EXPLOITING UNIVERSITY INTELLECTUAL PROPERTY IN THE UK

A Report prepared for the UKIPO

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Executive summary

The issue of exploiting and commercialising university intellectual property (IP) has generated much debate in the U.S., the UK and other countries. Most governments are continuing to encourage and facilitate the active exploitation of university generated IP. However, they also want to be assured as to the returns on investment in public funds for research.

In order to review the latest thinking, research and practice in the area, the UKIPO commissioned this report entitled "Exploiting University Intellectual Property in the UK." This Report formed the basis of a briefing made by the author to the Minister of Innovation, Baroness Morgan of Drefelin on January 29, 2008, ahead of the White Paper on Science and Innovation *Innovation Nation*.

Part A reviews how universities identify new knowledge which has the potential to be commercialised, including the results of interviews with six UK universities and desk research on the practices of U.S. Canadian, Danish, Belgian and Spanish universities.

Part B examines current practices of exploitation of university IP and relates them to the type of university, using evidence from the UK and brief reviews of the U.S., Canada, Belgium, Spain and Denmark.

Part C describes the measures UK universities have in place for undergraduates and post graduates aimed at raising their awareness on IP, and how their IP may be exploited and commercialised.

Part D provides a summary of lessons learnt, good practices and the underlying factors explaining these practices, and recommends further research with the aims of addressing remaining gaps in our knowledge.

The key findings of the report are as follows:

(1) There are five identified models of TTOs. (1) Internal to the university and is part of the university's administration. (2) External and autonomous but is a subsidiary of the university. This model aims to be self-supporting and profit generating. (3) Heavily reliant on government funding for its operations. (4) Not reliant on external funding for its operations. (5) A hybrid, consisting of a combination of any of the above.

(2) There is no single 'best practice' model for the exploitation of university IP. Successful universities display a variety of approaches and methods for IP creation, management and exploitation.

(3) However, there exist certain underlying fundamentals which appear to support good practice strategies. Successful universities have a professional TTO, with staff who possess both academic and business experience and skills. Such universities tend to have a commitment to building trust between academia and industry and an understanding of how academia and industry can work together productively. Senior university officials tend to keep in contact with, and learn, from their leading academics often on an informal basis. Speed of response on the academic side, for example in contract agreement, is particularly important when dealing with business.

(4) Rather than presenting complex legalistic explanations about IP protection, good practice universities explain clearly the process of commercialisation and the benefits arising from it and avoid negative incentives (e.g. overly bureaucratic processes and lengthy contractual

arrangements). An effective incentive structure is essential to encourage academics to engage in business consultancy as an entry point to larger contracts and joint R&D projects.

(5) Successful cases exhibit a combination of methods used to identify exploitable IP and a willingness to experiment with innovative approaches to IP exploitation. There is also an appreciation that IP cannot only be measured by number of spin outs, patents and licences and that informal knowledge transfers to and from industry cannot always be captured by indicators or numbers. Examples of these include active networking with business and other organisations, word of mouth, referrals and personal contacts, capabilities mapping/audit, voluntary and informal advice to business representatives, and outreach activities to engage the interest of business.

(6) TTOs and the relevant senior university officials need to be expert in three core activities: (1) IP opportunity recognition; (2) opportunity development; and (3) opportunity exploitation. This involves a knowledge of licensing, spin outs (as a fast route to market and a tool to engage potential investors), R&D research partnerships (as these help to generate more academic IP and provide a route to commercialisation). TTOs need to know how to encourage consultancy as this can often provide an initial route to the exploitation of the academic's IP and they need to have a realistic understanding of the wide and uneven range of capabilities of academics with respect to consultancy practices and generation of IP. Over bureaucratisation of procedures for engaging with industry should be avoided.

(7) The crucial but often under-studied role of the academic/inventor in comparison to studies undertaken on TTOs.

(8) It is important that universities engage in active measures to raise IP awareness and increase knowledge about the process of commercialisation and the benefits arising from it among: (1) the student body; (2) researchers (including contract researchers); and (3) lecturers and heads of faculties.

(9) Crucial to the successful exploitation of IP is expertise and commitment on the part of senior university administrators in order to support and build up exploitation and commercialisation. Without this, the TTO may become "isolated" and find itself not staffed with professionals who understand the technology/knowledge transfer dynamics between academia and industry.

Policy implications

(1) Policies aimed at fostering academic entrepreneurialism in general and IP in particular should take into account the fact that senior university administrators do not always support the kind of approaches identified here as good practice and that, sometimes, their support may be more rhetorical than real. To move towards good practice there may well be a need for internal cultural change at the university level, beginning with senior management.

(2) In the absence of a legislative framework, the UK has a potential comparative advantage in the commercialisation of university IP. This is because the UK system allows mechanisms for exploitation to be flexible and experimental and this can foster innovative approaches and lead on to good practices and IP expansion.

(3) Policymakers and university administrators should understand that the introduction of a legislative framework such as the U.S. Bayh-Dole Act needs to be approached with caution. Legislative measures need to take into account the varying cultures, histories and economic environments faced by UK universities.

Suggestions for further research

The report recommends that further research is needed to establish, in more detail, (a) how universities balance their three missions – teaching, research and commercialisation (b) the core motivations of successful academic entrepreneurial performance, (c) the broader economic benefits from academic research and who really benefits, and how much, from the exploitation, and (d) the range of exploitation routes that cannot be captured by metrics.

Exploiting University Intellectual Property in the UK

Introduction: the current debate

The issue of exploiting and commercialising university IP has generated much debate particularly in the U.S. Sampat suggests that "the dramatic growth of patenting and licensing of publicly funded research by American research universities in the closing quarter of the 20th century has stimulated some of the highest-profile debates in science and technology policy today" (2006, 34). In the aftermath of the Bayh-Dole Act, U.S. Professor Rebecca Eisenberg poses the question: "How can the [U.S.] Government funding of research be justified in the Bayh-Dole era, when research performers are encouraged to patent their results and to promote their private appropriation?" (Eisenberg, 1996, 1725) She argues that as public sector research becomes more commercialised, it becomes more difficult to justify public funding to support it. If private appropriation, such as through exclusive licenses, is expected and desirable, then it becomes even less clear why the government is paying for the research. She asserts that economic and social welfare may be better served by ensuring that new knowledge be made available to the public domain and in this, government "is uniquely situated to enrich the public domain, and we should be wary of disabling the government from performing this critical function" (1726) Other critics have contended that attempts at encouraging commercialisation of university research outputs have the potential to undermine the institutional roles of universities, namely teaching and research (Dasgupta & David, 1993) and that too much academic entrepreneurialism could compromise the provision of the public knowledge. Furthermore they argue that basic research may be substituted for near market activities, the rightful province of business firms (Lee, 1996; Nelson, 2004). Others assert that commercialisation can interfere with teaching and inhibit the ability of universities to develop top talent because commercialisation may lure good researchers to industry (Campbell & Blumenthal, 1999)

There are however as many advocates for the entrepreneurial university (Clark, 1998) as there are critics of it. An entrepreneurial university can be defined as a university that "combines teaching and research with the capitalization of knowledge" (Etzkowitz, 2002, 1) Many observers argue that UK universities indeed are becoming increasingly entrepreneurial (Clark, 1998; Etzkowitz, 2002; Etzkowitz et al., 2000; Maskell & Robinson, 2002) while others claim they are still limited in their entrepreneurial activities (Kirby, 2006). Certainly some, but not all, UK universities are becoming more enterprising in recognition of the importance of linkages between university research, and economic performance and societal needs (Gibbons et al., 1994; Meyer & Tang, 2007). These universities have apparently balanced the needs between academic research, commercialisation and the public good, for instance by arguing that by returning the revenues from exploitation back to the university, it is in effect helping the university's research infrastructure. On the whole, there is scarce data, especially in the UK on how these balances are achieved. For instance, there is anecdotal evidence that academics in certain disciplines see little benefit from exploitation of their IP. On the other hand, chemistry in one university is a major "money spinner," whereas in Sussex, the department was almost shut down.

In contrast to the arguments against academic entrepreneurialism, a seminal paper by Jensen and Thursby shows that the active pursuit of commercialisation can actually promote basic research and scholarly education (2004). These authors hold that increased academic entrepreneurialism could lead to an increase in the stock of patentable knowledge, which in turn could stimulate new innovations. They have also shown that increased university patenting licensing has indeed promoted industrial use of publicly funded research in the U.S. Other scholars argue that "exigencies of today demand a more intensive interrelationship "[between university, industry and government] for innovation (Etzkowitz & Leydesdorff, 2000, 121).

Both sides to the debate arguably have their merits. The practical and political reality, however, is that worldwide governments are continuing to encourage and facilitate the active exploitation of university generated IP. In the face of competing demands for public resources, governments, *inter alia*, want to be aware of the returns on the investment of public funds for research.

The Report is structured accordingly. **Part A** reviews how universities identify new knowledge that has the potential to be commercialised. This review especially focuses on the UK, the information of which has been garnered from interviews with six universities. This section also provides limited information based on desk research on the practices of U.S. Canadian, Danish, Belgian and Spanish universities. Information was collected from an interview with a leading Spanish technical university. **Part B** provides an overview of the practices of exploitation of university IP and attempts to relate them to the type of university. This section again focuses on the UK,[1] followed by fewer descriptions on the U.S., Canada, Belgium, Spain and Denmark. A short preview of the legislative or regulatory measures for each country is provided to set the context against which the exploitation activities are facilitated and undertaken.

Part C begins to describe how and whether UK universities have measures for undergraduates and post graduates that raise their awareness on how their IP may be exploited and commercialized. These mechanisms and supporting measures will focus on (1) educating undergraduates and post graduates in the field of IP; and (2) assisting undergraduates and graduates in the exploitation/commercialisation of their IP. This section focuses only on the UK as information on the other countries is not available or highly fragmented. **Part D** provides a summary of lessons learnt, good practice and the underlying factors for these practices. Then it concludes with recommendations for further research with the twin aims of filling gaps in our knowledge and extending the evidence supporting the findings in this study.

[1] A report prepared by Martin and Tang for the OSI (2007) discusses the channels of exploitation of publicly funded research. However, this Report for the UKIPO focuses more on the business-facing modes of exploitation, although there are some overlaps between the channels identified in the Martin and Tang report and this Report.

PART A: HOW UNIVERSITIES IDENTIFY EXPLOITABLE INTELLECTUAL PROPERTY

The UK: the policy context

Worldwide, the role of academia in fostering technology transfer and economic growth has been increasingly considered to be a key element of national Science and Technology policies (Nowotny et al., 2003; OECD, 2003). In the UK, the emphasis on the successful exploitation of academic research has been particularly pronounced. Since the 1993 Government White Paper, *Realising Our Potential* (OST, 1993), there has been an expectation that publicly funded researchers in universities and elsewhere have a duty to actively seek applications for the results of their research, to identify potential 'users', whether in industry or elsewhere, and to work with those users to ensure that the results from their research are successfully exploited.

Over the last 15 years, there have been various policy initiatives in pursuit of this, and financial resources have been increasingly made available by Government to stimulate the exploitation of publicly funded research and university-generated Intellectual Property. The UK Research Councils and the Higher Education Funding Council for England (HEFCE, and its equivalents in Wales, Scotland and Northern Ireland) have played central roles in these initiatives. HEFCE has for several years encouraged universities to put more emphasis on knowledge transfer through the Higher Education Innovation Fund. Similarly it has also reinforced the need for universities to maximise the exploitation of university research outputs and to undertake Third Stream[2] activities for the benefit of the UK economy (HEFCE, 2006).

The Lambert Report (Lambert, 2003) also underscored the vital importance of universities engaging more closely with industry so as to optimise the exploitability of their outputs and reported positively on the level of effort and progress that had been made by universities to date. Likewise, the UK Government's Innovation Review (DTI, 2003) highlighted the need for universities to engage more intensively and effectively in entrepreneurial activities, especially in the commercialisation of their research outputs and in the generation of economic contributions to society. In 2006, the Warry Report, *Increasing the Economic Impact of Research Councils* (Warry, 2006), published by the UK Research Council Economic Impact Group[3], highlighted the pivotal roles of the Research Councils in funding, strengthening and encouraging the successful exploitation of the national research base. One way of doing this is to ensure academic research funded by the Councils demonstrates a clearly articulated strategy as to how the funded universities intends to exploit its research "for social and economic benefit. The recent *Science and Innovation Investment Framework 2004-2014: Next Steps*, (HM Treasury, 2006) published alongside the 2006 Budget, reaffirms the Government's long-term commitment to the research base. The document highlights that more must be done to maximise the economic impact of public investment in research.

Modes of identification

There is a wide range of practices by the Technology Transfer Offices (TTOs)[4] to identify exploitable IP. They range from a structured proactive "business-facing" strategy to that of a more relaxed approach.

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2 Third Stream activities are generally concerned with the generation, use, exploitation and application of knowledge outside the university environment. See (Molas-Gallart et al., 2002)

3 See http://www.dti.gov.uk/files/file32802.pdf.

4 We use this term to cover business development units for the purposes of simplicity and consistency.

An objective of this study is also to find out if TTOs are aware of some of the main practices of business to identify exploitable IP. These include

(1) Market (including sectors) and web research, including research on demographic changes;
(2) technology scanning and foresight and reports such as from the TSB, DIUS;
(3) keeping abreast of regulatory developments that could support certain businesses, create new businesses or increase demand for certain products;
(4) exploring new opportunities from disasters and crises, such as flooding, climate change, new viruses, etc;
(5) R&D collaborative agreements, projects, partnerships;
(6) reading the newspapers.

As will be revealed below, there appears to be no lack of knowledge of these practices. Some of them adopt these practices, particularly market research and collaborative projects; others less regularly, simply because of time constraint. Others rely on academics to keep them abreast of regulatory developments or changing demography or work patterns and new opportunities identified from disasters, such as in pandemic flues Others who are aware of all business practices either do not have the resources to apply all of them, or simply find some irrelevant.

Oxford ISIS

Oxford ISIS' proactive strategy can be seen in the highly systematic process for identifying exploitable IP. It is an independent but a subsidiary unit of the university charged with IP exploitation. The process for identification is underpinned by an internal marketing system, with a Project Manager in charge of designated areas, such as life sciences, physical sciences, etc. There are 27 Project Managers who promote the benefits of ISIS through events, such as seminars, coffee meetings, posters and announcements. These managers keep abreast of the research undertaken and ongoing and with the academic, identify the potential exploitable IP.

These Project Managers are ex-academics with Ph.Ds who have also worked in industry. This combination of skills facilitates an understanding of how academics and industry "think and behave" and thus equips the Project Managers to be sensitive to the concerns of both parties. By allocating a Project Manager to a certain area of research (although there are some areas that are converging, such as medical research and the life sciences), a relationship is built up between him/her and the researchers. (See more on this below.) Through this relationship and the frequent events with researchers, Project Managers find it easier to identify exploitable IP. The Project Manager is in charge of the IP from "cradle to grave" in the identification and exploitation process.

Imperial College Business Development Unit

Imperial College has three main groups that deal with the commercialisation of the university's IP. The first is Imperial Consulting, which deals exclusively with consultancy assignments, is self-supporting and a profit centre. (More on this below.) Imperial Innovation is charged with the "hard" aspect of technology transfer via patents, licences and the creation of spin outs, and all contractual agreements regarding all forms of IP. In the last 3-5 years, it has expanded its remit to include investment in projects for Imperial's spin outs. In 2006, it was listed in the London Stock Exchange, with the University holding majority shares. It is a profit centre. As with Imperial Consulting, it does not actively identify exploitable IP; it manages and formalizes the process for exploitation, such as IP contractual arrangements, and helps with the patenting process.

The third unit, the Business Development Unit, is the one that deals mainly with identification of IP. This Unit is divided into a few areas, for instance BioPharma, Defence, Creative Industries, etc.

Its focus is on the "broader view of knowledge transfer," according to Dominique Kleyn, Director of BioPharma. While it takes a commercial "outside in" approach in the identification of exploitable IP as well in its management practices, its mandate is not dictated primarily by generating revenue for the Unit. Instead, its aim is to engage with industry primarily with the aim of *generating* and exploiting IP for the university. It also builds and manages networks of companies and has just started to help bring in collaborative R&D projects and funding into the University. Business Development is partly funded by the Higher Education Innovation Fund and the university, and reports to the Pro-Rector of Commercial Affairs and is part of central administration.

Within the BioPharma division, there are two market analysts who regularly study market trends, as one way to identify where Imperial's IP can be exploited. Realising the disutility of conducting IP seminars and lectures for academics because the academics could not really "relate" nor appreciate the value of how to patent, etc, the Business Development Unit has now stopped these lectures and instead have seminars to discuss the capabilities of academics (area expertise) and explain the processes for commercialization, in which a patent could be used in this process. This has proved, according to Dominique Kleyn, much more successful as academics have become more ready to disclose their inventions, etc. Thus the operating principle underlying how BioPharma identifies exploitable IP is through mapping the capabilities of the University's academics through a suite of mapping tools. The rationale for this is to help "match make" the capabilities with the identified potential and eventual opportunities.

The mapping is first done through segmenting the market, for instance, the segments found in biopharma. Within each segment, key drivers and areas of industry interest are identified. From these segments, dimensions of the map are developed. For instance, for infection, the dimensions could be vaccine development, epidemiology, etc. From these dimensions, themes are drawn, for instance, vaccine development. Once done, the search for research opportunities begins.

Opportunities are searched from BioPharma's large list of clients, although the division continues to develop contacts with new companies. To aid with the development of new clients/industrial research partners, a Communications Manager will shortly be hired to undertake this task.

Other ways of identifying exploitable IP include selecting the top 20 companies that the Division regards as potential clients. An important part of the criterion for choosing these top 20 companies is through an examination of their R&D spend. This is then followed by inviting these companies to BioPharma to explore common themes of research and the companies' "wish list." Another way is making note of all relevant meetings to meet SMEs, who are often not the "radar." Another way is to be actively engaged in proposal writing. For instance, Invitations to Tender by the TSB (Technology Science Board) require the participation of an industrial research partner. This route has proved to be an effective way of identifying potential clients. In sum, BioPharma adopts a "relations-based approach that will generate transactions," but Dominique emphasised that building a relationship with the academics and industry take priority.

Warwick Ventures

An equally proactive business-facing strategy but comparatively less structured than that practised by ISIS Oxford and Imperial College, is one adopted by Warwick Ventures. It is a department of the University and is supported at the moment, financially by the University, and partly by the Higher Education Innovation Fund. Warwick Ventures has five business managers (two of whom manage the life sciences, computer and electronics), with the balance overlooking the other areas of research. It also has one marketing manager and one administrative assistant. All five business managers have industrial background, which the Director unequivocally says is a crucial factor in the development and success of a TTO.

Warwick Ventures exploitation activities focus mainly on patents, licences and spin outs. Blessed with a cadre of entrepreneurial academics developed in the Business School and Advanced Manufacturing Centre, the TTO is approached by academics with their inventions. Entrepreneurial academics are also a good source for identifying exploitable IP. For instance, academics pick up leads from reading the newspapers. With other academics, the TTO "chases them."

The TTO also maintains close contact with Heads of Department with the aim of obtaining "intelligence" of any potential exploitable research. It also interacts with the Research Office for leads on the areas of increasing research, which could provide further information on the exploitability of Ventures' existing portfolio of inventions. This version of "technology audits"[5] can be effective in identifying opportunities. Reflecting Oxford ISIS' internal marketing scheme, Warwick Ventures maintains very close contact with academics through staff meetings, newsletters, website releases and "chasing academics."

Portsmouth Research and Knowledge Transfer Services

An "audit of capabilities," is practised by Portsmouth, in much the same spirit of Imperial's Business Development Unit as discussed above. The TTO – Research and Knowledge Transfer Services is organised according to four sectors that more or less reflect SEEDA's four priority areas (South East England Development Agency). They are (1) health and well being, and the environment, (2) technical innovation, (3) enterprise innovation, and (4) defence and homeland security. Each sector has a manager, all of who have industrial and academic backgrounds. The Research and Knowledge Transfer Services also has a Business Development Manager, charged with managing the Knowledge Transfer Partnerships (more below).

Another approach is through market research. Portsmouth Research and Knowledge Transfer Services, for instance, not only does this but also uses its Business School to help undertake this task. Market assessment is undertaken to help establish the viability of licensing the technology. Associated with market research is the use of patent databases to indentify potential licensors and where possible, through trade fairs. When done, the TTO approaches the companies identified through such searches. According to Dr. Ederyn Williams, Warwick Ventures, while market research is a useful tool, experience has shown that this may not be an effective method for identification, except in the field of pharmaceuticals. The difficulty is particularly experienced in cross-disciplinary inventions/technologies.

Portsmouth's four sector managers work closely with academics to find out their expertise (capabilities) in areas of research and the clients they work with. Through this, the sector managers can then help identify exploitable IP and market these to industry. They conduct regular meetings with the academics explaining the purpose of the TTO, helping the academics to coordinate research, broker the formation of networks and to help bring in funds for the researchers. A merit of this "softly softly" approach, according to Dr. Kate Charles, Contracts and IPR Manager, is that it does not tend to give the wrong impression that the TTO is only after the academics' IP for the express purpose of "making money." Among many academics "commercialisation" has a somewhat tawdry reputation.

University of Hertfordshire Intellectual Property and Contracts Services

One could describe University of Hertfordshire's commercialisation strategy as a "one hundred per cent" business facing approach. This is primarily because the university focuses on applied

[5] A technology audit essentially involves systematic scrutinising inventions for their patentability and commercial potential of the invention. This audit is sometimes entirely undertaken by external or in-house experts. Some TTOs preferred to outsource part of the audit to patent agents (Meyer & Tang, 2007).

research, which *always* involves collaboration with industry. Hence, leads for such research come from academics. Similarly, identifying opportunities for consultancy is led by academics who (1) know the opportunities in their areas of research; and (2) have close working relationships with a stable of large and small clients (public and private sector). Interestingly, "commercial deployment" is part of the academic's job description. Unlike Imperial College's Business Development Unit's mapping of capabilities and Portsmouth's Research and Knowledge Transfer Services Contracts' audit of capabilities, Hertfordshire's Brian Robinson, Head of IP and Contracts Support, admits that he no longer practices this mapping because academics' expertise is "a moving target" as researchers often change their focus of research.

What he has introduced to keep track of academics' interest and research *foci*, is an online IP service for the university. This online services offers advice on IP matters, how to write up Non Disclosure Agreements and multiparty agreements, and any other matter that has to do with commercialisation of university IP. Each query or "case" is carefully documented and is monitored by a junior contract office for follow-up action. This service has helped to close contracts, assist with arrangements for joint research and register trademarks. Importantly, it helps to collect information on the interests of academics.

Identification of opportunities for exploitation of Hertsfordshire's IP is also assisted by the Research Office. These are divided into three Institutes and each is led by a unit leader. Each unit oversees various areas of research, such as physics and astronomy, environmental monitoring, biocomputation, etc. While these Institutes principally administer funded research, the unit leaders also actively network, go to conferences and search for new opportunities. As with the academic's job description, active search for commercial opportunities is also part of the unit leader's job description. Help from the research offices also gives the TTOs a head start for potential exploitation.

Postgraduates who are employed by the University are obliged to report any IP that could be registered or exploited. This encourages them to be aware of exploitation opportunities.

University College London Business Plc

UCL Business Plc is a wholly-owned subsidiary of University College London, It was formed through the merger of UCL BioMedica PLC and UCL's internal knowledge transfer department in 2005. The subsidiary is made up of Physical Sciences, Biomedical, Clinical Trials Division and Consulting and has a total staff of about 40. UCL Business is self-supporting and aims to be profit centre.

According to Dr. Steven Schooling, Director of Physical Sciences, a useful way identifying exploitable IP is "walking the hallways" in search of inventions or innovations that may be developed further, licenced, or patented. Suggestions for exploitation may also come from among some of the inventors themselves. Underpinning this apparently relaxed approach is the conviction that nothing works as well as building a personal relationship between academics. While some exploitable IP will or could slip through the cracks, UCL Business does not seem to be adversely affected by this rather casual way of "doing business," since in a matter of a few years, they have managed to generate a positive cash flow.

Another rather unusual method is the "gut feeling" approach. Not exactly "scientific" nor structured, Dr. Schooling argues that one is able to identify an entrepreneurial academic from the characteristics of the academic. For instance, an academic who is involved in joint research and undertakes consultancy assignments, and/or is aware of the market in which her area of research is, will more than likely have some existing IP that could be exploited, or could be encouraged to

consider commercialising "future" IP. "Gut feeling" can also be applied toward the viability of commercialisation of an invention/method, etc. Here the TTO, either through personal knowledge of the market or technology/invention in question, strongly feels that the invention can be licenced to known companies in that area of business. Market research is of course another method for identifying the opportunities for the University's IP or to reinforce the "gut feeling."

As a way of building trust and raising the awareness of the services UCL Business offers, it (1) showcases a successful spin out and (2) holds events for individual faculties to explain the services, with the hope that this awareness raising "snowballs and reinforces" the profile of UCL Business to other faculties. With increased awareness raising academics may be encouraged to be more forthcoming with their IP. UCL Advance, which brings together academics, investors and businesses, is also an active program that holds several events to explain the commercialisation process to all students and academics and to network academics with potential clients. This initiative is also to encourage collaboration among researchers, businesses and investors. UCL Advance also publicises "innovation competitions," such as the London's Entrepreneurs' Competition, which offers a cash prize of £15000. As an added incentive to be entrepreneurial, academics' performance in successful exploitation of their IP, participation in joint R&D projects/partnerships and consultancy is part of the criterion for promotion.

Dr. Schooling, however, is sanguine about the effectiveness of these awareness raising events and insists that word of mouth, personal relationships with academics, and potential investors and clients are really the most effective ways of identifying exploitable IP. As he cheerfully notes, he worries when he sees that his five business managers do not have a "wad of coffee receipts" to be reimbursed.

U.S.: the policy context

The Bayh-Dole Act 1989 allows universities to retain ownership of the IP generated from federally funded research in return for which they must file for patents and collaborate with businesses to promote commercial application of the inventions. The Act has caused a flurry of TTOs to be established even by large research intensive universities, such as Columbia. Most of these TTOs have as their primary mandate to commercialise IP with the aim of generating revenues for the university.

Modes of identification

Our desk-based research did not yield too much information on how U.S. TTOs identify exploitable IP. However, given a prevailing mandate to maximise licensing revenues for universities, some of which are given bonuses for their performance, one can surmise that TTOs will be "rather aggressive" in identifying commercialisable inventions/technologies.

Yet Jensen and Thursby(2000) in a survey of 62 top universities, found that TTOs waited for inventors/researchers to report their inventions. They find that convincing faculty to disclose inventions is a major challenge, and a number of survey respondents stated that balancing the objectives of faculty and administrators is problematic.

Despite the paucity of available information, it is inarguable that many of the modes of identification discussed in the UK section are practised in the U.S. For instance, R&D collaborative agreements and projects are a long standing tradition in the U.S. (more below on mode of exploitation) as are networking and consultancy services.

Belgium, Canada, Denmark and Spain

Our desk-based research did not provide information on how the TTOs of these universities identify exploitable IP. However, in the case of Spain, an interview with an ex-TTO Director of a leading and large technical university, the University Polytechnic of Valencia (UPV), revealed that under his management, identification was done on an informal basis, principally by "chatting" with researchers, similar to the practice of "walking the hallways." Identification was also primarily done by professors, and in the case of UPV, by one "lone star" highlighting the role of the inventor/academic in any study on university IP exploitation. The current TTO is now an administrative unit, whose primary role is in managing contracts, etc. It does not actively seek opportunities for exploitation of the university's IP.

In stark contrast to UPV, is the University of Santiago de Compostela (USC), which was founded in 1495. It is located in Galicia, a low-income region. The total budget of the university in 2004 was €209 million euros, of which 10.6% came from R&D public funds and 5.7% from R&D and consultancy contracts with enterprises, government entities, etc. It is a traditional university that incorporated technical studies only 25 years ago, in line with other similar Spanish universities.

The TTO was established in 1989 and has increasingly developed an active policy and incentive system for encouraging the exploitation of its university IP. The TTO continually seeks to diversify its funding base, and importantly, vigorously promotes joint R&D partnerships with industry. With the help from academics, the TTO seeks out these opportunities and is committed to working out mutually beneficial terms for the partnership. Through its incentive system of 60% return to academics for any licences executed, this has stimulated academic interest in exploiting IP. It has also encouraged more disclosures and patenting by academics.

The main mode of identifying exploitable is through the academics. The professionalised staff also attempt to identify, develop and exploit opportunities by maintaining contact with the academics. (More on USC's modes of exploitation in Section C).

PART B: MODELS AND PRACTICES FOR THE EXPLOITATION OF UNIVERSITY IP

Models of TTOs

The role of university TTOs or business development units is central to the exploitation of university IP, as already noted above. To encapsulate, TTOs undertake a range of activities, from bridging the divide between academy and industry (where it exists), identifying potentially commercialisable IP and market opportunities, filing of patent applications to completion of licenses, etc. In between these tasks, TTOs also help to market the research results and create networks of industrial links. Many TTOs also help to manage seed funds, negotiate research contracts, identify funding opportunities and provide incubator services/facilities (Meyer & Tang, 2007).

However, this range of tasks varies from university to university for a number of reasons. First, if the university is already well known to industry, there is less need for the TTO to market the university and its IP as industry will often approach the TTO. Second, if the university is a pioneer in establishing business schools, the entrepreneurial mindset is somewhat already entrenched in academics, for instance, Warwick Business School. Third, resources for staffing the TTO are a key consideration. How trained is the personnel? How big is the TTO? How is it structured? What kind of institutional support do the university senior administrators provide to the TTO? Thus, the structure, experience and support of the TTO by the university, including faculty, is a *sina qua non* condition for successful exploitation (Colyvas et al., 2002; Meyer & Tang, 2007; Sampat, 2006). More importantly, the "vision" of senior university administrators is integral to the development of an entrepreneurial university, according to TTO senior personnel who were interviewed for this study and previous studies.

There are essentially five models of TTOs:

(1) the internal model, in which the TTO is fully integrated into the university administrative structure;
(2) the external model, in which the TTO operates outside the university as an independent entity, or as a subsidiary of the university, but has autonomy over its operations. These are generally for-profit organisations, or aim to be self-supporting;
(3) TTOs that are heavily reliant on government funding for its operations;
(4) TTOs that are less dependent on government funding for its operations, as exemplified by U.S. TTOs, that are primarily revenue-generating.
(5) A hybrid consisting of a combination of any of the above four.

The adoption of these models can be dictated by the size of the university and its research intensity, for instance, but at the end, it is shaped by the institutional practice, governance and "vision" of the university. Some studies have shown that universities that are relatively more effective in technology transfer are characterised by higher average faculty salaries, a larger number of qualified staff for technology licensing, larger R&D funds from industry and government sources, or an entrenched practice of working with industry (Rogers et al., 2000)[6] and greater experience and professionalisation of the TTO (Siegel et al., 2003). But while these studies assess "success" in terms of indicators, such as patents, licences and spin outs, they do not capture the range of IP exploitation activities that cannot be captured by metrics, a point echoed by several TTOs. For this study it is difficult to devise a taxonomy of UK university IP exploitation strategies based on the characteristics of the university and the TTO. Such a taxonomy requires an in-depth investigation of a large sample of universities.[7]

[6] Cited by Baldini (2006).
[7] The author and a colleague at SPRU are currently undertaking a Gatsby funded project to investigate this issue.

This section first focuses on how British universities identify exploitable IP. It is then followed by a brief overview on the U.S., Canada, Denmark, Belgium and Spain.

The UK

Models of TTOs

There is a mixture of TTO models among UK universities. Large research intensive universities, such as Oxford and UCL belong to the external model or a hybrid as illustrated by Imperial College in which its Business Development is HEFCE supported but its Imperial Innovation is publicly traded. A majority of the TTOs are also supported either by university and government funding, or both, but are not largely reliant on these sources, and in many cases are for-profit operations.

Warwick, Hertsfordshire and Portsmouth TTOs are integrated into the university administration. All are largely supported by university and the Higher Education Innovation Fund but not all are profit generating. Portsmouth's TTO does not have its central objective to be a for-profit organisation; neither is Imperial's Business Development Unit.

IP exploitation practices

All the universities interviewed, including information gathered from desk-based research, show a mix of methods of exploitation practices. Same methods are often deployed by the universities. Thus, this section will not discuss the practices under each university. Instead, it will discuss the range of practices, indicating where relevant, the university's practices.

The TTOs interviewed, however, share one common feature. They all practise the three phases that scholars who study the creation of new firms assert are necessary to cultivate entrepreneurialism. These are (1) opportunity identification; (2) opportunity development; and (3) opportunity exploitation (Van der Veen & Wakkee, 2006).

Patents, licences, spin outs: the three main common practices

Patents, licenses and spin outs provide a major part of the metrics to capture the IP exploitation activities of universities. They are in other words the key proxies for all university commercialisation activities; hence these are grouped together.[8] According to the 2004 Unico survey, British universities are doing better in the exploitation of their IP. For instance, 885 new patent applications were filed during FY2004 with 569 being granted across the 116 universities surveyed (Unico, 2005). A greater proportion of new patents were granted from outside the UK, particularly in the U.S. and a fifth of these were granted in the UK, the rest being in Europe and Japan. The increase in the number of granted U.S. patents in 2004 over 2003 is also noteworthy. In 2003, 98 patents were granted in the U.S., in 2004, 130. This suggests that, although not surprisingly, that the U.S. market is also considered the predominant market for university potential commercialisation in the same way that business regards the American market (Unico, 2005).

The number of spin outs created also showed an upward trend in 2004 from 2003 – 229 and 151, respectively (Unico, 2005). For the large research intensive universities, spin outs are an important mode of exploitation. For the Physical Sciences of UCL Business, spin outs are the most important route to market. Why? Because there is "something tangible" to show potential investors or licensees. Also spin outs are the best mechanism for "disruptive" technologies, either to create new

[8] Associated with patents are filings and disclosures, which this study will not address.

markets or to stimulate competition, according to Dr. Schooling. For incremental technologies or innovations, licensing would be the most effective form of exploitation.

Licensing income from UK universities too has increased from about £31.5 million in 2003 to about £40.5 million in 2004 (Unico, 2005). About 90% of this income came from patents, although there was no data on the *number* of patents that generated this income.[9] There are different approaches to licensing. In the case of disclosures, the Project Manager (Oxford) approaches an identified company who may be interested in licensing the non-patented technology. He provides no details of the technology/invention unless the company shows interest, after which a Non Disclosure Agreement is concluded. In the case of patented technologies/inventions, the Project Manager approaches his/her network of companies to identify any interest. Warwick Ventures also benefits from this approach. In the case of potential patents, Oxford ISIS Project Managers undertake due diligence on the invention. He/she undertakes market and web search to try and identify an opportunity for the said invention. Prior art is also checked for eventual patenting. Imperial Innovation also undertakes the entire process for IP protection and all contractual agreements for licensing, but unlike ISIS' Project Managers, does not actively get involved in the identification of opportunities.

The kind of licence, exclusive, non exclusive or sole exclusivity, generally depends on the invention/technology and market. The licencees can be from any country. Licences are generally for patented technologies/inventions but IP generated by social scientists have also been licenced (Oxford and UCL Business), although social scientists are more often involved in Knowledge Transfer Partnerships. (See below for more on this.)

Table 1 encapsulates the figures for UK universities in patents, licences and spin outs.

Table 1. Summary of key performance indicators

	FY2004	**FY 2003**
Total patents granted	569	669
Total granted in the UK	141	118
Total granted in the U.S.	130	98
Licence agreements executed	1118	333
Licensing income	£40,344,543	£31,370,187
Spin outs	229	151

Source: Adapted from Unico 2005.

According to the survey results of Proton[10] (Proton, 2007)and the ASTP (Association of European Science and Technology Professionals)[11] (Arundel & Bordoy, 2007), European research institutions, including the UK, performed better by a difference of 45% than American universities in terms of the number of start-ups established. The ASTP data on responses from the European TTOs also show that the UK outperformed Danish universities, for instance, in patents granted, licensing income generated and the number of start ups. Overall, the above two European surveys suggest that Europe is comparatively more successful in commercialisation and company creation.

[9] The number of patents is an important consideration because, as in the case of the University of Wisconsin at Madison, its one patent is generating the largest share of the revenues from its portfolio of patents.

[10] ProTon Europe is the pan-European network of Knowledge Transfer Offices (KTOs) and companies affiliated to universities and other Public Research Organisations funded by the European Commission.

[11] ASTP has 25 members, of which 19 are Member States of the European Union. The ASTP survey also reflects an improved performance in the number of patents granted, licensing income and the number of start-ups across Europe from 2004 to 2005.

It is however important to note that the revenues generated by European licences are less than those in the U.S.

Policy makers charged with encouraging the commercialisation of university IP can find comfort in these performances. However, figures for patents, licenses and spin outs need to be examined in detail in order to understand that these sterling increases are not uniformly experienced across all UK universities. In other words, there are still many "laggard universities" as there are universities who have yet to adopt a proactive entrepreneurial policy. Thus active exploitation measured by patents, licences and spin outs, may provide a skewed picture as these indicators are likely to be concentrated in a limited number of universities. Also there are other practices that do not always have a numerical value, or are not systematically captured, but are just as important in university IP exploitation (see below). These cautionary remarks notwithstanding, UK universities on the whole seem to be becoming more entrepreneurial.

But what about other practices?

Patenting; licensing; and spin out companies are the common proxies for university entrepreneurial activity. But what about other IP exploitation channels that are not systematically captured by HEFCE or the Association for Science and Technology Professionals, for instance? Knowledge Transfer Partnerships, a key program sponsored by the then DTI, collaborative research projects, building relationships and networking activities are all modes of IP exploitation. Of course the focus on patents, licenses and spin out companies is easily explained by the fact that they are easily and quickly measurable, and numbers "carry weight." But not to address the other forms of exploitation will result in underestimating university performance in, AND an inadequate understanding, of exploitation of university IP.

Building a relationship

There is broad consensus among all the Heads of the TTOs (or divisions of them), that *building relationships with academics and industry* underpins successful IP exploitation. This is inarguably obvious, yet when one thinks of modes of exploitation, building such relationships does not immediately come to mind. Yet the unanimity expressed in the interviews about this channel of exploitation as not often perceived as such is an issue increasingly addressed in the literature (Fisher & J Atkinson-Grojean, 2002). Particularly, how do you build trust with the academics so that they may understand that their IP is "safe" in the hands of the TTO and that exploitation benefits the university and the economy? How do you convince academics who fervently believe that publicly funded research should be in the public domain and that the commercialisation of university IP does not hurt the "public good"? How do you convince industry that the university is not out to extract the "maximum" licence fee or royalty, as t is commonly perceived?

As described above, business managers and senior TTO personnel expend much effort in building these relationships and maintaining them because it is through these firm relationships that the IP generated can be more readily made known to the TTO. At Portsmouth, for instance, the four sector managers continually "pound the pavement" with academics to explain, in a "softly softly manner" what commercialisation of their IP entails and how it may benefit them, the university and society as a whole. At UCL Business, "walking the hallways" is more than just for exercise. As already discussed above, getting academics to disclose their inventions and then convince many of them of the benefits of commercialisation is a gruelling task.

Networking and associations

Networks provide opportunities for existing university-business relationships to be strengthened and deepened, as well as offer the possibility of new relationships to be developed. A point not always readily appreciated by policymakers (and universities that are still lagging in their entrepreneurial activities) are the increased benefits from networking with other industrial participants. This may not only lead to new collaborations and sources of expertise, but also enables domestic companies to be aware of the competitors. As observed by many of the interviewees, networking activities can open doors to SMEs who are often "locked out" of networks that largely involve research intensive universities and corporations. The University of Hertfordshire and Portsmouth University, in particular, deliberately target SMEs in their networking activities.

Networks could involve participation of business angels and venture capitalists, in addition to a range of industrial representatives. The obvious merit in this practice is that it provides a wide array of expertise and sources of potential exploitation. Networking, however, requires both skill, experience, stamina, and resources and these, particularly the latter, are often limited. Networking is often abetted by pre-existing contacts and reputation. Thus it is not a truism to assert that reputation of the university lures more contacts and opportunities, and such "branding" has a snowballing effect.

Networking can also result from consortia of universities, such as BusPlus, which is coordinated by Portsmouth. This was started n March 2007 from SEEDA funding, which will end in March 2008. This consortium has been particularly successful with SMEs, who are often left out of Knowledge Transfer Networks (more below) because these firms are often not in position to spend the resources to be involved in these schemes, which normally require a year's participation by the company. SMEs generally have limited resources. BusPlus, on the other hand, allows SMEs to have a student to work with the SME for a shorter period, and thus does not impose too much time and financial burden on the firm.

Networks of research centres of excellence exemplified by those found in the U.S. and Canada are actively supported by public and industry funding. In the U.S., for instance, Engineering Research Centers (more below) are specifically targeted to provide industry access to expertise and facilities, and to facilitate collaboration between industry and students. These Centers are located in universities and are obliged to develop a strategic plan to integrate research, teaching and collaboration with industry (Knee & Martin, 2007).

Networking can also take the form of creating a "club" or an association to which members have to pay a membership fee. Membership entitlements include easy access to academics of the university, advanced notification of patent applications and granted patents, tailored seminars and research presentations, training workshops, for instance, for technology transfer personnel from outside the university, and newsletters of social and research developments in the university. Networking can also take the form of "breakfast clubs," to which companies are invited and researchers make presentations on their research, such as those organised by Portsmouth. These clubs/associations are also used, importantly, to link researchers with industry. A notable example of such a club is the Oxford Innovation Society. Our past research has also shown the benefit of newsletters to industry, in particular, which has resulted in commissioning of studies by members (Molas-Gallart & Tang, 2007).

Consultancy

In many of the research intensive universities, consultancy services form an important component of their exploitation strategy. Imperial Consulting handles exclusively the consultancies brought in

by academics. It generated about £15 million in 2007, is fully self-supporting and is a "small profit" centre. To encourage universities to increase their consultancy undertakings, the universities generally retain about 10-20% of the fees charged as an overhead or fee for administering the contract. This fee is also to ensure that academics are covered for liability, etc.

Oxford University has a unit called Oxford University Consulting and has an impressive catalogue of clients, which covers a wide range of multinational companies and international organisations, such as Astra Zeneca and the UN, and the public sector. Oxford University Consulting also works with private clients to help them commercialise their IP, who either do not know the most efficient way of commercialising, or who are foreign companies who want to commercialise their technology in the UK. The organisation also conducts training in technology transfer and project management.

Imperial Consulting (ICON) registered £15 million turnover in 2007. Consultancy is a clear mechanism for exploitation and as noted above, ICON is self-supporting and handles exclusively the large assortment of consultancy assignments that the University's academics bring in. UCL Consulting, established in 2004 with the Higher Education Innovation Fund, now has a turnover of more than £5 million, when previously it only made a £100K. Consultancy, according to Dr. Schooling is a good entrée for academics to know how companies work and *vice versa*. These assignments can then be further developed into networks of clients.

Consultancy services are also key mode of exploitation at the newer and smaller universities, such as Portsmouth and Hertfordshire. In Portsmouth, these assignments are mainly brought in by the sector managers, academics and the academic networks of which the University are part. Assignments are also obtained from UPEL (University of Portsmouth Enterprise Ltd), which is a wholly owned subsidiary of the University, whose main aim is to provide consultancy services to industry. In the case of Hertfordshire, consultancies are the prime route of exploitation and these are mainly brought in by the academics.

Consultancy work is also a common practice at Warwick although such work is undertaken by individuals and faculty members and do not go through the TTO. In recognition of the contribution to university revenues and its role in the exploitation of university IP, Warwick is in the process of centralising its consultancy activities.

Knowledge Transfer Networks

Knowledge Transfer Networks (KTN) are an important means of exploiting university IP, particularly for the social sciences and management studies. KTNs are programs in which university personnel or graduates are placed in businesses to help business improve their performance through the application of knowledge to their innovation processes, and to help develop new technologies. These also provide a forum in which businesses have the opportunity to collaborate with universities, national as well as European, to access the research base and to network with other experts in the field of innovation and development of emerging technologies. For instance, The Grid Computing Now! KTN has been set up to promote the early use of Grid computing[12] by UK businesses and to show the benefits of this emerging set of technologies (DTI, 2006a). This program is being underwritten by the (then) DTI, Research Councils, Regional Development Agencies and the Devolved Administrations.

[12] Grid computing is about the development of computer systems that allow organisations make more efficient use of their processing power and to access and use data held in different formats on different systems.

Collaborative R&D partnerships and projects

In a large survey of UK universities conducting joint research with industry, the authors find that "joint research" is a highly significant factor for knowledge transfer and connecting with industry. The underlying purpose of conducting such research is to keep abreast of industrial research, increase the applicability and exploitability of university research and obtain access to research expertise in industry (D'Este-Cukierman & Patel, 2005). According to Research Division at Oxford University, such partnerships and collaborative projects are a significant mode of exploitation of academic research. Collaborative R&D (or research) projects and agreements are *the* major mode of exploiting IP by the University of Portsmouth, in comparison to patenting, licensing and spin outs. All the other universities interviewed regard these collaborative projects an important channel. Where problems or difficulties may arise in some cases is found in the assignment of the joint IP ownership and the negotiation of subsequent licences that emerge from these joint research activities. It is worth noting that in such collaborative agreements, an "anticommons" situation with regard to IP does not arise.[13]

BioPharma, at Imperial College, noted above has an innovative way of stimulating R&D collaborative partnerships and projects. In addition to identifying industrial partners for such arrangements, BioPharma has successfully bid for project money from the London Development Agency, for instance, to investigate genomic medicine. With this funding, BioPharma has set up a group of researchers, in this case, called London Genetics, which works with Imperial and seven other universities, with the aim of developing a business plan to attract private sector partners for further project funding to conduct further research. When additional project funding is received, London Genetics then seeks the help of the Business Development Unit to recruit more researchers. London Genetics also uses conferences to meet with SMEs as potential research partners.

Hertfordshire's second most important mechanism is R&D collaborative research with industry. How it deals with the joint ownership that may arise from the collaboration, particularly in the case of third party funding is straight forward – the commercial partner either gives easy licensing terms to the University but retains the right to use the IP non-exclusively, or *vice versa*. In other cases, such as in the Knowledge Transfer Partnerships (more below), the industrial party allows the University a licence to exploit the IP but outside the area of the company's business area.

Collaborative projects and partnerships, however, need not be on an awesome scale. They can be much smaller in monetary value but the impact can be just as significant. For instance, collaborative projects under the European Commission Framework programs have been an important channel to bring together European scholars, and non EU Member States, such as Israel, Australia, Canada and the U.S. As the innovation process is tending toward an "open" model (Chesbrough, 2003b)[14], the "not invented here" syndrome may no longer be regarded as a "bogeyman."[15] For instance, the Japanese electronics giant, Sharp Corporation, has located its European R&D centre in the Oxford Science Park, where British and Japanese researchers work together.

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[13] "Anticommons" is a term that first appeared in a seminal paper by Heller and Eisenberg (1998) in which the authors argue that "overloading" collaborative research with IPR threatens joint research. The authors were investigating the area of biomedical research. The term has now become part of the vernacular in innovation and management studies.

[14] The open model essentially refers to the necessity of looking outside the corporation for new sources of ideas and collaboration, when necessary, in order for the corporation to develop new innovations. "Specifically, companies must now harness outside ideas to advance their own businesses while leveraging their internal ideas outside their current operations" (Chesbrough, 2003a, 1).

[15] Of course, protecting one's IP in these collaborative projects is a crucial consideration. See (Tang & Molas-Gallart, 2008)

Collaborative projects with industry, such as those undertaken under the EPSRC, TSB and the Faraday Partnerships are another important route to exploiting university IP. A Faraday Partnership is a network of organisations, including Research and Technology Organisations, universities and businesses, aimed at improving the innovation performance and competitiveness of UK industry through research, development, knowledge transfer and exploitation of new and improved science and technology from the UK science base or elsewhere (DTI, 2006b). In 2004-5, Faraday Partnerships have involved more than 1200 companies and 500 universities, and have licensed/commercialised more than 20 new products during the year. Since 1998, they have licensed/commercialised over 200 new technology based products and processes, and have spun out 30 small growing companies (DTI, 2006b, 6). The value of such undertakings is also rapidly being recognised by the ESRC, which through its new Business Engagement Strategy, is encouraging social scientists to work with industry in ESRC-funded projects.

Continuous Professional Development

Conducting workshops, workshops and seminars to which participants have to pay a fee is another method of exploitation. Modular degrees are also one way of providing continuous professional development. In Portsmouth, the sector managers actively market these courses. This practice is hardly captured in the metrics for university exploitation activities. For all the universities interviewed, the turnover from this activity is increasing significantly.

Funding of Proof of Concept

The availability of proof of concept funds (PoC) is not widely available to English universities, despite the importance of research at this stage. Scottish universities, however, are provided several "rounds" of such funds by Scottish Enterprise. Furthermore, UK companies do not seem ready to licence "embryonic" and proof of concept technologies, unlike U.S. companies (see below). Some universities, such as Portsmouth, however, attempt to fund PoC projects through CommercialiSE, funded by the Higher Education Innovation Fund. This is a consortium of 9 universities in the South East, managed by Oxford Brookes University, from which PoC funding, upon application, is available. Some local Regional Development Agencies, such as the East of England Development Agency, also fund these projects, but the consensus among TTOs interviewed is that there are insufficient funds for these projects.

According to Dr. Schooling, PoCs are also a significant route to commercialisation. PoCs help to develop a fledgling or embryonic technology further and through these efforts, become closer to market and hence more attractive to licencees or investors. For instance, he has ring fenced about £300K from the Higher Education Innovation Fund and together with a joint fund with Imperial College and some other universities, pump primes PoCs.

"Internal" programs to foster academic entrepreneurialism

These are distinctly different from the training seminars or courses that many universities offer to academics on entrepreneurialism. Perhaps these internal programs are idiosyncratic of some universities, and in this study, Hertsfordshire, whose Vice Chancellor's strategic agenda from a few years ago was to make the University "truly" business-facing. There is a structured program called UH Evolution, which aims to make staff think "commercial." As noted above, "commercial deployment" is part of the academic's job description. A sub-project of UH Evolution is UH Talent which is aimed at student placement (more of this below). Another sub-project is UH Mindset, which is a robust campaign to help academics understand what business facing means. UH Invest is aimed at developing a business model to bring in partners to the University's start ups or to bring in partners and create spin ins for the University. Its main objective is to create opportunities for the

University's postgraduates (and even staff) who could then contribute to the spin in, either in kind or in the form of equity. The target group for these spin ins are the local companies.

A key sub-project for helping to exploit IP is the UH Innovation Centre, which was established in 2003. This involves leasing rented space, not for the purpose of operating a real estate business, but to lure businesses to rent space so as to benefit from working with the University through joint R&D projects or to establish joint businesses (spin in). There are now 15 small companies located at the Centre, including one spin out from the University and another from an alumnus.

There is also a plan to introduce a "SWOT" (strengths, weaknesses, opportunities and threat) program to identify the SWOT of the University's business facing activities. Associated with this is a planned undertaking by the TTO to help make the University "more agile" with the creation of start ups, particularly in helping to further the University's understanding of risk in such ventures.

Brian Robinson asserts that the most important factor for successful exploitation is to "have an exploitation route built in first in joint R&D partnerships and an exit strategy" for the University. He further adds that the key driver for exploitation is "create the IP for the client and then ensure that the partner has an exploitation plan. The aim is not to create the IP and then look to exploit it." This is possibly a practical strategy, but such a strategy is clearly more applicable to a university whose main focus is applied research.

The U.S.

Models of TTO

U.S. TTOs are largely not reliant on government funding in the way that UK TTOs are. Instead, they are generally internal and may be supported by university fund, but more often than not, adopt the external model. Stanford Research Institute, which was formed by Stanford University in 1946, is a notable example of an external TTO. However in 1970, it separated from Stanford, and is now known as SRI International, a non-profit organisation that continues to help commercialise technologies. A well known and often used example of a current successful external TTO is the Wisconsin Alumni Research Foundation (WARF).

WARF is an independent, non-profit foundation chartered to support research at the University of Wisconsin at Madison (UW-Madison) and the designated technology transfer organisation for the University. However, it is a separate entity from the University but partners closely with it. Since its founding in 1925, WARF has been patenting and successfully licensing the University's IP. Its clients include a range of leading domestic companies throughout the U.S. and worldwide. Given the Foundation's vintage and reputation, its industrial networks are reputedly impressive.

The Foundation also returns the licensing income back to the UW-Madison, the inventors and their departments and each year, contributes over $45 million to fund additional UW-Madison research, which often includes supporting highly innovative, early-stage research for which no other funding sources are available. (http://www.warf.org/about/index.jsp?cid=26). Since making its first grant of $1,200 in 1928, WARF has contributed more than $915 million dollars to UW-Madison, including monies to fund research, build facilities, purchase lands and equipment, and support faculty and graduate student fellowships each year.

The interesting aspect of the relationship between WARF and UW-Madison researchers is that the latter are under no obligation to use its services for commercialisation of its IP, except in the case of federal funding. Most use its services, however, because of its expertise and industrial links. So while WARF is somewhat the de facto TTO for the university, researchers are still free to use (or

not) its services. Litan, Mitchell et al. (2007) call this model "free agency," in which academic researchers have the freedom to find the best arrangement and way of commercialising their IP. We have already noted that UCL Business also adopts this approach.

Patents, licensing, spin outs

The Bayh-Dole Act has stimulated dramatically the increase of university patenting and licensing (Henderson et al., 1998; Jensen & Thursby, 2000; Mowery et al., 2001). Scott Shane also finds that in a study on the university share of patents from 1969 through 1996 across 117 lines of business in the U.S., there is a significant correlation between the effectiveness of licensing in a particular line of business and university share of patents in the post-Bayh-Dole period (2004). This finding suggests that Bayh-Dole did indeed stimulate universities to increase patenting in those fields, which have a greater potential to be licenced for further development and commercialisation.

It is however interesting to note that while there has been a marked growth in university patenting, industry does not uniformly regard patents as a principal way from which they benefit from academic research, at least according to a study by Cohen et al. (2002). In a survey of R&D managers of firms in the U.S. manufacturing sector, the authors find that respondents ranked patents and licences near the bottom of the list as ways in which industry could learn from academic research. They also find that in most industries, the channels reported to be most important are publications, conferences and informal information exchange. While these channels may be useful to industry, from the perspective of the university, these channels may not be efficient "income generators." Nonetheless, the AUTM data show that for 2003-2005, U.S. universities were "aggressive" patentees (AUTM, 2007). According to a pilot survey on how university researchers use their patents more than 50% of the researchers patented research tools (Hansen et al., 2005).[16]

An interesting feature of U.S. university licences is the frequent licensing of proof of concepts (PoC). This is not a well adopted practice by companies in the UK, as already discussed above. Jensen and Thursby found that out of the total number of licences, 48% involved PoCs and only 12% were ready for commercialisation. The majority of the inventions ready for commercialisation were reagents and software. Licences for PoC, however, often oblige the invention to continue working on the invention with the licensee so that it may be commercialised. The central underlying rationale for such licences is to give some protection to firms from competitors and to induce firms, therefore, to invest in bringing the invention to practice (Colyvas et al., 2002). A study by Colyvas, Crow et al (2002, 66) found that where inventions were "ready to use" out of the university laboratories, there was less interest by firms to commercialise them because of perceived competition for such technologies. This, perhaps, helps to explain the 48% vs. 12% data by Jensen and Thursby.

It is also interesting to note that while patents are an important outcome from research, the TTOs who Jensen and Thursby surveyed reported that patents granted in comparison to licences are less important. This may reflect the fact that patents are an intermediate input to licensing. Many managers said that for financial reasons their policy is to apply for a patent on an invention only after they have identified a potential licensee (2001).

The number of patents granted to American universities outstrips that of the UK and Europe together, as already noted above. According to Proton (Proton, 2007)and the ASTP surveys (Arundel & Bordoy, 2007), Europe out-performed U.S. universities in the number of start ups and

[16] A research tool is a technology used to conduct research but it not the subject of the research itself.

the number of licenses, [17] although the value of U.S. licences is staggering, running to hundreds of million dollars for each of the several universities.

An examination of the AUTM data reveal that the number of start up companies for the period 2003-2005 by research intensive universities such as MIT and Harvard reflect 20 and 14, respectively (AUTM, 2007). According to a pilot survey on how university researchers use their patents, among other objectives, about 40% of the researchers reported that they had not created start ups or licensed their patented technology because they were planning to conduct further research (Hansen et al., 2005). A study by Goldfarb and Henrekson estimates that of the 3,378 U.S. start up companies created between 1980 and 2000 (Litan et al., 2007), more than 66% of these remain operational, with six per cent having gone public (Goldfarb & Henrekson, 2003). Similar survival data for UK (and European) start ups would be equally useful in assessing the "real" contribution of this mode of exploitation to the economy, for instance, in terms of job creation or revenue generation. Of course, this can only be examined after a longer period, for instance, after a decade.

Collaborating R&D partnerships and projects

The Intel's open model of collaborative industry-university research is a leading example of open innovation and collaborative partnerships in the U.S. Recognising that universities are a key source for new ideas, the company has set up laboratories designed to house Intel and university researchers to harness and develop on these ideas. The issue of keeping Intel's IP proprietary does not appear to be a key concern as the company believes that their strategic advantage lay "downstream" as the work moves toward technology and product development (Tennenhouse, 2004).

The U.S., on the whole, has a long and well known history of working and collaborating with industry, the main examples being MIT and Stanford (Mowery et al., 2004). This kind of culture is relatively new to the UK and Europe, and it is for this reason, among many others, as noted above, UK policy measures have been instrumental in encouraging universities to develop a more "open" attitude toward working with industry, never mind commercialising their IP. It is also for this reason that many European countries are reforming university IP regulations to reflect the Bayh-Dole, with the aim of fostering academic entrepreneurialism.

Networking and associations

In 1985, the U.S. National Science Foundation created the Engineering Research Centers (ERCs). The mid 1980s was the period of the "Four Asian Tigers" in the Far East (Taiwan, South Korea, Singapore and Hong Kong). The explicit aim of the ERCs was to provide an environment in which academia and industry could collaborate to pursue and develop strategies that would have the potential to spawn new industries, products and processes, and to commercialise the research outputs (Knee & Martin, 2007). The ERCs are only part funded by the National Science Foundation with additional funds provided by the universities and industry. Each Center receives about $2.5 million to $8 million (£1.3 million to £4.2 million). The National Science Foundation contributes between $1.8 million to $3.3 million (£1 million to £1.7 million) (Knee & Martin, 2007). The balance comes from the university and industry. The funds are used to support networking activities, the research portfolio and the purchase of capital equipment.

[17] It is not clear how the Proton and ASTP surveys came to this conclusion and the time constraints for this project does not allow a further investigation. However, a quick perusal of the AUTM U.S. data does reveal that more than 40% of American universities did not report start ups. A majority reported one or two start ups over the period 2003-2005.

U.S. universities have a range of other university-related associations and "clubs" to which paid subscription is required to receive a portfolio of services, including research presentations and seminars for professionals in the public and private sectors. UK universities, as noted above, also run such clubs.

The powerful role of the alumni office in many of the universities, often managed by business professionals, can be seen not only in the "mega" fund raising drives that it organises and the constant networking with alumni and alumnae, but in obtaining sponsorships of research and the commercialisation of university IP, in some cases. Except for a handful of universities in the UK, the absence of effective alumni offices is stark. The attempt to harness alumni with the aim of potential exploitation has just been adopted by University of Hertfordshire. This merits notice.

And others

Undertaking consultancy assignments is a frequent practice among U.S. university researchers. As with European and UK academics, these consultancies are with the public and private sectors. Provision of executive-type training courses is also common among universities.

What is however not widely practised in Europe and the UK, is the mobility of U.S. academics between industry and the public sector. U.S. faculty members can spend a few years in government or the private sector with no negative impact on or stigma to its academic career when the ex-academic returns to academia. Furthermore, faculty members who move into the private sector carry with them their "university-generated IP," which also could be used productively for innovation activities. In Europe and the UK, it is widely regarded that once "you leave academia for industry or government, it's goodbye to your academic career." This situation is slowly changing, but not without much resistance by the academic world.

While working in government may not directly result in the commercial exploitability of the academic's knowledge and IP, U.S. academics could use their knowledge to sponsor research that could be of potential commercial value in the mid to long term. Examples of such research may be seen in the different projects of the U.S. Advanced Technology Program administered by the National Institute for Standards and Technology.

Canada: the policy context

Canada has no specific legislation targeted to stimulate the commercialisation of university IP. Neither does it have a legislation that imposes a uniform regime for the determination of IP ownership of publicly funded research. However, the active exploitation of university policy was mandated by Government policy, after the Federal Government in 1996 positioned academic research as an "engine" of international competitiveness (Fisher & J Atkinson-Grojean, 2002, 467). There has been a flurry of TTO construction since then. Canada's embarking on academic entrepreneurialism started "seriously" in the late 1990s.

Models of TTO

Canada has distinctly three models of TTOs: internal, external and highly reliant on government funding. Canadian TTOs became what we know today as TTOs only in the mid-1980, when a TTO-like structure was established by 11 universities. Previously these TTOs were known as "Research Offices" that did not exploit university-generated IP (Fisher & J Atkinson-Grojean, 2002). These Research Offices only became TTOs when the Federal, Provincial and Municipal governments began funding them. The trend continues till today.

The sources of funding come from the Intellectual Property Mobilization Programs run by NSERC (Natural Sciences and Engineering Research Council), Canadian Institutes of Health Research (CIHR) and Social Sciences and Humanities Research Council (SSHRC). Many of the Provincial Governments have introduced funding activities to encourage and enhance the local commercialisation activities in their provinces. Federal funding programs include the Canada Foundation on Innovation, the Canada Research Chairs Program, the networks of Centres of Excellence and Genome Canada (AUTM, 2007). Thus, it can be seen that Canada relies heavily on government funding for exploitation of university IP, thanks to Governments' recognition of the importance of capacity-building to deal with university commercialisation matters.

Many TTOs, in spite of being 15 years old, are still not self-supporting. This could be explained by the observation that Canadian academics, particularly of the "older generation" are resisting academic entrepreneurialism (Fisher & J Atkinson-Grojean, 2002). Another problem could be in the scarcity of experienced personnel working in the TTOs. To address this personnel problem, various funding activities have been introduced to address the retention challenge through internship and training opportunities. All regional networks have active training programs to improve their commercialisation capacity and share good practices. These are also funded federally or provincially.

As with the WARF model of "free agency," Canadian academics in many universities do not need to go through their university TTO to exploit their IP. While it is mandatory to disclose their discovery, there is no obligation for the academic to commercialise it through her university.

Patents, licensing, spin outs: the three main practices

The total number of patents is unknown for the period 2005, although AUTM data shows the increase in the number of disclosures rose from 1307 in 2004 to 1423 in 2005.

The number of non exclusive licences executed in 2005 increased to 339 from 274 in 2004; the number for exclusive licenses fell from 270 to 164. Licence income also increased steadily from 2000 although in 2005 it declined by about C$3 million owing to the appreciation of the Canadian dollar against the U.S. dollar. But between 2001 and 2003, income from IP increased from $52.5 million to $55.5 million (6%). License income is paid in U.S. dollars. Another reason for the decline was the weakening technology market in the mid 2000s in North America (AUTM, 2007). These reasons also explain the reduction of the number of licenses.

The number of start up companies also declined from about 45 to 38 in 2004-2005. The main reason for this decline is the lack of venture capital in the weakening technology market of this period. A quick look at the AUTM data for the number of start ups reveals that the majority of universities did not create any company, with the highest number registered as two in a handful of universities.

However, data is available for 2003 and reflects the performance of Canadian universities and teaching hospitals in their patenting, licensing and spin out activities. These are encapsulated in **Table 2**.

Table 2. Summary of patenting, licensing and spin out activities of Canadian companies, 2003

Number of patents issues	347
Number of new licences	422
Number of spin outs	17

Source: Adapted from (Read, 2005)

It is interesting to note that the highest number of spin outs was created in the field of Health Sciences since 1998 when data began to be systematically collected. There were 307 compared to 160 in Information Sciences. Also since 1998, 45% of all patents have been commercialised (Read, 2005). Canadian universities have spun off over a 1000 firms since the 1980s, 100 of which have become publicly quoted. Two-thirds of them are still quoted in the TSX (Toronto Stock Exchange), and a few have been listed in the CDNX and in NASDAQ. Nearly half of these spin-off companies are specialised biotechnology firms, and around a quarter of them are Information Technology companies (Niosi, 2006).

Consultancy

Judging from the figures provided by Read (2005), the majority of the universities reported that a maximum of 25% of their time is involved in consulting assignments. This illustrates that consulting is also an active means of IP exploitation.

Networks

In 1989, Canada adopted a similar approach to the U.S. in its creation of the Networks of Centres of Excellence (NCE) Programme. NCEs were aimed at supporting academic-industry research collaboration. Virtual research clusters to establish new identifiable groupings were established to link these NCEs because of the geographical dispersion of Canadian researchers. These Networks are nation-wide, multidisciplinary and multi-sectoral research partnerships, in which these new groups of researchers collaborate on common research problems, and with industrial participation, aim to commercialise the research outputs. The Networks also support collaborative R&D with industry, postgraduate training, technology transfer and networking activities. They are partly funded by the NCE Programme, which is funded by the Canadian Research Councils and Industry Canada (a Government Department), supplemented with funds from industry, the universities and provincial sources. On average, NCEs are funded about C$7.5 million (£3.6 million) with approximately 50% of funds received from the NCE Programme. There are currently 24 NCEs in areas, such as engineering, manufacturing, health and biosciences, ICT, natural resources and the environment (Knee & Martin, 2007).

Our desk-based research did not yield much more information on the other modes of exploitation. One can, however, safely speculate that continuous professional development courses are provided based on a quick scan of leading Canadian universities,

Denmark: the policy context

Denmark, since 1955, had transferred the right to inventions to employers, except in the case of lecturers and scientists in universities – "professor's privilege," which allowed retention of the IP with academics or jointly with industry. However, in 2000 this was changed, and the Danish Law on University Patenting (LUP) transferred patents previously owned by the scientists or jointly owned with industry to the university. The Law was aimed at ''...ensuring that research results produced by means of public funds shall be utilized for the Danish society through commercial exploitation'' (Valentin & Jensen, 2007). The principal instrument of effecting this was to allocate ownership to the universities. The Law also mandated that ownership of inventions resulting from collaborative work with third parties, such as firms, would be assigned to universities, unless prior agreements were made to renounce in full or in part the right to the inventions However, the university will consider renouncing ownership if the invention is completed in cooperation with or is financed in full or partly by a third party (Baldini, 2006). All researchers *have* to disclose to the university any invention resulting from research, after which the university proceeds to patent it as well as attempts to commercialise it.

This Law was inspired by the U.S. Bayh-Dole Act. Then in 2003, Denmark introduced the Danish University Law with the main aim of making the country's universities more responsive to market needs for teaching and research. This Law essentially introduced academic entrepreneurialism to Danish universities. It also encouraged the creation of spin outs.

Patenting, licensing and spin outs

Following the enactment of the LUP in 2000, the Ministry of Science, Technology and Innovation established five patent consortia to deal with patenting and to create further collaboration between public research institutions and businesses. The patent consortia were divided into technological areas, for instance, biotechnology, medical technology, energy, etc. These consortia provide a forum where experiences were shared among the members and expertise was increased. At the end of 2003, the consortia were amalgamated into the National Network for Technology Transfer to help public researchers and staff from companies involved in the commercialisation of inventions to develop competences, share experiences and exchange knowledge. The Network is almost entirely funded by a Governmental grant: the membership fees cover only about 10% of the running costs (Baldini, 2006). The Danish Government set aside a ring-fenced grant to help universities implement the Law, especially for the cost of patenting.

An informative paper by (Valentin & Jensen, 2007) analysed the impact of the LUP on Danish university patenting, focusing on biotechnology, historically the most productive area of Danish university patenting activity. (It is also well acknowledged that "general purpose technologies," such as biotechnology and software find more commercial opportunities than specific technologies.) The authors find that the LUP has had a negative impact on the number of Danish patents. In contrast, for instance, Sweden still maintains the "teachers exception" and this has been argued to be particularly beneficial for academia-industry collaboration in biotechnology.[18]

Prior to the LUP, Danish scientists did not patent much and patents arising from collaborative research were generally assigned to firms in exchange for approval to use the results for publications and sponsorships of doctoral students. Thus ownership of IPR was seldom an issue of concern of the two parties. However with the enactment of LUP, companies now have to be concerned with IPR issues not only with those resulting directly from the research, but with potential inventions that result from the research. This problem is particularly exacerbated with basic research since it is often exploratory.

So has the LUP discouraged university researchers from collaborating in basic research and to patent? Yes, to a large degree, argue Valentin and Jensen. Other studies have shown that when firms have to worry about the whole package of IPR ownership and cannot be sure that commercialisation will result from such joint academic-industry research, they become increasingly cautious about such research, even as firms benefit tremendously from basic research (Calvert & Patel, 2003).

Valentin and Jensen (2007) find that in the case of biotechnology joint research LUP has negatively affected the contribution of university scientists to the inventions of Danish biotech firms. The post-LUP decline in academic involvement affected also other Danish firms, such as those developing advanced drug discoveries and which traditionally rely on university collaboration. In their comparison with Swedish universities, Valentin and Jensen find that between 1994-2000 (pre-LUP), Danish patenting performance in biotechnology matched that of Swedish academics. This was not the case post LUP. In addition to the reduction of patents, there were also fewer biotechnology spin outs. The authors conclude "by far the largest part of this academic inventive

[18] The authors were comparing the Danish and Swedish performance in patenting activities arising out of joint industry-academic research.

potential simply seems to have been rendered inactive as an effect of LUP" (Valentin & Jensen, 2007, 20).

The survey undertaken by the Ministry of Science Technology and Innovation and the Network for Technology Transfer, in contrast, show a rosy picture of the commercialisation activities for Danish Public Research Organisations (PROs) (Ministry of Science Technology and Innovation, 2004). This survey covers the period 2000-2004. The 22 Public Research Organisations comprise 9 universities, eight Government research institutes and five research hospitals. However, the data does not show a breakdown of the areas for the granted patents, licences and spin outs. Table 3 presents the figures for these activities.

Table 3. Performance of Danish PROs in patenting, licensing and spin outs 2000-2004

Year 2004	Universities	Government Research Institute	Research Hospital
Patents issued	2	11	2
New licences executed	19	20	6
Spin out companies	5	2	0

Source: Adapted from the Ministry of Science Technology and Innovation Survey (2004)

Table 4. University patenting, licensing and spin outs 2000-2004

Activity	2000	2001	2002	2003	2004
Licenses executed	6	6	14	22	19
Patents issued	0	0	1	6	2
Spin outs	1	5	3	4	5

Source: Adapted from the Ministry of Science Technology and Innovation Survey (2004)

The survey also noted that university licences grew from 11 in 2000 to 45 in 2005 and one spin out in 2000 to five in 2005. The data suggests that for a small country with a very short history of university commercialisation activities, Denmark on the overall appears to be progressing.

Baldini (2006) also shows a positive outcome from the Law: it led to a great number of university disclosures. The author shows that in 2000 the first year of implementation of the LUP, universities filed 13 applications, almost doubling the previous year and tripling over the years 1997 and 1998. In 2001, 45 filings were made but then dropped to 30 in 2003 (Baldini, 2006). A suggested reason for this is the diversion of resources from patenting to commercialisation, marketing and filing at foreign patent offices, which require huge translation costs. Also starting from 2002, there was a notable expansion of TTO personnel, spurred by the rapidly increasing number of invention disclosures and the need to actively exploit inventions, which might otherwise remain unexploited.

Although Baldini does not study in detail the patenting activity of Danish before the LUP and confines her investigation to 10 universities post-LUP, she appears to be buoyant about the initial positive impact of the Law on university patenting activities at least for the first three years after the

Law.[19] She, however, cautions that (1) it is still early to assess the "real" effects of the Law as it takes a long time for universities to adapt (or not) to changing environments, to implement measures; and to judge the impact; and (2) that institutional differences need to be considered in such a judgement.

Belgium: the policy context

There is no one policy promoting technology transfer in Belgium because of the federal-regional political system in Belgium. This section focuses on the Flanders region, which is reputedly known for outstanding entrepreneurial activities by a handful of its universities, particularly KU Leuven. The creation and development of TTOs are relatively recent in Europe.[20] In Belgium, however, the establishment of TTOs was facilitated by an R&D Law in 1980, although very few TTOs were established after the Law was enacted. The Law also created technological brokerage companies which acted as an intermediary between academic research and industry (Van Dierdonick et al., 1990). Since the early 1990s, these have ceased operations and most of them have become consulting companies, probably because of the eventual increase in the number of TTOs. In a sense, exploitation of university of IP exploitation goes back to more than 20 years, but progress in this activity has been slow.

The 1995 Decree in Flanders underpins how Flemish universities conduct their exploitation activities. It states that the contractor is responsible for all costs directly linked to the execution of contract research, namely the use of infrastructure, services or personnel from the university (Debackere, 2000)) The Decree also mandates university ownership of the IPR of research undertaken by university researchers, unless the university fails to exploit these results within a time span of three years or rejects the researcher's request for filing a patent. Furthermore, it determines the criteria that need to be fulfilled before a university can invest in spin out companies. The university will only invest if the spin out has a clear marketing plan to exploit its technology/product/process (Debackere, 2000). There are no other regulations for Flemish universities. So, most of them have their own internal regulations to exploit the IP generated by the universities.

Models of TTOs

Belgian TTOs are largely reliant on support by regional governments. Many still remain small and are reputedly rather inefficient (Debackere, 2000), with the exception of KU Leuven (more below). Thus exploitation of Belgian university IP is insignificant in terms of volume and influence, when compared to Denmark or Finland, for instance (Debackere, 2000).

Patenting, licensing and spin outs

The number of patent applications by Belgian universities jumped from about 4 patents a year in the early nineties to about 24 patents a year in the late nineties. During the period 1985-1999, Belgian universities owned 153 patents, mainly in biotechnology (Saragossi & van Pottelsberghe de la Potterie, 2003). This growth can be attributed to two major changes. The first one is due to the new technological opportunities resulting from research activities related to the biotechnology sector. The second one is based on an increased propensity to patent technologies as a result of the establishment of more TTOs. The differences in patenting performance between Belgian universities are large, a main reason being that the bigger university patentees are those who conduct more joint research with specialised government-sponsored research centres, and they are

[19] In an article on Italian patenting activity, Baldini et al. show that the implementation of a Bayh-Dole like law in Italy resulted in increased university patenting (2005). Little, however, is known about the performance of these patents.

[20] The TTOs interviewed report that "droves of European TTO personnel" visit them quite regularly.

also generally the large research intensive universities (Saragossi & van Pottelsberghe de la Potterie, 2003).

The percentage of patents owned by Flemish universities and public sector research organisations grew from 19.7% before 1995 to 28.5% over the period 1991-2000(Meyer et al., 2003). Here we can observe the impact of the 1995 Decree. A total of 306 U.S. patents, over the period 1991-2000, originated from Flemish universities, which represented five per cent of all Flemish patents in the Flemish U.S. patent database. KU Leuven accounts (more below) for about half of all the patents. It is also worth noting that about 23% of all Flemish academic patents are foreign-assigned (Meyer et al., 2003).

A well known example of successful exploitation of IP from a Belgian university is that of K.U. Leuven. With a stated policy of technology transfer and commercialisation of the university's IP, the university carries out the greatest share of Belgian universities' exploitation. The TTO is known as the Leuven Research & Development (LRD) and started out as a small TTO about 28 year ago. In a Europe-wide survey of TTO practices, LRD has been identified as best practice (Polt, 2001).[21]

LRD has several divisions, including an IPR division and is fully integrated within the University. However, it operates autonomously although its operating budget is provided by the University (Debackere, 2000; Debackere & Veugelers, 2005). About 26 professionals assist with contract research and these now represent a major part of the University's revenues. A patent fund has also been set up to help researchers to patent. An interesting feature is the part-time (20%) employment of junior researchers to assist as "innovator coordinators." They act as permanent liaisons between the LRD and researchers, and through constant meetings with faculty, these innovator coordinators are able to instil trust on the part of academics. As researchers themselves, they are thus sensitive to the concerns of faculty members.

Spin out activity is aided by a seed capital fund in partnership with two Belgian banks.

In order to assist the start-up entrepreneur, LRD also has access to an "Innovation & Incubation Center" that is jointly owned and operated by the University and the local Regional Development Agency. This Center, which is located in the campus, provides accommodation and managerial support for the university's spin out companies.

The number of spin outs has increased exponentially in Flanders since the mid-1990s. Several factors account for this increase. First is the Decree that made it easier and clearer to start up companies; second, the availability of pre-seed capital funds; third, more TTOs and the creation of Business Angel networks (Debackere & Veugelers, 2005).

In 1999, Leuven Inc. was established which acts as a network organisation bringing together '"like-minded people" from academic research groups, entrepreneurial start-ups, supporting services such as consultancy and venture capital, and established companies in the Leuven area (Debackere & Veugelers, 2005, 336). The aim of Leuven Inc. is to support and to stimulate the exchange of business experiences between its members and does this through frequent informal networking, information and training sessions. Leuven Inc. has close ties to the Cambridge Network. By the end of 2003, the university had generated 60 spin-off companies, with 54 companies still operating today. They are distributed across a wide variety of disciplines (Debackere & Veugelers, 2005).

[21] Cited by Debackere (2005).

Other methods

Although our desk-based research did not uncover in detail other methods of exploitation, R&D collaborative with industry has traditionally been an important mode of university IP exploitation for Belgian universities. Before the Decree of 1995, universities that conducted research jointly with industry had their patents or IPR assigned to the company. Meyer et al show that the industry share of patents declined from 67.2% before 1995 to 57.9% after 1995 (2003), as a result of increased university patenting.

Spain: the policy context

The Spanish Higher Education Sector spends 29% of the Spanish Gross Domestic Expenditure on R&D and employs 38 % of the total research personnel and 49% of the total number of Spanish researchers. Universities are the most important organisations within the "scientific sector" (universities, research institutes, etc.), accounting for 60% of its R&D expenditure and 70% of researchers. The public sector is also the principal funder of R&D research of universities-- 86%, while the private sector funds 7%, foreign sources 6%, and private non profit entities, 1%.[22]

Spain's entry into the European Union in the 1980s catalysed a change in the legal framework for Spanish universities. These changes substantially changed the way universities operated. The most significant laws revolved around three Acts of Parliament related to R&D activities: the University Reform Act 1983 (URA), the Patents Act 1986 and the Act for the Promotion and General Coordination of Scientific and Technical Research 1986 (Science Act).

The URA gave Spanish universities autonomy to manage their budgets and assets, including ownership of IPRs. It also introduced, for the first time, the ability of universities to enter into contracts with third parties for scientific, technical and artistic work. The URA was reformed in 2001 and 2007 and introduced three key changes: (1) the importance of the "third mission" – knowledge transfer and commercialisation of university IP; (2) an incentive structure for academics to undertake these activities, such as the distribution of revenues generated from IP commercial exploitation; and (3) universities were free to establish the revenue sharing regime. Ownership of IP however was assigned to the university.

The Spanish Patent Law, 1986, states that universities will apply for patents resulting from research of their researchers. It obliges academics to disclose and declare intent to commercialise within three months. Universities do not have to pay a fee to the Patent Office for its service.

The Science Act established the National R&D Plan as its most important instrument. From 1988, programs were introduced to increase joint R&D with industry. Particularly important was the establishment of a Research Results Transfer Office (OTRI, i.e., TTO) in every Spanish public university, to facilitate R&D cooperation between universities and the private sector. The protection of university IP was a key objective and the creation of the OTRI Network[23] by Vice Chancellors of all Spanish Universities. This Network was to organise training, establish working groups, and develop other activities oriented towards training and the dissemination of good knowledge transfer practice. The new national R&D Plan (2008-2011) continues these objectives but has included the vital importance of spin out creation. To develop this activity, Government has introduced new statutes specifically aimed at supporting these new companies through financial benefits and employment support measures.

[22] The figures were provided by a Dr. Elena Castro-Martinez senior research at INGENIO, the research centre at the University Polytechnic of Valencia.

[23] http://www.redotriuniversidades.net/

Models of TTOs

While the legal framework clearly supports the commercial exploitation of university IP, the performance of Spanish TTOs is reputedly concentrated in only a very limited number of universities. The main reason for this is that Spanish TTOs have become an administrative unit, focused primarily on the contractual and legal aspects of academic entrepreneurial activities and generally less on helping to develop collaborative R&D partnerships with industry, networking with academics and industry, developing new clients, etc.

Spanish TTOs are supported by Government and universities, and very few aim to be a profit centre and self supporting. Most of them have become a central administrative unit. The following describes the activities of one of Spain's leading TTO, based in the University Polytechnic of Valencia (UPV), a leading technical university, also well recognised for its commercial activities. This section traces the early development and mission of its TTO and how its mission has changed today, *despite* the current impressive exploitation of the University's IP.[24]

There is one clear lesson from this case study: the role of the academic. [25] This role is currently under-studied. Therefore a comparison of universities' performance in entrepreneurial activities in any country needs also to investigate the role of academics/inventors in such activities.

In 1989, the UPV Centre for Technology Transfer (CTT) was a very small office doing little. Prof. Ignacio Fernandez, currently Director of INGENIO, the Research Centre of UPV, joined CTT in 1989 as Director and had a staff of 3 administrators and one graduate. This grew over the years to reach seven administrators/support staff, four employees of whom were university graduates.

The underpinning idea for CTT was to build a small and flexible group capable of offering services in an environment that Prof. Ignacio defines as "hostile": the university would not grant long term employment to the CTT,[26] was not supportive of it and was mainly oriented toward teaching. Promoting research was ignored, except in very few exceptions. The main objectives of the CTT were (1) to promote and increase the University's participation in competitive research projects; and (2) to promote links with industry.

This required a change in culture. The Director had to convince the academic staff that they had to engage in R&D activities and that working with firms and making money "was good." To achieve these objectives the CTT provided a "listening" environment for faculty and to develop relationships of trust between faculty and the Unit. Here, an aspiring business-minded academic could find a sympathetic staff member who could be helped with her entrepreneurial pursuits. CTT ran into severe difficulties as UPV's existing administrative structures were inflexible and resisted all attempts to develop links with industry and engage in research contracts.

However, the CTT rapidly implemented new measures, particularly regarding changing the distribution of revenues from contracts. Until then this was regulated by a complex "incomprehensible" formula. The new system established that 10% would be retained by the University and 90% for the researcher. An independent account was set up in a different bank from that of UPV's to manage the funds obtained from contracts. This allowed the researcher to do what he/she wanted with the funds each brought in.

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[24] The interview was conducted with Prof. Ignacio Fernandez de-Lucio, with the help of Prof. Jordi Molas-Gallart, both at INGENIO, University Polytechnic Valencia. In 2007, Prof. Fernandez was awarded the national prize for his contribution to Spain's technology transfer activities.

[25] This point was also highlighted in the discussion that followed the briefing "Exploiting IP by UK universities" for the Minister of Innovation, Baroness Morgan of Drefelin, Lancaster House, January 29, 2008.

[26] Retention of TTO staff is a problem identified by some UK TTOs who were interviewed.

Another measure was the establishment of procedures for contracting students to work in projects, templates for contracts, etc…The CTT only managed contracts that were above approximately £2500 pounds, which constituted 90% of the contracts and generated 10% of the income for the Unit. For these contracts the CTT developed a standard "service contract," which virtually automated the management of small contracts.

With the departure of the management in 1998, the CTT began to formalise more procedures and the Unit evolved from being a support service to an administrative unit entrenched in central administration. It now has 45 staff members. Today, it mainly administers the contracts and commercialisation activities undertaken by the academics and does not actively identify, develop and exploit opportunities for commercial or joint research purposes.

In contrast to the administrative focus of UPV's TTO, the University of Santiago Compestuelo's (USC) operates more in the way of the TTOs studied in this report.[27] Created in 1989, the TTO had a staff of three; this had grown to 31 by 2006, of which 13 were university graduates (5 specialised in IPR, licensing and spin offs). It instituted IPR regulations and policies (ownership of IP belongs to the University) and introduced an incentive system that stimulated the University's academics to pursue commercialisation of their IP, for instance, through licences.

The TTO also introduced a robust spin out policy at the end of the 1990s, with the creation of an incubator, UNINOVA, one of the first university incubators in Spain. With the formulation of a set of procedures for spin out creation and assessment in 2000, USC also formed a risk capital society (UNIRISCO) with the other two Galician universities and several financial and private investors.

Patent, licences and spin outs

For UPV, from 1989 to 1998, there was very little IP that could be formally protected (apart from copyright) and there were no formal processes for identification. The majority of the contracts did not conduct joint R&D research. Instead, the CTT's main focus was to create a solid network of good and active researchers. These could be individuals that had come to the CTT for help and with whom a relationship of trust had been developed. The CTT would also try to identify through personal contacts possible clients (private and public), and through networking. When the Unit identified promising researchers they would help to contact potential industrial partners, for organising meetings with the latter. Once the relationship was established the CTT would not "interfere," and would, instead, offer services to the researchers, such as helping them to negotiate contracts to ensure mutually beneficial terms.

Although today the UPV is a leading Spanish university in the number of patents granted, the majority of these patents are attributable to a single "star researcher," who is also a key licensor. With this exception; Prof. Fernandez still argues that exploitation of UPV's IP goes beyond patents and licensing. Instead, providing advice and working with companies in the region are more useful forms of exploitation as these could lead to joint research and research contracts, for instance.

Still when one looks at the number of spin outs and patents of UPV today, one cannot help but be adequately impressed with its performance. For instance, the University spun out eight companies in 2007; five in 2006 and two in 2005. This growth of new companies has been apparently attributed to the sole effort of academics, abetted by the marked increase in faculty members. There were 2,283 contracts from industry in 2005, amounting to more than 13 million Euros. In 2005, 94 licences were executed, reflecting an increase from 44 in 2004.[28] Here, one could conclude that

[27] The information on USC was provided by Dr. Elena Castro-Martinez, a senior researcher at UPV.

[28] Figures from the Annual Report 2004-2005. There was no breakdown for the kinds of technologies that were licenced.

UPV is an entrepreneurial university despite a TTO that operates significantly differently from those we have reviewed above.

The University of Santiago Compestuelo's (USC), patent applications rose from 38 in 1989-1996 to 114 in 1997-2005.[29] Here, any invention not patented by the TTO can be done individually by the academic with financial assistance from the University. In the event the patent is licenced, the University retains 10% of the revenues. In 2006, the TTO received 76,000 euros in licensing revenues.

Between 2002 and 2006 18 spin outs were created from USC research groups. In 2004 USC assigned ownership of six nanotechnology patents to Advancell in exchange for the company's total capital. Advancell is a Catalonian spin out. This share was initially valued at €200,000. In 2007, Advancell set up a branch in Galicia with 4 employees, and the value of USC´s share in the company is now estimated at €1 million. From 1999-2006, USC had created 120 companies (spin outs and start ups) that hired a total of 377 employees.

The USC case is notable because it is located in a very low income area. Perhaps the "moral" of the story is that exogenous factors can also be a stimulus to the creation of an innovative and active TTO, who sees, as part of its role a responsibility to contribute to the regional development. Indeed, there are several studies that show how universities can contribute to regional development (HEFCE, 2003).

[29] www.oepm.es

PART C: MEASURES TO SUPPORT AWARENESS OF IP AND IP EXPLOITATION

There is a paucity of detailed information on these support measures, apart from the courses offered to raise IP awareness among undergraduates and postgraduates. Some of these courses go beyond the general IP legal considerations by exploring IP issues specific to particular scientific areas. For scientists, patent law is explored in terms of the unique challenges associated with protecting the intellectual assets of hi-tech companies in the medical, pharmaceuticals, computing and engineering sectors. Courses at undergrad and postgraduate courses on entrepreneurship and IP are also offered. Workshops for postgraduates on how to identify business opportunities are conducted from time to time. These kinds of courses are offered, for instance, by Oxford Science and Enterprise Centre and Manchester Science Enterprise Centre.

Specific examples, however, have been identified through the interviews undertaken for this study: University of Hertfordshire and Portsmouth.

University of Hertfordshire

University of Hertfordshire's Centre for Entrepreneurial Development has an innovative program for ensuring that all students know about IP and entrepreneurship, particularly for undergraduates. The Director Nigel Culkin rightly recognises that IP and entrepreneurship must be addressed collectively. So in 2006, he piloted an entrepreneurship-IP half module, which drew only about 1000 students. However in 2007, student enrolment in this module increased to 13,000. Now working with the University's faculties, he intends to increase this half module to an accredited full module by 2011. The Centre also recruits the help of UKIPO to talk to students about IP issues.

Nigel Culkin has also instituted a training program to build consultancy experience, among other things, for graduates and postgraduates, among other topics. Industry experts are brought in to talk to students across a range of disciplines. Encouraged by the positive reaction of the University's Director of Quality Learning, this training program may be soon accredited across all disciplines. Associated with this is a "crown jewel" of a measure – the Graduate Consulting Unit (GCU), which provides a "safe bridge"[30] for the University's under- and postgraduates to test and implement their learning with the University's clients and to build "self-efficacy" in business matters. Open primarily to the best students, there are currently about 50 students who are conducting fee-earning projects worth about £250,000.

Another measure to raise IP-entrepreneurship awareness is Enterprise Wednesday, which is conducted in cooperation of Prof. Narin of Cambridge University. Participation runs to about 50-80 students per Wednesday. Faculty members also participate.

A fourth measure is to run competitions to attract fledgling entrepreneurs with bright ideas. A non-accredited program FLARE – Business Ideas Challenge, which was first introduced in 2003 attracted several students across several disciplines to submit ideas for starting a business. This Program ended in 2007 and the 2007 winner has started a company. To nurture the company, the main sponsor of FLARE has offered the winner office space in one of its locations. Previous winners have also started up companies and have used the Innovation Centre (see Part A, University of Hertfordshire) to incubate their businesses. Winners are also helped by the Centre to draft business plans.

[30] Interview with Nigel Culkin, January 22, 2008.

The University also runs LiveWire, a similar program to attract students to submit business ideas and plans. The winner would then be rewarded with a cash price and free consultancy advice from a local company.

In 2007, Nigel established UH Angels, an organisation to attract alumni, with the twin purposes of identifying business opportunities and "wealthy investors." The University has several past students from the Far East, particularly China, and reckon that it is worth tapping into these potential sources of business and investment. This, as discussed above in the section on the U.S., echoes what most American universities do, as well as what some large UK universities do.

The most recent measure by Nigel Culkin is to introduce in 2008 Business Challenge, an unaccredited program but which he hopes to have it accredited. To implement this program, he has taken over a Student House, which accommodates four students. Four previous winners of FLARE will be given free housing for a year, will be mentored and given "incubator" space at the Innovation Centre to develop and grow their business.

Portsmouth University

Portsmouth Centre for Enterprise, headed by Richard Sant is charged with raising IP awareness and supporting the entrepreneurial aspirations of student. Richard is in the process of developing policies and measures that specifically aim to educate students, particularly undergraduates, to the importance of IP and its potential value. Presently, the measures are plainly to offer support to students if there are queries on IP.

The measures to support students' entrepreneurial pursuits are much more expansive. The most important measure is the Ideas Competition that the Centre conducts every year. These competitions are sponsored by local business and the County Council. There are two stages to this competition. The first stage, which awards a prize of £5000, is for the undergraduate with the best idea. The second stage, which has a prize of £10,000, is awarded to a student who has submitted the best business plan. The winner of this stage may *not* have submitted his/her idea to the first stage. The Centre considers a good business plan to be more important than a good idea. Mentoring services are then provided to this winner on a one-to-one basis, who is then encouraged to submit an idea. The prize of £10,000 may also be awarded to students who are free lancing, such as in designing web pages or printing tee shirts. The guiding principle underlying the competition and mentoring services is to "raise self-efficacy," in student entrepreneurial pursuits, according to Richard Sant.

There are two way of realising the business plan. One is through the provision of incubating space. This involves hot-desking in the Centre, the purpose of which is mainly for further development of the idea. The second way is to create a spin out in which the University takes an equity stake.

There have been, to date, about 10 spin outs by undergraduates. The most successful spin out has been a recent winner in the Ideas Competition. She now has a thriving business in a computer game, which is retailed throughout the country, and has just concluded a deal with Pixar (now part of Disney Productions). She is also in the process of concluding another contract to produce a game involving the Harry Potter character. This example must surely be an exemplar of a successful spin out of an undergraduate.

The Centre also conducts "fun outings, "such as dinners on and visits to the historic ships that are docked in Portsmouth Harbour. The aim of these events is to create a stimulating environment for ideas. These have generated enthusiastic response from undergraduates (not unsurprisingly) and Richard Sant believes that these away-from-the-classroom events can be an important means of

generating and exchanging ideas as students are collectively exposed to environments that they may not be on their own.

PART D: A SUMMARY OF GOOD PRACTICES

Good practices for identifying exploitable IP

There is no optimal or "best practice" for the exploitation of university IP. Successful universities display very different approaches and methods for IP management and exploitation. However, from the information gathered, one can determine a suite of good practices. They involve and are in no particular ranking:

(1) the establishment of a professionalised TTO, whose staff possesses a mix of academic and business experience;
(2) the commitment to building and maintaining trust with the academics and industry and to understand how academia and industry work;
(3) "walking the hallways" and keeping in constant contact with academics on an informal basis;
(4) to adopt a "softly softly" approach plainly explaining to academics the process of commercialisation and the benefits from it, and to avoid giving the impression of "going after" the academics' IP, or to present complex legalistic "explanations" about IP protection;
(5) the establishment of an incentive structure for academics to engage in (1) consultancies as an entry point to knowing how companies operate and with the aim of developing a steady client list; and (2) joint R&D projects/partnerships as an effective way to exploit university IP;
(6) the avoidance of over bureaucratisation of procedures and processes for industry engagement;
(7) the application of a combination of methods to identify exploitable IP AND a willingness to experiment with different and innovative methods;
(8) the knowledge that exploitation of IP is not *only* to produce the greatest number of spin outs, patents and licences, but that exploitation crucially includes knowledge transfer and may not be captured by indicators or numbers.

Good practices for successful exploitation of IP

1. Total support from, and the ability of the TTO in three activities: (1) opportunity recognition; (2) opportunity development; and (3) opportunity exploitation
2. Licensing;
3. Spin outs as they provide a fast route to market and a tool to engage potential investors;
4. R&D research partnerships and projects as these help to generate more academic IP and provide a route to commercialisation;
5. Consultancy as this provides an initial route to the exploitation of the academic's IP ;
6. Undertaking a "capabilities map" or "capabilities audit" to match industry needs BUT this needs to be done in close coordination with the Research Division and academics who are more aware of what the areas of research interests are – academics' capabilities are often a "moving target";
7. The implementation of active measures to raise IP awareness and increase knowledge about the process of commercialisation and the benefits from it among (1) the student body; and (2) researchers (including contract researchers) and (3) lecturers and heads of faculties;
8. Submitting bids to Invitations to Tender that require an industrial partner

The *sine qua* condition for successful exploitation is the commitment of senior university administrators to supporting the exploitation and commercialisation of their universities IP. Without this, the TTO may find itself isolated and may not be staffed with professionals who understand the technology/knowledge transfer processes between academics and industry.

Lessons learnt

1. Policies aimed at fostering academic entrepreneurialism must take into account (1) that senior university administrator do not always support the kind of approaches identified here as good practice, and that sometimes their support may be more rhetorical than active; (2) that there will be often a need for internal cultural change at University level; (3) that awareness raising measures for academics and the student body will be necessary (4) that TTOs must be professional and understand how *both* universities and industry work; and (5) that the TTO's (often informal) efforts in building and maintaining trust and relations with academics and industry are crucial.
2. The role of the academic/inventor is vital to successful exploitation.
3. There is no optimal or "best practice" because of the varying characteristics and governance structures of UK universities. There are however a suite of good practices.
4. UK, in the absence of a legislative framework, has a comparative advantage in the commercialisation of university IP. This is because it allows mechanisms for exploitation to be flexible and in some cases experimental, which could then lead to good practice.
5. It is important for policymakers and university administrators to understand that the introduction of a legislative framework such as the U.S. Bayh-Dole Act must be approached with caution. Legislative measures need to take into account the varying culture, history, economic environment and other contextual factors faced by UK universities.
6. There is broad consensus among TTOs that metrics or indicators (often focusing on counting numbers of patents and spin-out or estimating income streams) do not capture the wide range of IP exploitation activities, many of which are informal or relate to the introduction of changes in practices and organizational structures.

Support measures for raising IP awareness and student entrepreneurial aspirations

The main support measures for raising IP awareness are seminars, IP courses (mainly at the postgraduate level) and competitions for ideas that could be developed into businesses.

The University of Hertfordshire should be particularly noted for its innovative measures to educate undergraduates on IP and entrepreneurialism. An example of these may be seen in the year-free accommodation for selected winners of the University's FLARE program to further develop their ideas into businesses. Mentoring and incubator space are provided by the University to these winners.

Portsmouth University also has created several spin outs from its highly successful Ideas Competition. An exemplar can be found in the thriving computer game business started by a winner of this Competition. She now has her computer game retailed throughout the country, has concluded a contract with Pixar (Disney Productions) and is in the process of concluding a contract for the production of a game involving the Harry Potter character.

Suggestions for further research

(1) How do universities balance their three missions – teaching, research and commercialisation?
(2) Exploring the role of the academic/inventor in the exploitation process. What are the key issues with UK academics on the topic of IP commercialisation. For instance

- is there a tenacious adherence to "public research for public good"?
- what are their motivations for patenting or not?
- is it a lack of clarity of how the economy benefits from their research or who really benefits from the exploitation?

- is it problems arising from project partners regarding the joint IP? Or why should a securely "tenured" academic risk his income to create a start up?
- is there a lack of institutional support?

(3) Current proxies for successful IP exploitation focus on patents (including filings and disclosures), licensing and spin outs, do not give equal importance to other important paths of IP exploitation, such as maintaining a strong relationship with academics and industry, collaborative research partnerships, networking, continuous professional development and executive training services, support measures for entrepreneurial undergraduates and postgraduates and outreach activities. More investigation is required to assess the extent of these activities as mechanisms of IP exploitation.

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