Investment Fund to be incubated within the British Business Bank, doubling the annual allowance for people investing in knowledge-intensive companies through the Enterprise Investment Scheme (EIS), and also doubling the annual investment those companies can receive through EIS and the Venture Capital Trust (VCT) schemes.

8.1.2 Influencing factors by stakeholder group

Universities tended to think that government and research funding bodies, with their funding, rules and regulations, positively affected research commercialisation (27%, compared with 12% thinking the influence was negative). Spin-outs were significantly more positive (43%, compared with 9% negative) and licensees were on balance positive (22%, compared with 9% negative). Sources of national finance were seen as helpful by 18% of universities (8% negative), 38% of spin-outs (5% negative), and 15% of licensees (5% negative).

[36] PACEC, 2013. The evaluation of the Scottish seed fund. *Scottish Government*.
[37] Mason and Harrison, 2013. Business Angel Investment Activity in the Financial Crisis: UK Evidence and Policy Implications, *Environment and planning C: Government and Policy*.
[38] PACEC, 2015. The nature and value of university start-ups, *HEFCE.*

[40] 2015/16. HEBCIS data for university annual returns. *HESA/HEFCE*.
[41] Accessed at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/661397/PCR_Industry_panel_response.pdf

All of the university respondents who expressed an opinion, all of the licensees, and 90% of spin-outs, said that the government could do more to stimulate the supply of capital investment to help support IP commercialisation. When asked to specify at which stage in the commercialisation process the perceived gaps occurred, all stakeholders clearly identified the earliest stages of commercialisation as requiring the most funding.

This finding suggests that there is still untapped commercialisable IP within UK universities – the volume of investment is rising, as set out in the literature review above, but all parties (universities in particular) suggest that more resources could be allocated to developing IP to the point where it is investable.

Table 10: Interviewees' views on perceived funding problems

	% of all respondents		
Funding problems	**Universities**	**Spin-outs**	**Licensees**
Proof of Concept / seed stage	90	41	77
Start up and initial growth	48	33	46
Early growth	44	17	31
Later growth	42	14	23
Consolidation	38	3	15
Major expansion	35	3	15
Other	29	5	15

Source: Interviews with universities, spin-outs, and IP licensees

The surveys also dealt directly with the sources of funding which stakeholders said were most appropriate to deal with these funding gaps. The recommended sources by stakeholder type are set out in the table below.

Table 11: Interviewees' views on desirable funding solutions

	% of all respondents		
Funding sources	**Universities**	**Spin-outs**	**Licensees**
University investment funds	64	19	45
Tax relief on investment	60	26	45
Tax relief on profits	55	23	45
Co-investment support (match funds)	50	21	55
Investment bank	45	19	36
Other	38	23	45

Source: Interviews with universities, spin-outs, and IP licensees

Universities were most likely to recommend that they receive support for their own **investment funds**, so that they can invest directly in commercialisation; this was suggested by 64% of the respondents who expressed an opinion on types of funding. These funds could be ring fenced for spin-out investment with appropriate criteria set where universities faced constraints and there were definitive IP opportunities that could be explored and commercialised. The scale of support (for specific deals or for the universities) is uncertain but could be reviewed in consultation with universities. The more research-intensive universities have set up wholly (or partly) owned **subsidiary technology transfer businesses** and **investment funds** which can include university funding in conjunction with funds from business angels and Venture Capital firms. Those that had not been able to set up these funds, either with their own resources or in partnership with local investors, frequently suggested that Universities could be supported by government to help set up their own funds, which could stimulate potential co-investment subject to agreed criteria on how the funds could be allocated. The HEIF funding stream, or a separate fund, may be an appropriate mechanism to build internal capacity to develop commercialisable IP and to attract investment. These issues are addressed directly in the case study research with the highly-active universities of Oxford and Imperial College, in the university fund recently developed by Swansea, and in Nottingham which has recently moved to spin-out its business support unit.

Businesses, on the other hand, were most likely to suggest **direct funding** of their own business activities at various stages of development. There was a lot of interest in increased **grant funding**, especially for new start-ups and for developing products to investor-readiness or market-readiness. *"There's funding mechanisms for really early age stuff. The bit that's missing is going to develop something. Taking it from TRL 3*[42] *so it's ready for investors to put something into." "To me it's about the investor ready bit. Getting something to take to a funder, angels, VCs, high network individuals, getting something from concept IP to take to get investor ready."* There was also a need for funding to get over the **"valley of death"**[43] period once a product was marketable.

When the businesses that recommended **investment tax reliefs** were questioned on their reasons for doing so, virtually all (particularly spin-outs) stated that they were a way to encourage and de-risk investment. The qualitative comments that were made were all about "tweaks" to the existing systems, rather than any sort of dissatisfaction with the concept of tax relief as a policy vehicle for government. A recurring problem was the short timescale of schemes such as SEIS and EIS; investors would withdraw funds and look for a new investment when the reliefs expired, but companies needed long-term funding. *"Those schemes have helped but they create their own problems, and the major one is that after 3 years there's no further benefit from the tax relief, so at that point the EIS investor wants to exit and place the money in another tax efficient vehicle."* There is a need for long-term patient capital. *"You're withdrawing help at the point where things are getting commercially exciting."* There was a suggestion that funding start-up businesses using loans rather than some form of grant for product development or business growth would reduce the incentive to pull out before the company became profitable, and would also eventually replace the funds so they could be reused – a finding that appears to be additional to the literature review.

The reliefs were also recommended by universities: 60% suggested **tax relief on investments**, and 5% **tax relief on profits**, as policy initiatives to stimulate investment. The tax relief available through SEIS, EIS and VCTs was supported by most respondents as a positive way of attracting investors – although some considered the thresholds could be raised and the timescales expanded. The suggested tax relief on profits could be viewed as helping to re-cycle funds for further investment – not all the money saved would leave the technology investment ecosystem. There were also suggestions for an extension of R&D tax credits for incorporated spin-outs (at higher thresholds) which could help stimulate the flows of capital.

Half of the universities, and 55% of external businesses (licensees), suggested **co-investment support / "match funding",** potentially provided by an institution such as the **British Business Bank**. The business respondents also made the point that matched funding could act to de-risk investments and attract additional external funding.

As set out in the table above, a large proportion of universities and businesses suggested 'other' responses that were not pre-coded into the questionnaire. The most common of these was to augment the above options (co-investment, grants etc) with specific **regional funding**, especially where the local innovation ecosystems were relatively weak and the role of spin-outs was lower and investors less active. There was some concern that venture capitalists tended to focus on London, Cambridge, and Oxford, to the exclusion of promising opportunities in other areas; respondents suggested the government could act to raise awareness of investment opportunities across the country. Finally, **patent application costs** were mentioned as prohibitive by some spin-outs and any assistance to cover these would be welcome.

Incidence of funding: Qualitative discussions, with universities, businesses, and their representative groups, generated some interesting feedback on how the balance of incentives for commercialisation in general should be directed at universities or businesses, as incentivising activity has the potential to change the behaviour of the beneficiaries of support. Funding universities to make their own investments or co-investments in their technology could encourage universities to ask for more ownership of the company. Investment can be stimulated by providing appropriate reliefs on returns, whereas funding businesses to buy services from universities (such as through consultancy arrangements) would create a different form of commercial relationship – or as one business said: *"We can have different conversations with them."* Businesses expressed some concern that universities were unclear over whether their primary aim was commercial return or high-profile impact, which raises further questions about where funding should be directed and what conditions should be attached to it. This ambiguity is removed when university IP is exploited by independent commercialisation companies with a mission to generate income and return it to the parent university.

[42] Technology Readiness Level 3 is critical function/proof of concept.
[43] The "valley of death" is the period of negative cashflow during product development, before sales are underway and revenue is received from customers.

8.1.3 Influencing factors by stage of commercialisation

Accessing opportunities: The perceived funding gap at the **concept stage**, which was reported on by all stakeholder groups, shows that it is a challenge for universities to find the necessary resources to push development of the IP to the point where it was commercialisable. The overall amount of government funding available is not seen as a particular constraint in this context, based on the in-depth qualitative interviews with universities, but it could potentially be focused at the early stages of the commercialisation process, for example through Proof of Concept/Market funds and Accelerator programmes

The size of the individual investments or grant awards that could be accessed for individual projects did not appear to be an issue with universities; rather it was **the overall availability of funds for allocation**. The time period over which grants should be used was also not considered to be a major constraint, although in the life sciences, health, and medical sectors it takes longer to both prove and test applications and drug therapies. A few universities and spin-out respondents raised an issue with challenge funds such as those issued by Innovate UK's fund programme, which may issue calls at specific times of year rather than be available on a continuous basis when the technology had reached the appropriate stage.

The key stage of development of IP in terms of the technology readiness levels (TRLs) was clearly at level 3, "critical function / POC", with related issues at the adjacent level 2 (technology concept) and level 4 (validation stage). The questionnaires used the TRLs throughout the interviews and the piloting and interviewer feedback revealed that these were well-understood by stakeholders – however, there was a small amount of qualitative feedback that the linear process set out by the individual TRL stages was limited, and did not necessarily reflect the technological processes involved. At this stage of development, the preferred method of funding was by grant, in the opinion both of institutions and their early-stage spin-outs. Loans could form a liability for the company that may restrict the perception of investors and applications for operational funding from banks. In addition, there could be grants to institutions as additional monies and "ring-fenced" funding purely for the POC activities and subject to university procedures so long as these were not complex, bureaucratic and/or slow.

Early stage companies: The spin-outs we spoke to had explored various different sources of finance. Though many had secured venture capitalist investment, others had experienced difficulty attracting investment from VCs. Some suggested that VC activity tends to be too concentrated in the '"Golden Triangle"' region, a criticism also made of angel investors, though with exceptions; for example, one Scottish respondent noted the strength of their local angel networks *(see also Chapter 7 on the importance of local economic conditions)*

Some of the spin-outs with experience of seeking multiple rounds of funding reported that businesses, business angels and Venture Capitalists are cautious about risks of investment in higher risk technology businesses, particularly in seed and early stages prior to the prospects of growth being demonstrated. Some early stage respondents suggested that joint/co-investment funds between the government and investors could be used to minimise risks along with tax incentives, on any further R&D needed and on profits when they resulted.

Many spin-outs had made use of grant funding and government backed support, such as that provided by Innovate UK. Some of those who had accessed grant funding found it helpful, although they said the process of application and the decision-making process could be better streamlined. Others suggested that match funding can be difficult for small early stage companies to access as the input required by the company (e.g. application processes and provision of evidence of trading) can stretch limited resources.

It was generally acknowledged by businesses that there were funding constraints and gaps in investment, especially at the seed, start-up and early stages where the technology and its application was still being developed and the revenue streams (although with potential) had not emerged. This is especially the case where on a regional basis the market is not sufficiently well-developed to form an innovation ecosystem with investors. There was also a specific request for assistance on assessing the technological and market feasibility of IP before a lot of resources were spent on trying to obtain funding.

Later business stages, such as consolidation and expansion, were still subject to constraints, although at the later stages of growth businesses are more influenced by trends in the wider investment market. There was a perceived lack of funding for scaling-up successful businesses, and potentially strong indigenous firms (with international markets) could relocate (e.g. to the high-tech locations in the States) or be taken over. All stakeholders believe there is a greater funding constraint at earlier stages in comparison to later stages,

8.1.4 Emerging conclusions

The current policy environment is favourable for universities and businesses alike, but there is scope to increase the availability of funding, which need not require an overall increase in the *amount* of funding if it could be targeted more effectively at a local level or at specific stages of commercialisation and available when required. Careful consideration needs to be given to timescales, terms and conditions of incentives, and how they link with each other. The major funding gaps are seen by all stakeholder groups to be at the earliest stages of development – POC and POM, followed by seed funding. Tax reliefs are seen as highly useful and valuable in making IP attractive to investors.

The **POC** stage is important not only to assess the validity of the technology for commercialisation but also to help de-risk the opportunities for potential investors. POC can overlap with proof of principle and Proof of Market (POM). While a number of agencies provide POC funding and grants linked to accelerator schemes, it was considered that their funds were sometimes difficult to obtain because of their applications to certain technologies (or sectors), their challenge fund nature, the time required and the cost of obtaining these, and insufficient levels of funding available. Additional funds could speed up the commercialisation process and spread the costs and risk: these could be earmarked for use with specialist consultants and accompany a "matchmaking" service.[44]

Provision of capital could be stimulated in several different ways. The likely impact could depend on the scale of investment. The direct funding and co-investment models would merit further consideration in consultation with universities to help determine what was required and feasible:

- **Direct funding:** for universities aimed at supporting **proof of concept** funding, and to start-ups aimed at **investor readiness** or **feasibility studies/consultancy;**
- Incentivising or co-funding **University investment funds;**
- Tax relief on **investments** or **profits;**
- **Co-investment / matched funding support**, perhaps backed by a specialist **investment bank;**
- **Regional funding** to support local innovation ecosystems with lower levels of commercialisation activity and active investors – **the SIA initiative should provide specific information on regional economies with significant research assets that could benefit from support for commercialisation; and**
- Support for universities on cost of **maintenance of patents.**

The co-investment model in particular could be an appropriate method to allow more of a partnership approach between government and investors, with potentially differential matching ratios for levels of risk and the stage of technology that companies were at. For example, the seed and early stage businesses were potentially riskier than those who could show a revenue stream and sustained growth potential. The Swansea University case study shows an interesting example of an investment fund that combines matched funding for growth with funding streams for research and development of IP, thus increasing leverage on government funding and also ensuring that the vehicle as a whole is constantly developing economic impacts (new opportunities are receiving IP development and investment-readiness funding while more mature opportunities receive growth investment from the same vehicle).

[44] A template would be the "Grant for Investigating an Innovative Idea" piloted by DTI in 2005.

9 AVAILABILITY OF INFORMATION

This chapter covers the different perspectives on the availability of information to support commercialisation among the different stakeholders, their relative importance at different stages in the commercialisation process, and the potential policy responses.

9.1.1 Existing evidence from the literature review

The common factors influencing commercialisation that were identified by the **literature review** included:

- Availability of information on opportunities for commercialisation;
- Availability of best practice and guidance;
- Transparency in university IP policies; and
- Transparency in examples of transactions.

An adequate and accessible flow of relevant information between the universities (and within them) and potential partners, such as businesses and investors, is critical to the commercialisation process. The information needed includes, for example, the policies of the partners, their preferred aims and practices, the likely opportunities (re technology and IP for spin-outs and licensing), and resources available.

Commercialising university IP includes specific steps that are taken such as the organisation of events that bring partners together, network development, workshops, support for start-ups, collaborative research, contract research, and consultancy, and the placement of students and graduates with businesses.[45] The REF and case studies also encourage demonstration of the effectiveness and impact of university activities, which can be provided by an example of a successful spin-out or licensing agreement.[46] A second type of mechanism related to these is wider academic engagement (i.e. knowledge exchange in the broader sense), which is seen as of growing importance to support innovation.[47] These forms of knowledge exchange and engagement have the potential to allow feedback between commercialisation participants, continuously informing each other and feeding back on university regulations and governance, their skills and experiences, and the development of good practice and greater transparency.

A further issue concerning information is the capacity of universities to protect technologies and IP that result from research. The literature review indicates that the technology needs to be disclosed or embodied in some form (through public disclosure or by protection through a patent) in order to enable successful commercialisation, rather than remaining as tacit knowledge.[48] Also, it highlights that it can be very difficult to identify business opportunities where the information from the university or the inventor (academic) is not available and the inventors have a better knowledge about the value of university IP than other parties do. This is especially true for cutting-edge technology that has the potential to be disruptive and is difficult to conceptualise in the market.[49]

A number of barriers can constrain access to information, including a lack of time, the difficulty of finding suitable partners, a lack of resources and capabilities to engage with partners and cultural differences between the potential partners on the basis of their overall aims, priorities and strategies. These barriers can impact not just on the awareness of partners and opportunities but also issues that arise in the negotiating process on, for example, the value of IP and realising the value for those that take a stake in it.

[45] Wright et al, 2006; see footnote 12, page 27.
[46] Shane S, 2004, UNICO, 2006a and McMillan T, 2016; see footnote 7, page 19.
[47] Perkmann et al. 2013. Academic engagement and commercialisation: A review on the literature on university-industry relations, *Research Policy, page 423-442, volume 42, issue 2.*
[48] Shane S, 2004, UNICO, 2006a and McMillan T, 2016; see footnote 7, page 19.
[49] Ibid.

9.1.2 Views on specific types of information by stakeholder group

When universities were asked about the specific factors influencing the decision to commercialise IP, some mentioned universities' awareness of businesses seeking commercialisation opportunities (17% thought this was a positive factor and just 3% thought it was negative). Spin-outs were much more positive about university awareness of businesses seeking opportunities, with 21% citing this as positive and none as negative; this may be because spin-outs tend to work with the more active universities. Licensees were more divided, with 17% saying university awareness was a positive factor and 14% saying it was negative.

Similar numbers commented on the level of business awareness of commercialisation opportunities in the universities. One in ten university respondents thought the level of business awareness was a positive factor, and 7% thought it was a negative. Spin-outs were more positive about business awareness (12%, compared with 3% negative) and licensees had stronger opinions (22% positive; 7% negative).

A few universities commented on the development of good practice and guidance, and the use of contract toolkits; 7% thought this was a positive factor and 5% thought it was a negative. Spin-outs and licensees were more likely to see this as positive (14%, against zero negative, for both),

The survey respondents from all stakeholder groups were asked a question about whether they viewed the availability of information on commercialisation opportunities, for themselves *and for the other stakeholder groups,* as "effective", "somewhat effective", or "not effective". The table below, which shows only the percentage answering "not effective" for each category, reveals a difference between the opinions of universities (which see few problems with availability of information on opportunities), and those of spin-outs (30% of which see information for businesses as "not effective") and licensees (41%).

Table 12: Interviewees' views on problems with availability of information on opportunities – percentage rating it "not effective"

	% of all respondents responding "not effective"		
Information about opportunities	**Universities**	**Spin-outs**	**Licensees**
…for businesses	6	**30**	**41**
…for universities	4	13	12
…for investors	2	3	12

Source: Interviews with universities, spin-outs, and IP licensees

The survey also asked how different kinds of information were viewed by the stakeholder groups. Universities were more satisfied than businesses with the effectiveness of best practice guidance (which was the most positively-viewed type of information), impartial advice, and guidelines or toolkits.

Table 13: Interviewees' views on the effectiveness of different kinds of information – percentage rating it "very" or "partially" effective

	% of all respondents responding "very" or "partially" effective		
Views on kinds of information	**Universities**	**Spin-outs**	**Licensees**
Best practice guidance	51	27	31
Impartial advice	40	24	31
Guidelines/toolkits	47	24	31

Source: Interviews with universities, spin-outs, and IP licensees

The following paragraphs aim to explain why these differences exist by providing examples of both university and business views from qualitative responses.

Some of the respondents from more active commercialising universities suggested that the focus of information provision should be on the range of universities with intermediate-to-high research intensity but with lower commercialisation activity. This reflects the fact that they have strong research bases and the greatest potential to benefit from increased commercialisation. As set out in the cluster analysis in Appendix A (section 12 below), the distribution of commercialisation activity (chiefly measured by IP income) is very much more skewed towards the most active universities than the distribution of research intensity. In other words, there are institutions with comparable research bases to the most successful commercialising institutions, but with much less IP income, that could be assisted.

A small number of university respondents, in qualitative comments, did express the opinion that the awareness among businesses of opportunities that universities have in terms of IP is not as high as it could be in the UK – stating, for example, that they needed to "educate businesses on how university tech transfer works".

The businesses and spin-outs suggested that a government forum or hub could help facilitate university-business information exchange/ interactions, and could provide a formal mechanism by which academics and universities could better interact with industry. A comment from a licensee on this issue was:

"There's not really any forums where you can see tech and IP that's ready for market."

Finally, a minority of business respondents argued that a lack of information was not a key barrier to knowledge exchange and commercialisation, arguing that the requisite information is available and that it is simply a question of ensuring it is accessible to those who need it. Indeed, one respondent stated that there was a surfeit of information in this area, and that their problem had been sifting through an 'overload' of potentially relevant information.

"I think people worry about this too much, in the days of Google it's very easy to find out who's doing what. I think if I people really want to find out then they can find out… If you have an enquiring mind as a business and you want to find out about things it's easy enough. A lot of people get hung up about portals and networking and it's pretty straightforward really isn't it, the world's a pretty connected place."

Investors agreed that information levels are not causing any particular problems. One investor stated that it is their role to find companies to invest in, and in order to be successful, one should be proactive in the area. Of those that discussed provision of information, one investor mentioned other factors (such as skills) as being a larger issue to acknowledge; overall, issues of skills, resources, the university science base, and issues relating to equity shares were all brought up by investors more frequently than issues relating to provision of information.

Stakeholders views on transparency

All respondents were asked about the potential for government to facilitate greater transparency over how universities, businesses, and investors approach commercialisation. This transparency falls into two main areas: publication of information about university policies on matters such as standard contract terms, preferred equity shares, IP valuations, and royalties (and the evidence underlying these); and provision of information on transactions between universities and businesses in order to provide benchmarking information for potential future partners.

The table below shows the breakdown of responses to this question. Broad majorities across all stakeholders said that something could perhaps be done by government to improve transparency for universities and businesses, with slightly less believing that this could be done for investors. However, qualitative discussions revealed that they were sceptical as to the feasibility of facilitating greater transparency, with some noting the difficulties that could arise in revealing potentially commercially sensitive information. Examples of information that would be problematic to disclose would include the details of particular licensing deals or the position taken by the different parties in spin-out negotiations, the value of IP, and share distributions at the early stages. Others argued that greater transparency may not be of particular benefit given that all licenses and spin-outs are necessarily different, with different requirements, circumstances and technology.

Table 14: Interviewees' views on potential for government to facilitate greater transparency over how universities, businesses, and investors approach commercialisation

	% of all respondents responding "Yes"		
Government could facilitate greater transparency	**Universities**	**Spin-outs**	**Licensees**
…for universities	73	69	85
…for businesses	57	77	69
…for investors	57	38	38

Publicly available case studies demonstrating successful examples of commercialisation may be of use, particularly for licensing agreements, although the REF impact case studies cover this to some extent. There are commercial databases in the market in some sectors which purport to hold information on a large number of deals agreed between universities and businesses, and there could be value in having such information made more publicly available. It is unclear whether there is scope or need for a national initiative to increase availability of such data. In qualitative discussions, businesses and universities alike noted that any initiative to create a publicly-available transaction database would have to hold the confidence of both businesses and universities regarding its reliability and representativeness. A centrally-managed national database may be less effective than local measures to improve information sharing and networking between universities and businesses.

With regard to whether government might be able to provide greater transparency as to how universities, businesses, and investors approach commercialisation, the **licensee and spin-out** participants suggested it would be of value to have greater transparency over the level of equity shares universities typically seek in their spin-out companies. A small number of spin-out respondents said that they did not have a clear picture of standard university terms and conditions on matters such as equity shares and royalty payments before they entered the set-up phase prior negotiations, and may have made different choices if this information were readily available to academics. In this way, making IP policies public, at least in summary form, is of use to businesses and academics immediately and in the future. It provides academics and businesses with information for negotiation purposes in the present. It is also of use to current and future academic researchers in deciding what to do with their research portfolios and even in deciding which university to work for if they have commercial ambitions – this may lead to longer-term benefits as academics improve their commercialisation skills (or alternatively make an informed decision to focus on pure research).

Similarly to businesses, a majority of our investor participants thought greater transparency of deals, and university policies, terms and conditions for commercialisation, would be useful. In particular, greater transparency could help build awareness of the practicalities involved in negotiating terms and conditions, ownership of IP and distribution of monetary benefits. In general, investors mentioned the need to share more information about the spin-out and licensing process amongst universities.

One investor mentioned that transparency was important to individual academics within universities:

"Lack of transparency for academics as to what the normal IP licensing arrangements are, if there is IP to be licensed they tend to be unsure as to what position they can take about the IP, they don't know whether they can negotiate with the university or not"

Another investor thought transparency can help make the process of commercialisation quicker:

"I think having those standard terms and publicising them and being transparent about what is offered would save time during the process."

9.1.3 Importance of information and transparency at each stage of commercialisation

The issues discussed above are linked to specific stages of the commercialisation process. Information on availability of opportunities between universities and businesses is used at the very beginning of **assembling the inputs**. Information for and concerning investors can be of use at the assembling inputs stage but the investors will play their role at the **negotiations** and **post-transaction management** stages. Transparency of IP policies and examples of

previous transactions are intended to influence the **negotiation** phase (or possibly in seeking further rounds of investment **post-transaction**).

9.1.4 Summary and emerging conclusions

The contrast between the views of universities and business on the availability of information on commercialisation opportunities and processes is a key finding. Businesses perceive a lack of information which universities do not – given that universities hold the relevant information on IP, if on a case-by-case basis they do not feel that there is a need to release it (or publicise it more widely, if it is technically in the public domain) then this is a barrier for businesses to access it and a constraint on potential commercialisation.

Universities had more favourable opinions of available **best practice guidance**, **guidelines and toolkits,** and **impartial advice** than businesses (see section 9.1.2). This suggests that the information gap is not simply in terms of what universities make available about their commercialisable IP base and opportunities for collaboration – it extends to information from central government and sector representative bodies that could be made available for businesses.

A minority of businesses said government needed to establish mechanisms or hubs to support knowledge/ information exchange between universities and businesses. To put the scale of the problem in context, issues relating to "University awareness of businesses seeking IP / commercialisation opportunities", "development of good practice and guidance and use of contract toolkits", and "businesses' awareness of commercialisation opportunities with the university" were much less prominent in the unprompted survey responses on the influencing factors (positively or negatively) to the same extent as issues of skills and resources, local economic conditions, and central government funding and policy (discussed in thematic chapters 4, 7, and 8) – see also the detailed quantitative tables in Appendix E.

The universities were cautiously in favour of increased transparency, provided that it offered broadly based information on potential opportunities, rather than detailed information on valuations, shares/equity and royalties, as this formed part of the negotiations. Businesses and spin-outs were also in favour of greater transparency in broad terms, over typical university equity shares and royalties, or through publication and explanation of policies; they were also in favour of a slightly higher level of transparency than the universities such as provision of information on example transactions.

10 CASE STUDIES

Examination of particular examples of university technology transfer infrastructure, individual transactions, and examples of commercialisation in the devolved administrations.

10.1 Northern Ireland context: Queen's University Belfast.

10.1.1 Background

Queen's University Belfast organises its commercialisation activities through a central TTO (the Research and Enterprise Directorate). Queen's provides an integrated approach in its support for commercialisation, physically housing all the University's commercialisation support services together within one building and providing one repository of support throughout the commercialisation process. The University is also able to invest in its own spin-out companies through a subsidiary company, QUBIS Ltd.

The primary aim of the University in IP commercialisation is supporting the dissemination of knowledge to provide economic and social benefit. Indeed, this is particularly important for Queen's as a Northern Ireland based institution, and the University is keenly aware of the potential for positive impact through its commercialisation activities in improving productivity and driving economic growth in one of the more economically disadvantaged regions of the United Kingdom. Queen's also considers demonstrating impact through the REF to be an important aim and significant influence on its commercialisation activities, particularly given the link between the REF and university funding. A secondary aim of the University's commercialisation activities is the generation of income; generating income through commercialisation activities enables the University not only to invest in improving the student experience and in supporting research, but also facilitates further investment in future commercialisation activities. It is also an important aim given that Queen's fees and funding levels are lower than those of some other comparable universities.

Within the different departments and research areas of the University particularly active areas for commercialisation include computer science, pharmaceutical sciences, chemistry and chemical engineering, life sciences and medicine.

Queen's does not have a strong preference with regards to the form of IP commercialisation at the University between spin-out companies and IP licensing, and will situationally assess each opportunity to ascertain the most suitable route in any particular case. However, there can be some added impetus towards the formation of spin-out companies given the University's ambition to contribute to the development of a knowledge economy in Northern Ireland and the tendency for spin-out companies to become locally rooted.

Positive influencing factors in the case of Queen's University include consistent support for commercialisation activities within the leadership of the University. For example, QUBIS, the University's subsidiary which invests in its spin-out companies, has been in existence since 1984. QUBIS itself positively influences the University's activities by enabling the University to financially back its own spin-out companies. Other positive factors include the quality of the University's commercialisable research base as a research-intensive Russell Group institution and the commercial expertise and experience of staff supporting commercialisation activities. Potentially negative factors concern the local economic ecosystem in Northern Ireland. This can produce challenges with regard to access to capital in comparison with other parts of the United Kingdom, with private investors such as business angel networks or venture capital activity relatively thin on the ground. Access to people can provide a similar challenge, particularly with regard to the availability of experienced entrepreneurial expertise to lead the University's spin-out companies. Lastly, the local ecosystem provides relatively little access to large corporate businesses or industrial companies, and this comparatively narrow corporate base means that Queen's spin-outs can find fewer potential customers to be immediately available.

10.1.2 Spin-outs

The process of commercialisation through the spin-out route at Queen's places significant emphasis on external input, expertise and advice. It does not begin the typical process by having an academic team present a business plan which would then be subject to approval by a university committee. The process begins with a disclosure by an academic or academics, and thereafter an individual member of Research and Enterprise will work with the academic to assess the potential routes to commercialisation. Rather than relying on just the TTO, a crucial priority for the University is securing the involvement of an external expert in a management or leadership role with the business. This will typically

be an individual with entrepreneurial experience and knowledge of the business's proposed sector or market of operation. This process can also help to provide an external validation function for the University, and the opinion and interest in involvement with the business of external experts can serve to help differentiate viable business propositions from unviable propositions. The University further assesses the business through business model canvassing and customer discovery processes, as well as running the business through ICURe and Lean Launchpad style programmes. The Lean Launchpad has been piloted by the University and offers intensive help to companies focusing on the market and customer base. This enables further external scrutiny of the business proposition. The decision to approve the formation of companies, as well as approval of potential investment by QUBIS into the company, will be taken by a management board within the University as well as the board of QUBIS which includes external entrepreneurs, ensuring yet further external input and scrutiny during the process of spinning-out. The existence of QUBIS has also allowed the growth of an informal angel network which may be beneficial given the local economic activity was perceived as a negative factor.

The University has a clear policy regarding the initial equity distribution in the spin-out, which is an equal split between the academic founder and the University. However, the University will display flexibility and reduce the equity holding it seeks as appropriate to the particular situation; for example, if the University hasn't invested significantly in patenting or committed significant business development resources to supporting the business then the University will seek a reduced equity share. The University will also seek to incentivise entrepreneurial involvement through equity allocations to external experts, and so will again reduce the equity share it seeks in these cases.

The University will typically seek a seat on the board of the spin-out in order to continue to support the business. The University also has a clear policy to provide spin-out companies with use of their facilities for 3 years.

Potential challenges during the spin-out process can include achieving the involvement of an external expert in the leadership and management of the company, securing a suitable management team more broadly, establishing a clear customer or market need, and accessing further funding.

10.1.3 IP Licensing

The licensing of IP at Queen's University is managed by the commercial development team within the Research and Enterprise Directorate, who have responsibility for locating partners for IP licensing opportunities. The University does not find licensing to necessarily be easier than the formation of spin-out companies, as licensing will still require development and advancement through the TRL scale to a point at which the IP may present a viable opportunity for an industrial or corporate partner.

The biggest challenge in the licensing of IP for Queen's is the asymmetry of information between the University and the partner. The partner's knowledge of the marketplace, the potential value of the IP under consideration and the need for further technological or product development is typically greater than that of the University; this can lead to issues in valuations, the most common of which would be that the University opens negotiations with a high valuation, to avoid the risk of missing out on full value for a technology for which they do not fully understand the market potential. Greater experience and a portfolio of licenses can help to ameliorate this issue to a degree.

Administration of royalties has not typically been an issue for Queen's, providing the license is constructed well in the negotiations. A licensing pipeline committee meet and discuss licensing deals to manage this process. Additionally, the University has well-established processes in place when managing licenses, for instance; larger license deals can occasionally go through a review function and the University may go on to hold discussions with the licensee.

10.1.4 Conclusions: Practices and polices

With regard to the possibility of greater transparency in this area, Queen's believe their own policies to be currently fairly clear and transparent. It was indicated that there could be scope for a sector body (for example PraxisAuril, or the Russell Group) to codify and explain the different approaches that universities take in commercialising their research. Businesses could however benefit from additional information, in terms of increasing understanding their understanding about how best to work with universities and set expectations in advance.

In terms of the incentives provided by government policy, the REF along with the wider impact agenda was likely to have had a very significant impact in incentivising universities to engage with commercialisation. This is particularly due to the link between REF and funding, which is a particular concern for Queen's.

Funding was seen as a key issue, and the University said that they had lower access to funding than universities in mainland Great Britain. With regard to specific government interventions in this area, EIS and SEIS were considered to be important initiatives that could potentially be expanded. Additional funding on a national level targeted at the POC phase of commercialisation would be particularly valuable.

10.2 Scotland context: The University of Edinburgh

10.2.1 Background

The University of Edinburgh organises its commercialisation activities through a centralised Technology Transfer (TT) office together with Edinburgh Research and Innovation Ltd, a subsidiary company. Further support for knowledge exchange activities is provided by the University Innovation Fund, amongst others. The University provides support for spin-outs, licensing of IP, funding and consultancy. It also uses specialist external advice drawn from the relatively mature innovation ecosystem in Scotland. The primary aim is to ensure knowledge generated in the University is disseminated and exploited for wider social and economic benefits. Income is a related aim to help cover university costs associated with IP and to support the exploitation process.

The University's policies and information on its approach to commercialisation along with the support it offers are publicly available, for example, on its website and in annual reports.

There is no preferred form for commercialising IP between spin-out companies and licensing to other organisations. It depends mainly on the type and stage of the technology developed, the participation of the academics, likely success in time, the likely team/lead partners and funding availability amongst other things.

10.2.2 Spin-outs

When spin-outs are formed the TTO has the main role. Key factors are the IP / technology availability which is usually at a relatively early stage (i.e., the technology concept / proof of principal / concept, with associated due diligence), the academic preference for the spin-out route or not, the likelihood of an implementation/management team being recruited and potential investors.

The University takes a flexible approach to the distribution of equity reflecting its overall aims to ensure the economic and social benefits of IP are realised. Generally, the allocation of shares is agreed to help ensure the partners are incentivised and the company can meet its aims.

The spin-out process is more complicated and takes longer than other licensing deals.

The distribution of shares and business management arrangements follow an general process from valuing the IP, estimating inputs/costs and likely returns. Any issues are usually satisfactorily resolved through negotiations.

Any key issues are dealt with at an early stage to help ensure the company grows and becomes successful over time.

10.2.3 IP Licensing

The licensing route is the responsibility of the TTO staff in liaison with the academic(s), it is often quicker and easier than the spin-out route to commercialisation primarily as the technology is more developed at (or beyond) the POC stage and has reached the validation stage.

Any issues such as the fee structure for royalties over time and access to academics are dealt with at an early stage. Very few potential deals do not go ahead and a flexible approach to the negotiations ensures mutually satisfactory outcomes.

During the exploitation process there is regular contact with the licensee and ongoing management issues do not usually pose problems given overall agreement on, for example, the field of use of the technology, links with other IP/technology and any handback arrangements when the IP is not used enough.

10.3Wales context: Swansea University

10.3.1 Swansea's approach to commercialisation

Swansea University is a research-led university that since its foundation in 1920 has specialised in applied research and developed strong links with industry. The make-up of research in the University lends itself naturally to commercialisation for impact, with the main sources of IP being its College of Engineering and the Medical School. There is a clearly defined IP policy which sets out the parameters of ownership and entitlements to IP, which has helped build a culture of innovation.

It is a challenge for the University to fund companies with the budget and capability to spend significant amounts of money on R&D, so the University relies to an extent upon the Welsh Assembly Government to invest into collaborative R&D projects bringing SMEs and large businesses together into consortia with academics at the University (and other universities in Wales) to generate scale of activity. Brexit is seen as a significant challenge as around 55% of current research income is EU funded. Another international factor is around the visibility of Welsh research internationally, although the universities in Wales in general are seen to be working hard to increase their international profile.

The department of Research, Engagement and Innovation Services is the central department responsible for technology transfer, which historically has managed and led the functions around disclosures, engagement with the academic community, and engagement with stakeholders in industry. The department also manages the interface with the wholly-owned subsidiary company Swansea Innovations, which is assigned university IP at the point in time where there is technology ready for commercialisation and is responsible for commercial services including IP management, business engagement projects, and legal support.

Earlier in the year, Swansea's services benefited from a major ERDF funded project, "AgorIP" ("agor" is Welsh for "open", but the name also has echoes of "agora", the Greek word for "marketplace"). This has significantly increased Swansea's ability to invest in technology transfer, particularly since Welsh universities no longer receive HEIF funding which historically had been the only central government funding which could be allocated to technology transfer (alongside other forms of knowledge exchange). The AgorIP initiative is a £13.5 million programme supporting eligible projects with Assessment, Proof-of-Concept, and Investment-Readiness, which can be used to leverage additional backing from several different sources. Investment-ready opportunities will be introduced to appropriate funders and assistance is available where required throughout any negotiation processes.

The TTO has a triage process which helps to determine if an opportunity is significant enough to command the input of further resources. A typical triage process would establish some threshold of commercial promise above which resources would be deployed – and such a threshold would typically be quite high because resources are limited. The Swansea model is a "return on investment" triage process, so that an opportunity with a modest level of commercial opportunity attached to it will be taken forward provided that the cost of doing so is low.

The return on investment model also assists in the decision between the license and the spin-out, due to the potential cost to market: if the cost to market is significant, then it would typically be a license opportunity because market reach would be required to recoup that cost. In some cases, if a proposition has some value but the cost to market is too high, the IP can be "given away" to a commercial partner with an agreement that the University will be the first port of call for development assistance such as consultancy at a later stage if commercialisation proceeds. If the scale of opportunity and cost to market are both relatively low, there is a potential opportunity for a spin-out; Swansea has a set of protective measures for small academic-led companies protect them from early-stage financial difficulties and enable them to start trading and see if there is a market for their product. Finally, if the cost to market is low but the scale of the opportunity is high then the proposition is already a potential investment opportunity for the Venture Capital community.

The engagement process between academics and the TTO has been streamlined and involves the support of external business angels to provide another layer of triage. Rather than ask an academic inventor to complete a technology disclosure form, in Swansea external business angels will carry out a structured interview with the inventor, complete the form on their behalf and add in their own feedback on the commercial prospects for the opportunity. In this way the exposure to external advice from the business community occurs at a very early stage, and can carry additional weight with the academic inventor compared to an opinion solely from the TTO.

Swansea is now in the second year of managing its own University Investment Fund (with internal and external investor funds) that can be used to provide seed funding. Welsh Government investment from the fund must be matched with independent co-investment, and is also typically matched with a government grant for creating economic activity. In this way, the University's investment is matched at least threefold, and the incentives are provided for the university to invest (it receives co-funding to develop its IP and grant money from government to develop new opportunities), and for government (because its funding is being matched by university and investment money which is immediately used to create economic activity outside the University).

The fact that the University has a direct stake in the businesses and IP that the Fund invests in means that the University balance sheet contains entries for intellectual property. This type of investment is not unusual for the more active universities. This raises the profile of the investments within the University but also enables the University to borrow for finance for development against these assets.

In summary, Swansea is pursuing a number of innovative models to stimulate commercialisation and ensure that the incentives of university, investor and government are all aligned. The seed funds in particular are features typically found in much larger commercialising institutions and could provide a model for other research-intensive but lower-commercialising universities to help them generate impact, provided the initial funding could be accessed.

10.4 The University of Nottingham

10.4.1 Background – spinning out spin-out support

The University of Nottingham is a Russell Group institution, ranked 8th for research power in the 2014 Research Excellence Framework. It has a broad portfolio of research strengths, with commercialisable IP typically arising from the faculties of Medicine and Health Sciences, Science, and Engineering. In common with other commercialising institutions, the majority of Nottingham's spin-out portfolio tends to be biomedically-based, as for these sorts of discoveries the IP has to go through regulatory hurdles and requires further investment to take it forward.

The institution has had a TTO entirely embedded within the business support function of the University for the past 20 years. However, the institution is currently in the process of spinning out a small portion of it, specifically the part for supporting spin-out companies. This is to be called Nottingham Technology Ventures. The University view is that, particularly in the early days of making new invention disclosures, it is essential for a TTO to be able to build close relationships with the academic community in order to be able to access research and make disclosures. However, by the time that a spin-out is a reasonable possibility, the disclosures are quite a long way down the path to being worked up into commercial propositions. Proximity to researchers is therefore of greater importance when it comes taking initial disclosures, working these up and moving towards licensing, than it is at the point of development where a spin-out could be formed. Also, a different sort of expertise is required for providing spin-out company support and engagement with the venture capital and investment community. Finally, having some separation from university pay scales makes it easier for the University to attract the type of experienced serial entrepreneur who has the right sort of network and connections.

This approach is a hybrid of the typical embedded TTO, and the route taken by many of the other Russell Group universities of separate vehicles for IP commercialisation. If successful, it will offer the "best of both worlds" in terms of a close working relationship with the academic community and an in-depth understanding of university priorities and mission, with the right sort of expertise to make a success in the spin-out arena.

10.4.2 A new spin-out with a licensing agreement

We have interviewed a high-growth potential company that was established to commercialise technology patented by a professor at the University. The University TTO had commissioned a consultant in 2011 to investigate the commercial potential of the technology and identify potential commercial partners with the intention of securing a licensing agreement. However, it was not until later that year that a potential lead business partner to drive the technology forward became available. Discussions with the lead scientist followed, and a proposal was put forward to form a new company if the university would agree to license the technology into the company, at which point the new team would start to secure funding to take the technology out of the laboratory and into the market. The company was registered in January 2012.

The external business team, with the external business partner as CEO and the consultant as CTO, had had experience of similar ventures in the past and the support offered by the TTO and legal department was sufficient to start the company.

External investment was provided by private investors, not institutional/VC funding; this was a conscious decision by the University and TTO to ensure that the investment would be made with the intention of remaining on-board for the longer term necessary to develop an early stage but potentially disruptive technology to the point where it could trade and grow.

The negotiation of equity stakes was reasonably straightforward. The chief drivers of negotiations related to the university starting point were the level of investment required to develop the technology, the scale of the potential return. Aside from returns on the initial stake, the university would benefit from publicity, demonstration of impact, and potential future research funding, if the company is successful. The university remains an observer.

The company has located at premises in BioCity in Nottingham, which has helped to attract good quality scientific staff onto the project. There is a good network of skilled people in Nottingham for such ventures to tap into.

The technology is unique to the University and this company, and potentially serves a global marketplace if its laboratory potential can be realised in the form of a product. This in the end has pushed it towards the spin-out route for commercialisation rather than a licence to an existing business. There is a significant risk involved with the amount of investment required to develop a suite of products, and it is difficult for a university or TTO to take the necessary steps to carve out a market niche, or invest the resources necessary to develop something that may never produce a return. Experienced business partners willing to take these risks are required, and in this case it took considerable time, use of paid consultancy, personal networks and a few chance encounters to bring a team together.

There is a potential market failure that a venture of this sort illustrates, in that considerable experience is required to develop technology and grow a new company, but money for salaries is hard to come by when a company is at an early stage and there are uncertainties which lead to excessive risk aversion. This is a risk for the first staff working for the new company, and even though they can be founder shareholders there is considerable dilution of their equity when external investment is made. It is very difficult to value the future potential of a technology and the current system favours later stage funders when technology has been tested and revenue streams are clearer. These may not be the people taking the initial risks. Potential policy responses, as identified by the research team, would require increased funding from government or Research Councils to de-risk technology (e.g., through POC/Market or Accelerator funds) or initiatives to raise the awareness of opportunities amongst potential partners or investors.

10.5 The University of Manchester

10.5.1 Structure of commercialisation support

The University supports technology transfer and commercialisation through a separate wholly-owned company, UMI^3, University of Manchester ‘Inspire, Invent, Innovate’.

UMI^3 maintains two separate branches: an Innovation Centre (UMIC) for physical assets and an IP Commercialisation centre (UMIP). Most commercialisation activity is channelled through UMIP, though it engages with other parts of the University as appropriate (e.g. contracts office). UMIP has a specialist IP team and does no routine outsourcing of expertise beyond the minimum required (i.e. patent agents), though the University does make use of specialists with domain expertise when appropriate.

10.5.2 University policy

The University’s wider strategic objectives treat commercialisation as an instrument of research impact, intended to support diffusion of technologies to the wider economy. The University does not specify a preference of IP licensing over spin-outs, as is typical for larger institutions with high levels of activity.

As with other universities that are more active in commercialising IP, best practice guidance is supplied on websites, such as the UMI^3 website, alongside the University’s IP policy and guidance for researchers on the spin-out and licensing process.

The shares of return on IP for inventors are determined according to the route ('channel') used for commercialisation, reflecting the extent of the University's involvement. The University's share of income from the IP is split 50:50 between the school/faculty(s) from which the IP originated and the UMI[3] technology transfer fund. This approach is similar to that used in the more research intensive universities, but the distribution can depend on the relative costs incurred in developing the IP and technology.

Licensing

The main licensing channel, 'Protect and develop', provides the inventor(s) with an 85% return as a starting point on IP up to £4million and 50% of returns over this amount.[50] Where the University is involved in commercialisation, it retains an additional share of 5%-15%, plus an additional 15% for proof of principle funding up to £70,000 or 30% above £140,000, with a sliding scale in between. The policy differentiates Manchester from a number of other universities which only pay out licenses once costs have been recovered, potentially many years later.

Spin-outs

The share of equity between the University and the inventor similarly depends on the channel for commercialisation, the University's involvement in the process and the amount of Proof of Principle funding supplied. As above, the University takes a base rate of 15% up to £4 million (50% above), with added shares for involvement in commercialisation for management services by UMI[3] (added 5-15% depending on commercialisation route), and where Proof of Principle funds are required (added 15% up to £70,000 or 30% above £140,000 with a sliding scale in between).

10.5.3 Case Study: Pharmaceutical R&D and licensing deal

Company characteristics

The university engaged a large pharmaceutical enterprise based overseas to explore potential licensing opportunities for its technology. The company employs over 400 people, split between its research & development and sales & distribution teams, and enjoys a large and diverse global export market. The firm has a dedicated IP and R&D team which engages industry associations and networks as well as higher education researchers to explore business development opportunities. It has explored half a dozen licensing opportunities with higher education providers in the last 5 years, and is increasing its interest in these opportunities, particularly with British institutions.

Motivation for engaging the university

The company's motivation for engaging the university was mostly animated by the desire to secure new technologies for the company's product pipeline, and to deliver shareholder value.

The main internal influences were the strategic direction of the company to secure the pipeline and lock-in future revenue. The company noted that they lacked the skills and high-level research required to develop the product quickly and could not reproduce these in-house in time.

The decision to engage with Manchester University was influenced by the perceived high standard of UK universities, both in ethics and scientific pedigree, and the country's legacy of high quality medical research funding.

The transaction

The business sought a variety of external parties to support the negotiations and the final deal. These included accountants, international contract lawyers, internal legal teams.

The technology was relatively well-developed (technology readiness level 5: in situ validation), having been tested in international trials already – a pilot in Africa.

[50] Return on IP = aggregate income and capital received less tax and costs.

The business had not developed plans for monitoring the performance of the license or a means of comparing performance across license families. They did note however, that a key test would be the speed at which the product could be deployed to the market and the speed at which it would subsequently generate revenue.

The university team appeared cautious following initial contact, in the business's view (through a mutual contact at the TTO), having previously lost IP due to involvement in a previous deal in which the field of use of the IP was not as expected. It therefore took more time to establish mutual understanding and produce a Heads of Agreement.

The business cited 'red tape' and 'bureaucracy' within the university as the largest cause of delay, as well as difficulty understanding its own tax implications going forward.

Business view on improving interaction

The biggest problems occurred for the company before the negotiations started, in getting the university to agree its approach to the specific IP and its overall objectives. This can be an issue related specifically to the IP itself. Although the University publishes its guidelines it cannot cover all types of IP. This was primarily because decisions had to be made on the feasibility participation and resources required compared to other potential options.

The business noted a potential role for government in linking researchers and industry, helping to save industry from doing a large amount of global networking and research to know what opportunities were on offer. Proposed policy solutions included additional advice and guidance on tax and international business support. They also suggested a licensing or IP 'hub' for businesses to secure support.

10.6 Imperial College, University of London

10.6.1 The University policy context

Imperial College organises and delivers its commercialisation activities through a centralised Technology Transfer Business (TTB) i.e. the Touchstone Innovations Group which is partly owned by the College. Within Touchstone, Imperial Innovations Ltd is a linked company which provides technology transfer services to the College. This arrangement provides support for spin-outs, licensing of IP, consultancy and investment. It uses some specialist external advice drawn from organisations that form part of the mature innovation ecosystem in London and its network. The primary aim is to ensure knowledge generated by Imperial is disseminated and exploited for wider social and economic benefits. Income is a related aim to help cover University costs associated with IP and to support the exploitation process.

The College's policies and information on its approach to commercialisation, along with the support it offers, are publicly available on its website and through various papers/reports it makes available, sometimes in conjunction with the more active commercialising universities.

The primary sources of university IP are driven mainly by the research funding it receives through the Research Councils, collaborative research and to some extent quality-related funding (QR). The main departments are medicine/health, biotechnology, chemistry and engineering.

There is no preferred form for commercialising IP between spin-out companies and licensing to other organisations. It depends mainly on the type and stage of the technology developed, the type of participation sought by the academics, likely success in time, and the investment needed amongst other things.

The University policies and practices are designed to facilitate and encourage successful spin-outs and licensing agreements so that IP can be exploited for wider societal benefits.

The process of identification of IP for potential spin-outs, and licensing opportunities, includes liaison between Imperial Innovations and departments and academics on a regular basis to identify opportunities resulting in a short list for consideration based on the factors above. Discussions are usually held with seed/early stage investors and licensing partners (for initial and further stages of investment) and sometimes external specialist advice is used.

10.6.2 A new spin-out company supported by a Royal Academy of Engineering Enterprise Fellowship

We have interviewed the founder of an Imperial College spin-out who established their company with the support of a Royal Academy of Engineering (RAE) Enterprise Fellowship. The RAE Enterprise Fellowship scheme offers bespoke support and mentoring to the founders of high-tech companies; it aims to help bring engineering innovations to market for wider public benefit, to improve the skills of the awardee, and to develop role models of entrepreneurship. A number of Imperial College spin-outs have been founded by RAE Enterprise Fellowship awardees.

The company's founder worked as a postdoctoral researcher within one of the university's departments and was designing custom instruments to support the work of a senior academic. This work produced the main innovations which instigated the commercialisation process. The impetus to spin-out a company came from the desire to generate a positive social impact through the innovation, while the nature of the intellectual property concerned and the need for further development of the technology precluded the consideration of the licensing route to commercialisation.

The founder made use of the resources and support provided by the RAE Enterprise Fellowship from the start of the spin-out process. At the earliest stages the Fellowship provided the company with general information concerning the formation of a company as well as financial support, which then comprised seed funding for the company and supported the academic personally during the spin-out process. The RAE also provided support and advice during the founder's negotiations with Imperial.

The academic founder of this spin-out sought to be highly involved in managing the process of commercialisation and the growth of their business, as envisaged by the RAE Enterprise Fellowship. In their view, this was the source of some problems in their negotiations and relationship with Imperial. The founder believes that the university was more used to academic founders taking a less involved role in commercialisation, with the university's standard approach allowing the university to essentially manage the process on behalf of the academic. They also believe that the university may have been more accommodating of their position had they been a more senior academic. The misalignment of expectations between the university and the founder fed through into some dispute over equity allocations, as the university's standard equity position (a 50/50 split with the academic founders) assumed a prominent supporting role for the university in the commercialisation process. As in this case the founder was seeking to do much of the 'heavy lifting' of managing and growing the spin-out, they found it difficult to justify the university taking a large equity share in the company. Perhaps reflecting similar experiences amongst other spin-outs from the university, Imperial are currently piloting a programme called Founders Choice, whereby the academic founders of spin-out companies can choose between greater or lesser levels of support from the university as required in their particular case. Those requiring lesser support are then able to seek a correspondingly lower university equity stake in the spin-out during the company's formation. This avenue was unavailable during the foundation of this spin-out company.

The initial equity allocation was an equal split between the university and the founder and broadly in accordance with the standard procedures, although the founder was able to take up share options as the company developed which have subsequently increased their share of the company and reduced the university share. This is an approach used by other universities often related to the input of the academic following start-up and during the growth stages. With regard to the governance of the spin-out, the university have had the right to representation on the company's board, but has yet to take up this right. The spin-out continues to be based in university facilities, within the researcher's original lab.

The company has not taken on any external equity investment, though it has won three Innovate UK grants as well as numerous other smaller grants. Rather, the growth of the business has mainly been financed organically through revenue generation, reflecting the fact that the spin-out's main product was relatively market-ready at an early stage and the fact that the spin-out was able to enter into a deal to sell products to a large international corporation relatively early.

The founder of this spin-out considered the support offered by the RAE Enterprise Fellowship to be highly important in supporting the commercialisation of their research. In particular, the mentorship offered through the Fellowship helped to provide access to external commercial acumen that otherwise would have been unavailable to the founding academic, and supported the development of the academic's own commercial expertise. The financial support provided by the Fellowship was also highly important, particularly at the early stages of the company's formation.

10.7 The University of York

10.7.1 The University Policy Context: structure of commercialisation support

The University of York supports technology transfer and commercialisation through a central Research and Enterprise Directorate. The Research and Enterprise Directorate works with academics to identify commercialisable intellectual property, to assess the potential of any given opportunity, and to evaluate the most appropriate route to commercialisation for their research. The Directorate then provides professional support to academics to continue the process of commercialisation through a Business Development Team, an IP and Legal Team, and a Continuing Professional Development team.

The University can make use of external support during the commercialisation process on a case by case basis. For example, external patent attorneys have in the past been used during some aspects of the process of managing patent filings, while the University will also make use of external consultancy on occasion should it be considered necessary in a particular case. The University will also work with external venture capital organisations to support commercialisation.

10.7.2 University policy

There are a number of aims the University seeks to achieve through the commercialisation of IP. An important priority is generating impact through the University's research, and commercialisation offers an avenue through which to demonstrate this. The University also places a high priority on providing economic and social benefit through the commercialisation of its research, both at a local level, through establishing locally rooted spin-out companies and supporting local employment, or at a wider national level in contributing to the UK economy as a whole.

The University also considers the formation of spin-outs to be a potentially useful vehicle for further engagement with academic research, for example through leveraging Innovate UK support to further effective knowledge transfer. An additional aim for the University is furthering the development of an entrepreneurial spirit at the University, and developing the commercial skills of academic staff (which may engender further success in commercialisation in the future).

As with many institutions, of the University's different research areas commercialisation activity has tended to particularly originate within the sciences, and in particular York's Computer Science and Electronic Engineering departments. As with many other larger higher education institutions, the University has no clear preference for IP licensing as against the formation of spin-out companies.

The University has a clearly established policy with regard to the equity shares it seeks in its spin-out companies, which is for a 40:60 equity split between the founders and the University respectively. However, the University does consider this to be open for negotiation. The University is also likely to reduce its equity holding in order to incentivise third party involvement with the spin-out. The University will typically appoint a director to the board of the spin-out, and this will most likely be the business development manager who had previously been involved with supporting the commercialisation process on behalf of the Research and Enterprise Directorate.

10.7.3 Case Study: A new medical diagnostics spin-out company

We have interviewed the founder of a University of York spin-out company which specialises in medical devices for the diagnosis and monitoring of Parkinson's disease, Alzheimer's disease and a range of other neurodegenerative diseases. In this case, the initial decision to commercialise was chiefly instigated by the academic founder, while the decision to pursue a spin-out route to commercialisation was made in consultation with the university business development team. The founding academic was supported by the award of a Royal Academy of Engineering Enterprise Fellowship as well as several other competitive awards, which enabled the founding academic to buy back their time from the university to devote to establishing the company.

The company was incorporated in 2013. The founding academic was aware of the university's established 40:60 policy on equity splits, though they found that in practice the university seeks a considerably lower equity stake, as it will negotiate away a level of equity share in order to incentivise external involvement in the company; in this case, the company was able to use this approach to allow it to recruit an external Finance Director directly from industry.

There are a number of challenges and issues the company faced during the spin-out process. The founder of the company believes the university lacks experienced staff to deal with external investors and manage the negotiation process. They said that the university, as a major shareholder, included certain specifications in the shareholders' agreement which meant the company has to seek university consent in order to take certain actions or decisions. This is something the founder felt might potentially dissuade external investors becoming involved with the company. Patent costs were another significant issue for the business; the university initially supported the company by covering these costs, however, after they escalated the university moved the costs on to the company, which became a significant issue for the business going forward.

The founder also considered the recruitment of staff to be a significant issue for the spin-out. In particular, they found it was difficult to recruit sufficiently skilled people into a newly formed business as it provided less security than an academic post. This is an area where the founder believes KTPs can be of use to allow the company to acquire the skills it needs.

10.8 The University of Oxford

10.8.1 The University policy context

The University of Oxford organises and delivers comprehensive commercialisation activities through Oxford Innovation (OI) and Oxford Sciences Innovation (OSI) linking technology transfer with investment in technology, spin-outs and licensing. OSI manages a significant investment fund bringing together investors from, for example, the UK, the USA and Far East. It occasionally uses specialist external advice drawn from the organisations in the mature innovation ecosystem and its network in the Oxford area, London, the South East and internationally. This network is a source of potential investors, Board members and management team members for spin-outs. The primary aim is to ensure knowledge generated by the University is disseminated and exploited for wider social and economic benefits. Income is a related aim to help cover university costs associated with IP and to support the exploitation process.

The University's policies and approach to commercialisation together with detail of the organisations above are publicly available on the University websites.

The primary sources of university IP that can be commercialised are driven mainly by the research funding it receives through the Research Councils, collaborative research and to some extent contract and consultancy research as well as government quality-related funding (QR) where academics who do the research can translate it into IP for spin-outs and licensing. The main departments are those that carry out research in the fields of health, biomedicine, biotech, pharma, life sciences, engineering, space and the physical sciences generally.

There is no preferred form for commercialising IP between spin-out companies and licensing to other organisations. It depends mainly on the type and the degree of participation preferred by the academics, likely commercial success, and the investment required amongst other things.

The key positive contextual factors for commercialisation are the policy framework of the University and its specialist companies (OI and OSI). These have advantages in that they are flexible, focussed, have skilled staff with professional business investment backgrounds, a high level of funding and a strong network.

There is a well-developed process to identity IP opportunities for potential spin-outs, and licensing, including liaison with the departments and academics on a regular basis resulting in a short list for consideration based on the likely success and benefits to participants and society . The appraisal is usually forward looking and covers not just the initial stages of the spin-outs and licensing but the later rounds of investment required, the identification of potential board and management team members and the role of academics within a planning framework.

10.8.2 A pharmaceutical business

The company founders were University of Oxford academics carrying out biochemistry research within the university, who set up the business over ten years ago. They have grown it, to the point where it now has a stock market listing.

The founders had previously set up another spin-out company which had been successful and could draw on this experience. The licensing route was not considered as the science/biochemistry technology was at a stage that provided a suitable basis for founding the company.

Oxford Innovations was directly involved in helping to set up the company and advising on the process, management and potential funders. The business management team, which includes the founders, continues to work very closely with the university and with key academics. There have been several stages in the business's development, and two of them have involved the university; the first of which was the founding of the company and the second where new technology in a similar field was used.

In terms of funding there were some relatively small amounts at the start. This was used with an investment group to facilitate an IPO listing. Within 3 or 4 months the company was able to raise substantially more for development and growth. No other VC groups were involved apart from those at the initial stage of investment. Time was taken to build the right management team. The university still has a small equity stake in the company. The company continues to fund work within the university and support postdoctoral researchers.

The university had observer rights in the company to begin with. Sometimes, in the view of the spin-out interviewee, the academic collaborations could be difficult to sustain and align. For example, academics have a requirement to publish and the company's drive is to develop products or services that can be commercialised. These two aims don't always square with one another. However, the participants have worked very hard to align their objectives.

The spin-out interviewee considered that it is natural in the early stages for the company founders to think they could be faced with the "valley of death" and not be able to commercialise the IP. A related issue was that funding can pose a real problem for university spin-outs. The spin-out interviewee considered that generally there wasn't enough capital available and there are more ideas than there was funding for them. It is probably somewhat easier to raise funding in the UK compared to many parts of Europe, but it is worse compared to the US. It is one of the reasons why the company is also listed in the US. For what the company was trying to do there just wasn't the supply of investors or funds to develop the ideas in the UK, although the availability of funds has improved. The spin-out founder thought the negotiation stage with the university could have been better especially to speed-up decisions.

In terms of management, recruiting people of the right calibre is always an issue and a function of having the right funding in place to be able to recruit people with the skills required. Board level recruitment is easier and often comes through the investors. A big issue can be staffing at intermediate levels in the company. In the past, the UK could supply staff because of the size of the pharmaceuticals sector and expertise of potential candidates. The spin-out interviewee considered that the UK now had a smaller number of researchers because of pharma firms closing and/or contracting, in spite of some firms growing. It was thought recruitment of staff from Europe was now more difficult because of BREXIT.

In terms of government/university policy issues greater provision of information was not a high priority and the company was well informed. There was no problem in accessing technology in terms of knowing what was available. The bigger issue was facilitating the actual transfer and taking it to market.

The spin-out interviewee considered that where the "valley of death" issue arises there was no easy way in which it can be solved. There would always be risk and careful financial judgement needed to be made about investment. One solution would be to have a larger public funding market in London, for example, along the lines of NASDAQ in the USA, which would help improve the overall flow of funds and spread the risks. The spin-out interviewee thought the government may be able to incentivise and stimulate a better public funding market for life sciences based on the USA model to help resolve funding issues and achieve scale-up for businesses.

The spin-out founder thought the government's catalyst funds and the innovation awards have been effective in assisting early stage firms. The streamlined bureaucracy for making awards is now more practical. The amount of funding the government puts in gets positive leverage from private investors so it is possible to get 4 or 5 times the awarded amount. There are steps that could be taken through the tax structure to try and encourage pension funds and others to invest in newer more innovative companies.

The spin-out founder considered the government had been helpful by ensuring university TTOs were adequately staffed in such a way as to encourage technology transfer and deal with the issues. However, further steps were required. Universities should be permitted to make a return on their investments but it should not be a priority. The objective should be to ensure that ideas developed in the universities are commercialised and are for the general public good.

The spin-out interviewee thought the main challenge was getting the right quality people into TTOs and managing them well. One of the issues is that there can be appropriate staff but not enough decisions were delegated to them to allow progress to be speeded up. The company negotiated deals relatively quickly with TTOs but it then took months before the university moved forward – although the scope of the deal didn't change. Hence bureaucracy should not result in delays which restricted progress.

10.9 The University of Cambridge

Cambridge University is one of the world's top universities and sits at the centre of Europe's most successful technology cluster, the "Cambridge Phenomenon" – a cluster of 5,000 high tech companies employing 60,000 people and turning over £12Bn p.a. in a city of just 130,000 people. Cambridge Enterprise is a wholly owned subsidiary of the University that supports the academic community in undertaking consultancy, protecting and licensing the registrable Intellectual Property (IP) they create and creating and investing in spin-out companies.

The IP Policy of the University is unusual in that it allows researchers to opt out and take personal assignment of IP they have created if they wish. This results in Cambridge Enterprise having a strong customer service ethos as evidenced by the very low opt-out rate and the high satisfaction rates – 90% of researchers who have worked with Cambridge Enterprise would recommend Cambridge Enterprise to a colleague. Providing a great service, building a trust relationship with researchers and working with them – sometimes over many years - to translate their ideas into a commercially viable opportunity are important and word of mouth recommendation is the most effective marketing tool. Another important factor in generating word of mouth is Consultancy support which engages with significantly more researchers than either spin-outs or licensing. Consultancy also engages strongly with the Arts, Humanities and Social Sciences, which generate some of the largest consultancy contracts which can lead on to licensing, spin-outs and research collaborations.

The highest priority given to Cambridge Enterprise by the University is to get the ideas and innovations out there creating social and/or economic impact. Making money is the lowest priority, although coincidentally this approach also generates great financial returns. Licensing to incumbents in the market place is therefore, subject to the wishes of the researchers, the preferred option as they have the resources to translate the opportunity with speed and scale.

However, as with their peers at Stanford and MIT, too often the idea is at too early a stage or too disruptive to generate industry interest in which case Cambridge Enterprise will help create a spin-out company to take it forward, investing up to £1m per company in seed funding to get it off the ground and through its sister organisation, Cambridge Innovation Capital, up to £10m to take it forward. When seed funding a spin-out the criteria are not valuation, exit value or RoI but, "If successful will it make a significant difference and if so how do we make it happen?" In making that judgement Cambridge Enterprise is fortunate to be able to draw on the collective experience of the ecosystem's successful entrepreneurs. Their seed investment decisions have leveraged in over £1.5Bn of third party money and provided world leading returns which go to support the next generation of spin-outs.

The reputation of the University and the vibrant entrepreneurial ecosystem that has built up around it, as with Stanford and Silicon Valley or MIT and Kendall Square, give it unique advantages not only in supporting spin-outs and licensing but also in fostering an entrepreneurial mindset across the campus. While the networks of successful entrepreneurs, angels, investors, incubators, science parks and world leading research institutes create an environment with the resources to support new ideas with ambition, it is highly relevant that 50 years ago there was no cluster, no "Phenomenon", just world leading research that has made a significant contribution to growth.

10.10 Aston University

10.10.1 Background and the TTO model

Aston University is a research-led university noted for its graduate employability and strong links with business, driven in part by a high rate of student placements. The institution is strategically positioning itself as a university for business and professions, and has a hierarchy of university policies driving commercialisation activity, including a Research and Enterprise Strategy with targets for licenses and spin-outs, Commercialisation and IP policies that set out IP protection arrangements internally and staff respectively, and an Impact strategy which sets out Aston's plans for delivering impact from research. Enterprise forms part of the curriculum so that graduates and undergraduates are motivated to create their own businesses.

The institution used to out-source some of its IP commercialisation activity (including management of the patent portfolio) to the University of Oxford (Oxentia), while retaining a small amount of internal resource. This option was expensive, and as the commercialisable IP base developed it became more efficient to move to internal resources. Aston now has a director of IP and Commercialisation to oversee this activity internally, and a Research and Knowledge Exchange department that works closely with industry partners and internal financial and research teams. This arrangement permits it to maintain access to internal legal and financial support services for spin-outs, business development functions for identifying potential licensees, and the generation of research. Due diligence and decisions on approving commercialisation projects are carried out by an Intellectual Capital Exploitation (ICE) Panel which academics pitch to directly with ideas. As part of a medium sized institution, the TTO interviewees said that Aston's executive management team were relatively "close to the action" and could influence activity significantly and offer support.

Institutional focus on commercialisation is on generation of impact, on the region and for the UK generally. As the time lag to commercial success or generation of additional funding can be very long, the primary objective is not to generate a return to the University – having said which, the University has benefitted financially from successful commercialisation in life and health sciences, engineering and applied sciences. There is somewhat of an institutional preference for licensing rather than spin-outs, as it is a less resource-intensive route to commercialisation, potentially a quicker route if partners can be identified, and is a good fit for the sorts of technologies in which the institution has research strengths.

The institution has a strong focus on collaborative research with industry, which often leads to IP agreements being put in place so that any viable technology developed is licensed back to the partner company for exploitation. These business links, and the activities of the Business School (which has venture capital experience in senior management), help the University as a whole to understand what businesses need from their IP. An initiative is currently in progress to engage marketing and business oriented students in evaluating potential markets for technology early on, thus reinforcing the strategic link between the University's enterprise and entrepreneurship curriculum and its research faculties. When spin-outs are judged to be the most effective route to commercialisation, external management teams are brought in.

10.10.2 An IP licensing transaction

In developing this case study two staff members were interviewed from a company involved in biologic discovery for therapeutics and diagnostics. They provide services to pharmacological and other biomedical firms by screening very large libraries of biological entities into smaller pools of candidate molecules that have a higher chance of having a useful and relevant function for their users.

There was a fair degree of serendipity in the initial connection between this company and Aston, which was made at a networking event at a conference. The company were aware of the problems and limitations with their business model and were looking for potential partners but were not actively looking for a technological solution at that point. The academic inventor also happened to be known to the company CSO through a previous role but had not developed this specific IP at that stage. The initial patent application had been filed some 4 or 5 years previously and the technology was seen as being in a very "raw" state, but the fit with this company's business was extremely good: it supported their core business and their existing platform for interrogating biological libraries, there was a clear path to commercialisation of the technology to improve their systems, and the potential product was of immediate interest to their current customer group. The company believed that considerable development work would be needed to develop the technology to the point where it would generate a commercial return; however, they believed that they could use another technology that they had bought in to assist in refining the research into something relevant for industry.

The negotiations went very smoothly, and the group were able to proceed from an original commercial discussion and Expression of Interest to a transactive document in just 6 weeks. The company were impressed with the TTO's understanding of the value of the technology at its stage of development and viewed their terms (which were skewed towards eventual royalties rather than an up-front fee) as reasonable and sensible. Too high a value on the technology would have prevented the technology ever entering the market at its stage of development, and the costs of maintaining the IP would have continued to build up for the university. The academic inventor and TTO were keen to commercialise and for impact to be generated from the IP, having maintained the patent for some time and having investigated alternative routes to commercialisation in the past.

10.10.3 General lessons

A key influencing factor for the company, based on their experience of other deals, is how open the university and TTO are to commercialisation. This particular transaction was the easiest deal that the company had negotiated (including four licenses with other UK universities and two from the US), and the openness of the institution, their wish to see a deal done to generate impact, and the involvement of the academic inventor as an active facilitator and provider of information and expertise in relation to the technology were all extremely useful. The academic inventor collaborated with the business on several projects going forward, including BBSRC-funded work and collaborative research.

The four sticking points typically experienced by this particular business in licencing deals have been:

1. The royalty rates;
2. **Minimum royalty levels and performance obligations:** the points/milestones at which these kick in, and how quickly they increase. With technology coming out of universities at early stages of development, there can be considerable work to be done to bring products and services to market, and so minimum royalty payments at too early a stage can be off-putting;
3. **Ownership of arising IP / freedom to operate:** Universities can continue to research and innovate and develop their IP base, which can be a constraint on the development of licensees and raise questions of ownership of arising IP, especially if there is a collaborative arrangement to develop the technology with the university;
4. **Payment of historic patent fees:** universities would ideally wish licensing companies to cover all historic patent fees. There is a debate to be had around this, particularly if licences are non-exclusive. The initial patent fees can be seen as part of the risk the university takes when it invests in creating an IP asset in the first place, and a licensee would rather share that risk, since they are investing themselves to develop the IP further, rather than cover the university's outlay entirely.

Issues typically arise early on in the pre-negotiation process, rather than "at the table", although this is partly influenced by the fact that both parties have their own views on potential sticking points and wish to raise these at an early stage. Once a deal has been signed, a licensing arrangement is typically a simple one to maintain from both sides – however, there is a lot of value in building upon the relationship as the company may wish to use the inventors expertise in developing the product and for potential future technology transfer in the same area, the university and inventor can derive further income and research impact from potential contract or consultancy research, and both sides could enter a collaborative research arrangement.

In general, it is helpful if an academic inventor can be engaged, realistic about their technology and not defensive about its limitations (as in most cases it will not be fully proven). TTOs need to be able to judge the value of their technology and whether it is worth patenting. It is difficult for a small TTO to have the necessary depth of experience to cover a range of subject areas in the necessary detail, and the point was made by the business interviewees that there is an incentive for universities to band together to provide this depth. This is not just about saving money but could lead to streamlined processes and being able to afford to have more specialised individuals.

The University academics considered that Aston generated enough IP to be able to have good subject knowledge and maintain relevant experience – however, this was acknowledged as an issue for lower research-intensity institutions. The institution is involved in a CCF bid with the Midlands Innovation group of universities, and is enthusiastic about this Fund's potential to form deeper relationships between institutions, and the potential of the Midlands Engine SIA to identify and share research excellence and also provide an investment fund, which could assist at the seed stage in particular. The TTO maintains a network of other TTOs, shares best practice beyond the Midlands Engine area, and makes use of PraxisUnico resources. They are actively involved in attracting investors to the Midlands with the Midlands Innovation group, and make use of the alumni network which has been useful in raising funding for spin-outs.

A coda to this transactional case study is that the biological subject lead from the TTO that was central to this deal has now left the university – this highlights the value of specialists, the need for universities to attempt to match commercial salaries, and the pull of London and the "Golden Triangle".

11 CONCLUSIONS

This section presents our conclusions on the overall functioning of the knowledge exchange system as it relates to the commercialisation of university IP.

11.1 Overall conclusions

Our research suggests that approaches taken to knowledge exchange and the commercialisation of university IP are **working reasonably well and that the steps taken by participants have improved processes and outcomes over time**.

- The overall system and policy context for commercialising university IP in the UK broadly operate to encourage and support commercialisation, develop the skills and capacity of universities to develop commercialisation opportunities and engage with external partners, encourage businesses and investors to use their resources and skills to engage with universities, and stimulate the information sources and networks that allow commercialisation relationships to be formed.

- Although numbers of new spin-outs have fluctuated in recent years, the amount of external investment in spin-outs has been rising since 2013, suggesting a possible increased focus on quality and commercial viability of spin-out opportunities.

- There are also further improvements to practices underway including, for example, increased funding and support, greater incentives for academics, improved capacity and skills in universities (especially the research-intensive ones) and good practice models. The more active universities also have direct links and relationships with investors to help identify, fund, and manage opportunities, to address many of the perceived constraints and barriers that were identified by the survey research without the necessity of intervention by government.

- Generally, while some of the issues are complex, and reflect the different aims and priorities of the participants, it was viewed as a reasonably well-functioning system, and that many of the perceived constraints, barriers and pinch points identified by stakeholders were already being addressed, often by participants working together to identify and address issues.

- The analysis of views on the factors that influence outcomes and the features with potential problems reflect this position. Across all interviewees, there were more positive views and factors identified (including the strongly positive ones) compared to negative ones. The main positive features, on balance, included the university wide factors such as leadership, the strategic direction and aims, and the universities balance of priorities. Other positive aspects were the national factors such as the sources of funding and finance (which underpinned the research that led to IP for commercialisation) and the REF context and impact measures. The local economy and innovation ecosystem was important especially for the more research-intensive and active universities – but posed difficulties for those where the infrastructure was weaker and they were more geographically remote.

Our respondents recognised that while the current approach had many positive features there was always some scope for improvement, and it seems likely that the pinch points and issues identified mean that at least some potentially valuable commercialisation opportunities are not currently being exploited. This is supported by our analysis at Appendix C that suggests that there are likely to be at least some viable spin-out and licensing opportunities that are not pursued due to resource constraints in universities.

Potential for improvement

Specific suggestions for improvements are discussed in the preceding chapters. We conclude by discussing our assessment of the key themes in the suggestions made by respondents, how these relate to recent policy developments, and what this implies for the scope and nature of further action to improve conditions for commercialisation.

- Respondents reported that the most influential factor on commercialisation is the **skills and experience of university commercialisation staff** (the TTO). The research confirms that stakeholders view **universities as resource-constrained** in terms of the numbers and skills of staff, the available time for commercialisation activity, and funding for staff and to invest in IP to take commercialisation forward, despite the influence of the REF and the development of university strategies to drive KE and commercialisation.

- A recent policy initiative with potential to support many of the suggestions made is the **Connecting Capability Fund**, which will help to address issues of resource constraints, skills development, information sharing, and building local clusters of expertise. The **Science and Innovation Audits** also have the potential to build local clusters of expertise, share and publicise commercialisation opportunities, and attract funding for partners to address regional issues. The impacts of these initiatives on commercialisation should be monitored closely as they have the potential to decrease the gap between the few very successful commercialising universities, and other research-intensive institutions with potentially exploitable IP assets.

- There are trade-offs between devoting time to commercialisation and other factors driving academic behaviour. Research and teaching career paths are well-established, and universities may not have consistently reacted to the need to incentivise academic staff appropriately so that they are able to prioritise and commit to commercialisation and spin-out development – but this may be a less significant concern than the general level of funding for maintenance of skilled TTOs and the maintenance of patent portfolios.

- The qualitative discussions with universities suggests that it is commonly considered a struggle to maintain IP, business development, research and innovation teams all with the necessary skills or experience to drive commercialisation activity forward. This can be a function of the funding available, which can be short-term and hence creates uncertainty. Until a critical mass of successful commercialisation activity and concomitant returns on investment can be developed, this will remain an issue outside the largest commercialising universities.

- A common theme among all the findings on influencing factors and commonly-experienced barriers is the **large set of incremental advantages that the handful of highly successful commercialising universities have**. There are large, well-resourced universities outside the "Golden Triangle" of London, Oxford, and Cambridge, including high research-intensity universities with nationally-recognised research specialisms. Many of these are based in innovation ecosystems with strong local business activity and availability of investment, and some have been able to resource their own investment funds in partnership with local investors[51]. But when all these advantages are combined with the economies of scale that permit a large TTO with a wide range of specialists, a broad IP portfolio, strong local networks of technology entrepreneurs and serial CEOs to assist in assembling an effective management team, the catalogues of past deals that provide useful benchmarking information and help in the development of well-refined policies that streamline the negotiations, and policies to free up academic time to pursue commercialisation opportunities, it becomes clear why the distribution of IP income is so heavily skewed towards a few institutions.

- Businesses are much less satisfied with **the availability of information** on commercialisation opportunities than universities, and less satisfied with the effectiveness of best practice guidance, impartial advice, and guidelines or toolkits (see 9.1.2 above). The research results provide evidence on the paramount importance of commercialisation skills and resources. They point to a requirement for further training, guidance on practices and/or case studies that help reduce complexity[52] for all participants in the commercialisation process. There is also the need for **greater transparency on university policies,** in broad terms, to streamline the negotiation process and help manage expectations among partners.

Although our interviewees made a range of suggestions for potential improvements, they did not generally specify precisely how the issues expressed above could be addressed. Nevertheless, the implication was that government (and HE and research funding bodies) had a role to play in co-ordinating activities, alongside action from universities and best practice groups working with businesses and investors.

[51] Examples of university investment funds outside the Golden Triangle are given in the case studies of the University of Manchester (via its exploitation arm UMI^3) and Swansea University Innovation Fund. In other cases, a venture capital firm such as Mercia or IP Group will develop a commercialisation with individual universities – these firms have developed regional teams to seek out opportunities beyond the Golden Triangle.

[52] Several Government studies highlight the requirement for more information and guidance to help resolve issues between the types of participants and reduce the complexity. Note the Dowling, UK-IRC and Lambert reports.

A core finding of the research is the diversity of opinions on the constraints and pinch points experienced by the survey respondents. The appropriate policy responses need to take this into account in terms of the flexibility that they offer their beneficiaries and the focus of their intended impact, for example by geographical region, subject specialism, or commercialisation maturity. The flexibility of HEIF funding and the REF impact agenda allow universities to focus on the forms of knowledge exchange and commercialisation that best suit their local context. The emerging Knowledge Exchange Framework (KEF) is also designed to incentivise the creation of economic and social impact from university knowledge, and develop guidance and metrics for monitoring outcomes, without being prescriptive about the form of activity. Recent policy developments such as the SIAs, the CCF, the encouragement built into HEIF funding strategies to stimulate and monitor collaboration, and the Research Council Accelerator funds, seem to be well-targeted on the resourcing, networking, informational and local economic constraints identified. As a result, the rate of growth in IP income may continue to outpace the rate of growth in KEC income overall.

12 APPENDIX A: UNIVERSITY CLUSTER ANALYSIS AND SAMPLE SELECTION

12.1 Cluster analysis of university research

In order to select a representative sample of universities to interview about the KEC model, it was necessary to develop a framework to characterise the different research and IP commercialisation profiles of universities.

The analysis suggests the following characteristics of each cluster.

Group 1: Large research-intensive universities with significant IP activity

- Large, high research intensity universities
- Large KE portfolios with a significant IP component (17% of total KE income derives from IP licensing and sales of shares)
- Large absolute patent portfolios, and much larger patent portfolio per £million research income when compared to other groups
- Successful in converting patent applications into patents granted (56% converted)
- A particularly heavy emphasis on non-software IP compared with other groups, as well as other forms of IP
- Success in realising value through the sale of shares in spin-outs
- High number of spin-outs per annum, securing approximately £12.2 million per spin-out in external investment

Group 2: Large research-intensive universities with relatively low IP activity

- Large, high research intensity universities
- Large KE portfolios but with a relatively low IP component (just 2.6% of total KE income derives from IP licensing and sales of shares)
- Relatively large patent portfolios compared with groups 3 and 4, but significantly smaller than group 1
- Successful in converting patent applications into patents granted (61% converted)
- Within their IP, a much larger *proportion* of IP income derives from software licenses compared with Group 1
- High number of spin-outs per annum, securing approximately £12 million per spin-out in external investment, in line with that of Group 1

Group 3: Mid-sized research-intensive universities with relatively low IP activity

- Mid-sized, high research intensity universities
- Large KE portfolio relative to the number of academics) but with a relatively low IP component (just 2.6% of total KE income derived from IP licensing and sales of shares)
- Relatively small patent portfolio compared to both Groups 1 and 2
- Within their IP, a much larger *proportion* of IP income derives from software licenses compared with Group 1 – similar to that of Group 2)
- Moderate number of spin-outs, securing approximately £11.3 million per spin-out in external investment

Group 4: Mid-sized, medium research-intensive universities with limited IP activity

- Medium research-intensity universities
- Smaller KE portfolios, both in absolute terms per university and per academic, with small IP components (just 0.6% on average)
- Size of patent portfolio scaled by research income similar to groups 2 and 3
- Within their IP, a much larger *proportion* of IP income derives from other forms of IP compared with Groups 1, 2 and 3, and a similar amount from software in line with Groups 2 and 3)
- Low number of spin-outs per annum, securing much less external investment per company (£1.8 million) compared with the other groups

Group Universities with no IP activity

- Universities with no observable IP activity in the HEBCIS datasets

The following set of tables (Table 15 to Table 18) presents an analysis of key commercialisation related indicators by different clusters of universities. These clusters were identified through a statistical cluster analysis to reveal different groups of universities based on commercialisation related activity and performance. Four distinct groups were generated through this process.

Table 15: Contextual data for each cluster (mean over period 2012-15)

	All HEIs	Cluster				
		1	2	3	4	No_IP
Academic staff FTEs per HEI	957	3,380	3,434	1,883	838	241
Research income (£000s) per HEI	44,629	332,921	267,099	108,740	25,023	1,523
Research income (£000s) per academic FTE	47	98	78	58	30	6
KE income (£000s) per HEI	23,669	116,512	103,650	51,051	18,644	1,890
KE income (£000s) per academic FTE	25	34	30	27	22	8
IP income (£000s) per HEI	763	19,390	2,661	1,242	119	0
IP income as % of KE income	3	17	3	2	1	0
Number of HEIS	164	4	8	11	104	33

Source: HESA HEBCI surveys.

Table 16: Key commercialisation process metrics, by cluster (mean over period 2012-15)

	All HEIs	Cluster				
		1	2	3	4	No_IP
Disclosures per HEI	27	129	151	49	20	0
Disclosures per thousand academic FTEs	28	38	44	26	24	0
Patent applications per HEI	13	111	63	28	8	0
Patent applications as share of disclosures (%)	47	86	41	57	38	n/a
Patents granted per HEI	6	63	38	10	3	0
Patents granted as share of applications (%)	47	56	61	37	36	n/a
Cumulative patent portfolio per HEI	107	1,343	601	187	51	0
Cumulative patent portfolio per £million research income	2.4	4.0	2.3	1.7	2.0	0
Number of HEIS	164	4	8	11	104	33

Source: HESA HEBCI surveys.

Table 17: Income from different types of intellectual property, by cluster (mean over period 2012-15)

	All HEIs	Cluster				
		1	2	3	4	No_IP
IP income (£000s) - Non-software	434	10,152	1,814	775	72	0
Non-software IP income as share of IP income (excluding sale of shares) (%)	82	88	81	77	63	n/a
IP income (£000s) - Software	45	289	344	144	19	0
Software IP income as share of IP income (excluding sale of shares) (%)	9	3	15	14	16	n/a
IP income (£000s) - Other	52	1,074	82	92	23	0
Other IP income as share of IP income (excluding sale of shares) (%)	10	9	4	9	20	n/a
IP income (£000s) - sale of shares	231	7,876	421	231	5	0
IP income - sale of shares per £million of	5	24	2	2	0	0

research income						
Number of HEIS	164	4	8	11	104	33

Source: HESA HEBCI surveys.

Table 18: Spin-out activity and investment, by cluster (mean over period 2012-15)

	All HEIs	Cluster				
		1	2	3	4	No_IP
Spin-outs - Number per HEI	1	4	4	2	1	0
Spin-outs - Active per HEI	8	43	34	18	6	0
Spin-outs - External investment (£000s) per HEI	5,590	47,820	44,649	20,023	1,424	0
Spin-outs - External investment (£000s) per spin-out	6,265	12,209	12,040	11,392	1,814	n/a
Number of HEIS	164	4	8	11	104	33

Source: HESA HEBCI surveys.

12.2 University sample selection

The four distinct groups of the cluster analysis were used to select the sample of universities to be interviewed. There were 33 universities with no IP activity, and these were excluded from the sample. There were 23 universities with significant IP activity, broadly those with IP income over £1 million and these were included in the sample – these comprised clusters 1-3. The remaining 104 universities (in cluster 4, the lowest non-zero IP activity cluster) had an average IP income of just over £100K. These were sampled to give regional and national coverage; higher weighting was given to those with greater research activity (research income, and research intensity). This has created a total sample of 39 universities.

Below are the universities with significant IP activity (all included, in order of IP income; the bold and italic groups indicate the 3 sub-clusters within the top 23 institutions):

Cluster 1
The University of Cambridge
The University of Oxford
The Institute of Cancer Research
The Queen's University of Belfast
Cluster 2
University College London
Imperial College of Science, Technology and Medicine
The University of Manchester
The University of Edinburgh
King's College London
The University of Leeds
Loughborough University
The Open University
Cluster 3
The University of Bristol
The University of Nottingham
The University of Southampton
The University of Glasgow
Cardiff University
London School of Economics and Political Science
The University of York
The University of Aberdeen
The University of Dundee
Aston University
Oxford Brookes University

Sample criteria:

For IP cluster 1 (104 universities), we investigated the spread of institutions by region, and created a set of quotas by allocating 1/6th of the institutions in such a way that the regions were proportionately represented but every region had at least one respondent. This resulted in a further 16 universities (for a total of 39). The proportion of commercialising institutions in each region that were to be included, overall, ranged from 20% (North East) to 50% (Northern Ireland).

Table 19: Sample quotas

		Group A		Group B	A+B	
	Commercialising institutions	IP clusters 1-3	IP cluster 4	Proposed IP 4 sample	Overall sample	Proportion of region (%)
East	7	1	6	1	2	29
East Mid	8	2	6	1	3	38
London	31	5	26	4	9	29
North East	5	0	5	1	1	20
Northern Ireland	2	1	1	0	1	50
North West	12	1	11	2	3	25
South East	12	4	8	1	5	42
Scotland	15	4	11	2	6	40
South West	9	1	8	1	2	22
Wales	8	1	7	1	2	25
West Mid	9	1	8	1	2	22
Yorkshire & Humber	9	2	7	1	3	33

Within IP cluster 4, the sample was deliberately biased towards those with higher research intensity, on the grounds that institutions with a stronger research base that were not commercialising their research were of interest to the study. Six of the institutions within IP cluster 1 were in a high research intensity cluster, 16 were in the medium research intensity group, and the remaining 82 were in the lowest research intensity cluster. We randomly selected 3 high research intensity institutions (50% of the total), five medium research intensity institutions (about 1/3), and eight in the lowest research intensity group (about 1/10 of the total), as well as two of the ten Arts institutions in the sample. Within these constraints, the institutions were selected at random.

Cluster 4
The University of Liverpool
The University of Warwick
The University of Sheffield
Cranfield University
The University of Durham
The University of Lancaster
The University of Sussex
The University of St Andrews
The University of Exeter
The University of Northampton
Birkbeck College
Courtauld Institute of Art
Goldsmiths College
Royal College of Art
University of the Highlands and Islands
Swansea University

13 APPENDIX B: LITERATURE REVIEW

13.1 The knowledge exchange and commercialisation model (KEC)

This review summarises key insights from the academic and practitioner literature on the factors influencing the commercialisation of university intellectual property (IP). In doing so, it focuses primarily on the formation of university spin-outs (USOs) and the licensing of university IP, but also considers what we know about the factors influencing knowledge exchange mechanisms more generally, and research contracting in particular.

The objective of the literature review is to examine the validity of the knowledge exchange and commercialisation (KEC) transaction model proposed by BEIS (Figure , next page) and the extent to which the phases of the model appropriately reflect the different stages of the commercialisation process. Critically, it seeks to explore what we know about the factors affecting the process at each of the different stages, and those wider, contextual factors that influence the process.

Sections 13.2 to 13.5 below address the key points and draw overall conclusions. The material is expanded in more detail in Sections 13.6 onwards.

13.2 The Commercialisation Process

The proposed KEC transaction model can be thought of as distinguishing three key phases of the transaction process (columns three – five in the model):

- Establishing transaction inputs (pre-negotiations)
- Transaction negotiations (negotiations)
- Post-transaction management (post-negotiations)

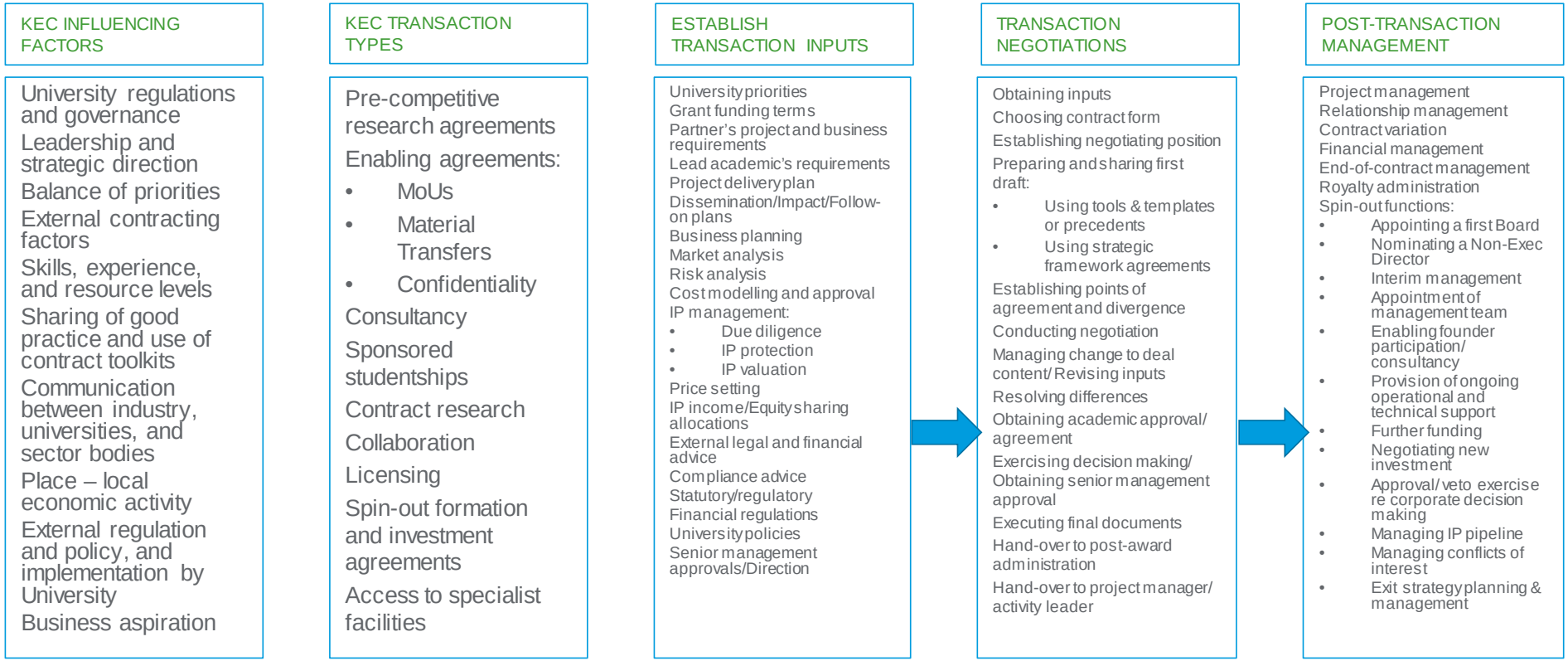
The content of each of the three transaction phases appears to highlight the process steps required to be completed within each phase in order to progress the transaction. As such, they do not in themselves, reflect specific barriers to commercialisation but rather points within each phase at which barriers or obstacles could emerge.

The transaction process takes place within a particular university context and is influenced by a set of university-specific (internal) factors. The university and the negotiating partner(s) are also set within specific local external contexts that have the potential to influence the process. These 'influencing factors' are depicted in the first column in the model.

The way the process plays out in practice, and the types of challenges experienced, will inevitably depend on the type of KEC mechanism (second column in the model). Different types of mechanisms seek to exchange different types of knowledge for different purposes. The motivations of the different stakeholders involved, and the nature of the negotiations may well differ. A lot is known about the variety of KEC mechanisms through which knowledge is exchanged between universities and organisations in the wider economy, ranging from the formal to informal, arm-length transactional to relational (Hughes et al. 2016; Hughes and Kitson 2014; Perkmann et al. 2013). These mechanisms can usefully be separated into those that seek to commercialise IP that has already been created through the formation of university spinouts (USOs) or its licensing to existing companies (hereafter referred to as 'commercialisation'), and other forms of knowledge exchange (hereafter referred to as academic engagement[53]). Many studies have now highlighted the growing importance of these wider academic engagement modes in exchanging knowledge to support innovation (see e.g. D'Este and Patel 2007; Hughes et al. 2016; Hughes and Kitson 2012; Perkmann et al. 2013; Perkmann and Walsh 2007).

[53] The distinction between "academic engagement" and "commercialisation" emerges from the literature and is also particularly relevant to the KEC model under review as a way of categorising the transaction types into "commercialisation" (licensing and spin-outs) and other forms of engagement.

Figure 1: Proposed knowledge exchange and commercialisation model



Some of these wider academic engagement mechanisms will generate new IP *as part of* the engagement process (e.g. through contract and collaborative research) that has the potential to be subsequently commercialised (including through licensing to existing companies or through the formation of a USO). For such mechanisms, negotiations between the parties involved will typically include agreeing the terms surrounding the future commercialisation of any IP generated. Both commercialisation and research contracting typically involve potentially difficult *negotiations* over terms and conditions between the funder of the work (e.g. the company) and the university, not least the future ownership of any intellectual property generated and the distribution of any monetary benefits that may arise.

It is also important to recognise the temporal dimension to, and interaction between, different types of KEC mechanism. The intellectual property (IP) that forms the basis of USOs or technology licenses will have been generated through research undertaken by a university, potentially in collaboration with others, with possible mixes of public, private and charitable organisations involved. The funding for this research may have been secured from a variety of different types of organisations both in the UK and from abroad. These can include the Research Councils, UK government agencies and departments, industrial partners, supranational organisations, and medical and other charitable organisations. In the process of setting up the research contracts that enable the research to take place, the different organisations may seek to impose different types of terms and conditions on how any resulting IP is to be exploited, including the distribution of ownership, compensation, and other terms. These conditions, established at the outset will inevitably influence the subsequent process and negotiations to commercialise it through the formation of USOs or licensing activity.

Given the importance of placing the discussion of issues in the context of a particular KEC mechanism, the literature review will first consider issues relating to commercialisation, and then, separately, for research contracting. That said it is likely that a number of issues will be common to both types of mechanism.

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

The performance of university spin-outs has sometimes been compared to other types of high-technology start-ups (for example corporate spin-outs (CSOs)) (Hewitt-Dundas 2015; Zahra et al. 2007). However, in making comparisons, it is important to recognise that USOs are typically very different types of new ventures, attempting to commercialise very different types of technologies and have very different resource requirements (Druilhe and Garnsey 2004; Shane 2004; Wright et al. 2006). The commercial knowledge and experience of founders is also very different in USOs compared with other high-tech companies (Druilhe and Garnsey 2004). Wright, Lockett, Clarysse and Binks (2006) – in their study of UK and European universities and their spin-out activities – highlighted a number of these differences (see table below). Many of these characteristics increase the risks associated with investing in USOs. While some of these factors could be remedied by changes in approach within university, some of them reflect the inherent nature of the IP emerging from universities (e.g. longer-term investment horizons and higher variability of returns).

Table 20: Characteristics of university spin-outs in comparison with high-technology[54] start-ups

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

Source: Wright et al, 2006;.
Note: respondents ranked each factor as: 1, strongly disagree"; 2, "disagree"; 3, "neither agree nor disagree"; 4, "agree"; 5, "strongly agree".

[54] The precise definition of "high-technology" is not provided in the paper itself.

13.2.1 Stages of the commercialisation process

The proposed KEC model distinguishes three key phases to the transactions: a pre-negotiations phase where transaction inputs are established; a negotiations phase; and a post-negotiations phase involving subsequent and ongoing transaction management. Within each of these phases, the model suggests a long list of steps. This section explores the commercialisation process in more detail, drawing on the academic and practitioner literature.

Table 21 Stages of the commercialisation process

Stage of commercialisation process	Comments and issues
Funded research	Research funded through variety of sources including industry, to produce new knowledge. In some cases, as a result of this process, technological inventions may emerge with commercialisable potential
Creation and disclosure of invention	Two conditions must be met: inventor must believe they have invented a new technology (not just produced a research result) and inventor must believe they have to disclose their invention to the university (decision influenced by university's policies towards disclosure)
Decision to seek IP protection	• Evaluation of invention disclosure: - Purpose is to determine whether a university should protect (patent/copyright) invention. - Determine whether inventor has made 'material use' of university facilities in creating invention - influences who owns IP • Conditions for TTO to seek to patent - must believe inventor has invented something novel, non-obvious, and valuable technological advance (conditions of receiving patent) - technology must be embodied in some form that can be patented rather than just being tacit knowledge residing in inventor's head - expect that profits from licensing invention will exceed cost of patenting it
Marketing the technology	• Ability to find private sector entities to licence and commercialise inventions • Role of inventors in helping to identify potential licensees • Incredibly difficult because many university inventions are not at a stage that is of interest to industry… too embryonic, not reached prototype stage, let alone demonstrated manufacturability and practicality in the market. Typically require substantial investments in product, and market development, and many will never succeed... high risk investment (Pressman et al., 1995:52). • A similar point is made in Wright et al. (2005) that venture capitalists often reject university spin-out investment proposals due to lack of prototype / early stage of development of product/service.
Optioning the technology	• Because of technical and market uncertainty of invention, potential licensees often unsure whether they would like to license them. Often take options to license, giving time to evaluate technologies further before they make decision to license. Process of optioning helps to mitigate technological/market uncertainty inherent in university inventions. • Some considerations: - Length of option? - Fields of use of option? - Exclusivity of option?
Licensing decision	• When licensing does occur, typically only one company interested in obtaining rights. Just 22% of technologies have more than one party interested (Jensen and Thursby 2001). As a result, university cannot typically drive hard bargains on terms • Typically, hard to insist on upfront fees other than covering patenting costs. Most of compensation is in form of royalties on sales of successfully commercialised products • Some considerations - Exclusivity of license? - Fields of use of license?
Decision to spin-out	• Most of time, established companies license IP - approx. 86%. Existing companies have a variety of advantages in commercializing university technologies e.g. market knowledge, relationships with customers, distribution systems, & related products. • University spin-outs are atypical examples of start-up companies. In addition to cutting-edge technology often based on very sophisticated science or engineering, companies are also very early stage ventures when they are formed. • Comparing university spin-outs to the typical start-up, which VCs refer to as seed stage companies… Lita Nelson (former Director of MIT's TLO) refers to USOs as 'minus two stage companies'. Unlike typical seed stage companies, typical USO begins with technology that has not been reduced to practice, has no business plan, no management and a need for capital to create the company that would bring these benefits together. • Very difficult to identify business opportunities from university technology. Importance of inventor in providing information to help recognized opportunity • Empirical evidence suggest that inventors often found spin-outs when they fail to licence to established companies (Lowe, 2002)… because inventors have better knowledge about the value of their university invention than do other parties[55].

Sources: Shane S, 2004; UNICO,2006a and McMillan T, 2016.

[55] The types of circumstances that favour spinouts vs licenses are set out in an appendix to this report.

A seminal book on USOs by Shane (2004) that brings together his extensive research on commercialisation in leading US universities including an in-depth study of Massachusetts Institute of Technology (MIT) provides detail on the nature and issues faced in commercialisation process, adding to the detailed list of process steps provided in the KEC model. Table 21 highlights the stages identified by Shane along with comments and key issues from the perspective of the TTO (or equivalent) receiving the invention disclosure up to the point they decide to license or create a USO.

13.3 Key Trends in knowledge exchange and commercialisation

This section summarises the current and recent trends in the knowledge exchange and commercialisation sector in the UK. Detailed charts can be found in Appendix C.

The income obtained by UK universities from research contracting is an order of magnitude higher than the income obtained from commercialisation activities. Collaborative research in particular has increased dramatically, particularly since the onset of the economic recession in 2008. Revenues from IP (excluding sale of shares in spin-outs) has been increasing steadily over time, while the returns to universities from the sale of shares in their spin-outs can be particularly lumpy.

Much of the *revenue* generated through licensing activity comes from non-software intellectual property. Note this does not imply a lesser value of software and other forms of IP as it says little about the types of licenses being negotiated and their compensation terms.

The number of spin-outs (both those with some university ownership of IP and other formal spin-outs) has been falling year-on-year since its peak in 2010. By contrast, the amount of external investment raised in these spin-outs has been increasing in recent years.

13.4 Key insights on factors affecting KEC from the literature

In considering the factors that affect the KEC process at different phases, we argue that it is necessary to consider different KEC mechanisms separately. We thus focus our primary attention on spin-outs and licensing (commercialisation) although we separately present some evidence on research contracting. These are two key sets of mechanisms that are often highlighted in the context of challenges over the negotiations between universities and companies.

In reviewing the academic, practitioner and other literature to examine what is known about the commercialisation process and the factors that influence it, it became clear that a number of areas where obstacles and challenges could emerge were not explicitly covered. This included:

- The search for potential investors and licensors and the difficulties associated with this;
- Post-spin-out technology and product development;
- The development of entrepreneurial capabilities as the company develops to overcome critical junctures in its journey to market and sustainability;
- While the KEC model explicitly acknowledge the variety of KEC mechanisms, it is also likely that the appropriate commercialisation pathway and the challenges faced by the stakeholders involved will be faced by the type of technology or knowledge being commercialised;

A lot of research has been done on the barriers to KEC engagements. These reveal a wide range of factors that can act to hinder the process, including: a lack of time and incentives to engage; difficulties in finding suitable partners; differences in the orientation of universities and companies that need to be bridged; a lack of resources and capabilities within universities and companies to engage; and transactional issues including rules and regulations and the negotiation of contractual terms. Interestingly, while some surveys of academics and companies find contract negotiations to be a frequently cited barrier, others suggest it is much less of a problem; and one that is largely limited to certain types of disciplines and KEC mechanisms. In seeking to understand the differing views on this contentious issue, it became apparent that the surveys ask subtly different questions, and target different types of academics and companies. These, we believe could explain the quite significant differences in results.

In undertaking the literature review, it also became apparent that there is a lack of evidence on how the factors influencing KEC processes evolve through time as the interaction emerges, is negotiated, initiated, sustained, and potentially renewed. It is also clear that, while some studies focus on specific types of KEC mechanisms (e.g. collaborative research, spin-outs, or licensing activity), others cover all forms of KEC making it harder to link barriers to specific types of mechanism.

Despite these issues, the review of literature revealed a number of key factors influencing the *commercialisation* process. In doing so, it was clear that the commercialisation of IP emerging from the university base involves multiple stakeholders with different motivations and objectives for getting involved. The often-complex negotiations between these parties must result in agreement on a variety of terms and conditions, some of which may result be contentious leading to conflicts that have to be resolved. Many issues, however, are not contentious and can be agreed relatively easily. In addition, the types of issues that arise appear to depend in part on the experience and expertise of the stakeholders (including the investors) involved.

Particularly contentious issues arising during the negotiations include:

- Ownership of the IP being commercialised (assignation vs exclusive or non-exclusive license);
- Agreement on the value of the IP being commercialised;
- The amount of equity allocated to the University as opposed to the academic inventor and investors – this is linked to the ability to agree the value of IP as well as the relative contribution of the University as compared with the academic inventor;
- The form and terms of compensation (e.g. upfront fees, royalties, and other forms of compensation);
- Freedom to operate – i.e. ability to continue to research and educate in the area;
- Agreement on warranties, indemnities, and limits of liability;
- Inclusion and conditions relating to the improvement of further developments of the IP.

The root cause of these contentious issues was not clear from our review of the literature. To advance policy and practice, it is crucial that we disentangle the extent to which these issues are the result of natural tensions and frictions likely to be present in any negotiation involving large sums of money, or due to unreasonable or inflexible positions adopted by the University, the academic inventor, or the investors and businesses involved.

In addition, research also suggests that issues around the 'readiness' of commercialisation proposals in terms of the extent to which they are addressing key investor selection criteria can be important in determining success. Given that investor experience appears to influence the weights they place on selection criteria, notions of investor 'readiness' need to be adjusted for the types and experiences of different investors.

The literature review also unearthed a wide range of 'influencing factors' affecting the commercialisation process. Frequently cited factors include:

- The scale and quality of the research base feeding the commercialisation process;
- The experiences, capabilities and networks of the academic inventors;
- The composition of the entrepreneurial team and its ability to evolve as the process advances;
- The scale and quality of support available through the technology transfer infrastructure within universities, including the levels of experience, technical and business development capabilities of staff;
- The levels of bureaucracy involved in the process, and selection criteria for advancing projects and making decisions regarding appropriate route to market;
- Clarity of university mission on commercialisation and visible commitment of leadership;
- University incentives for, and culture towards, commercialisation: including, in particular, faculty reward systems and a willingness of the university to invest in equity in spin-out companies;
- The experiences, capabilities and policies of investors for working with universities to commercialise IP;
- The strength of the local context within which the university operates. In particular, the availability and access to pre-seed and seed-stage capital; the strength of social networks between academics and investors; the absorptive capacity of local industry; availability of infrastructure and services to support the process.

The wider literature review also considered the range of factors – and those that are typically contentious in negotiations – influencing the research contracting process. These are presented in Appendix C.

13.5 Conclusions

The proposed KEC model provides a good starting point for exploring the factors affecting transactions between universities and external partners to commercialise their intellectual property. The model helpfully distinguishes different phases in the transactions: pre-negotiations, negotiations, and post-negotiations and identifies a range of steps that have to be undertaken within each phase. These transactions are set within a particular context and are influenced by a wide range of influencing factors. The model also recognises a wide variety of KEC mechanisms from commercialisation through spin-outs and licensing activity that seek to exploit IP already generated, to wider academic engagement mechanisms, a number of which will generate new IP.

Overall, it was clear from the review of academic and practitioner literature that further research was needed to better understand the challenges faced by different stakeholders involved in the commercialisation process, at what point of the process they are felt, and the underlying reasons why they emerge. In particular, the literature review highlighted a distinct need to: the review of the literature suggests that there is a distinct need for further research to:

- Identify specific factors influencing the commercialisation process that can be acted upon by those involved in the process;
- Understand how different factors influence different stages of the transaction process (pre-negotiations, negotiations, and post-negotiations);
- Understand the root causes of contentious issues that may emerge during negotiations, and in particular, the extent to which these are justified or unjustified given the different public and private missions of the key stakeholders involved;
- Understand with greater clarity which influencing factors are most important in shaping the commercialisation process, and how they influence each stage of the process.

Literature Review (Additional Background)

The Literature Review presented the theoretical background for the KEC model which was used as the basis of the current reesearch. It also summarised the key findings from a review of the academic and practitioner literature. This section of the literature review presents a more detailed discussion of the existing literature and background material.

13.6 Limitations of the KEC Model

Technology types and commercialisation routes

The proposed KEC transaction model says little about how the nature of the technology being commercialised influences the decisions being made. Shane (Shane 2001, 2004) argue strongly that the characteristics of the technology play an important role in influencing the decision to license compared to pursue a spinout. These characteristics are shown in Table 22 below.

Table 22: Characteristics of technologies favouring spin-outs and licensing options

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

Source: Shane S, 2004

Ultimately, the choice between licensing and spinout comes down to a balance between the characteristics of the technology; the academics involved and their entrepreneurial experience, motivation and objectives for engaging in commercialisation; university policies and resources to support the process; and, perhaps critically, the availability of investors willing to support the continued development of the technology into application and their preferences on the route to market (Hockaday, 2014). In addition, there is some evidence to suggest that the choice to license or spinout will be influenced by the sunk costs of product/service market entry, and the importance of complementary assets for the successful commercialisation of the IP, their availability, and who controls them (Teece 1986; Ceccagnoli and Hicks 2013). For example, if successful commercialisation of a piece of IP requires costly complementary assets that are controlled strongly by incumbents in an industry, a licensing strategy may be preferable to investing in a spinout company to compete directly in this market.

Searching for investors and licensors

The model also says little explicitly about the *'search' process* that is required, before any negotiations take place, to find potential partners and investors to take the IP forward towards commercial application (Shane 2004; UNICO 2006a). This process is incredibly difficult as many university inventions are not yet at a stage that is of interest to industry. The technologies are often very embryonic and may not have reached the prototype stage let alone demonstrated manufacturability and practicality in the market and represent high risk investments (Pressman et al. 1995; Shane 2004).

Post-spin-out technology and product development

The KEC transaction model also says little about developing an understanding of the subsequent technological and product development challenges that need to be addressed in order to successfully commercialise the IP. Shane (2004) highlights the nature of further technology and product development work typically required (Table 23). He also notes that the scale of further work and the ability of the founders to successfully deliver this is a key part of the consideration of whether or not to invest in a spin-out.

Table 23: Areas of further development for university spin-outs

Area of further development		Comments and issues
Additional technical development	Proof of principle	• Without proof of principle, impossible to create a prototype let alone a product/service that would solve a customer problem or meet customer need
	Prototype development	• Many spin-outs lack prototypes of their products at time of spin-out even if achieved proof of principle in the lab.

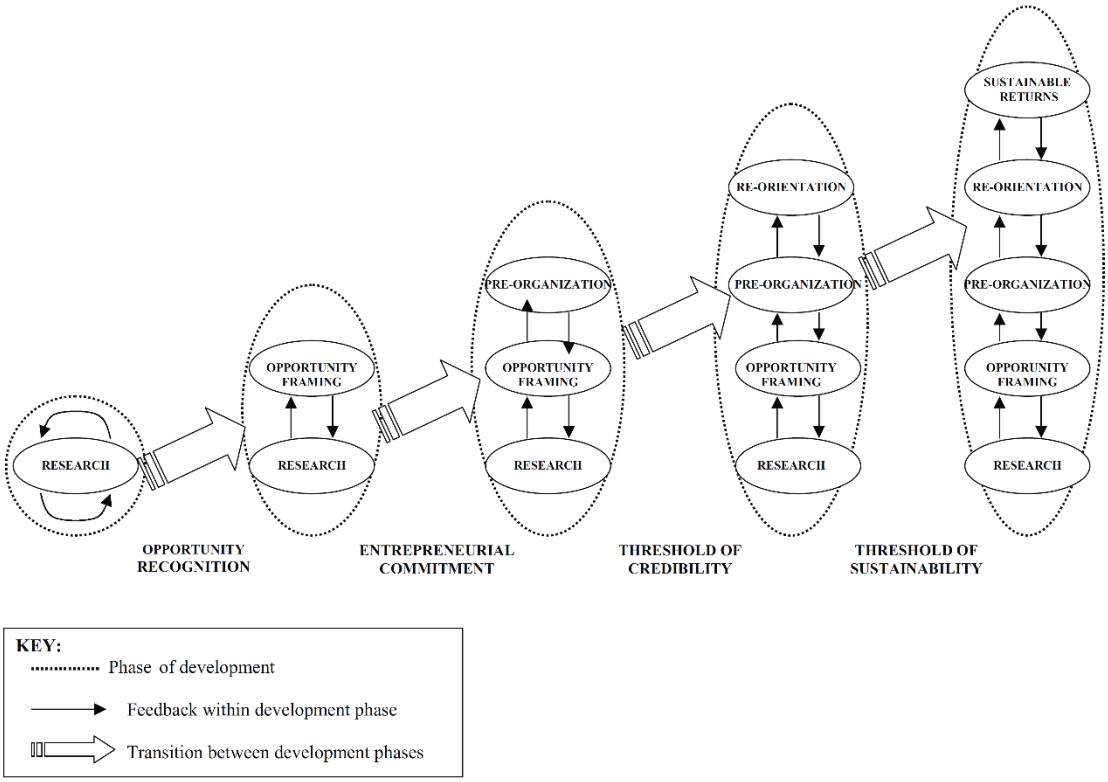
		• even if have prototype, may need additional prototype development e.g. because change in market application; initial prototype does not work properly or not as effectively as founders need to meet customer needs
	Product development process	Turn prototypes into products/services appropriate for the commercial environment. • Productizing the invention - often need additional technical development to turn technology into product/service. Must transform tech to meet customer need/problem. Also will often need to combine technology with standard features that competitor products and service have e.g. documentation, packaging, support services etc. • Ability of founders to develop capabilities of product development. This is very different from doing research. • Do founders have commitment to product development? • Product development time horizon can be long - markets / customer needs can change; competitor landscape can change… can easily miss opportunity - can lead founders to underestimate time/money required to develop successful spin-out • Product development uncertainties: - will technology adapt to commercial environment; - will founder have competence to turn invention into product; - will complementary technologies necessary to support product/service be developed in time
	Changes to make technologies appropriate for commercial environment	• Improving performance - e.g. to include new set of performance factors not present in research environment • Enhancing robustness - e.g. to stresses of real world • Adding supporting technology - e.g. by creating tools, supporting technologies, documentation, support services etc. because customers do not by technology… they buy a solution to a problem... So have to develop all things that are needed for a product to solve customer problem. • Scaling-up - Invention only produced in very small volumes at outset. How to produce at commercial scales of production? Often requires new ways of producing technology and/or significant changes in technology during the product development process. - Hard to get customer feedback until produce at scale because customers find it hard to see a product or service in the form that they would use it… • Increasing ease of use - making function of technology easier for customers - Form may need to change to meet standards or make appealing to customers - proper documentation needs to be developed/provided - adapting technology to fit technical standards prevailing in industry • Changing mechanisms and architecture - to adapt to customer preferences - to reduce costs - to enable manufacture at scale and/or speed - to exploit more readily available / effective commercial components
Developing a market for the technology		Significant market uncertainty… • Sufficient demand? • Customers willing to pay? • Can produce product / service economically? • Can it provide better solution to customer needs than alternatives?
Securing financing		Critical need to demonstrating the value of ventures. • Scale of markets • Proprietary technology - Investors favour spin-outs with strong patent protection - that possess patented technologies… easier to finance USOs with exclusive rights to patents - Potential investors focused very heavily on spin-outs IP position when deciding whether or not to fund it • General purpose technologies: Greater flexibility & adaptability – Gives investors more options if initial application field does not work out • Social ties: Founder-investor social ties… Help to mitigate information asymmetry and uncertainty… build trust

Source: Shane, S, 2004.

Critical junctures and non-linear development of spin-outs

Work by Vohora et al. (2004) on development of university spin-outs suggested that USOs develop in a non-linear fashion through five distinct phases: research, opportunity framing, pre-organization, re-orientation stage, and sustainable returns. Through nine in-depth case studies of spin-outs emerging from seven UK universities, they conclude that as USOs transition between each phase of their development, they face 'critical junctures' in terms of resources and capabilities they need to acquire to progress to the next phase. They identify four critical junctures that USOs need to overcome if they are to succeed: opportunity recognition, entrepreneurial commitment, credibility, and sustainability.

Figure 2: Critical junctures and phases of development faced by university spin-outs



Source: Vohora et al, 2004

Advancing through the different phases of development and overcoming the different critical junctures may well require further support for the academic entrepreneurs beyond their own learning journey. Such support could be provided by the university and affiliated institutions (e.g. incubators, accelerators, science parks, mentors etc.), particularly in the early phases. This development journey is not considered in the KEC model.

13.7 Factors affecting knowledge exchange and commercialisation processes

Many academic studies have explored the barriers facing KEC processes (Bruneel et al. 2010; Davey et al. 2015; Feller et al. 2002; Hughes et al. 2016; Hughes and Kitson 2012, 2014; Muscio 2010; Muscio and Vallanti 2014; Siegel et al. 2003a). In addition this issue has been explored in many government and practitioner-driven reviews into university-business linkages in both the UK (e.g. Dowling 2015; ICARG 2010, 2015; Lambert 2003; PraxisUnico 2016a; Witty 2013) and abroad (Merrill and Mazza 2010; NCURA and IRI 2006; PCAST 2008). These studies reveal a wide range of barriers to KEC, although few explicitly examine how different factors influence different phases of the KEC process.

While some of these studies explore the barriers to KEC mechanisms in general (Davey et al. 2015; Hughes and Kitson 2012, 2014; Muscio 2010; PraxisUnico 2016a), others are specific to particular mechanisms e.g. research collaborations (Bruneel et al. 2010; Dowling 2015; ICARG 2015; IP Pragmatics 2013; Muscio and Vallanti 2014; NCURA and IRI 2006; Tartari et al. 2012), university-industry research centres (Feller et al. 2002), or commercialisation (Bercovitz et al. 2001; Siegel et al. 2003a).

Key non-IP barriers often emerging from these studies include:

- A lack of time
- Difficulties in finding suitable partners
- Poor alignment or 'fit' between the different partners involved (in terms of time horizons, type of work, culture, and understanding of each other's working practices)

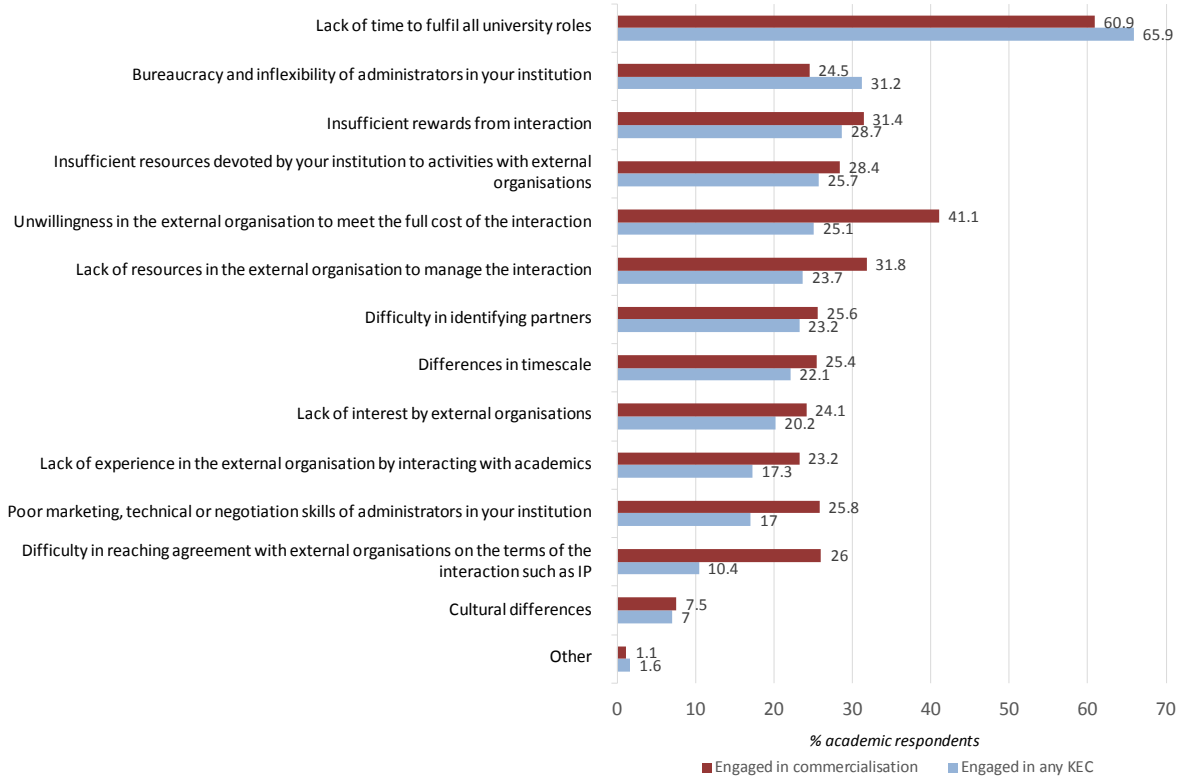
- Bureaucracy and inflexibility of university administrations
- Difficulties in developing strong and effective relationships
- A lack of resources in universities and firms to support the engagement, including a lack of government funding programmes
- A lack of, or conflicting, incentives for academics and firm staff to become involved
- A lack of capabilities of the parties involved in process to engage
- Absorptive capacity of firms, particularly SMEs to exploit university-generated knowledge and IP
- High turnover of company staff and a lack of continuity of company research strategies
- Rules and regulations imposed by universities or government funding agencies

More specifically related to intellectual property, there has been a persistent criticism by firms of universities that they overvalue their IP (Bruneel et al. 2010; IP Pragmatics 2013; Saraga 2007; Science and Technology Committee 2017). This is particularly challenging during research collaboration negotiations as the IP has yet to be generated. It is a particularly contentious issue, and one that generates high-profile criticisms of universities. However, it is also one that where the evidence underpinning it is far from conclusive. The concern was addressed in the Saraga Review on collaborative research negotiations (Saraga 2007), which questioned what was meant by 'overvaluation' in the context of the concerns raised by companies. It argued that "… *in some ways it [overvaluation] is shorthand to reflect driving a 'hard bargain' in relation to IP. It is clear that universities can drive a hard bargain, but it is also clear that companies do likewise*" (p. 10). They went on to note, "*there was some concern that both sides sometimes put excessive emphasis on IP within a negotiation (particularly when the potential value from IP is weighed up against the value of the research itself). So in that sense, IP can be seen as 'over emphasised' rather than 'overvalued*" (p. 11). The recent Science and Technology Select Committee report on Managing IP and technology transfer (Science and Technology Committee 2017) also reflected on these concerns but found that the evidence they collected did not confirm whether it was common practice.

Some surveys of academics and firms also suggest that many respondents find issues around negotiating contracts, including on IP terms, a barrier to engagement (Bruneel et al. 2010; IP Pragmatics 2013; Siegel et al. 2003b). This factor also emerges as important in the Dowling Review of long-term research collaborations between universities and companies (2015). However, other surveys of academics, firms and KEC professionals do not support this conclusion, finding this factor to be relatively infrequently cited as an important barrier to KEC activity (Hughes and Kitson 2012, 2014; Muscio and Vallanti 2014; PraxisUnico 2016a).

For example, Hughes and Kitson (2014) in their survey of firms found that just over a third of companies that had acquired a patent or license from a university found negotiations over the terms to present difficulties (Table 24). Other factors were much more frequently cited including the firm's ability to resource the engagement, their ability to find the right partner, and university bureaucracy (note that the survey did not consider the influence of company bureaucracy). Their academic survey (Hughes and Kitson 2012) similarly found that just 10% of academics engaged in KEC cited issues around negotiating the terms of the interaction (including on IP) as a barrier (see Figure 3 below). This rose to 26% when focusing on academics that had engaged in commercialisation, and were largely limited to academics in the medical, science and engineering fields (Hughes and Kitson 2012).

Figure 3: Barriers to knowledge exchange and commercialisation: perspectives of UK academics covering period 2005 – 2008 (% of academic respondents)



Source: Hughes and Kitson, 2012.

Table 24: Barriers to knowledge exchange and commercialisation: perspectives of UK-based companies covering period 2005 – 2008 (% of company respondents)

Constraint	All	Acquisition of patents and licenses owned by HEIs	
		Never	At least once
Lack of resources in the firm to manage the interaction	41	44.4	54.5
Lack of central government programmes that encourage interactions	28	30.2	72.7
Lack of regional programmes that encourage interactions	27.8	30.6	50
Difficulty in identifying partners	26.8	29.3	54.5
Insufficient benefits from interaction	23.7	27.1	9.1
Lack of experience dealing with academics and/or HEIs	20.9	23	9.1
Bureaucracy and inflexibility of HEI administration	20.3	21.1	63.6
Lack of interest by academics and/or HEIs	17.7	19.1	36.4
Incompatibility of timescales for deliverables	14.6	15.7	36.4
Cultural differences	7.5	7.8	36.4
Difficulty in reach agreement on intellectual property	5.7	5.3	36.4
N (unweighted)	580	500	20
N (weighted)	69,439	60,629	1,499

Source: Hughes and Kitson, 2014.

Most of the evidence on barriers comes from surveys of the academics and firms involved in the process. The recent survey by PraxisUnico (PraxisUnico 2016a) provides evidence on the challenges faced as perceived by the KEC professionals supporting the process. Again, as with many other studies on barriers, this study was not specific to commercialisation but nevertheless highlighted some particular concerns. A similar set of challenges emerge, including: a lack of incentives for academics to engage in KEC activity, and cultural differences between private sector and research organisations (i.e. alignment). The survey also suggests that navigating institutional governance and decision-making processes presents challenges, as does involving industry in early-stage projects, and securing external investment. As with the findings of the large scale surveys of academics in 2008 (Hughes and Kitson 2012) and in 2016 (Hughes et al. 2016), legal complexities around IP and licenses were reported by a relatively small proportion of the KEC community as a key challenge (fewer than 30%), with this factor ranking towards the bottom of the list.

13.8 Factors affecting commercialisation processes

The literature review now turns to what is known about the specific issues facing commercialisation in particular rather than KEC more broadly.

The commercialisation process involves complex negotiations between different types of stakeholders in the process, not least between the university and the academic inventor, the university and investors, and the academic inventor and investors. These stakeholders typically have quite different motivations and objectives for engaging in the process, which can lead to potential conflicts and obstacles that will need to be overcome (Lockett et al. 2003; Merrill and Mazza 2010; Science and Technology Committee 2017; Siegel et al. 2003b; Wright et al. 2006).

Table 25: Key stakeholders in the transfer of technologies from universities to the private sector

Stakeholder	Actions	Primary motive(s)	Secondary motive(s)
University scientist	Discovery of new knowledge	Recognition within the scientific community – publications, grants (especially if untenured)	Financial gain and a desire to secure additional research funding (mainly for graduate students and lab equipment)
Technology transfer office	Works with faculty members and firms/entrepreneurs to structure deals	Protect and market the university's intellectual property	Facilitate technological diffusion and secure additional research funding
Firm/entrepreneur	Commercializes new technology	Financial gain	Maintain control of proprietary technologies

Source: Siegel et al, 2003b.

Good practice guides provide a useful starting point for understanding the key issues that are likely to be faced by the negotiating parties involved in commercialisation. Research Consulting – in a review of effective practice in KEC for HEFCE (Research Consulting 2016) – highlighted a number of such documents relating to spin-outs and licensing activity. These include materials produced by a range of UK-based organisations in particular the Intellectual Property Office (UK Intellectual Property Office 2014), PraxisUnico/UNICO (now part of PraxisUnico) (PraxisUnico 2014a, 2014b, UNICO 2006a, 2006b).

Factors affecting the commercialisation process

In the context of *licensing activity*, PraxisUnico (2014a) noted that the following standard issues typically arise:

- What IP will and will not be included in the licence and what scope the licence will have (fields of use, territories)
- Exclusivity of the licence, rights of the university to use IP for research and teaching, and sub-licensing rights
- Compensation terms (upfront fees, royalties, milestone payments etc.) and how these are to be calculated
- Warranties, limits on liability, and indemnities
- Commitments of licensees to exploit the IP and consequences of failing to meet these obligations
- Access to improvements or upgrades as part of the licence
- Duration, (early) termination and consequences of termination

The process of *spinning out a company* from a university will involve a number of these issues as well as others related to the formation and successful development of a new start-up firm. UNICO (2006a)[56] highlights the wide range of issues typically arising during this process (Table 26). These cover areas including building alignment between the university and its TTO, the academics involved and the investors around issues such as what IP will form part of the deal, timescales, and further work required to commercialise the technology; performing due diligence including establishing whether any terms and obligations from related research contracts will affect the IP, third party infringements, and understanding the business proposition; and the negotiations. With respect to the latter, key issues include: establishing ownership of IP, its valuation and compensation terms; warranties and limits on liabilities; inclusion of access to improvements and further developments of the IP; equity distributions and investor rights.

Table 26: Typical issues arising in the spin-out process: perspectives of university-based commercialisation practitioner experts

Area	Issues Arising
Alignment of university, academic and investor interests	• Are timescales for exit consistent with funding requirements (spin-outs) • Understanding of technology and what will be required to commercialise it • What IP will / will not be part of the deal
Due diligence	• Terms of research contracts or other obligations affecting IP • Potential third party infringements • Warranties about state of IP • Understanding of the business proposition • Consents from relevant academics/funding bodies to transfer IP to USO • Whether IP is ready for spin-out or whether it should be bolstered prior to commencing process
Term sheet legality and commencing negotiations	• Expectations about whether term sheet is legally binding • Confidentiality • Exclusivity of negotiation period and related conditions and charges for exclusivity • Process and timeline for completing negotiations
Detailed negotiations	• Ownership of IP - Licence or assign IP to spin-out - If licenced, will IP be assigned at future date if certain conditions (e.g. viability of company) achieved? • Compensation - Valuation of IP - Upfront fees, royalty payments, or free of charge? • Warranties - What warranties are university willing to give about IP? - Limits of university's liability for breach of warranty • Improvements - Include improvements or further development of IP in deal? If so, what boundaries should be placed on these as well as access to related background IP? • Research agreements - Is a research agreement to be included between company and university? If so, what IP and other terms should be agreed? The same as in the licence or different? • Consultancy terms - What obligations do academics have under consultancy agreements? - Conflicts of interest? • Shareholder agreements - Equity distribution - Preferential rights of investors in relation to their shareholdings (e.g. anti-dilution, liquidation preference) - Decision-making (Provisions giving investors veto over direction of company, etc.; voting rights generally) - Pre-emption rights on issue of new shares and on transfer of shares, including drag-along and tag-along rights - Compulsory transfer of shares. Obligations on academic to hand back shares – good and bad leaver provisions - Board appointments and any special right of investor directors. Rights of university to appoint Board member or observer - Management. Selection and appointment of senior management of the company - Business plan. Agreement of business plan and budgets - University services. Provision of services and facilities by the university to the company,

[56] This is the most recent 'good practice' guide available in the UK on spin-outs (Research Consulting 2016)

	e.g. company secretarial services, use of lab space, etc. - Use of university name. Non-use of the university's name by the company

Source: UNICO, 2006a.

Contentious issues involved in the spin-out process

The negotiations involved in spinning-off a company based on university-generated IP will inevitably involve the many issues outlined above. These need to be discussed and resolved between the negotiating parties (the academic inventor, the university and the investors), who, as discussed earlier, will typically have quite different motivations for getting involved.

However, it is important to recognise that not all the issues outlined earlier will be contentious during negotiations. In a study of university spin-outs by Gregson (2011) that included a survey of 33 UK-based spin-out founders – identified particular issues that often emerge as contentious (Table 27). In addition, the type of issues faced may well depend on the types of investors involved and their experiences in investing in USOs (Wright et al. 2006).

A key issue is the willingness of universities, founders (the academic entrepreneurs) and investors to negotiate away from their initial positions, particularly around the following issues:

- Ownership of IP (assignation vs exclusive/non-exclusive licensing). Investors prefer assignation as they believe it increases value of company and simplifies the subsequent commercialisation process. However, this reduces University control over the IP, which may become particularly important if the USO fails (as many do). A particular concern surrounds the ability of the University to regain control of the IP and pursue other avenues for its commercialisation in the event of failure
- Establishing equity shares (percentage shareholdings allocated to University as owner of the IP). This is linked to the ability to estimate, and agree on, the value of IP by both the University and the investors. As discussed earlier, this can be incredibly challenging given that university IP tends to be the very early stage with even the application domain let alone market value often unclear at the point of commercialisation
- Royalty payments, upfront fees and other forms of compensation
- Warranties and associated limits of liability
- Inclusion and conditions relating to improvements or further developments (pipelines) of the technology/IP
- Rights of investors
- Compulsory transfer provisions of directors and company employees in Articles of Association

Table 27: Contentious issues in university spin-out negotiations

Extent to which respondents considered the following to be a 'contentious issues' in USO negotiations (5-most, 1-least):	Weighted average
Equity stake to be granted to the university and founders	3.7
Assignation vs. licence to the spin-out company	3.16
Warranty provisions	3
Equity stake to be granted to investors	2.8
Royalty rate payable to the university	2.41
Management remuneration	2.39
Consent of investors/investor director to certain issues	2.26
Composition of the board	2.08
The founder(s) leaving the university (e.g. secondment terms)	1.63
Compulsory transfer provisions	1.48
Other factors in the spin-out deal negotiations	1.18

Source: Gregson 2011; N = 33.

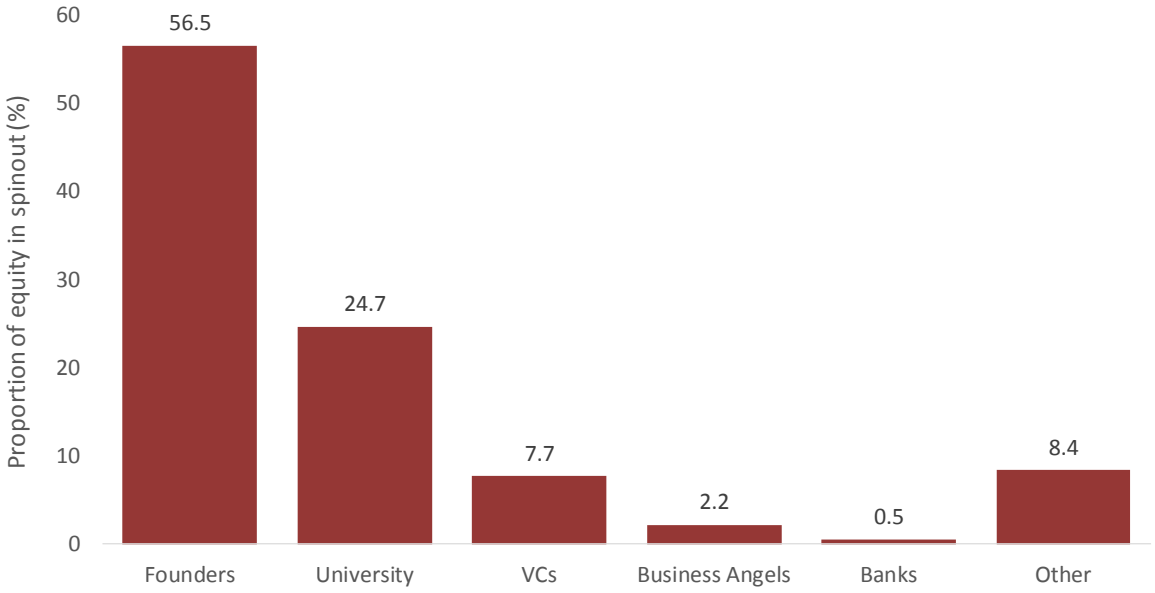
The contentious issue of equity distribution

The recent Science and Technology Committee report on managing IP and technology transfer (Science and Technology Committee 2017) raised suggests that negotiation delays arise because TTOs seek disproportionately large equity shares in USOs. However, it did not find evidence to confirm this claim. Part of the issue appears to stem from

evidence suggesting that universities have wildly different guidelines on the amount of equity they seek in USOs and whether this is negotiable (Wong et al. 2015). In their study of US and UK universities, Wong et al. (2015) found significant variation in the equity share guidelines, ranging from 20% in some universities in the UK (which was more likely to be the case with most spin-outs) to 67% in others, with some universities stating a willingness to negotiate and more so than not when additional rounds of funding are made by external investors the university share holdings were diluted. Their analysis of US universities found even larger variance, from 5% MIT and 10% at Stanford, to a relatively large number of universities with over 67%, for example, at Cornell University, Iowa State University, and the Universities of Massachusetts and Pennsylvania.

However, one must be very cautious with such analyses as it is based largely on the stated terms in university policies rather than actual terms agreed during negotiations. Indeed Wong et al. (2015) suggest that UK universities are often willing to negotiate on terms. A recent study on USOs found that the average equity share at foundation was 24.7% (Hewitt-Dundas 2015) (Figure 4), far lower than the 50:50 split suggested by Wong et al. as the position of many UK universities. A much earlier survey by Lockett et al. (2003) of 41 UK universities found that it was rare for any of the three core groups involved in the process – the universities, academic inventors, and investors – to take a dominant equity position of more than 50% in USOs at the point of foundation. However, they found evidence of significant variation between high performing universities (in terms of spin-outs) and other universities, with the former more likely to take out larger equity stakes compared with the latter. They also found significant variation even within the high performing group of universities.

Figure 4: Distribution of spin-out equity at company foundation (%)



Source: Hewitt-Dundas, 2015.

There is also some evidence from academic studies of technology transfer that a willingness of the university to make equity investments in USOs increases spin-out activity, while a royalty distribution formula that favours faculty members reduces such activity (Bray and Lee 2000; Di Gregorio and Shane 2003). This highlights the importance of incentives in shaping internal behaviours of academics towards one form of commercialisation pathway or another. Given this evidence, recent developments in the university sector, such as the growth of patient capital investors with significant funds for long-term investments in academic spinouts, and other forms of dedicated university spinout investments funds, would increase spinout activity from research intensive universities.

Non-contentious terms in commercialisation deals

While some terms in commercialisation negotiations are contentious, many are typically not (Gregson 2011). These include:

- Management related terms

- Service contracts to be put in place for founders
- Founders agree to restrictive covenants placed in Investment Agreement – namely 'not to be concerned in any competing business'
- Remuneration committee to be constituted to determine remuneration of directors and senior employees
- Investors have ability to appoint an investor director or an observer
- Certain decisions shall not be made by founders without the consent of investor, investor majority or investor director
- Company willing to move operating base to location favoured by investors

- Investment related terms
  - Investors obtain a preference in return of assets on liquidation of company
  - Investment made in tranches, further tranches based on performance milestones
  - Investors can transfer shares to their group companies without restriction
  - Prescribed minimum % of distributable profits to be offered by company/year
  - Fee for prescribed monitoring and/or arrangement to be paid by USO

Investor selection criteria, proposal readiness and investor experience

Wright et al., (2006) examined the reasons why venture capitalists rejected investment proposals, comparing *investors with experience in investing in university spin-outs* with *investors that do not* (Table 28).

Table 28: Key differences in reasons for rejecting proposals between university spin-out investors and non-university spin-out investors

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

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

** 5% significance level. ** 1% significance level. *** 0.1 significance level. # 10% significance level.*

Key findings include:

- Scale of investment required:
  - Seed/proof of concept stage deals may be too small for many VC firms as the transaction costs (costs of screening proposals and post-investment monitoring) are too high
- Screening of proposals
  - Both experienced USO investors and non-USO investors looked for the following in proposals from universities for investment:
    - Strong patent protection
    - Skills of the entrepreneurial team
    - Clear route to market for the technology
    - Investor policies not to invest in certain sectors
    - Familiarity with certain technological markets

        - Difficulties raising finance for certain sectors
    - However, there were critical differences between experienced USO investors and non-USO investors (see table below for details). These included:
        - *Size of the potential market*: Non-USO investors place greater emphasis on the size of the potential market when considering investment proposals. The difficulty many universities have in commercialising disruptive technologies emerging from basic research is that of identifying markets in which to apply the technology and estimating the level of demand. By contrast, USO investors on the contrary seem to be more concerned about the economic viability of the venture and find the estimated time to break-even a major point of importance.
        - *Ownership of IPR*: Joint ownership is much more important for *non-USO investors* as they feel uncomfortable investing in USOs when IP is licensed compared with being assigned in return for an equity share in the company. Some of these investors believe that separation is required to develop the spin-out without interference. *Non-USO investors* believe universities wish to retain ownership and control over IP without sharing in any of the risks involved in its development
        - *Working prototypes / proof of concept*: Non-USO investors also placed greater importance on prototypes in order to assess viability of technology while USO investors may invest at earlier stages and work with the USO to achieve proof of concept.
        - *Availability of a professional management team*: Non-USO investors put much more emphasis on having professional management team in place before the investment is made
        - *Difficulties in identifying key decision makers in university and lack of formalised university technology transfer procedures* also significant source of discouragement for non-USO investors
- Investor readiness:
    - Spin-outs need to be matched up to acceptance criteria expected by investors. TTOs can take a number of steps to help ensure that proposals being submitted to investors are 'ready' for consideration. These include:
        - Provision of help with business planning
        - Finding managers
        - Assisting with fundraising
        - Carrying out sufficient due diligence
- Venture capitalists' experience
    - Few VCs had strong relevant technological backgrounds potentially limiting their understanding of the technologies

The role of academic inventors and surrogate entrepreneurs

Research has also shown that the participation of academics in the licensing process is associated with both the greater speed of commercialisation and higher royalties (Markman et al. 2005; Shane 2004). This is likely related to the fact that the commercialisation process involves significant asymmetric information, with the academic holding significant tacit knowledge about the potential applications and benefits of the IP they have generated. Given this, close dialogue between the academic, the TTO, and potential investors can help increase understanding of the potential value of the IP, and what complementary assets and subsequent developments will be required to deploy the technology.

While the role of academics in the commercialisation process is important, some evidence has also emerged that surrogate entrepreneurs – that is entrepreneurs brought in from outside the academic sphere into leadership positions – can improve the likelihood of success for USOs (Franklin et al. 2001). However, other studies have suggested that strengthening the entrepreneurial capabilities of academics themselves, and enabling their learning as the USO develops, is preferable to hiring outsiders.

Influencing and contextual factors affecting commercialisation processes

The success of the commercialisation process is known to be affected by a wide range of factors. These have been studied extensively (see e.g. Bercovitz et al. 2001; Breznitz 2014; Franklin et al. 2001; Lockett et al. 2003; Lockett and Wright 2005; Markman et al. 2005; Rothaermel et al. 2007; Shane 2004; Siegel et al. 2003a, 2003b). Factors include: the capabilities

and characteristics of the academic entrepreneurs themselves; the TTOs and other supporting offices; university policies, incentives and culture; the local external environment; the capabilities and experiences of the investors; and the nature of the technology being commercialised. Key issues in each of these areas are summarised in Table 29.

Table 29: Influencing factors for commercialisation

Category	Factors	Sources
The strength of the research base	- Importance of the strength of the research base, particularly in science, engineering and health. It is from this base that IP with commercial potential emerges, and feeds the pipeline for commercialisation activity.	(Haeussler and Colyvas 2011; O'Shea et al. 2007; Perkmann et al. 2013; Zucker et al. 1998)

Academic founder & team characteristics	- Prior entrepreneurial experience / working with business
	- Strong social networks with investor community / companies decrease probability of failure
	- Strong social networks with parent university provide important infrastructure and expertise. However, overly strong ties can retard graduation from an incubator
	- Motivation and commitment to spin-out
	- Entrepreneurial and business knowledge
	  o Management knowledge
	  o Knowledge of product development and production
	  o Knowledge of markets and customers
	- Scientific excellence
	- Team complementarities and heterogeneity
	- Willingness to evolve team as needs change
	- Willingness to include 'surrogate' (external) entrepreneurs in leadership positions alongside academics linked to more successful spin-outs
		(Druilhe and Garnsey 2004; Ensley and Hmieleski 2005; Franklin et al. 2001; Grandi and Grimaldi 2003; Hayter 2013; Johansson et al. 2005; Perkmann et al. 2013; Rothaermel and Thursby 2005; Shah and Pahnke 2014; Shane 2004; Shane and Stuart 2002; Siegel and Wright 2015)

Technology transfer office (TTO) capabilities and resources	- Overall TTO resources and scale – TTOs often struggle with a lack of financial and human resources - Cumulative experience in commercialisation - Organisational structure and processes of TTOs affects information processing capacity, coordination capability across units and incentive alignment across units and across stakeholders - Capabilities of staff (marketing, scientific and technological, negotiation skills) and experience including in negotiations - Ability to attract suitable staff (compensation practices) found to be important - Access to outside resources (e.g. legal expertise). Evidence that commercialisation performance is related to expenditure on external IP protection - Technology/sector specialisation of TTOs - Internal commercialisation processes and practices including selecting appropriate route to market - Ability to develop proposals that meet relevant investor selection criteria (investor readiness) - Bureaucracy involved in commercialisation processes - Flexibility over terms and conditions in commercialisation processes - Understanding of business and product development by TTO staff (leads to more flexibility and trust and promotes willingness of inventors and investors to work with TTO) - Ability of TTO staff to translate technical and business jargon across university-business interface	(Bercovitz et al. 2001; Breznitz 2014; Feldman et al. 2002; Lockett and Wright 2005; Markman et al. 2005; McMillan 2016; O'Shea et al. 2007; Owen-Smith and Powell 2001; Shane 2004; Siegel et al. 2003b; Thursby et al. 2001; Wright et al. 2006)

University policies, incentives and culture	- Faculty reward systems found to be particularly important in shaping commercialisation performance, including royalty distribution and incentives for disclosing inventions - Equity distribution policies and practices/guidelines – some evidence by Lockett et al. (2003) based on 57 UK universities that successful universities always take equity stakes in spin-out companies - IPR ownership and preferred method of commercialisation (e.g. exclusive/non-exclusive licensing, spin-outs) - Other policies can be important for encouraging academics to engage in commercialisation, including tenure policies and protecting and encouraging junior faculty to engage, policies around leave of absence, and permitted uses of university resources - Research collaborations terms e.g. over background / foreground IP - Culture and perceived legitimacy of commercialisation amongst academics - Clarity of university mission and vision for university management of IP, and commitment of leadership to commercialisation (emphasized in both major UK (McMillan 2016)and US (Merrill and Mazza 2010) reviews) - Alignment of incentives across different university offices (e.g. TTOs, research contracts) and academics	(Bercovitz and Feldman 2008; Breznitz 2014; Chapple et al. 2005; Clark 1998; Di Gregorio and Shane 2003; Link and Siegel 2005; Lockett et al. 2003; Lockett and Wright 2005; McMillan 2016; Merrill and Mazza 2010; O'Shea et al. 2007; Siegel et al. 2003b, 2003a; Siegel and Phan 2005; Thursby and Kemp 2002)
Investor capabilities and policies	- Experience with investing in university spin-outs - Informational gap (e.g. understanding of investing in USOs, understanding of technology) - Availability of suitable investors (VCs, banks, business angels etc.) - Investor policies not to invest in particular technologies / sectors	(Wright et al. 2006)[57]

[57] Link to article: http://www.sciencedirect.com/science/article/pii/S0048733306000369

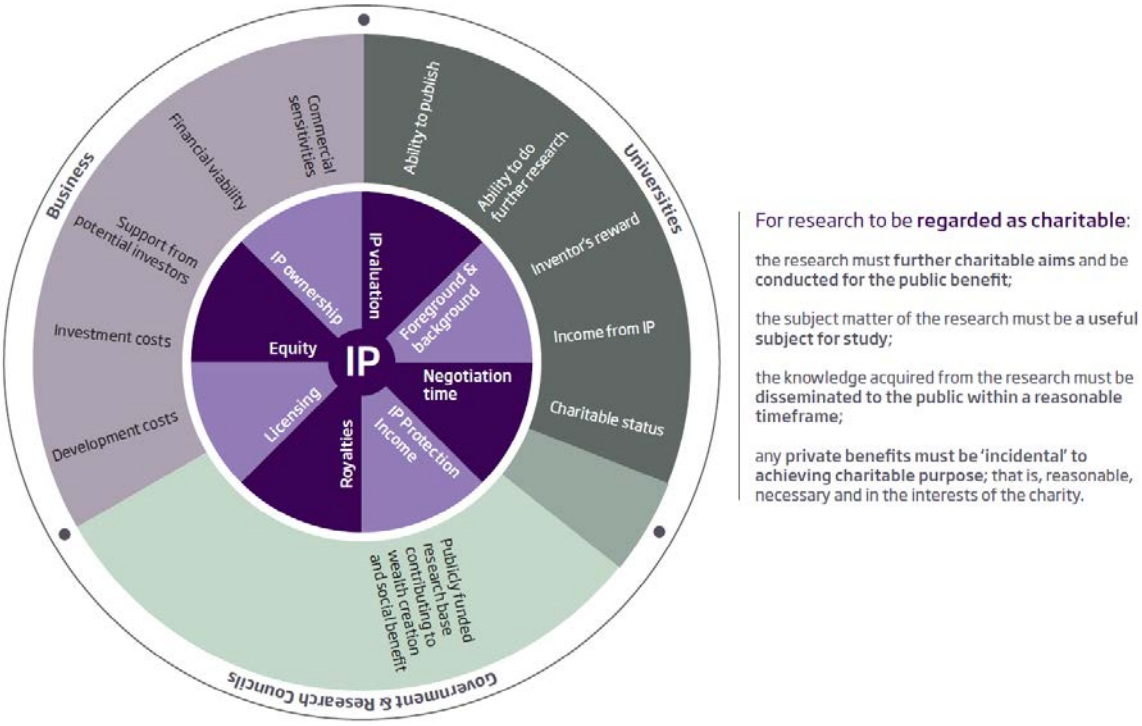
External local environment of university	- Availability and access to capital
	  o At the pre-seed stage capital to help develop university inventions to point where they become of interest to investors. This also provides a signal to investors that technology has been through some prior screening. Wright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

13.9 Factors affecting research contracting negotiations

This section now turns to the issues faced in research contracting between universities and industrial partners. By contrast to commercialisation activity, research contracts involving industrial partners generates a significant amount of income to universities (Ulrichsen 2015). The issues faced in setting up research contracts and in exploiting IP emerging from research are many and varied, and have been the subject of a number of government reviews and practitioner-driven studies (Business, Innovation and Skills Committee 2014; Dowling 2015; ICARG 2010; IP Pragmatics 2013; NCURA and IRI 2006; PraxisUnico 2016b; Research Consulting 2013; Saraga 2007; Science and Technology Committee 2013; UIDP 2012; UK Intellectual Property Office 2014; Ulrichsen and O'Sullivan 2015).

The Dowling Review (2015) highlights that developing research contracts will never be straightforward, not least given the very different aims of the different parties to the negotiations. These various aims of the key types of stakeholders were captured in the Dowling Review in a useful schematic.

Figure 5: Differing aims of universities, industrial partners and research councils in research contract negotiations



Source: Dowling Review, 2015.

A number of academic studies have also explored the barriers and enablers to research collaborations (Bruneel et al. 2010; Mora-Valentin et al. 2004; Muscio and Vallanti 2014; Plewa et al. 2013; Tartari et al. 2012).

Key factors and issues emerging from the practitioner and academic studies are summarised below.

Contentious terms in research contracting

A range of factors have been highlighted in the literature (in particular IP Pragmatics 2013; Saraga 2007; UIDP 2012; UK Intellectual Property Office 2014) as particularly contentious in the negotiation of research contracts between universities and firms.

- Agreement over the valuation of the IP – investors and companies often accuse universities of overvaluing their IP. However one could argue that this may be part of the bargaining process and that companies do likewise (Saraga 2007).
- Agreeing IP terms including:
    - Assignment of IP ownership / expectations of negotiating exclusive / non-exclusive licence agreements & related terms (e.g. length of time, method of exercising option, fees associated with option and /or licence)
    - Access/restrictions around university's background IP and other parties background IP
    - Compensation (one-off payments, downstream costs, milestone payments, royalties)
- Freedom to operate – i.e. universities must ensure they are able to continue to research and educate in the area in which the IP is being licensed or assigned
- Warranties and indemnities position with regard to licensed or assigned IP & limitations set
    - "*The clauses relating to liabilities, indemnities and warranties were also raised by both universities and companies as causing problems for both sides of the collaboration. Universities have a very different approach to risk management and will not take on risk of factors outside their control, whilst companies may be able to take more of a risk-reward approach to liabilities, indemnities and warranties. Some of this stems from the charitable status discussed above, and some reflects*

institutional practices. This can result in considerable frustration where a university feels that industry does not recognise that they operate in a different environment, or where a company feels that the university is demanding commercial style returns, but is not willing to make commercial-style commitments." (IP Pragmatics 2013 p. 68)

- Conditions on publishing (time periods for reviewing publications; delays, vetoes etc.)
- Confidentiality & implications of NDAs
- Classified work requiring secrecy and other obligations on the university - restrictions on research
- Compliance e.g. with standards, ethical requirements, export controls, immigration laws, employment law etc.
- Conflicts of interest

Factors likely to influence the research contracting process

Both academic and practitioner research has unearthed a wide range of factors that are known to influence the research contracting process. These are highlighted in the table below. Frequently cited in the literature as a key barrier are differences in orientation between universities and firms. This includes differing time horizons of deliverables, differing objectives and motivations, and different types of work as well as working practices (even within the broad category of 'R&D'). Nevertheless, scholars suggest that rather than eliminating differences, we need to find ways of *bridging* the gap between universities and firms. It is, after all, the differences that make universities attractive partners for firms that have long been withdrawing from undertaking basic research.

Other key barriers frequently cited in the context of establishing research collaborations include the incentives to interact, the ability to negotiate contracts and agree terms and navigate bureaucracies, the resources and capabilities to manage and nurture collaborations, and the organisational commitment to such activity. In addition, the ability to form strong, deep and trust-based relationships is believed to be critical to building successful research collaborations.

Table 30: Factors influencing the research contracting process

Category	Factors	Sources
Differences in orientation between universities and firms	- Understanding of differences in type of research / projects undertaken by universities and companies, working practices, timescales for delivering outputs (long-term/short-term), motivations of academic and industrial staff - Recognition by the company of the nature of academic research including timescales to impact and potential for failure - Understanding of each other's needs and capabilities, ability to deliver - Differing perceptions of what the problem is in negotiations (e.g. whether IP is a stumbling block)	(Bruneel et al. 2010; Davey et al. 2015; Dowling 2015; Feller et al. 2002; Hughes and Kitson 2012, 2014; Muscio and Vallanti 2014; NCURA and IRI 2006; Plewa et al. 2013; PraxisUnico 2016b; Tartari et al. 2012; UIDP 2012; Ulrichsen and O'Sullivan 2015)
Existing relationships, projects and trust	- Level of trust between parties - Prior relationships o Pre-existing professional relationships between universities and companies o Influence of terms agreed through previous contracts o Satisfaction with prior working relationship - Cost of changing partners ('lock-in') - Self-interested / opportunistic behaviour by one/both parties	(Dowling 2015; Mora-Valentin et al. 2004; NCURA and IRI 2006; Plewa et al. 2013; UIDP 2012; Ulrichsen and O'Sullivan 2015)
University and company strategies, policies and standard practices	- University & company IP policies and other relevant policies - Organisational approach to IP ownership (both university & company) - Red lines with regards to terms and conditions university can agree to (e.g. due to legal restrictions around charitable status, or institutional policies) - Conditions around public dissemination / publication of research outputs - Entrenched positions - Inflexibility regarding approach / conditions - Contract templates / position documents (e.g. on IP and publications, jurisdiction, governing law, indemnification) -	(Cyert and Goodman 1997; Dowling 2015; Elmuti and Kathawala 2001; Hughes and Kitson 2012, 2014; IP Pragmatics 2013; Muscio and Vallanti 2014; Tartari et al. 2012; UIDP 2012; Ulrichsen and O'Sullivan 2015)

Category	Factors	Sources
Commitment and incentives	- Commitment and motivation of senior university & company management - Commitment and motivation of academics and industrial staff who will be involved in collaboration - Lack of incentives within universities and companies for staff to engage in collaboration - Misaligned incentives between different parts of the university (e.g. TTO/central leadership/academics)	(Dowling 2015; Hughes and Kitson 2012, 2014; Mora-Valentin et al. 2004; Muscio and Vallanti 2014; PraxisUnico 2016b; Ulrichsen and O'Sullivan 2015)
Bureaucracy and processes	- Degree of university & company bureaucracy - Ability to navigate through the different approaches to legal and IP policy in both universities and companies - Established procedures for collaborations - Over-reliance on advice from legal professionals - Ability to escalate problems to more senior decision-makers	(Davey et al. 2011; Hughes and Kitson 2012, 2014; IP Pragmatics 2013; PraxisUnico 2016b; UIDP 2012; Ulrichsen and O'Sullivan 2015)
Finding the right people and partners	- Ability to identify the right university/industrial partners - Ability to identify right people to talk to / key decision makers (in university & business) - High turnover of staff in companies, including at strategic level	(Davey et al. 2011; Dowling 2015; Hughes and Kitson 2012, 2014; Muscio and Vallanti 2014; Tartari et al. 2012; UIDP 2012; Ulrichsen and O'Sullivan 2015)
Resource availability and capabilities to negotiate and collaborate	- Resource limitations - financial, personnel, legal etc. on both sides to support development of contract / collaboration o Resource constraints / workload of contracts / legal officers on both sides - Capabilities and experience of company/university contracts offices in working with universities/industrial partners - Skills and experience of the negotiating parties - Resource limitations within firm to fund the project - Availability of suitable public funding at appropriate stages of research and technology development to ensure pull-through of technology - Conflicts for academics with other research and teaching duties - Experience / ability of academics to meet deliverables / deadlines / expectations - Availability of suitable physical spaces for collaboration	(Bruneel et al. 2010; Dowling 2015; Hughes and Kitson 2012, 2014; IP Pragmatics 2013; Muscio and Vallanti 2014; Tartari et al. 2012; UIDP 2012; Ulrichsen and O'Sullivan 2015)

Negotiating the specifics	- Overemphasis on IP in research contract negotiations rather than collaborative aims
	- Conflicting goals and timelines are the biggest cause of negative experiences yet can be aligned with management from both parties
	- Misalignment of expectations of licensing revenue versus cost of commercialization can kill deals. Up-front fees, royalties, and other costs must be reasonable.
	- Mutual agreement on, and alignment of: vision, expectations and objectives regarding project/collaboration/partnership
	- Realistic milestones and deliverables given different types of organisations
	- Available budgets for the project
	  o Needs to be realistic and appropriate for partner
	  o Clarity of budget items
	  o Understanding of industry partner of indirect costs (overheads) requirements from universities (FEC)
	- University's ability to develop / submit proposals that fit the templates of companies
	- Ability to agree statement of work and terms within it
		(Dowling 2015; IP Pragmatics 2013; UIDP 2012; UK Intellectual Property Office 2014; Ulrichsen and O'Sullivan 2015)

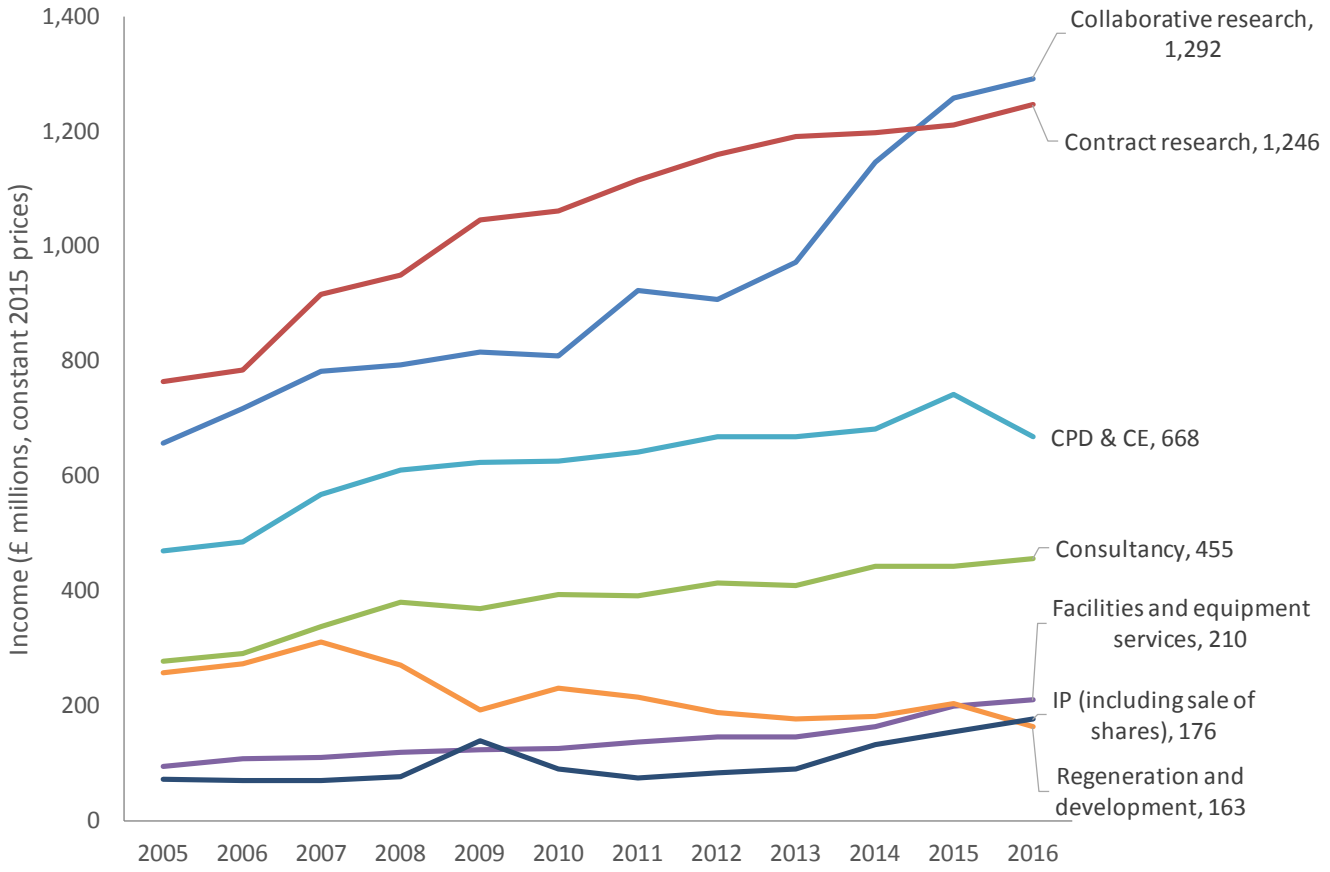
Category	Factors	Sources
Other	- Government rules and regulations (including inconsistencies in government policies towards IP) - Absorptive capacity of company to work with, and benefit from, universities - Changes in direction of firm R&D, technology and innovation strategies - Understanding of how universities can benefit firm - Ability to protect company IP, know-how from leakage to competitors	(Cyert and Goodman 1997; Davey et al. 2011; Dowling 2015; IP Pragmatics 2013; Muscio and Vallanti 2014; Ulrichsen and O'Sullivan 2015)

14 APPENDIX C: KEY KEC TRENDS AND INTERNATIONAL COMPARISONS

14.1 Key trends in knowledge exchange and commercialisation

The following section presents key trends in KEC in the UK, and situates the scale of commercialisation activity against other forms of KEC.

Figure 6: Income from knowledge exchange and commercialisation in the UK higher education sector, 2005 - 2015

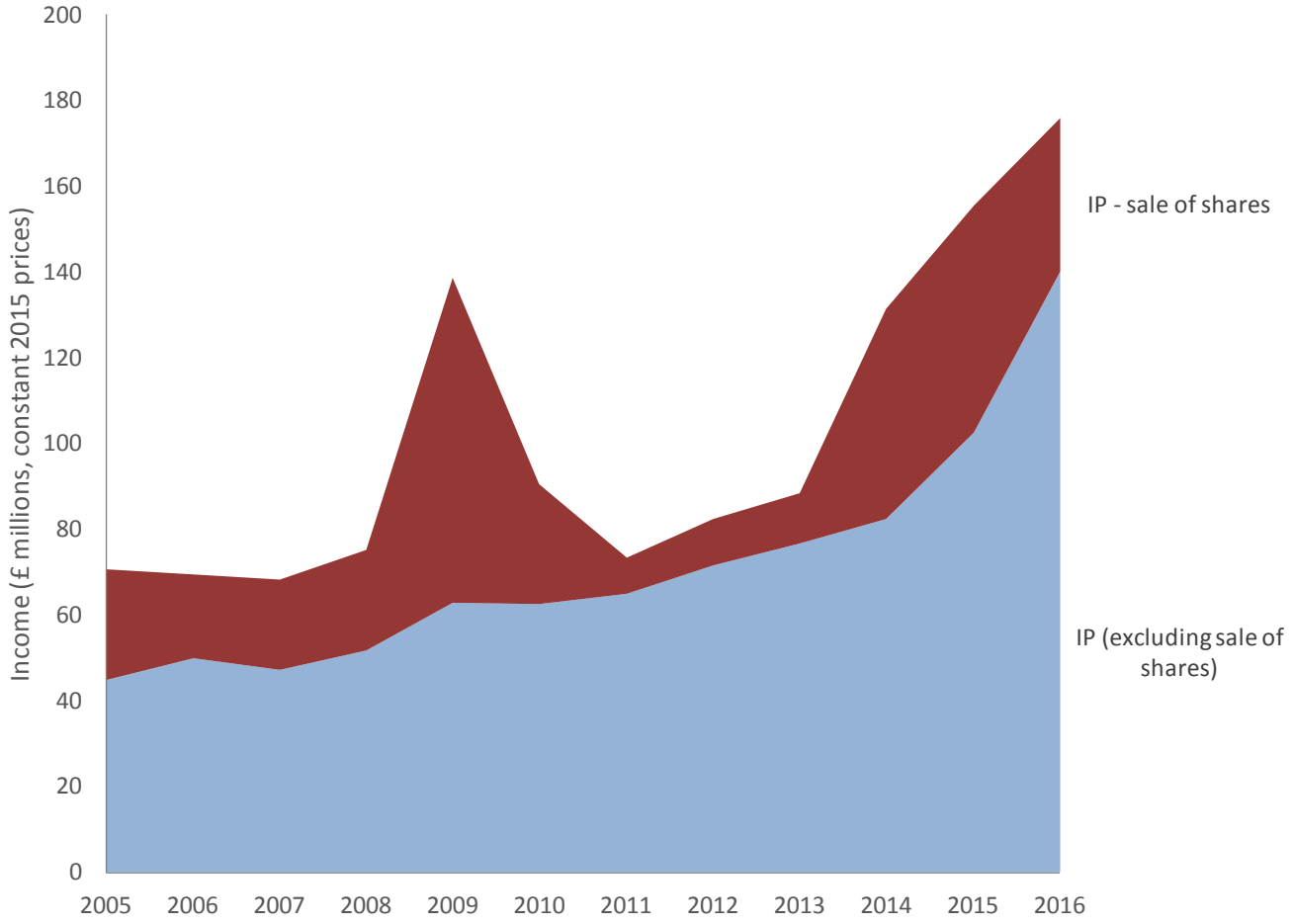


1

Source: HESA HEBCI surveys.

- Volume of research contracting is an order of magnitude greater than commercialisation activity when measured by the amount of income received by universities
- Collaborative research has increased dramatically, particularly since the onset of the economic recession in 2008.

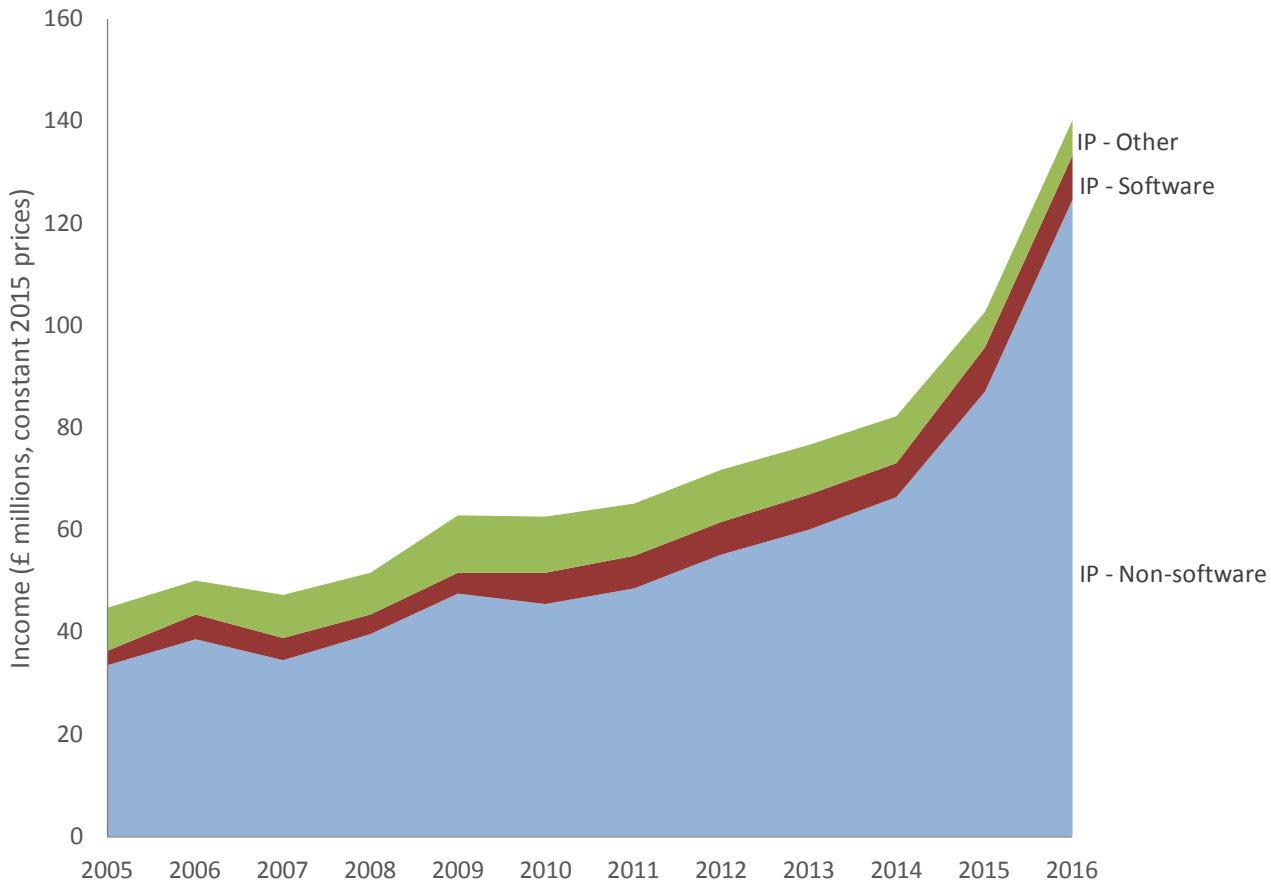
Figure 7: Income from intellectual property royalties, upfront fees and other sources, and from the sale of shares in spin-outs, 2005 - 2015



Source: HESA HEBCI surveys.

- Revenues from IP (excluding sale of shares in spin-outs) has been increasing steadily over time, while the returns to universities from the sale of shares in their spin-outs can vary greatly year-on-year. (Note that this includes licensing revenue which is subsequently distributed to the academic inventors)

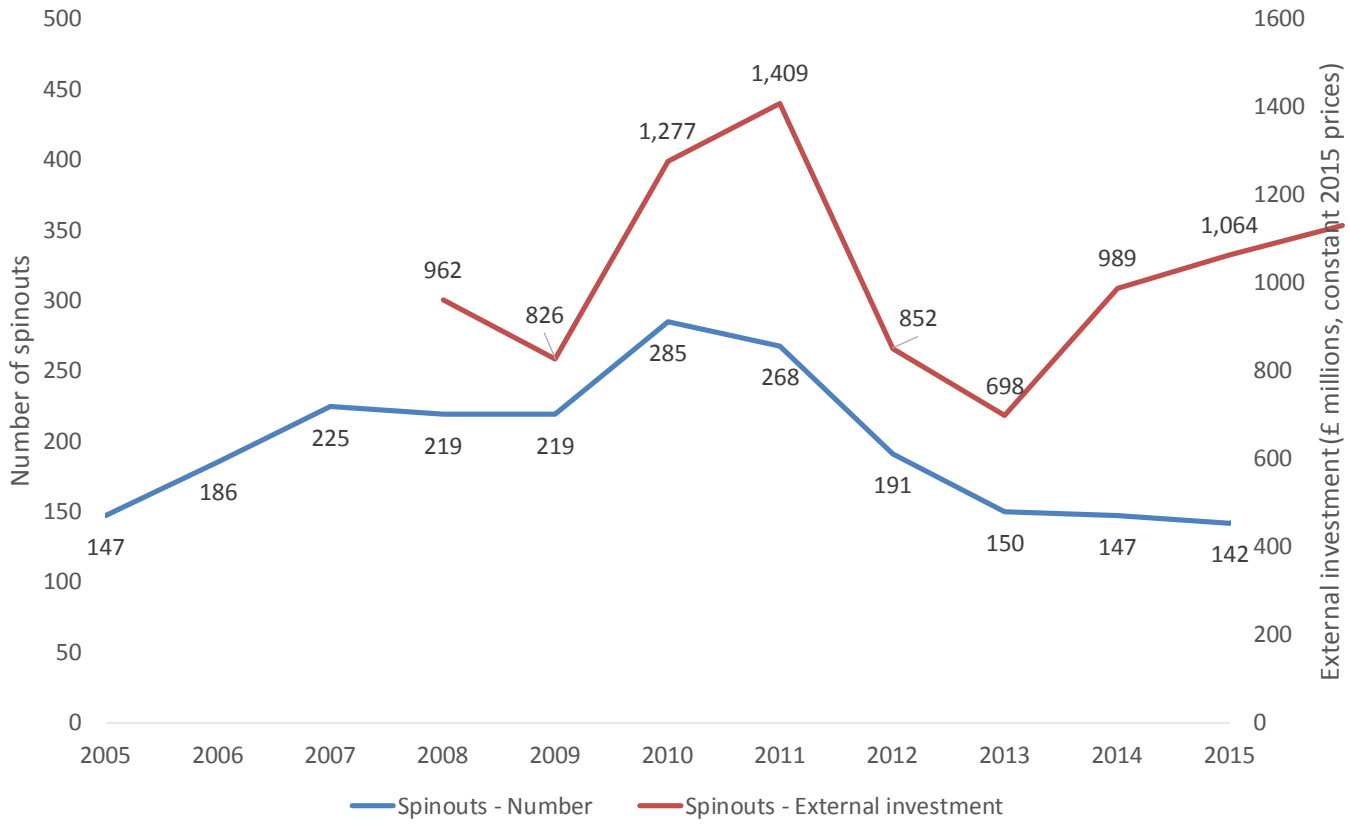
Figure 8: Income from different types of intellectual property (non-software, software, and other), 2005 - 2015



Source: HESA HEBCI surveys.

- Much of *revenue* generated through licensing activity comes from non-software intellectual property. Note this does not imply a lesser value of software and other forms of IP as it says little about the types of licenses being negotiated and their compensation terms.

Figure 9: Number of spin-outs and amount of external investment raised, 2005 - 2015



Source: HESA HEBCI surveys.

- The number of spin-outs (both those with some university ownership of IP and other formal spin-outs) has been falling year-on-year since its peak in 2010. By contrast, the amount of external investment raised in these spin-outs has been increasing in recent years.

Analysis: UK context and potential for additional commercialisation activity

This research and analysis on views has been carried out against a background where the number of spin-outs (including those with some university ownership of the IP and other formal spin-outs has been falling year on year since its peak in 2010. In 2010 there were some 285 spin-outs compared to 142 and 2015 a fall of around half. This may have resulted because of the financial crisis from 2008 onwards during which participants and funders were more risk averse. However, the amount of external investment in spin-outs after falling between 2010 and 2013 has been rising suggesting that there has been more of a focus on the spin-outs that were likely to be successful.

Within the national context the number of start-ups has been increasing since 2010, year on year. This has resulted in a 75% increase between 2010 and 2015. Similarly, the high-tech start-ups have been increasing over the same period by around two thirds between 2010 and 2015 although these businesses are not likely to be characterised by the more sophisticated IP and technology in university spin-outs. The number of licenses granted has risen every year since 2007/8, and has quadrupled since 2012/13 due to a small number of successful software licences. In 2009/10 there were c.4,800 licences compared to 41,400 in 2014/15. If one large institution responsible for this increase is excluded it represents just under a three-fold increase between 2009/10 and 2014/15. Overall IP **income** from licences and sale of spin-out shares has been rising at a trend rate of 8.6% per year since 2003/4 (though the increase has not been uniform – in particular there was a sharp intermediate peak in income in 2008/9 which was only exceeded in 2014/15). This may imply that the IP, or technology, has switched away from spin-outs to licensing which participants may see as less risky.

Based on the comments made about the process of commercialisation at the different stages, and some of the negative comments by university interviewees. It is very likely that some opportunities to commercialise IP have not

been identified and taken up. However, it is difficult to assess the scale and the nature of these. One indication is that many universities (particularly the more research intensive and active ones) go through a systematic internal process (sometimes on an annual, or ongoing basis) to identify a long list of potential opportunities. A process of filtering usually results in a short list of what are considered to be the more feasible opportunities that can be resourced and invested in. These are likely to represent a small fraction of the initial long list.

In the discussions with university staff they were asked to estimate the number of spin-outs and licensing agreements they considered in depth over the past five years and whether they went ahead or not. Around a quarter of interviewees were in a position to provide accurate information. The staff who could provide information estimated that on average some 15-20% of spin-outs they looked at in depth did not go ahead, largely based on the negative factors outlined above compared to some 20-25% of potential licensing agreements.

The survey findings above, combined with overall statistics from the HE-BCI survey on the overall amount of spin-out and licensing activity, can be used in a rough calculation to indicate the opportunities that were not taken up. Other opportunities were prioritised primarily because of their likely success, capacity issues and the willingness of academics and investors to participate at the time of the deal. This does not mean that those that did not go ahead were not viable. The choices made are more about priorities. For spin-outs, a 15-20% drop-out rate would imply some 25 to 30 spin-outs per year that were not taken forward. For licensing, a 20-25% gap would imply some 9,000[58] licence agreements annually. These estimates are based on the total of around 45,000 licence agreements in 2015/16, 15,000 of which generated income that year (HE-BCI tables 2017). However, these figures are skewed towards a small number of pieces of software IP with a large number of licensees and year-to-year variation is significant.

Several universities commented that there were definitely opportunities that were not being taken up in addition to those that got onto the shortlist for in-depth consideration. It was difficult to estimate the number but some thought that it could be a quarter again if internal capacity existed to fully assess them, alert businesses and investors and strengthen the interface with the private sector.

[58] Based on ~45,000 licence agreements in 2015/16, 15,000 of which generated income that year (HE-BCI tables 2017). However, these figures are skewed towards a small number of pieces of software IP with a large number of licensees.

14.2 International comparisons on commercialisation

There is a dearth of evidence comparing different countries' activity and performance in commercialisation (McMillan 2016; Ulrichsen et al. 2014). This is partly due to a lack of comparable metrics across nations on commercialisation-related inputs, activities, outputs and outcomes. In addition, significant structural differences in the research and innovation landscapes in different countries, and by implication, appropriate pathways for commercialising university-generated knowledge and IP, make comparisons relatively meaningless unless these differences can be accounted for (Ulrichsen et al. 2014).

Nevertheless, a number of comparisons exist. The McMillan Review of technology transfer included international comparisons of commercialisation activity between the US, UK and Japan It suggests that, adjusting for the scale of research activity between countries, the UK generates a similar number of USOs and a much higher level of cashed-in equity when compared with the US. However, the UK generates significantly less licensing revenues as a proportion of total research activity. This may reflect in part the structure of the US commercialisation system but also differences in industrial absorptive capacity for university IP between the US and UK. The Review also presented evidence that suggests that the UK has developed a world-leading approach in terms of university support for commercialisation, and it frequently engaged by other nations to disseminate its lessons learned and effective practices. Table 31 below summarises the evidence from the McMillan Review and the latest update to this evidence from the October 2017 HE-BCI survey report.

Table 31: Commercialisation activity in 2013/14 and 2015/16 for the US, UK and Japan

	US (AUTM)		UK (HEBCI)		Japan (UNITT)	
	2013/14	2015/16	2013/14	2015/16	2013/14	2015/16
Total research income (£M)	35,722	39,491	7,043	7,845	14,715	14,050
IP licence income (£M)	1,290	1,224	131	176	18	23.82
IP Licence income as % of total research resources	3.6%	3.08%	1.9%	2.24%	0.12%	0.17%
Spin-out companies formed	747	944	147	168	18	65
Research spend per spin-out (£M)	48	41.8	48	46.7	817	216.2
Patents granted	5,163	6,101	976	1,219	4,776	3,862
Research resource per patent (£M)	7	6.5	7	6.4	3.1	3.6
Industrial contribution (£M)	2,330	2,928	508	603	64	342
% industrial research	6.5%	7.41%	7.2%	7.69%	0.4%	2.43%
Sale of spin-out equity* (£M)	20	45.4	49	35.8	3.6	1.07
Sale of spin-out equity* as a % of total research resources	0.06%	0.115%	0.7%	0.46%	0.2%	0.01%

Source: 2013/14 data reproduced from McMillan, 2016; 2015/16 data from HE-BCI survey report © HEFCE 2017 (ref: October 2017/23). "Sale of spin-out equity" denotes "sale of spin-off shares" in the UK, "cashed-in equity" in US and Japan.

15 APPENDIX D: POTENTIAL POLICY APPROACHES

15.1 Policy framework

The table below sets out the commercialisation barriers which were established by the policy review, the sources of information used, and a set of potential policy approaches which could be used to resolve them and which were used as guidance for the section of the survey research which dealt with policy.

Table 32 : List of commercialisation barriers and potential policy approaches

Barriers	Potential policy approach
1. A lack of business awareness about IP opportunities for commercialisation (e.g., through licensing) in universities and who to contact about them.	Additional measures to publicise university opportunities (e.g., Konfer, university publications and awareness raising) and increase transparency.
The Science and Technology Committee outlines the points that some business especially SMEs, found it difficult to investigate potential licensing and collaborative opportunities and they found it hard to navigate information on a large number of institutions (i.e., HEIs). To make is easier for all businesses the Konfer system was rolled out as a pilot in 2016 as an outline "brokerage platform". It was designed to help identify opportunities and assist with business/academic 'matches'. It is operated by NCUB with other partners. However, it was questioned whether it is sufficient and a people based system was also needed to help provide depth to the 'matches' that Konfer could make. This comment has arisen in other reports for example, CBI "Best of Both Worlds". *Sources:* *Science and Technology Committee. Managing intellectual property and technology transfer. Tenth report of Session 2016-17* *https://www.publications.parliament.uk/pa/cm201617/cmselect/cmsctech/755/755.pdf* *Konfer online* *http://www.ncub.co.uk/konfer-online.html* *https://konfer.online/* *CBI. Best of both worlds. Guide to business-university collaboration. (2015)* *http://www.cbi.org.uk/insight-and-analysis/best-of-both-worlds/* *UK-IRC. Connecting with the Ivory Tower: Business Perspectives on Knowledge Exchange in the UK. NCUB, University of Cambridge, CBR, Imperial College. (2013)* *http://www.ncub.co.uk/index.php?option=com_docman&view=download&alias=67-connecting-with-the-ivory-tower-business-perspectives-on-knowledge-exchange-in-the-uk&category_slug=publications&Itemid=2728* *HEFCE. Higher Education Innovation Funding: Institutional five-year knowledge exchange strategies. (2016/17)* *http://www.hefce.ac.uk/pubs/year/2016/201616/*	
2. Lack of awareness amongst universities about which businesses to collaborate with.	Measure to develop initiatives to identify business partners, such as network building and events.
The research carried out with universities also indicates that they can have difficulty in knowing which businesses to partner with. This is reflected in the findings that just 21% of innovative	

businesses had used cooperative agreements with universities in the BIS Community Innovation Survey report. The UK-IRC report also shows that almost three quarters of businesses do not interact with universities and where they do it may not be continuous and in-depth. This includes innovative businesses in the science and technology fields. This partly reflects findings that research intensity and investment in R&D of UK businesses compared to those in other countries is relatively low. Hence businesses are less likely to engage with universities for R&D. Other research shows the relatively low interactions with businesses occurs because they are not aware of what universities offer or who to contact. Hence the "brokerage platform" referred to by the Science and Technology Committee seems to address this, to some extent, but scale up the ability to have an international mechanism to bring people together is a challenge. A handful of universities have started to operate their own online advice systems.

Sources:

National Centre for Universities and Business. The Changing State of Knowledge Exchange. UK Academic Interactions with External Organisations 2005-2015. (February 2016)
http://www.ncub.co.uk/index.php?option=com_docman&view=download&category_slug=reports&alias=429-the-changing-state-of-knowledge-exchange&Itemid=2728

BIS. The UK innovation survey 2015: main report. Innovation Analysis. (July 2016)
https://www.gov.uk/government/statistics/uk-innovation-survey-2015-main-report

UK-IRC. Connecting with the Ivory Tower: Business Perspectives on Knowledge Exchange in the UK. NCUB, University of Cambridge, CBR, Imperial College. (2013)
http://www.ncub.co.uk/index.php?option=com_docman&view=download&alias=67-connecting-with-the-ivory-tower-business-perspectives-on-knowledge-exchange-in-the-uk&category_slug=publications&Itemid=2728

3.	HEI IP not ready for investment or commercialisation (e.g. low TRLs) and a lack of investment readiness.	Ensure research outputs identify commercialisation opportunities – move the technology forward so it can be invested in.

This issue has arisen from the scoping interviews with the private sector and HEIs. The Science and Technology Committee[1] noted that based on its consultations that some of the smaller universities did not have the through put or capability to deal with technologies or the requisite experience. It considered that best practice should be developed in identifying and nurturing opportunities for technology transfer (pages 16 to 17). The review on the Changing State of Knowledge Exchange showed that some 43 per cent of academics were unaware of technology transfer offices (or their equivalents) as a resource to assist with commercialisation and 17 per cent were aware but had no contact. This unawareness was relatively high in the disciplines of health sciences, physics and maths where there can be an applied side to the research that can result in commercialisation opportunities (along with the arts and humanities). The technology transfer officers were the least cited sources for knowledge exchange. However, the remaining 40% of academics had had some contact with a TTO.

Sources:

Science and Technology Committee. Managing intellectual property and technology transfer. Tenth report of Session 2016-17
https://www.publications.parliament.uk/pa/cm201617/cmselect/cmsctech/755/755.pdf

National Centre for Universities and Business. The Changing State of Knowledge Exchange. UK Academic Interactions with External Organisations 2005-2015. (February 2016)
http://www.ncub.co.uk/index.php?option=com_docman&view=download&category_slug

=reports&alias=429-the-changing-state-of-knowledge-exchange&Itemid=2728

Technology Strategy Board. Evaluation of the Collaborative Research and Development Programmes. PACEC. (September 2011)
http://webarchive.nationalarchives.gov.uk/20130221185318/http:/www.innovateuk.org/_assets/pacec_evaluation_of_crandd_report_final260911%20(2).pdf

4.	Low incentives for academics to participate in the commercialisation of IP.	Improve rewards: shareholding / royalties, remuneration from IP career structures and recognition.

There are a range of issues and related research here which primarily cover knowledge exchange with some indicators for commercialisation and the role of academics. The Dowling Review notes that although the REF has stimulated a more positive attitude amongst academics to consider greater collaboration with businesses (and these could be given greater weighting on impact assessment). There is still the perception that collaborating with industry is damaging to academic career paths and that translational activities for academics should be rewarded more and seen as a "mark of esteem". In key disciplines business/academic connections should be made at an early career stage. The McMillan report recommends the development of entrepreneurial staff and appropriate rewards, and increased support for smaller, less-experienced technology transfer units (which face specific challenges of scale which larger-scale commercialising universities can meet with their own resources and experience). The NCUB report[2] shows that there has been a decline in commercialisation and patenting amongst academics between 2008/9 and 2015 with 8 per cent saying they had taken out a patent in (2008/9) and 6 per cent saying they had licensed their research compared to 6 per cent and 4 per cent respectively in the latter period (i.e., 2015). Commercial activity, in some form had dropped from 21 per cent of academics to 14 per cent, although the macroeconomic climate, not simply the rewards available to academia, had a bearing on this.

Sources:

HEFCE. Evaluation of the effectiveness and role of HEFCE/OSI third stream funding. PACEC. (April 2009)
https://www.cbr.cam.ac.uk/fileadmin/user_upload/centre-for-business-research/downloads/special-reports/specialreport-evaluationeffectivenesshefce.pdf

The Dowling Review of Business-University Research Collaborations. (July 2015)
https://www.gov.uk/government/publications/business-university-research-collaborations-dowling-review-final-report

HEFCE. University Knowledge Exchange (KE) Framework: good practice in technology transfer. McMillan group. (September 2016)
http://www.hefce.ac.uk/pubs/rereports/year/2016/ketech/

5.	Universities take an equity share in spin-outs that is too high, which can discourage other investors. Costs of licensing too high including royalty payments.	Examine the ceiling on HEI shareholding in spin-outs (but recognising that it becomes diluted anyway) and returns from licensing to encourage more external investment. Review university requirements and aims re income generation from spin-outs and licensing/royalties.

This point arose primarily from discussions with the private sector advisors who advise companies and investors that take a share in spin-outs and/or commit to licensing agreements. The Industrial Strategy Green Paper recognised the issue by calling for this research project on the approach to

licensing intellectual property and the principles for taking equity in spin-outs. Lambert and the Intellectual Property Office (IPO) guidelines also seek to address these issues in part.

Sources:

HM Government. Building our Industrial Strategy – Green Paper. (January 2017)
https://www.gov.uk/government/consultations/building-our-industrial-strategy

HM Treasury. Lambert Review of Business-University Collaboration. (2003)
http://webarchive.nationalarchives.gov.uk/20130129110402/http://www.hm-treasury.gov.uk/media/9/0/lambert_review_final_450.pdf

Intellectual Property Office. Collaborative Research between Business and Universities: The Lambert Toolkit 8 Years On. (2013)
https://www.gov.uk/government/publications/the-lambert-toolkit-8-years-on

6.	Income generation. The HEIF metric to generate income from licensing and spin-outs could discourage other investors.	Review with this element in HEBCIS returns on HEIF.

The HEBCIS returns made annually by universities to HESA/HEFCE on their knowledge exchange activities show the amount of income generated through knowledge exchange activities and those linked to research activities. The returns show that some £11,825m was generated over the period 2012/13 to 2014/15 from different types of research i.e. contract research 31 per cent of the total, collaborative 29 per cent, consultancy 11 per cent and some £377m (or 3%) from intellectual property and licensing activities. The funding formula to distribute funds to HEIs for KE via HEIF is based in part in on income measures which include intellectual property income and SME income along with, for example, contract and consulting research income and includes significant weighting on these aspects. Although the IP income is relatively small compared to the other research sources it is still significant in absolute terms where the source is primarily from business, in particular spin-outs and early stage firms, and can act as a disincentive for them.

Sources:

SFC. Evaluation of the HFU 2010/13 Demand-led Knowledge Exchange Programme. PACEC. (September 2014)
http://www.sfc.ac.uk/web/FILES/Knowledge_Exchange/HFU_Evaluation_Final_Report.pdf

SFC. Evaluation of the 2009/2010 SPIRIT Demand-Led Knowledge Exchange Programme Final Report 2013. PACEC (2014)

HEFCE. Higher Education Innovation Funding: Institutional five-year knowledge exchange strategies. (2016/17)
http://www.hefce.ac.uk/pubs/year/2016/201616/

7.	Difficult to value IP and what the “proper value” of IP in spin-outs / licensing should be leads to disagreements and delay.	Establish an arm’s length brokerage / arbitration / guidance service, if this is acceptable in the sector, to resolve issues quickly to allow negotiations to be more focused. Provide more information to allow comparisons/benchmarks to be made.

This point arises from discussions with private sector advisors and HEIs. The research that throws some additional light on this issue is shown below. The Science and Technology Committee report recommends that the skills needed to value IP and broker negotiations with spin-outs, licensee

businesses and investors should be examined. This is based on findings that the challenges posed by valuing technology, especially early stage technologies can mean that delay and difficulty in negotiations is unavoidable. The Russell Group submission also highlights this point due to "market uncertainty" especially where early stage university technologies are concerned. The value of IP helps determine what proper value should be and how it can be realised, i.e. what a reasonable rate of return would be given the specified levels of investment over time. Part of this relates to the 'field of use' of technology and whether it is broad or narrow and what can be done with it. The Scottish Government has carried out research on risk factors related to value and the forms of market features related to value and returns as part of its evaluation of co-investment funds. Part of the market failure includes excessive risk as a result of uncertain values and returns from IP investment.

Sources:

Science and Technology Committee. Managing intellectual property and technology transfer. Tenth report of Session 2016-17
https://www.publications.parliament.uk/pa/cm201617/cmselect/cmsctech/755/755.pdf

HEFCE. The Intellectual Property Regime and its Implications for Knowledge Exchange. PACEC/CBR. (2010)
http://www.pacec.co.uk/publications/the-intellectual-property-regime-and-its-implications-for-knowledge-exchange/

Scottish Enterprise. Economic Impact of the Scottish Enterprise Seed Fund. PACEC. (2013)
https://ec.europa.eu/growth/tools-databases/regional-innovation-monitor/sites/default/files/support_measures/reports/report-1.pdf

8.	Commercialisation processes too complex / bureaucratic.	Develop a template / guidance / pack for HEIs and businesses to simplify / speed up the process. (Along the lines of Lambert.)

The CBI report on business-university collaboration highlights that negotiations on collaboration can cause delays and adds to business costs which are then written off if an agreement is not needed. Related to this some academics and TTOs may be unfamiliar with business timeframes and the need for a market focus and the expertise is in different parts/faculties of the university if the required IP inputs are complex. The Dowling Review notes the excessive complexity of innovation support which required simplification. It also notes that there is scope for all parties to develop best practice in relation to IP and contracts. These points are also referred in the UK-IRC research where constraints involve HE bureaucracy and administrative practices as well as difficulty identifying academic partners which can be a constraint to activity. The businesses also have constraints through insufficient time, a lack of experience when dealing with academics, and (for larger licensees) their own internal processes and bureaucracy.

9.	The process is too time-consuming. Deters investors and increases costs for businesses and investors who seek to turn IP into products / services and get to market quickly (IP and technology can be overtaken rapidly in some fields).	Develop a template / guidance / pack for HEIs and businesses to simplify / speed up the process. (Along the lines of Lambert.)

Please see point 8 above for the main sources. PACEC reports on knowledge exchange also indicate the constraints faced by businesses. For example, where industry/university collaborative R&D projects were critical or very important for 60 per cent of firms involved in project there were

cost barriers in the run up to the collaborations. Reviews of third stream funding and HEIF indicate that academics and staff in universities can lack the time to engage with businesses, have other priorities (e.g. research) and can be characterised by bureaucratic and inflexible procedures which make it difficult to agree terms and contracts especially where IP was concerned.

Sources:

Technology Strategy Board. Evaluation of the Collaborative Research and Development Programmes. PACEC. (September 2011)
http://webarchive.nationalarchives.gov.uk/20130221185318/http:/www.innovateuk.org/_assets/pacec_evaluation_of_crandd_report_final260911%20(2).pdf

HEFCE. Evaluation of the effectiveness and role of HEFCE/OSI third stream funding. PACEC. (April 2009)
https://www.cbr.cam.ac.uk/fileadmin/user_upload/centre-for-business-research/downloads/special-reports/specialreport-evaluationeffectivenesshefce.pdf

HEFCE. Evaluating the Non-Monetised Achievements of the Higher Education Innovation Fund. PACEC. (October 2015)
http://www.hefce.ac.uk/pubs/rereports/year/2015/heifeval/

PraxisUnico. Knowledge Exchange and Commercialisation: The state of the profession in UK higher education. (2016)
https://www.praxisunico.org.uk/sites/praxisunico.org.uk/files/KEC%20RESEARCH%20REPORT%20-%20PRU.pdf

10. Complexity and delay over the requirement for university warranties	Develop a template / guidance / pack for HEIs and businesses to simplify / speed up the process. (Along the lines of Lambert.) Provide the HEIs with insurance / cover or a central agency to allow progress to be made more quickly

This relates to the points above but particularly where businesses and investors seeking to license IP require warranties from the university that what it covers is complete and valid and it is the rightful owner. This point was highlighted in the discussions with the private sector although as it is a detailed issue related to agreements there is little specific published research on this issue. In a general sense, the Lambert Review noted that there was a lack of clarity over IP ownership in 2003, which touches upon the warranties issue and collaborations.

Sources:

HM Treasury. Lambert Review of Business-University Collaboration. (2003)
http://webarchive.nationalarchives.gov.uk/20130129110402/http://www.hm-treasury.gov.uk/media/9/0/lambert_review_final_450.pdf

Intellectual Property Office. Collaborative Research between Business and Universities: The Lambert Toolkit 8 Years On. (2013)
https://www.gov.uk/government/publications/the-lambert-toolkit-8-years-on

11. Universities can take a short-term view to stimulate income. Investors often have medium-term plans for profitable exit and may not make longer-term commitments.	Review the need for short term income gains for HEIs in some circumstances. Stimulate the wider use of 'patient funding' with longer term horizons for reforms. Adopt the results of the Patient Capital Review (see below).

The Dowling Review makes the point that TTOs, as important players in the innovation process,

should gauge their effectiveness in terms of supporting translational activities over the long term and not on short term revenue generation (e.g. of the type required for the HEBCIS returns). The Science and Technology Committee also points out that TTOs should be focused on taking as longer-term approach rather than one based on short term revenue. As a result of this, and to overcome difficulties of obtaining long term finance and to remove barriers, some universities have developed a "patient capital" model. The government is undertaking a Patient Capital Review to explore these schemes.

12. Universities / academics seek to publicise the results of research which can give insights to commercialisation / translation opportunities. Investors prefer to ensure outputs are confidential	Adjust university / academic assessments based on publications / citations, REF where there are confidential commercialisation issues

This point arises from discussions with and surveys of businesses collaborating with HEIs. The CBI report "Best of Both Worlds" highlights that one of the weaknesses is where academics seeking to publish the results of their research as "it's what they are judged on". They may also be unfamiliar with the way businesses need to approach IP and confidentiality. This also has implications for demonstrating impact in the REF. Critical information can also be imparted to a number of organisations as the HEIs/academics work with "their whole industry" in some fields including the competitors of those seeking to license university IP. These points are picked up in PACEC reports related to the achievements of HEIF where it can be difficult to strike research contracts with universities because of issues of IP ownership and publications which could disclose IP. The UK-IRC report makes the point that IP issues are frequently less cited as a constraint by businesses (compared to other issues faced). However, this is because only a narrow group of businesses have IP related interactions – for those that do the constraint is still relevant. The PACEC report on IP concludes that, where they enter IP discussions, almost one in five experience a constraint.

Sources:

UK-IRC. Connecting with the Ivory Tower: Business Perspectives on Knowledge Exchange in the UK. NCUB, University of Cambridge, CBR, Imperial College. (2013)
http://www.ncub.co.uk/index.php?option=com_docman&view=download&alias=67-connecting-with-the-ivory-tower-business-perspectives-on-knowledge-exchange-in-the-uk&category_slug=publications&Itemid=2728

HEFCE. The Intellectual Property Regime and its Implications for Knowledge Exchange. PACEC/CBR. (2010)
http://www.pacec.co.uk/publications/the-intellectual-property-regime-and-its-implications-for-knowledge-exchange/

CBI. Best of Both Worlds. Guide to business-university collaboration. (2015)
http://www.cbi.org.uk/insight-and-analysis/best-of-both-worlds/

HEFCE. Evaluating the Non-Monetised Achievements of the Higher Education Innovation Fund. PACEC. (October 2015)
http://www.hefce.ac.uk/pubs/rereports/year/2015/heifeval/

SFC. Evaluation of the HFU 2010/13 Demand-led Knowledge Exchange Programme. PACEC. (September 2014)
http://www.sfc.ac.uk/web/FILES/Knowledge_Exchange/HFU_Evaluation_Final_Report.pdf

SFC. Evaluation of the 2009/10 SPIRIT Demand-Led Knowledge Exchange Funding

Programme Final Report 2013. PACEC (2013)

HEFCE. University Knowledge Exchange (KE) Framework: good practice in technology transfer. McMillan group. (September 2016)
http://www.hefce.ac.uk/pubs/rereports/year/2016/ketech/

13. The necessary business support for spin-outs is required to commercialise and grow and for licensees to fully utilise the IP. For example, finance for growth, access to grants, new investor tax incentives, legal guidance, the ongoing HEI / access to academics/researchers, product and service development marketing, business skills, arrangements for production and engagement with the key parts of the innovation eco-system, etc.	Build a strong and accessible support infrastructure / innovation eco-system with the appropriate networks, events, individuals and organisations to encourage know-how and investment.

The need for ongoing support to realise commercialisation after IP licensing agreements are signed and spin-outs seek to consolidate and grow are highlighted in a number of reports. Some of the points on finance for R&D and exploitation are picked up in the Science and Technology Committee report, for example, on R&D tax credits and the charging of VAT on the use of university equipment and facilities. Dowling also makes these points. The Lambert report sets out a framework on the legal collaborative issues and the IPO Review of the Lambert Toolkit provides an update on this. Access to academic researcher post negotiation and contracts are referred to in the CBI report "The Best of Both Worlds" where academics may be unfamiliar with business timeframes, they are often busy with other responsibilities (i.e., teaching and research) and may not be "on-tap" – although it is noted that there have been significant changes in university culture to collaborate with businesses. That innovative businesses at the spin-out and early stages use ongoing support is highlighted in a number of reports along with the need to strengthen the eco-system. The preparation of Science and Innovation Audits (SIAs) led by BEIS is one attempt to help address the issue of wider business and the interface with universities support.

Sources:

The Dowling Review of Business-University Research Collaborations. (July 2015)
https://www.gov.uk/government/publications/business-university-research-collaborations-dowling-review-final-report

HM Treasury. Lambert Review of Business-University Collaboration. (2003)
http://webarchive.nationalarchives.gov.uk/20130129110402/http://www.hm-treasury.gov.uk/media/9/0/lambert_review_final_450.pdf

Intellectual Property Office. Collaborative Research between Business and Universities: The Lambert Toolkit 8 Years On. (2013)
https://www.gov.uk/government/publications/the-lambert-toolkit-8-years-on

CBI. Best of both worlds. Guide to business-university collaboration. (2015)
http://www.cbi.org.uk/insight-and-analysis/best-of-both-worlds/

HEFCE. Evaluation of the effectiveness and role of HEFCE/OSI third stream funding. PACEC. (April 2009)
https://www.cbr.cam.ac.uk/fileadmin/user_upload/centre-for-business-research/downloads/special-reports/specialreport-evaluationeffectivenesshefce.pdf

National Centre for Universities and Business. The Changing State of Knowledge Exchange. UK Academic Interactions with External Organisations 2005-2015. (February 2016)
http://www.ncub.co.uk/index.php?option=com_docman&view=download&category_slug=reports&alias=429-the-changing-state-of-knowledge-exchange&Itemid=2728

HEFCE. Evaluating the Non-Monetised Achievements of the Higher Education Innovation Fund. PACEC. (October 2015)
http://www.hefce.ac.uk/pubs/rereports/year/2015/heifeval/

Scottish Enterprise. Economic Impact of the Scottish Enterprise Seed Fund. PACEC. (2013)
https://ec.europa.eu/growth/tools-databases/regional-innovation-monitor/sites/default/files/support_measures/reports/report-1.pdf

This policy framework was used, in discussion with BEIS, to prepare a set of areas and propositions for investigation in the empirical research with universities and businesses. These areas were:

- Specific financial issues for commercialisation such as equity shares, royalties, licence fees, valuing technology, warranties etc
- Availability of information
- Effectiveness of current policies to incentivise activity
- Funding constraints
- Transparency of licensing and spin-out agreements

There is some overlap between these areas – in particular, funding constraints are pervasive throughout but overlap particularly with policies to incentivise activity and some of the specific financial issues. There are also propositions framed in terms of providing additional information which are responses to the specific financial issues and are dealt with under the financial heading.

15.2 Summary of evidence from the surveys

The proposed policy approaches to be investigated under the five broad areas established above, and the broad thrust of the evidence generated by the research, are set out below:

Table 33: Summary of evidence on proposed policy approaches

Barriers	Potential policy approach	Evidence
Specific financial issues		
Universities take an equity share in spin-outs that is too high, which can discourage other investors. Costs of licensing too high including royalty payments.	Examine the potential for a ceiling on HEI shareholding in spin-outs (but recognising that it becomes diluted anyway) and returns from licensing to encourage more external investment. Review university requirements and aims re income generation from spin-	Equity shares are a common bone of contention but there was little evidence from the research that this is the most appropriate response. Valuations vary case-by-case depending on stage of IP, required management resource, and required investment.

Barriers	Potential policy approach	Evidence
	outs and licensing/royalties.	Universities more likely to view equity shares and royalties as a problem than businesses.
Difficult to value IP and what the "proper value" of IP in spin-outs / licensing should be leads to disagreements and delay.	Establish an arm's length brokerage / arbitration / guidance service, if this is acceptable in the sector, to resolve issues quickly to allow negotiations to be more focused. Provide more information to allow comparisons/benchmarks to be made.	Some evidence of demand. Could equally be addressed by transparency initiatives or (from university perspective) pooling of experience. Experience varies greatly between institutions by commercialisation activity. Delays are costly for SMEs.
Spin-out process is too time consuming. Deters investors and increases costs for businesses and investors who seek to turn IP into products / services and get to market quickly (IP and technology can be overtaken rapidly in some fields).	Develop a template / guidance / pack for HEIs and businesses to simplify / speed up the process. (Along the lines of Lambert.)	Strong demand for information in general from businesses. Complexity and delays a key issue for businesses. Information provision a cost-effective response.
Complexity and delay over the requirement for university warranties.	Develop a template / guidance / pack for HEIs and businesses to simplify / speed up the process. (Along the lines of Lambert.) Provide the HEIs with insurance / cover or a central agency to allow progress to be made more quickly.	Warranties a less significant issue than other specific issues in this class. Insurance not mentioned by respondents as a response.
Universities / academics seek to publicise the results of research which can give insights to commercialisation / translation opportunities. Investors prefer to ensure outputs are confidential.	Adjust university / academic assessments based on publications / citations, REF where there are confidential commercialisation issues.	Consensus position seems to be that this is a common problem but one that is endemic to the university/business relationship and can be managed with a suitable time delay. Potential to change REF to view patents on equal footing to journal outputs.
	Availability of information	
A lack of business awareness about IP opportunities for commercialisation (e.g., through licensing) in universities and who to contact about them.	Additional measures to publicise university opportunities (e.g. Konfer, university publications and awareness raising) and increase transparency.	Strong demand from businesses for information on commercialisation. Disagreement on best way to promote this.
Lack of awareness amongst universities about which businesses to collaborate with.	As above plus funding for regional or LEP innovation/ sector groups.	Smaller/regional universities dealing with issues of identifying supply. LEPs a good potential

Barriers	Potential policy approach	Evidence
		coordinator as motivated to increase local productivity through innovation.
HEI IP not ready for investment or commercialisation (TRLs) and a lack of investment readiness.	Ensure research outputs identify commercialisation opportunities – move the technology forward so it can be invested in.	Seen as a resource issue (funding for proof of concept or market) rather than information.
Commercialisation processes too complex / bureaucratic.	Develop guidance for HEIs and businesses to simplify and speed up the process; or fund training through e.g. PraxisAuril.	Larger universities have developed their own processes. For smaller universities, provision of information could assist, as could pooling of resources.
Effectiveness of current policies to incentivise activity		
Low incentives for academics to participate in the commercialisation of IP.	Improve rewards: shareholding / royalties, remuneration from IP career structures and recognition.	Incentivisation and allocation of time commonly identified as barriers. Recognition and career rewards may be crucial, however must reflect individual institutional missions.
Income generation. The HEIF metric to generate income from licensing and spin-outs could discourage other investors.	Review with this element in HEBCIS returns on HEIF.	Strong support for HEIF as a funding mechanism but little evidence that this is biasing activity.
Universities can take a short-term view in order to stimulate income. Investors (although not always noted for a long-term approach) may want to take a medium/long term view.	Review the need for short term income gains for HEIs in some circumstances. Stimulate the wider use of 'patient funding' with longer term horizons for reforms. Adopt the result of the Patient Capital Review.	HEIs claim to be motivated more by strategic goals and charitable status. Business more likely to perceive investors as motivated by exit; also cognisant of incentives to exit given by time-bound support (e.g. EIS). The Government Patient Capital Review explores these schemes.
Funding constraints		
The necessary business support for spin-outs is required to commercialise and grow and for licensees to fully utilise the IP. For example, finance for growth, access to grants, new investor tax incentives, legal guidance, the ongoing HEI / access to academics/researchers, product and	Build a strong and accessible support infrastructure / innovation eco-system with the appropriate networks, events, individuals and organisations to encourage know-how and investment.	Funding gaps perceived particularly at proof of concept, proof of market, seed stages. Early funding essential to develop IP and de-risk investment. Tax incentives seen as very valuable if designed with

Barriers	Potential policy approach	Evidence
service development marketing, business skills, arrangements for production and engagement with the key parts of the innovation ecosystem, etc.		appropriate limits and timescales. Evidence of demand for regionally-directed support (outside London/ Oxford/ Cambridge) and strong evidence of value of networking and personal relationships as spur to activity.
Transparency of licensing and spin-out agreements		
Lack of information on policies, transactions and agreements, leading to increased perception of risk on the part of negotiation participants.	Produce databases of benchmark transactions that could be accessible by universities, businesses, investors.	Some enthusiasm for transparency but lack of certainty how to implement (or by whom), or the scale of the benefits. Larger universities content with their own databases. Case studies or template contracts could be useful.

16 APPENDIX E: DETAILED QUANTITATIVE TABLES

The surveys of universities, businesses, and spin-outs asked in some detail about the influencing factors and issues arising at each stage of the transaction negotiation. The survey results are given here, and the key points are written up in the main text.

The respondents were not given the full list of possible entries for each question and were not prompted directly, so as to avoid leading questions or any bias introduced by the interviewer. Instead, they were allowed to respond in their own words, and their responses were recorded using a coding framework.

For the questions on general influencing factors and establishment of transaction inputs (which had a large number of possible pre-coded responses), the interviewees were given broad headings to consider as a partial prompt. These are the headings that emerged from the development of the KEC transaction model at the design stage of this project, and are shown below. The text of each prompt is shown in **bold** below: the normal text that follows was not used as part of the prompt but is shown here for clarity.

General influencing factors:

- **Internal factors relating to the Higher Education Institution or business**: regulations and governance, leadership and strategic direction, strength of a commercialisable research base, and awareness of potential commercialisation opportunities, etc;
- **Internal factors concerning skills and resources:** the role of individual academics, the staff and financial resources levels for commercialisation, skills and experience relating to IP, use of good practice guidance, and communication between industry, universities, and sector representative bodies;
- **Local or regional external factors:** the strength of local economic activity, the local innovation and investment ecosystem, the presence of significant local competition;
- **National external factors:** government and research funding bodies and their rules and regulations, the Research Excellence Framework, the interface with supply and demand from UK businesses and universities, and national competition; and
- **International external factors:** the interface with supply and demand from multinational companies and international universities.

Establishing the transaction inputs:

- **Establishment of roles, responsibilities and priorities:** for the university, the lead academic inventor, business partners, and the relationship to funding terms;
- **Planning:** project delivery, business planning, market research, risk analysis, and securing a suitable management team;
- **IP management:** due diligence, protection, warranties, valuation, field of use, etc.;
- **Finance:** equity sharing allocations, value of royalties, payment milestones, forms of external finance; and
- **Regulation, compliance, and advice:** external professional advice on points of law, regulatory compliance, finance, university and company policies.

16.1 Influencing factors

Table 34: University views of specific positive and negative influencing factors

Specific influencing factors	% of all respondents			
	Strongly negative	Negative	Positive	Strongly positive
University regulations and governance	1	0	5	19
University central leadership and strategic direction	0	6	11	41
University balance of priorities (e.g., teaching, research, commercialisation, dissemination/ publishing)	6	5	9	23
Strength of University commercialisable research base	3	0	3	23
University awareness of businesses seeking IP / commercialisation opportunities	0	3	3	14
Role of individual academics	8	16	4	14
Skills and experience of the internal IP team	5	5	9	28
University Resource levels: staff	20	28	7	10
University Resource levels: finance	10	23	5	11
Development of good practice and guidance and use of contract toolkits	0	3	2	7
Communication between industry, universities, and sector bodies	1	2	5	17
Some other internal factor	5	4	1	2
Place – local economic activity ecosystem	5	14	16	33
Significant local competition	0	1	0	2
Some other local/regional factor	4	5	2	4
Government and Research Funding bodies' rules and regulations	4	8	7	20
REF	0	1	10	41
Sources of national finance and management skills	4	3	4	14
Interface with demand from UK businesses (incl. terms of collaborative research, etc., leading to generation of IP)	0	3	4	19
Interface with supply from UK businesses (e.g. presence of significant competition)	0	1	3	7
Businesses' awareness of commercialisation opportunities with the university	3	4	1	9
Some other national external factor	3	4	1	1
Interface with demand from multinationals (incl. terms of collaborative research, etc., leading to generation of IP)	1	1	5	18
Interface with supply from multinationals (e.g. presence of significant competition)	0	0	4	8
Some other international factor	8	4	2	5

Source: Survey of university staff.

Table 35: Spin-out views of specific positive and negative influencing factors

Specific influencing factors	% of all respondents				
	Strongly negative	Negative	Positive	Strongly positive	Top 3
University regulations and governance	3	8	17	10	2
University central leadership and strategic direction	3	7	20	19	0
University balance of priorities (e.g., teaching, research, commercialisation, dissemination/ publishing)	2	2	12	8	2
Strength of University commercialisable research base	0	0	17	15	3
University awareness of businesses seeking IP / commercialisation opportunities	0	0	14	7	0
Role of individual academics	0	5	20	24	10
Skills and experience of the internal IP team	7	20	15	20	12
University Resource levels: staff	3	15	10	14	2
University Resource levels: finance	0	8	8	10	2
Development of good practice and guidance and use of contract toolkits	0	0	7	5	2
Communication between industry, universities, and sector bodies	3	3	12	5	3
Some other internal factor	3	2	0	8	8
Place – local economic activity ecosystem	0	3	17	19	2
Significant local competition	0	2	2	0	0
Some other local/regional factor	0	0	0	10	3
Government and Research Funding bodies' rules and regulations	2	7	12	31	3
REF	2	3	7	20	3
Sources of national finance and management skills	0	5	14	24	3
Interface with demand from UK businesses (incl. terms of collaborative research, etc., leading to generation of IP)	0	0	8	5	0
Interface with supply from UK businesses (e.g. presence of significant competition)	0	0	5	2	0
Businesses' awareness of commercialisation opportunities with the university	0	3	7	5	0
Some other national external factor	0	3	0	2	3
Interface with demand from multinationals (incl. terms of collaborative research, etc., leading to generation of IP)	0	0	2	5	0
Interface with supply from multinationals (e.g. presence of significant competition)	0	0	2	2	0
Some other international factor	2	0	2	3	2

Source: Survey of university spin-outs.

Table 36: Licensee views of specific positive and negative influencing factors

	Strongly negative	Negative	Positive	Strongly positive
Company central management and strategic direction	0	0	5	24
Skills and experience of company staff to access and commercialise IP	0	5	7	17
R&D/IP resource levels - staff	0	10	12	12
R&D/IP resource levels - finance	0	0	10	12
Development of good practice and guidance and use of contract toolkits	0	0	2	5
Communication between industry, universities, and sector bodies	2	10	10	7
Awareness of universities with IP available for commercialisation	2	5	10	12
University balance of priorities (e.g., teaching, research, commercialisation, dissemination/ publishing)	0	15	12	7
University IP/commercial skills and experience	2	24	12	10
University awareness of businesses seeking IP / commercialisation opportunities	2	12	10	7
Place – local economic activity ecosystem	0	5	12	24
Significant local competition	0	0	0	5
Government and Research Funding bodies rules and regulations	2	7	12	10
Sources of national finance and management skills	0	5	10	5
Interface with universities at research stage (incl. terms of collaborative research, etc., leading to generation of IP)	0	2	10	2
Other UK businesses (e.g. presence of significant competition)	0	5	5	2
Availability/suitability of international universities to engage with	0	0	5	24
Significant competition from multinational businesses	0	0	5	2

16.2 Set-up Phase

Table 37: University views of specific factors influencing the spin-out process

Specific influencing factors	% of all respondents			
	Strongly negative	Negative	Positive	Strongly positive
University priorities	1	7	6	28
Skills in the University	7	6	8	27
Grant funding terms	0	1	0	1
Partner's project and business requirements	0	7	0	17
Lead academic's requirements	10	14	1	10
Roles of individual academics (shareholding, management, access)	10	21	0	10
Responsibility to publish results	1	1	0	1
Project delivery plan	0	0	0	18
Business planning	0	6	3	20
Market analysis / competition	1	1	0	11
Risk analysis / failure	6	1	0	14
Cost modelling and approval	0	0	0	10
Time to market / start of return	6	6	0	10
Securing suitable management team	3	6	0	14
Due diligence	0	3	3	11
IP ownership and protection/ patents	4	8	3	23
University IP warranties	10	3	0	6
IP valuation and price setting	6	3	1	10
Extracting proper value from the IP	1	0	0	15
Termination of agreements / what can be handed back	6	1	0	7
Field of use of IP (broad, narrow, exclusive/non-)	6	0	1	6
Value of royalties	7	6	0	3
Payment of royalties	0	3	1	8
Payment milestones	0	0	0	7
Equity sharing allocations	8	7	3	10
Form of finance	0	8	0	10
External legal advice	0	0	0	8
Regulatory/compliance advice	0	0	3	8
Financial advice	0	0	1	10
University policies and approval	0	0	0	8

Source: Survey of university staff.

Table 38: Spin-out views of specific factors influencing the spin-out process

Specific influencing factors	% of all respondents			
	Strongly negative	Negative	Positive	Strongly positive
University priorities	12	14	17	12
Skills in the University	7	20	18	14
Grant funding terms	1	8	13	4
Partner's project and business requirements	0	1	8	5
Lead academic's requirements	1	6	22	10
Roles of individual academics (shareholding, management, access)	4	8	22	16
Responsibility to publish results	1	1	6	1
Project delivery plan	0	5	10	4
Business planning	2	11	17	7
Market analysis / competition	2	11	14	4
Risk analysis / failure	0	7	7	2
Cost modelling and approval	0	4	6	1
Time to market / start of return	6	11	5	2
Securing suitable management team	1	7	14	8
Other planning factors	8	10	0	0
Due diligence	1	4	6	4
IP ownership and protection/ patents	10	18	6	8
University IP warranties	0	4	4	2
IP valuation and price setting	5	12	6	6
Extracting proper value from the IP	0	13	4	1
Termination of agreements / what can be handed back	0	2	2	1
Field of use of IP (broad, narrow, exclusive/non-)	0	6	2	1
Other IP factors	0	1	0	1
Value of royalties	0	10	5	4
Payment of royalties	0	5	7	5
Payment milestones	1	4	4	1
Equity sharing allocations	5	14	11	6
Form of finance	5	12	12	2
External legal advice	1	5	10	4
Regulatory/compliance advice	1	5	7	2
Financial advice	2	0	8	4
University policies and approval	4	8	5	2
Other factors	1	0	0	1

Source: Survey of spin-outs.

Table 39: University views of specific factors influencing the licensing process

Specific influencing factors	% of all respondents			
	Strongly negative	Negative	Positive	Strongly positive
University priorities	3	3	3	57
Skills in the University	3	3	3	54
Grant funding terms	0	3	3	3
Partner's project and business requirements	0	9	0	26
Lead academic's requirements	6	9	6	29
Roles of individual academics (shareholding, management, access)	9	9	3	17
Responsibility to publish results	0	3	0	6
Project delivery plan	0	0	3	46
Business planning	0	3	0	43
Market analysis / competition	0	3	0	43
Risk analysis / failure	6	0	0	46
Cost modelling and approval	0	3	0	34
Time to market / start of return	0	6	3	49
Securing suitable management team	0	0	0	43
Due diligence	0	4	6	47
IP ownership and protection/ patents	0	4	6	54
University IP warranties	40	4	3	0
IP valuation and price setting	11	14	3	29
Extracting proper value from the IP	0	14	3	25
Termination of agreements / what can be handed back	11	4	3	4
Field of use of IP (broad, narrow, exclusive/non-)	22	0	3	29
Value of royalties	11	11	3	29
Payment of royalties	7	4	6	29
Payment milestones	0	4	3	11
Equity sharing allocations	0	4	3	11
Form of finance	0	4	3	11
External legal advice	0	4	3	18
Regulatory/compliance advice	0	0	3	18
Financial advice	0	0	3	18
University policies and approval	0	0	3	36

Source: Survey of university staff.

Table 40: Business views of specific factors influencing the licensing process

Specific influencing factors	% of all respondents				
	Strongly negative	Negative	Positive	Strongly positive	Top 5 problems
Business priorities	0	0	12	4	
University priorities	8	28	12	0	0
Skills in the University	0	8	12	8	0
Grant funding terms	4	4	4	0	0
Partner's project and business requirements	0	4	8	4	20
Lead academic's requirements	4	20	16	0	13
Roles of individual academics (shareholding, management, access)	4	12	12	4	0
Responsibility to publish results	0	4	0	0	0
Project delivery plan	0	0	8	0	0
Business planning	0	4	4	4	0
Market analysis / competition	0	0	8	0	0
Risk analysis / failure	0	0	4	0	13
Cost modelling and approval	0	4	4	0	0
Time to market / start of return	8	4	4	0	0
Securing suitable management team	0	0	0	0	0
Due diligence	0	0	0	0	0
IP ownership and protection/ patents	4	8	4	4	0
University IP warranties	0	0	4	0	13
IP valuation and price setting	12	24	12	4	7
Extracting proper value from the IP	0	8	4	0	0
Termination of agreements / what can be handed back	0	0	0	0	0
Field of use of IP (broad, narrow, exclusive/non-)	0	0	0	0	0
Value of royalties	0	4	8	0	20
Payment of royalties	0	0	0	4	20
Payment milestones	0	4	4	4	0
Equity sharing allocations	0	0	0	0	0
Form of finance	0	0	4	0	0
External legal advice	0	0	4	0	0
Regulatory/compliance advice	0	0	4	0	0
Financial advice	0	0	4	0	0
University policies and approval	0	4	8	0	0

Source: Survey of businesses.

16.3 During the negotiations

Table 41: University and spin-out views on problems during spin-out set-up negotiations

	% of all respondents			
	Universities		Spin-outs	
Specific influencing factors	Somewhat of a problem	Significant problem	Somewhat of a problem	Significant problem
Obtaining inputs	5	0	8	5
Choosing contract form	3	0	12	5
Recruiting suitable management team	18	3	3	0
Establishing negotiating position	15	0	28	11
Heads of Agreement	18	0	6	2
Using external/internal guidance/tools	0	3	6	2
Establishing points of agreement and divergence	15	8	12	12
Conducting negotiation	13	5	23	14
Resolving differences	8	5	12	17
Obtaining academic approval/ agreement	13	3	3	0
Obtaining senior management approval	3	0	5	3
Executing final documents	5	0	11	9
Hand-over to post-spin-out administration	5	0	5	2
Hand-over to project manager/ activity leader	5	0	2	0

Source: Survey of university staff and spin-outs.

Table 42: University and business views on problems during licensing negotiations

	% of all respondents			
	Universities		Licensees	
Specific influencing factors	Somewhat of a problem	Significant problem	Somewhat of a problem	Significant problem
Obtaining inputs	4	0	0	0
Choosing contract form	12	0	0	0
Recruiting suitable management team	4	0	0	0
Establishing negotiating position	4	0	17	11
Heads of Agreement	28	0	0	0
Using external/internal guidance/tools	4	0	0	0
Establishing points of agreement and divergence	12	0	6	6
Conducting negotiation	8	4	22	11
Resolving differences	4	0	6	6
Obtaining academic approval/ agreement	16	0	6	6
Obtaining senior management approval	0	0	6	0
Executing final documents	16	0	6	0
Hand-over to post-spin-out administration	0	0	17	6
Hand-over to project manager/ activity leader	0	0	0	0

Source: Survey of university staff and businesses.

16.4 Post-transaction management

Table 43: University and business views of aspects of managing spin-outs and licences after transactions

Specific influencing factors	% of all respondents			
	Somewhat of a problem	Significant problem	Somewhat of a problem	Significant problem
Management issues for spin-outs	**Universities**		**Spin-outs**	
Appointing a first Board	26	9	10	2
Appointment of management team and roles	63	17	17	2
Finding suitable facilities	20	6	17	3
Provision of ongoing operational and technical support	9	0	9	5
Managing IP pipeline / use of other IP	9	3	3	3
Managing conflicts of interest	11	6	11	5
Exit strategy planning & management	3	0	4	4
Growth issues for spin-outs	**Universities**		**Spin-outs**	
Business planning	3	0	8	1
Product/service development and exploitation	37	0	13	17
Market entry and subsequent growth	54	0	20	14
Marketing/sales skills	9	0	14	7
Investment in future IP/technology (internally or licensing)	34	0	5	2
Overall business investment	11	0	8	4
Difficulty finding partners	11	0	5	3
Recruitment of staff/skills development	40	9	25	4
Development of entrepreneurial culture	3	0	8	0
Innovation network/ecosystem not mature/supportive enough	9	0	8	0
Further funding and sources	23	3	24	17
Public funding for business growth	20	3	9	3
Tax incentives for business growth/investment	0	0	4	1
Access to university/academics responsible for IP	9	6	4	0
Licensee issues	**Universities**		**Licensees**	
Relationship management	19	9	24	2
Licensing contract variation	13	0	12	2
End-of-contract management	0	3	10	2
Royalty administration	13	0	15	0
Management of licensing income / timescales	22	0	17	2

Source: Survey of university staff.

FOR FURTHER INFORMATION CONTACT

Matt Rooke

Associate Director

RSM
49-53 Regent Street
Cambridge
CB2 1AB

01223 311649
matt.rooke@rsmuk.com

rsmuk.com