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Exploring the “Value” of Academic Patents: IP Management Practices in UK Universities and their Implications for Third-Stream Indicators

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EXPLORING THE “VALUE” OF ACADEMIC PATENTS: IP MANAGEMENT PRACTICES IN UK UNIVERSITIES AND THEIR IMPLICATIONS FOR THIRD-STREAM INDICATORS

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Third-Stream activities have become increasingly important in the UK. However, valuing them in a meaningful way still poses a challenge to science and technology analysts and policy makers alike. This paper reviews the general literature on “patent value” and assesses the extent to which these established measures, including patent citation, patent family, renewal and litigation data, can be applied to the university context. Our study examines indicators of patent value for short and mid-term evaluation purposes, rather than indicators that suffer from long time lags. We also explore the extent to which differences in IP management practices at universities may have an impact on the validity and robustness of possible indicators. Our observations from four UK universities indicate that there are considerable differences between universities as to how they approach the IP management process, which in turn has implications for valuing patents and how they track activity in this area. In their current form, data as collected by universities are not sufficiently robust to serve as the basis for evaluation or resource allocation.

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Introduction

Over the past few years, many countries have taken measures to promote knowledge and technology transfer between universities and industry. In the UK, such an activity is widely regarded as a Third-Stream activity. Exploiting university research results and knowledge often involves setting up a technology and licensing infrastructure nationally as well as locally. However, in the UK, there remains a few universities that do not have any type of technology transfer function. Along with such an emphasis on Third-Stream activities goes a need for developing indicators that effectively capture the value generated by such activities, particularly for accountability purposes. As public funds are increasingly being dedicated to develop knowledge and technology transfer functions in universities, the UK Government is increasingly requiring measures to demonstrate some form of return on its investment. This paper reviews the progress that has been made regarding measuring the value of university patents, which continues to remain a key performance indicator.

Estimating the value of patents has been a well-researched topic in the legal-economic literature, in which various measures have been developed. These are based on patent citation, (foreign) application, licensing, and patent renewal data. Litigated patents are also increasingly associated with high value, namely because of the prohibitive costs involved. While some measures can be derived from patent data directly, others are more difficult to trace. Furthermore, much of the research has focused on corporate patents. On the other hand, studies exploring the value of university patents (e.g. by way of tracing patent citations) are rather “historical” in their orientation and tend to cover periods of patenting undertaken in the past and thus do not adequately provide a value estimation of recent university inventions.

This article explores the extent to which it is possible to adopt the framework developed by the economists and legal scholars to the university context. As noted above, one challenge with respect to developing Third-Stream indicators is to find measures that capture also relatively recent developments. Moreover, value measures need to consider the specific environment in which universities operate, which we argue has the potential to influence the kind of commercialization activities.

Objectives

Patenting and Intellectual Property (IP) management are intrinsically complex issues, especially when they are discussed in the Higher Education context, the reasons of which are discussed below. The aim of this article is to develop an understanding of IP management practices of universities in the UK and the possible effects of these (differing) practices for Third-Stream indicators, particularly those of patents. Its purpose is to understand these processes and their implications on indicators rather than present quantitative data on university patents.

This article does not seek to develop a generic approach to quantifying the value of a university patent. Instead, it aims to explore whether analysts and evaluators can meaningfully and justifiably compare university patenting performance across the range of universities, while at the same time omitting consideration of possible differences between the universities.

Furthermore, this article focuses on the possible implications of IP management practices on *short* and *mid-term* measures of patent value, instead of on the historical analysis of university patents. The importance of these shorter-term measures lies in the allocation of public monies that are generally awarded to universities around a 5-6-year cycle and often even in shorter periods. While some established measures, such as patent citations, can serve as indicators of patent value, they might not necessarily be available to an evaluator allocating funding to universities. Furthermore, an effective resource allocation process requires early access to reliable data (more below). This paper critically examines the extent to which established indicators can be applied in this context.

This paper is organized as follows. The next section clarifies the rationale and relevance of our study. Then relevant Background is described by briefly reviewing the UK policy context for the stimulation of exploitation of UK university research. This is then followed by an overview of Established Measures of Value of corporate and academic patents. This section particularly raises questions as to the applicability and utility of “corporate” measures for university patents in the short to mid term. The section on Methodology describes the in-depth case studies that the authors undertook to explore how Technology and Transfer Officers (TTOs) perceive the value of university patents and manage the IP their university generates.

This section is followed by Findings and Discussion, respectively. We find that there are prevailing differences between the four big "patenting" universities that we interviewed regarding their IP management practices, which in turn have influenced their perceptions on how they value their university patents. However, all identified, unsurprisingly, licensing as an important measure of patent value, although patent renewals while agreed to as a useful indicator of value, was not systematically undertaken by the TTOs. Here, we also present a summary of key differences between universities and their implications for Third-Stream indicators. We conclude, among other observations, that the diversity of approaches adopted by the TTOs for the exploitation of research output questions the utility of enforcing targets on universities as a measure of their Third-Stream activities. This then raises the possibility of designing a composite of indicators that could better fulfill the objectives for evaluation of university Third-Stream activities.

Rationale and Relevance

While this article focuses on practices in the UK, its relevance goes across national borders. Internationally, academic research is facing a trend toward more accountability. More and more quantitative indicators are used (or contemplated) to assess the quality and quantity of university generated scientific work and its impact on technological development and innovation. While this trend has emerged first with respect to publication-based (bibliometric) indicators for the purposes of performance evaluation, other indicators, such as patent and patent application data are now used for resource allocation by public authorities (DEBACKERE AND GLÄNZEL, 2004, BUTLER, 2003). For instance, the IOF-Key in the Belgian region of Flanders used patent counts of and applications by universities and their technology transfer organizations to help determine the distribution of applied R&D funds between Flemish universities. The evolving uptake of patent indicators in resource allocation makes it necessary to develop a better understanding of the measures and the processes underlying patenting activity that could affect the robustness of these measures.

Any patent indicator can only receive broad acceptance if it is acceptable to all players involved, that all relevant actors adopt the same or similar mission and operate

in a comparable framework. Importantly, a degree of diversity in approaches to managing IP within a country and within a small set of universities suggests a central policy conclusion: that a comparison or benchmarking exercise of technology transfer activities or exploitation of research output across the emerging European Research Area and beyond would yield misleading conclusions.²

Another fundamental question is whether the state of indicator development is at the stage that would allow analysts to devise measures that are robust enough to capture the value of inventions. Simple counts of patent applications may be open to easy manipulation. Researchers have been shown in other contexts to adapt quickly to changed incentive structures and rapidly learn how to “play the system.” It would, arguably, be naive to assume university technology transfer offices would not adopt similar practices to obtain public funding.

So, are there indicators that could trace more reliably the value of university patents that are not readily vulnerable to easy manipulation, and importantly can be collected with relative ease? This paper aims to explore if establishing targets for university patenting activity would yield the results that policy makers and relevant stakeholders are seeking, for instance, the performance of university entrepreneurial activities. This question leads us then to the more specific question of how one can track the value of Third-Stream activities through patenting in an evaluation context.

Background

The UK Policy Context

The UK has since around the mid 1980s promoted entrepreneurial activities at universities, mainly as a result of the then Thatcher Government’s heavy budget cuts aimed at universities in 1981. This provided the genesis of the “entrepreneurial” university (CLARK, 1998). Today, while teaching and research activities remain central tasks, Government is increasingly calling upon universities to play a more direct role in supporting economic development and to have a direct impact on society – Government’s Third Mission measure (MOLAS-GALLART ET AL., 2002). To address

² Exploratory research by MEYER ET AL. (2005) illustrates the difficulties analysts experience when comparing mere patent counts across science systems in Europe that follow different regulatory regimes with respect to faculty inventions.

this challenge, Government has had to devise mechanisms to calculate the level of core funding to be awarded to universities. At the same time, universities have had, and continue to find a balance between the wide range of roles and responsibilities that the Third Mission measure has additionally created for them.

To date, the Research Assessment Exercise (RAE) determines levels of core research funding, and student numbers still drive core funding for teaching activities.³ The implementation of Government's Third Mission measure in the mid 1990s has resulted in more universities actively developing engagement with industry and attempting to enhance their contribution to the economy and society. These activities are broadly known as "Third-Stream" activities. Since 1999, as part of the implementation of the Third Mission measure, the Higher Education Funding Council for England and Department of Trade and Industry have allocated Third-Stream resources to universities through discrete calls for tenders under a number of different schemes for seed funding and entrepreneurial activities, albeit for a defined period of time.⁴

This bidding-based resource allocation prevents institutions from managing such funding sources on a long-term strategic basis. However, Government has shown signs of making funding for Third-Stream activities a permanent feature of university funding. Against this, the emergent policy issue is how to assess, measure and support the broad range of Third-Stream activities undertaken by UK universities. (MOLAS-GALLART, 2004).

While there are several elements of Third-Stream activities and various approaches to measuring them, university patents remain one of the indicators that have received the most attention among researchers, policy-makers and other stakeholders. Yet our understanding of patent indicators remains incomplete, particularly in the context of universities and other public sector research organizations. The collection of UK

³ For a more detailed description, see e.g. SHATTOCK (2003). Note that in addition to the RAE there is also a Teaching Quality Assessment exercise, which does provide an indicator of the quality of the teaching program, but it does not have a direct impact on levels of funding (MOLAS-GALLART ET AL., 2002).

⁴ These include the Higher Education Reach-out to Business and the Community initiative, the University Challenge Fund (£50M seed capital) and the Science Enterprise Challenge Fund (£25M). Currently, Government makes available £187M in England over 2004/5 and 2005/6 through its New Expanded Higher Education Innovation Fund (HEIF 2). The Fund aims to promote enterprise in universities, improve the infrastructure and capability to transfer knowledge from universities into business, and provide seed-corn funding for spin-out companies or the development of commercial enterprises to promote Third-stream activities.

universities' commercialization activities to date has been modeled on North-American survey formats (e.g. UNICO-NUBS or PROTON surveys), but they mainly offer counts of patent filings as a main indicator. Other Higher Education-Business Interaction Surveys have traced the number of disclosures. Yet there is little data gathered on the potential value of *granted* university patents, patent applications in foreign jurisdictions and patent renewals, the latter two of which are argued to be useful indicators of patent value (more below).⁵

In the light of the importance of the Lambert Report (LAMBERT, 2003) which, among other things, highlights Government's emphasis on university entrepreneurialism, this article is perhaps timely to cast additional light on the "valuable" patenting activities of UK universities. As with ALLISON ET. AL (2003), value in this article refers to private or commercial gain to the university, although we caution against ready acceptance of this dimension (more below).⁶ We define *academic patents as those that are owned by universities*; that is ownership of the IPR (Intellectual Property Right) resides with the universities.

Changes in the International Context: The "pro-patent era"

Admittedly, the importance of patents for innovation and the general economy continues to generate debate. Josh Lerner pointedly reminds us that "[t]he impact of intellectual property rights on innovation is one of the most persistent empirical questions in the economics of technological change" (LERNER, 2001). Nonetheless, with respect to patents, its apparent positive role in the economy was heightened in the mid 1990s when policymakers and economists began hailing this period as "the pro-patent era." European lawmakers, in particular, reacted to this apparent rise of a "pro-patent" era (KORTUM AND LERNER, 1997; HALL AND ZIEDONIS, 2001, EUROPEAN COMMISSION DIRECTORATE GENERAL ENTERPRISE, 2000; GRANSTRAND, 2000; RIORDAN, 2000) with unease and resolve. European policy-makers generally take it as axiomatic that changes to patent law can encourage European firms, particularly smaller companies, to patent more and develop competitiveness (EUROPEAN COMMISSION DIRECTORATE GENERAL ENTERPRISE, 1998). European policymakers

⁵ It should be noted that the survey instruments cover income from royalties and licenses. Yet these measures do not tend to be directly linked to patenting activity.

⁶We acknowledge that the value of academic patents can also be cast in terms of reputation, breadth of academic research, etc.

believed that the European innovation system has not been as successful in commercializing inventions as those of America and Japan. Their resolve in extending the patent system stemmed from a conviction that new IPR policies could enhance and maintain the competitiveness of European firms. Thus, this period saw and continues to experience an acceleration of patent applications, both at the US and the European Patent Offices.

The proliferation of patents after 1998 was largely animated by the US in allowing patentability of software-based "business method" applications, which was widely disallowed prior to the opinion given by the US Court of Appeals for the Federal Circuit (CAFC) in *State Street Bank & Trust v Signature Financial Group* in 1998.⁷ In this case, the CAFC settled the statutory status of a software-implemented business method by ruling that it could constitute "statutory" subject matter for a US patent.⁸ This decision opened the floodgate to business method patent applications in the US. For instance, 2,658 applications for business method patents were filed in 1999, reflecting almost 100 per cent increase from 1998. The European Patent Office (EPO) received an onslaught of such applications, particularly from US companies, and although it rejects in principle the granting of software-based business methods patents, the EPO has granted several such patents.

Following public outcries against such patents by a wide coalition of big and small software developers in Europe, and users, the European Commission and the UK Patent Office conducted two public consultative hearings, both of which resulted in a resounding stance against the granting of software-based business method patents. Despite this, the European Commission in 2002 proceeded with the drafting of a directive on the "patentability of computer-implemented inventions" (which included allowing software-based business methods), on the argument that if Europe did not adopt a similar policy to the US regarding business method patents, the region would

⁷ This case had originated with a software product used to fix closing prices of mutual funds for reporting purposes, on which Signature had obtained a patent for in 1993. When licensing talks broke down between the two parties, State Street Bank sued in 1996 to invalidate the patent on the grounds that it was a business method and hence was not patentable under U.S. patent law. Signature appealed. See Josh Lerner, "Overview of Financial and Business Method Patents," <<http://www.people.hbs.edu/jlerner/publications.html>> Visited June 24, 2002.

⁸ According to one definition, business method patents, which include Internet patents, are defined as any computer-assisted implementation of a systematic means or method of administering, managing or operating an enterprise, including a technique used in doing or conducting business. Until then, mathematical algorithms and "business method" were non-statutory subject matter, and were not generally patentable.

lose its competitiveness in this sector. Despite several rewrites, the Directive has stalled.

Yet, the impact of patents on innovation, despite a substantial corpus of work this issue has been unable to settle patent policy and its benefits to the economy (TANG AND PARÉ, 2003). Interestingly, regarding the economic effects of software patents in the US, James Bessen and Robert Hunt found evidence that software patents substitute for R&D at the firm level and are associated with lower R&D intensity – arguably resulting in less innovation. They conclude that this result therefore makes reconciling with the traditional incentive theory of patents difficult (BESSEN AND HUNT, 2004). Stuart Macdonald also worries about how “patents have become an end” instead of as a means to stimulate innovation (MACDONALD, 2004).

Nonetheless, the controversy over the impact of patents, and in particular software-based business method patents, on innovation continues to rage but its stark implication is that no matter what, “patents still matter.” And this returns us to the point made above that patents remain widely regarded as an important indicator for Third-Stream activities. Yet, it is worth noting what Fritz Machlup said when he testified before the U.S. Senate in 1958, warning that “no economist on the basis on the present knowledge [of the patent system] could possibly state with certainty that the patent system, as it now operates, confers a net benefit or a net loss upon society...the safest policy conclusion is to muddle through...” (MACHLUP, 1958). Almost 50 years later, the US Federal Trade Commission Report on *How to Promote Innovation Through Balancing Competition with Patent Law and Policy* (FTC/DOJ 2003) concluded similarly. These observations thus reinforce our argument that while patents are useful indicators for research output, caution needs to be exercised for using them in an unquestioning manner for estimating value and public resource allocation for universities’ performance.

Established Measures of Patent Value

There is a broad and well-established literature on measures of patent value.⁹ As noted above, most of the contributions are by economists.¹⁰ Before elaborating upon them it

⁹ Here, we acknowledge that there is also a large body of work on valuating intangible assets, including patents, which is based on accounting methodologies. For purposes of “elegance” and the fact that the

is important to recognize that these are essentially academic models that may not easily or necessarily be simply transferred into practice. For instance, PETRUSSON (2004) cautions against economics-driven approaches that estimate values, which he argues are in essence “contextual constructions” that cannot be separated from the purposes of valuation.¹¹ He warns:

”[As] most of these theories would become self-fulfilling if they [were] made operative, they primarily have an academic interest, e.g. if there is a direct correlation between the value of a patent and the number of patent claims the application includes, [organizations] would simply add more claims to their application” (PETRUSSON, 2004, 48).

This point is particularly important in the context of this paper, which is concerned with adopting indicators for evaluation for public resources/funding. Rather, all indicators need to be considered in the light of their applicability and manipulation robustness.

With this caution in mind, we now turn to the established measures of patent value. Several empirical strategies have been developed to approximate the value of a patent (SAPSALIS AND VAN POTTELSBERGHE, 2003). These approaches are based on different datasets of patent families and patent counts, cover various time spans and use different data sources. In addition, the functional forms of the empirical models vary from one study to the other.

There is also a long-standing tradition to explore the connection between litigation and value (PRIEST AND KLEIN, 1984; BEBCHUK, 1994). With respect to patent disputes and litigation, Lanjouw and Schankerman show that characteristics of patents and their owners strongly affect the probability of filing a suit. Particularly they show that patents with a high number of claims, which they describe as valuable patents are more likely to be litigated, or at least provides a significant impetus for litigation (LANJOUW AND SHANKERMAN, 2001, 2002; ALLISON AND LEMLEY, 1998; ALLISON, LEMLEY ET. AL, 2003).

TTOs interviewed were not in a position to address these, we have not considered these methods. For a succinct overview of the main accounting-based methods, see IVERSEN AND KALOUDIS (2003).

¹⁰ As PETRUSSON (2004, 48) states in his critical survey on the “creative quest” for new models in valuation and evaluation, “economists in academe tend to be particularly creative and pretentious in their modelling.”

¹¹ MACDONALD (2004) also notes that “the patent system tends to be viewed from the perspective of lawyers and economists...” p. 135.

Patent renewal data can also be counted amongst the established measures of patent value. One of the most comprehensive attempts at using patent renewal data to uncover the value of patents was conducted by PAKES AND SCHAKERMAN (1984). Most countries require a payment of annual renewal fees to maintain patent protection until the statutory limit of 20 years. The authors assume that patentees engage in a renewal decision by estimating the patent's profit-maximizing return, thereby inferring the value of patents. Their model assumes that patents are renewed if the current returns to a patent are greater than the current cost of renewal. Lanjouw et. al attribute to Putnam's study on application data as a pioneering attempt to integrate such data into the analysis of the value of patent protection (LANJOUW, PAKES, AND PUTNAM, 1998, 409).

Putnam's analytic framework incorporates the inventor's prior decision to patent in other countries into Pakes and Schankerman's renewal model. However, Putnam assumes that the returns earned in a given country do not depend on whether the patent is renewed in a second country, but that patentees apply in other countries because the net returns (returns minus application and renewal costs) is positive. Putnam's study thus allows one to obtain information about the family size of an invention within a few years of first filing, which in turn shows the patentee's perception and expectation of the value of the patent as well as the international flow of returns from the patent family.

In another study, Lanjouw and Schankerman develop a composite quality index that attempts to show when patentees are likely to renew and defend a patent. Basing quality on four indicators, backward citations ("*references*" in the bibliometric notation), forward citations ("*citations*" in the bibliometric notation), family size and the number of claims, the scholars find that forward citations and family size are important determinants to renew whereas claims and backward citations are not (LANJOUW AND SCHANKERMAN, 1999). However, Harhoff et al. (HARHOFF, SCHERER, AND VOPEL, 1997) found a significant correlation between patent value and backward citations. Backward citations of patents are theorized to reflect the technical novelty of a patent (REITZIG, 2003).¹² These contrasting conclusions illustrate the ambiguity of the use of citations.

¹² Apart from the above cited studies which seem to come to different conclusions about backward citations as an indicator of patent value, they could conceivably also be open to, to a certain extent,

Established measures and university patenting

While most of the established measures of patent value have been used in the context of a firm or country studies, only relatively few studies have applied these measures to university patenting. Notable exceptions are to be found mostly in the US context.¹³ Here, patent citations are the mostly used indicator. SAMPAT AND ZIEDONIS (2004) observed in their study on patent citation–value relationship of the Universities of California and Columbia inventions that patent citations are good predictors of *whether* university patents are to be licensed or not but are *not* good predictors of the associated license revenues.¹⁴ As a result of using patent citations as an indication of the value of university patents these studies tended to be more “historical” in their orientation, and thus tend to suffer from a considerable time lag (HENDERSON, JAFFE AND TRAJTENBERG, 1998). To illustrate this, in their 1996 study Henderson, Jaffe and Trajtenberg examined a university patent data set in the period 1965-1992, yet they analyzed patent citation data for patents with application years through 1988 only.¹⁵ While none of this invalidates their analysis, the considerable discrepancy between period studied and compilation of the data makes studies involving such time lags inappropriate for the context of our study, which focuses on value estimates for comparatively short-term evaluations.

Studies using granted patent data as a value indicator can be seen in the work of GUELLEC AND VAN POTTELSBERGHE (2000). The authors explored the value along a timeline. Figure 1 illustrates a value scale related to various stages in the patenting process. Within the universe of inventions depicted, the value of inventions is indicated by the shade of darkness, that is the darker the area, the higher the value of the inventions. Previous work (LANJOUW, PAKES AND PUTNAM, 1998) essentially focused on comparing patents from zone 4 to zone 1. Guellec and Van Pottelsberghe,

some manipulation on the part of applicants submitting excessively long lists of self-references that examiners at least in part may choose to cite.

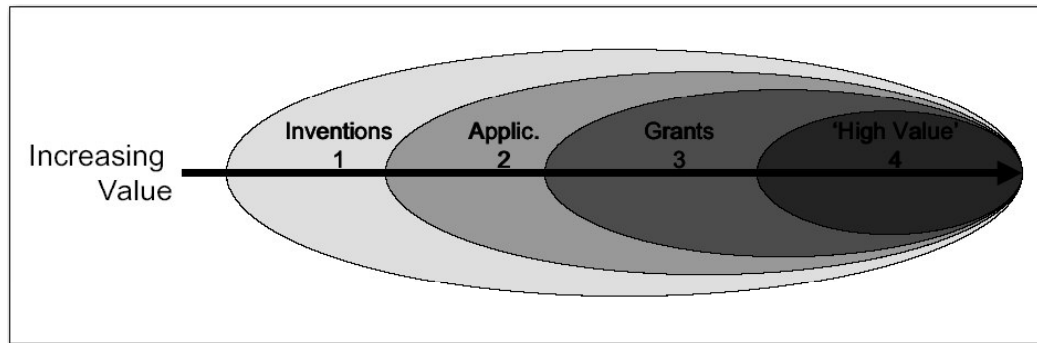
¹³ See, for instance, HENDERSON ET AL. (1998), TRAJTENBERG ET AL. (1997), MOWERY ET AL. (1999), MOWERY AND ZIEDONIS (2002), SAMPAT AND ZIEDONIS (2004). More recently there have also been some European efforts (see e.g. SAPSALIS AND VAN POTTELSBERGHE, 2003).

¹⁴ There is anecdotal evidence that patent applicants, such as large chemical and software firms tend to submit excessive self-citations, sometimes totally irrelevant to the invention in question, with the aim of making their applications “impressive.”

¹⁵ More recent non-university examples are the value-oriented studies by FLEMING AND SORENSON (2001) and HSIEH (2004) which both apply a 6-year citation window. JAFFE AND TRAJTENBERG (1995) report that citations to US patents peaked within 3-5 years after the patent were granted.

however, examined the value issue further “upstream” comparing inventions of zone 3 with those of zone 2. The authors concluded that patent grants have a higher value than applications.¹⁶ Zone 4 signifies potential high-value patents; the authors concur that high numbers of citation, renewal rates and family size imply value. The OECD, however, in their large study of several European public research organizations, including universities, employ only patents and licensing income (OECD 2003).

Figure 1. The value of inventions and the value of patents.



Source: Adopted in modified form from Guellec & Van Pottelsberghe (2000)

A similar logic has been adopted in some US studies. For instance, MOWERY AND ZIEDONIS (2002), in their research on academic patent quality and quantity before and after the Bayh-Dole Act used other measures to track patent quality. These were focused on “intensity” and “yield” of a university’s marketing efforts. To capture ‘marketing intensity’ they calculated the share of disclosures that resulted in issued patents, generated patent applications, or were licensed. “Marketing yield” was approximated by ratios, such as the number of issued patents in relation to patent applications, or licensed patents in relation to issued patents.

Cost-benefit analyses are an entirely different approach toward evaluating patenting activity within the university context. While they are admittedly not strictly related to valuating individual university patents, estimating the cost of establishing and maintaining IP management facilities may become an important factor for future evaluators who will view Third-Stream activities from a more holistic organizational

¹⁶ The authors argue that two factors suggest that the patents granted have a higher private value than the ones that are withdrawn or refused. The first one is related to the technological value and is intrinsic to the granting process. The search and examination procedures have to confirm that the invention is novel with respect to the state of the art, industrially applicable and inventive in character – i.e. it surpasses the skills of a professional confronting the problem concerned (*grant reflects value*). The second factor is related to the legal rights conferred to the patentee. The exclusive exploitation of the invention induces a potentially higher return (*grant generates value*).

perspective. For instance, TRUNE AND GOSLIN (1998) offer a model for assessing the viability of the financial profitability/loss of technology transfer programs by comparing royalty payments to estimates of technology transfer office costs, patent fees, legal expenses, and new research grants.¹⁷ Future evaluative activity may also take the cost factor into account despite a lack of a direct link to the value in terms of traditional indicators. Nonetheless, we feel it is necessary to view established indicators *vis-a-vis* IP-related costs, especially because IP protection costs and outlays for operating technology transfer offices are arguably a measure that is likely to be available on a shorter-term basis. The study by TRUNE AND GOSLIN (1998) used aggregate estimates of these costs across a range of universities but future evaluations are likely to use estimates, if not real costs, at the level of individual universities. Differences between universities in handling their IP management practices may affect the cost structures and therefore the overall profitability of TTOs and their IP management practices considerably in this respect.

Finally, it should be noted that while work e.g. on the Triple Helix of university-industry-government relations, ETZKOWITZ AND LEYDESDORFF (2000), for instance have rightly pointed to a blurring of boundaries between the academic and industrial spheres, one needs to bear in mind that the university is a multifaceted organization where traditions and norms still persist (e.g. CLARK, 1998). This implies that “value” in the sense discussed in our paper may not do justice to the university environment. However, we adopt the approach of the body of work that deals with university patenting and value, that is, to discuss the value of patents against the commercial framework. However, we raise the question as to whether such a framework of analysis is ultimately appropriate for evaluating universities’ performance whose tasks go beyond the commercial imperative.

Methodology

The objective of this study is to explore how IP management practices in universities can affect Third-Stream indicators. To this end, a thorough understanding not only of the relevant indicators is needed but also of the underlying IP management processes

¹⁷ Using AUTM data, the authors found that while half of the programs in these institutions appeared to be profitable, many smaller university technology transfer programs that had been in existence for only 5-10 years did not seem to have successfully exploited their research output.

that may affect these indicators. We argue that a better comprehension of the nature of IP management processes allows us to assess better whether certain patent-related indicators can be used in short-to-mid-term evaluations. While we can draw on extensive literature that addresses patent valuation (albeit not predominantly in a university context), there is very little research on the Higher Education sector when it comes to specific IP management practices. This determines the focus of our empirical research.

More specifically, we seek to explore university practices at the various stages of the IP process from the identification of patentable inventions to filing practices, to maintaining patent portfolios and to undertaking litigation. In this effort we are guided by a number of central questions:

- Can one distinguish different types of attitudes and practices in handling invention disclosures?
- What is the university's approach to filing applications? How are patentable inventions identified? What determines the extent to which disclosures reach the filing stage?
- To what extent can one distinguish different patterns between universities and their handling of further national (foreign) filing?
- How are patent renewals determined? Are there different practices or policies for maintaining a patent portfolio? What underpins the practices/policies?
- What are the respective approaches towards litigation?
- What are the policies and practical arrangements with respect to different channels of commercialization (most notably spin-outs and licensing)?

In our interviews we sought to identify the TTOs' practices and explore differences between institutions. In particular, we were interested in exploring how and where such practices may affect value-related measures of patent activity.

This paper examines the above issues in more detail by drawing on a small number of case studies of UK universities that actively promote technology transfer activities. Since our research is primarily exploratory aimed at understanding IP management policies and their possible impact on the use of patent indicators, we applied a case

study approach because of the need to understand the perceived complexity of these processes (YIN, 1984).

We applied a purposive sampling approach. The four universities are not (and were not intended to be) representative of UK universities, but we selected them because they belong to the Russell Group of large, research-intensive universities, are among the biggest receivers of research funds and have a considerable history in technology transfer activities. The underlying idea was that if we can identify substantial differences between universities within the leading group of research universities that all have extensive experience in technology transfer and also a rich potential of marketable inventions, how much greater will the differences be between Higher Education Institutions of different backgrounds. We contend that if substantial indicator-relevant differences between organizations with a similar background can be identified, then one could plausibly argue that such diversity would be even greater across the UK. In fact, differences may be sufficiently large that any comparison, evaluation or ranking across the range of universities would be grossly misleading.

The case studies were based on in-depth interviews with key personnel at each of the organization's Technology Transfer Office and were complemented by data on patenting, licensing and spin-out activity provided by the interviewees. The questionnaire was semi-structured, in which TTOs were asked to describe their respective practice for identifying and selecting patentable inventions, filing patent applications, patent renewal, portfolio maintenance, licensing and litigation. As we had undertaken to treat the limited data provided to us confidentially, they were sufficient to allow us to understand the extent to which, among other things, initial applications that had survived the national filing stage.

We, however, did not enquire in detail of the university's general practice for such activities because, to reiterate, our main interest lay in the IP management strategy of the Technology Transfer Office, which is mainly charged with undertaking and assisting with the commercial exploitation activities on behalf of the university. For similar reasons, we did not include academic inventors in this study. We acknowledge that the IP strategy for the university may be different from that of the Technology Transfer Office. For instance, for non-RAE or non-Third Stream reasons, universities may only file patents but may not renew nor attempt to license them when granted. As

our study is exploratory, we felt that we had to narrow our focus and concentrate on data collection from the TTOs mainly.

We also sought to find out if the TTOs had the capability of compiling patent data and the amount of time required in compiling such data. The underlying purpose for this exercise was to discover if they had “proper” audits of the university’s patent data and exploitation activities. We inquired also as to what extent TTOs could conceivably adjust their patenting practices to anticipated and existing policy guidelines, and their views on the significance of patents for measuring Third-Stream activities. Based on the interview data, we mapped out the IP management practices for each university. We also attempted to examine to what extent the respective practice could have an impact on value indicators. Furthermore, we related patent data received to the established value measures discussed above in order to construct some pattern of “commonality.” Finally, we tried to assess the “manipulation robustness” of key indicators, i.e. the extent to which these measures are open to influence by TTOs willing to “play the system.”

Findings & Implications for Indicators

Differences between Universities

The commercialization process for UK university patents varied across the universities interviewed. We found that they differed substantially in their set up and also followed considerably different strategies in managing IP. As differences in IP management approaches may result from the structure of the tech-transfer function, we first looked at the differences in TTOs’ institutional setup.

Infrastructure & TTO Set-up

Our interview data points to three differences with respect to how TTOs are set up:

1. The TTO function either can be taken over by an independent university-owned company or carried out through a separate administrative division within the University.

2. Differences with respect to the level of collaboration with university research services divisions and external partners were reported. For instance, in one case some of the tech transfer related functions were taken over by the Research Services division, which focuses on obtaining funding from various sources. This unit is active in determining the ownership of the IP of an invention or research results when they are brought to its notice by researchers. When patentability and no restraints on the commercialization of the invention are verified through external patent attorneys and by in-house legal teams, Research Services then hands over the details of the invention to the TTO for possible commercial development. In other cases the TTO had a broader remit.
3. TTOs were either following a “general approach,” had specialized units according to disciplines and technology fields, such as life-sciences/medical, or set up units dedicated to a particular tech transfer function, such as for the creation of spin-offs (new ventures), provision of business development services (such as helping to develop entrepreneurship skills) and specialization in technology transfer activities, including licensing.

Possible implications of these differences are difficult to determine in this exploratory study but the Technology Transfer Office’ structure arguably can affect an organization’s IP policy, strategy and practices, for instance with respect to operating cost. Also, the remit of the TTO and its division of labour with other university divisions can also affect the cost structure of IP-related operations, which in turn can influence the cost-benefit type analysis of tech-transfer programs.

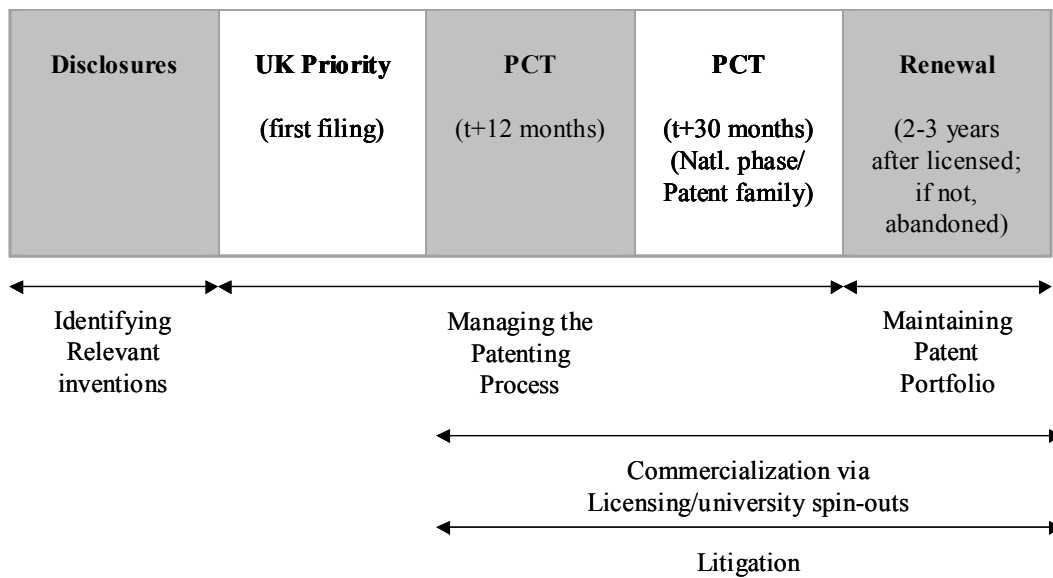
Differences in IP Management

There are different ways for illustrating how one can illustrate different approaches to IP management. One way of them is to follow the invention disclosure and patenting process. While the TTOs differ to some extent in nearly all the stages of this process, they seem to follow the same patenting timeline (Figure 2). First, inventions with patentability and commercial potential are identified (typically through “disclosures”). Then, patent applications generally go the Patent Cooperation Treaty (PCT) route to take advantage of the 30-month period, in which the applications undergo further

search and preliminary examination. This gives the university time and more certainty for filing with foreign patent offices (widely known in the UK as “going national,” or creating patent families) as well as it further helps the university to determine the invention’s “robustness.” The PCT route also helps to manage costs compared to that incurred in filing with national (foreign) offices. The first twelve months after the PCT initial filing also allows the TTO to assess if the inventor is committed to commercialization of his invention (see below). If no license or spin-out is identified at the end of the 30-month period, it will not be unusual for patent applications with national patent offices to be dropped. If TTOs or their partners choose to maintain the patent, renewal fees will then need to be paid.

As all TTOs interviewed shared this timeline we used it for structuring our observations. Table 1 presents an overview of key differences and maps them against possible implications for indicators that could be used in Third-Stream evaluation exercises.

Figure 2. The patenting “timeline” in relation to IP management activities



Identifying relevant inventions

There are three observed differences:

1. The TTOs overall attitude toward identifying patentable inventions ranged from a proactive strategy that emphasized the use of “technology audits” to that of a more “relaxed” approach that relied

more on academics to be forthcoming with their inventions or one in which involved the TTO “walking the hallways” in search of patentable inventions.

2. TTOs tended to rely on external or in-house experts to a different extent. Some tended to outsource the technology audit partly, which also involved external patent agents in early stages when evaluating the patentability and commercial potential of the invention. Others preferred to rely more on in-house experts.
3. The differences described may result in different disclosure and also in different filing rates. There may not necessarily be any immediate impact but more formalized measures or the involvement of external experts could affect the cost structure, which thus could matter in cost-benefit analyses of tech-transfer programs.

Managing the Patenting Process

At this stage of the technology transfer process, we observed substantial differences between the TTOs interviewed. In particular, the level of application filings varies considerably. While there are TTOs that prefer to file applications for a broad range of inventions they deem patentable, others are more selective and seek patent protection only for the inventions they regard as commercially viable. As a result, the number of dropped patents (when going “national”) varied with the universities, ranging from about 80 per cent of PCT filings and leaving about only 10 per cent of these filings to proceed to national filing in the case of one university to an average of about 50 per cent in another university.¹⁸

The implication with respect to Third-Stream indicators should be immediately apparent. The differences in filing practice strongly affect the patent counts reported. If initially filed applications are considered, the TTO who files indiscriminately can point to an impressive number of patent applications even though only very few of its initial applications may survive. Correspondingly, a TTO that has a “value-driven”

¹⁸ Apart from this, we identified another difference with respect to managing the patent process. Some TTOs outsource the task of filing.

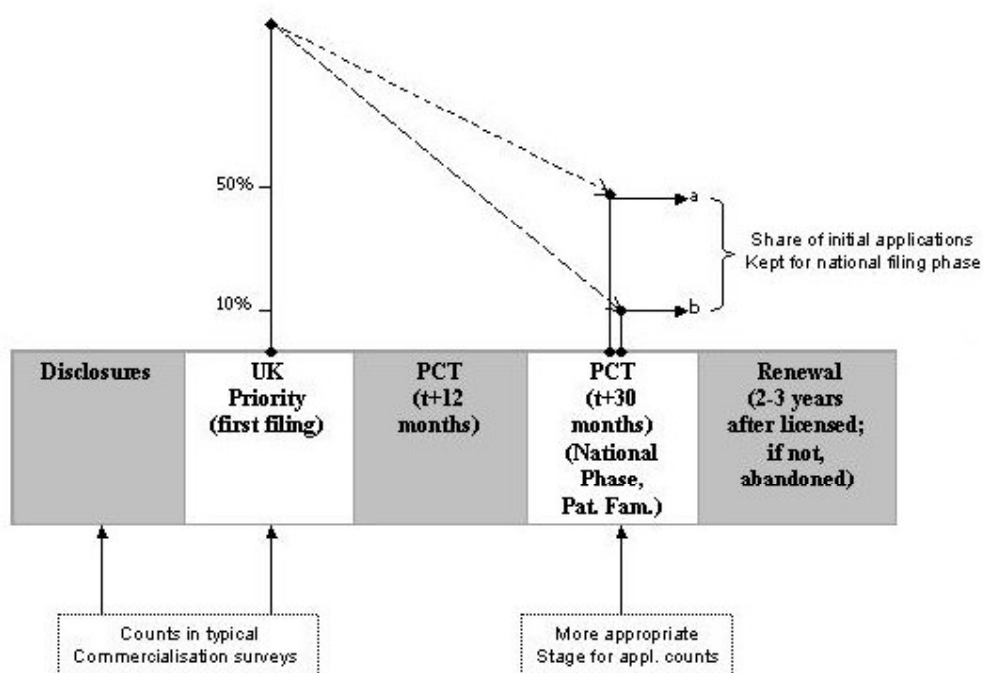
Table 1. Differences between Universities and their possible implications for Third-stream Indicators

	OBSERVED DIFFERENCES	POSSIBLE IMPLICATIONS	VALUE LINK?
TTO SET-UP	<ul style="list-style-type: none"> independent company or separate administrative division within the University differences in level of collaboration with research services divisions general approach vs specialized divisions (either by S&T field or by tech transfer function) 	<ul style="list-style-type: none"> no direct implications but set-up affects an organization's IP policy, strategy and practices likely to affect the cost structure of IP-related operations, which in turn could influence cost-benefit type analysis of tech-transfer programs 	possible
IP MANAGEMENT:			
<i>Identifying relevant inventions</i>	<ul style="list-style-type: none"> proactive vs "relaxed" approach differences in reliance on in-house vs external experts tech audit partly outsourced different degrees of inventor involvement 	<ul style="list-style-type: none"> can affect disclosure counts and successive, derivative measures not necessarily immediate impact but can affect cost structure which matters in cost-benefit analyses of tech-transfer programs 	possible
<i>Patenting</i>	<ul style="list-style-type: none"> level of application filings varies substantially filing formal application through TTO or external patent agents filing of provisional application ("inventor's note") 	<ul style="list-style-type: none"> strongly affects patent counts reported assigning value to patent counts problematic 	ambiguous depends on stage
<i>Licensing</i>	<ul style="list-style-type: none"> structured "market research" vs "gut feeling" approaches different approaches to revenue sharing varying appreciation of licensing vs. spin-out commercialization 	<ul style="list-style-type: none"> does not necessarily have any effect but can affect cost structure can affect revenue measures reported 	Yes
<i>Spin-outs</i>	<ul style="list-style-type: none"> structured "market research" vs "gut feeling" approaches different approaches to revenue sharing 	<ul style="list-style-type: none"> (as above) 	Yes
<i>Renewal/ Patent portfolio</i>	<ul style="list-style-type: none"> varying approaches with respect to developing technology portfolios differing data collection practices 	<ul style="list-style-type: none"> can strongly affect cost structure and thereby overall revenue numbers 	Yes
<i>Litigation</i>	<ul style="list-style-type: none"> out of court settlement vs. never litigating preference for licensee to litigate vs. university action direct litigation by university 	<ul style="list-style-type: none"> can strongly affect the resources and cost structure 	Yes

Source: Authors' elaborations based on interview data.

initial filing strategy with a higher survival rate may lose out to other TTO's that are more "generous" in filing applications. Figure 3 illustrates this situation from yet another viewpoint. First filing counts tend to be used in commercialization and tech transfer surveys. What happens then in these cases is that two institutions may have the same level of initial filing activity even though one keeps 10% and the other about half of its initial patents "when going national." While one may argue about the value of the remaining patent applications, it is quite clear that associating initial counts with value is highly problematic at best.

Figure 3. Survival Rates of Patent Filings at Different Universities



Licensing & Spin-outs

With respect to both licensing and spin-outs, one can distinguish between TTOs that follow a more structured "market research" approach and those where TTOs with vast business experience follow their "gut feeling." This gut feeling is however often reinforced with discussions with the inventor on the potential utility and licensing opportunities of the invention. Even where systematic market research is involved, the inventor sometimes assists with the identification of potentially commercial viable or strategic market areas, for instance, in optical communications or bionano technology.

There are also different approaches to revenue sharing. For instance, one university returns 87.5 per cent to the inventor for a royalty of up to £50 thousand; 45 per cent for an amount of £500 thousand; and 22.5 per cent for over £500 thousand. In some cases, the intermediary obtains a percentage of the licensing revenues. Another has a licensing schedule that returns to the inventor, the university and the department of the inventor an equal share of 30 per cent each, with the balance of 10 per cent for the TTO as a management fee. It is arguable that revenue sharing schemes and their underlying incentives to license can have some impact on licensing activity.

While in most cases, unsurprisingly, the number of licenses exceeds the number of spin-outs, as the latter involves more work and difficulties, we detected a varying appreciation of licensing compared to spin-out undertakings. There are universities that are more enthusiastic about the spin-out route than others. As for implications on indicators, a strong focus on spin out generation may lead to a substantial but delayed revenue stream. More importantly, however, it binds additional resources, which affects costs and thereby also possible cost/benefit analyses of commercialization activities.

Renewal and Maintenance of Patent portfolio

We also observed some differences with respect to patent renewal and the maintenance of patent portfolios. Different renewal/portfolio practices were reflected in the ways data was collected. As to the time frame for which patents are renewed, in one university, renewals are undertaken by the TTO for 3-4 years after PCT filing, after which the patents are not maintained if the technology involved has not been licensed during this period. For one university, ownership of the patent returns to the inventor after the third year if the inherent technology has not been licensed. In other words, it is up to the inventor to decide if he wants to renew the patent at his own cost. Another university prefers its commercial partners or licensee to decide on renewals, as it prefers not to bear the cost of the maintenance process. It, however, does continue to renew a limited number of patents that have not been licensed out on the grounds of perceived “value.” Yet another university does not routinely collect such data and therefore was unable to clarify its practice on renewals and creation of patent families.

The decision to maintain patents even if not necessarily licensed out or used to set up spin outs can strongly affect the cost structure and thereby overall revenue numbers. Building up a patent portfolio may be prudent in the long term, but in the short run it is associated with additional costs. Evaluators would need to pay attention to this particular aspect of IP management strategy.

Litigation

Litigation is a rare phenomenon in the university context. In light of the high cost and their resource constraints, TTOs tend to avoid litigation as best they can. Here, we observed two approaches. Either TTOs aim for out of court settlement or they have a policy of never litigating along with a preference for the respective licensee to litigate. Despite this, there was consensus that litigation bestows value for a particular patent.¹⁹ Of course, litigation can strongly affect the resources and cost structure of tech transfer operations. Yet, when universities litigate for infringement of their patents, this invariably indicates the worth of the patent(s) in question.

Observations in Relation to Established Indicators

While the previous section focused on differences between universities that could distort comparisons of patent-related Third-Stream indicators, this section presents our observations with respect to the established indicators of patent value. Table 2 presents an overview of our findings. These observations are based on the TTOs' opinions about the suitability of these indicators. In addition, we also inquired about the availability and accessibility of data pertaining to renewals, patent families and litigation. In sum, while all the aforementioned indicators were accepted as reasonable or at least potential indicators of patent value, issues arose chiefly over the timing and accessibility of such data. These issues are discussed below in further detail.

¹⁹ One of the TTOs declared that his university had directly litigated against the infringer.

Table 2. Established Indicators as Potential Value Measures

Indicator Type	Observations	When?	Accessibility of data	Implications for indicator development
Patent Family Data	TTOs build up patent families Costs are an issue Japan not that often covered	2.5 years after filing	Relatively easy (if in-house)	Triad patents problematic as TTOs tend to avoid filing in Japan, But family size is a potential indicator
Renewal Data	Keep or return to inventor Different approaches	3 to 4 years after filing	Relatively easy (if licensee not responsible for it)	Potential indicator but could be beyond short-term evaluation horizon
Litigation Data	Accepted indicator	Full blown trial, instigated by university rare. Out of court settlements preferred by universities Licensee generally responsible for litigation	Relatively difficult (as licensee generally responsible)	Good indicator but litigation seldom undertaken by universities
Licensing	Different practices of revenue sharing	About 2.5 years after filing	Revenue data relatively easy to collect	Fair, but interpretation dependent on strategy and approach; also sector-dependent
Spin-outs	Different practices of Equity involvement Revenue sharing			

Data on Patent Families and Renewal

All the universities we interviewed filed in the US. Where the TTO did not rely on external sources, patent family data was easily accessible. We observed that filing in Japan was less regular, largely because of the costs involved in translation and enforcement. This is an important observation since there is a trend to associate value with inventions that are protected by so-called Triad patents, i.e. inventions for which patent protection is sought in the US, Europe and Japan (see e.g. DERNIS ET AL., 2001).

The TTOs also accepted renewal of patents as a valid indicator of value. However, typically the responsibility for maintaining the patent shifts to the licensee so that data might not be accessible with similar ease as in the case of patent families, unless the TTO makes it a point to track this activity. Also, the time lag might make it difficult for evaluators to use this indicator in assessing more recent inventions.

Litigation Data

The universities interviewed accepted litigation, *prima facie* as an indicator of patent value, although it did not feature significantly in their activities. This is because (1) the costs involved in litigation; and (2) it is usually the licensee or spin-out who is responsible for litigation. Hence the universities reported only a limited number of litigated patents, (judged against their commercial activities since 1990) in which they were directly involved. These cases were largely settled out of court and settlements appear to be the norm rather than full-blown trials. Nonetheless, it is arguable that a scarce number of litigation can help to indicate the value of patents; after all the potentially prohibitive cost of litigation can be in itself a deterrent to undertake such action.

Licensing and Spin-out Data

The terms of licensing generally depend on the technology and market sector, although the use of exclusive licenses seems to be the common practice. In some cases, sub-licensing rights are awarded, while in other cases, such as with software and biological reagents, they are non-exclusive with no right to sub-license.

Unlike renewal or litigation data, licensing and spin-out data are available relatively shortly after the initial filing or patent grant. Renewal data can be obtained after the first year of grant and in this sense they can be used for short to mid-term evaluation purposes. The problem arises when renewals become the responsibility of the licensee and unless there is a diligent effort by TTOs to monitor such renewals, such data can escape observation.

Conclusions

This paper has argued that measuring Third-Stream activity in general, and more specifically developing better value estimates for university patents are still facing challenges. Counts of patent applications are often the only indicator used in short-term evaluations of university knowledge transfer and patenting activity. Furthermore, there is also considerable diversity as to what is counted.

Regarding renewal data, limitations also occur. The time constraint is the most noteworthy for shorter term evaluations of Third-Stream activities. Although these numbers can be compiled relatively quickly, their collection is exacerbated by the fact that licensees are generally responsible for renewal. So as noted above, unless TTOs are assiduous about monitoring the “active life” of the patent in question, these numbers can elude collection.

With respect to licensing and spin-outs, the interviews confirmed the view that it is very difficult to find a common basis for comparisons, even more so than for patents and patent applications. Our interviewees stressed different approaches and also asserted that income generation is not necessarily the common primary aim. The latter observation thus raises the question as to whether it makes sense to compare universities in terms of the revenues they achieve, which continues to be a main and popular tool for evaluation of universities research performance.

Against the analysis this paper has presented, our research suggests that a more reliable measure for comparing patent applications between universities are counts of inventions that have reached the national-filing phase. This is because either licensees have been found or the TTO associates some commercial potential with them that makes it worthwhile bearing the substantially higher costs of national filing. Additionally, at this stage the differences between the Technology Transfer Offices in initial filings are also leveled out as Offices with an initially higher rate of priority filings withdraw or drop them for perceived non-commercial viability. However, admittedly, these counts may still endure difficulties as an approximation of patent value. The review of the established patent value literature reminds us of highly skewed value distributions (“tail in the tail”).²⁰

As for the possibility of manipulation of data by TTOs to satisfy government policy requirements, one could design a system of Third-Stream indicators or composite indicators that contain a range and variety of measures. The system would need to be

²⁰ One should also note that the counts of application at this stage could be susceptible to “gaming” or “manipulation.” To illustrate, a technology that is licensed before patent-grant might see the number of countries it enters into national phase reduced to suit the market-presence of the licensee. Thus the perverse situation of a “valuable” technology (in the revenue sense) would appear to be less valuable than patents that enter national phase. On the other hand, the need to “go national” is enhanced because of the need to extend protection of the licensed technology. Such behaviour arguably depends on the technology in question, the type of license agreement and the availability of TTO resources, the latter of which is a reported major constraint of Technology Transfer Offices. Thus we maintain that counts at the stage of “going national” are to be preferred to counts of initial filings.

balanced: on the one hand, it would need to be sufficiently complex but robust because there are too many indicators that may be manipulated or micro-managed. On the other, there would need to be a “consensual” rationale for selecting each measure in order for the entire indicator system to gain a sustainable level of acceptance by all actors involved.

Finally, in the light of the above concerns with respect to evaluation, we argue that using any indicator for purposes of resource allocation would seem even more problematic. Research on indicators has not reached the stage that would permit one to base such decisions on any one (patent) indicator. For example, the analyst (and evaluator) needs to consider that universities operate in different regulatory environments. Some universities in certain countries may enjoy incentive mechanisms that could well impact their rationale for patenting; whereas universities in other countries may behave differently because of the institutionalized research funds allocation mechanisms in which counts of university patents can have a considerable effect on how certain types of public R&D and technology transfer funds are distributed across universities. In the UK context, we have already illustrated the divergent approaches in IP management adopted by TTOs even within a small number of similar universities.

Despite the readiness of some interviewees to meet targets, there was also the avowal that such indicators should not be given its current prominence as approximate measures of valuable or useful inventive output. Against this finding, we caution policy makers and other stakeholders against rushing into establishing a misguided or insufficiently substantiated incentive system based on rather simplistic indicators.

All this leaves ample opportunity for future research. While it seems problematic to make across-the-board comparisons or compile rankings, there may, however, be some merit to comparing universities’ patenting activity selectively at a more disaggregated level. Finding appropriate ways to classify universities and TTO approaches in ways that facilitates such comparisons could be a priority research issue, which will concomitantly take field or discipline-specific conditions and mission-orientation of Technology Transfer Offices into account.

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References

- ALLISON, J. R., LEMLEY, M. A. (1998), Empirical Evidence on the Validity of Litigated Patents. *AIPLA Quarterly Journal*, 26 (3): 187-275.
- ALLISON, J. R., LEMLEY, M. A., MOORE, K. A., TRUNKEY, R. D. (2003), Valuable Patents. In: *Berkeley Olin Program in Law & Economics*, Working Paper Series (University of California, Berkeley).
- BEBCHUK, L. (1994), Litigation and Settlement under Imperfect Information, *RAND Journal of Economics*, 15: 404-415.
- BESSEN, J., HUNT, R. M. (2004), An Empirical Look at Software Patents, National Bureau of Economics Research, Working Paper No. 03-17/R.
- BUTLER, L., (2003), Modifying publication practices in response to funding formulas, *Research Evaluation*, 12 (1): 39-46.
- CLARK, B., (1998), *Creating Entrepreneurial Universities: Organizational Pathways of Transformation*, Kidlington, Pergamon.
- DEBACKERE, K., GLÄNZEL, W. (2004), Using a bibliometric approach to support research policy making: The case of the Flemish BOF-key, *Scientometrics*, 59 (2): 253-276.
- DERNIS, H., GUELLEC, D., VAN POTTELSBERGHE, B. (2001), Using patent counts for cross-country comparisons of technology output, *STI Review*, 27: 129-146.
- EUROPEAN COMMISSION DIRECTORATE GENERAL ENTERPRISE. (1998), *First Action Plan for Innovation in Europe*, Brussels.
- EUROPEAN COMMISSION DIRECTORATE GENERAL ENTERPRISE. (1998), *Green Paper on Innovation*, Brussels.
- EUROPEAN COMMISSION DIRECTORATE GENERAL ENTERPRISE. (2000), *Innovation Policy in a Knowledge-Based Economy*, Luxembourg.
- ETZKOWITZ, H., LEYDESDORFF, L. (2000), The dynamics of innovation: from national systems and 'Mode 2' to a Triple Helix of university-industry-government relations, *Research Policy*, 29 (2): 109-123.
- FTC/DOJ. (2003), *How to Promote Innovation Through Balancing Competition with Patent Law and Policy*, Washington, D.C.
- FLEMING, L., SORENSON, O. (2001), Technology as a complex adaptive system: evidence from patent data, *Research Policy*, 30 (7): 1019-1039.

- GRANSTRAND, O. (2000), The shift toward intellectual capitalism - the role of infocom technologies, *Research Policy*, 29 (9): 1061-1080.
- GRAHAM, S. J. H., HALL B. H., HARHOFF, D., MOWERY, D. C. (2002), Post-Issue Patent "Quality Control": A Comparative Study of U.S. Patent Re-Examinations and European Patent Oppositions. National Bureau of Economic Research Working Paper 8807:1-44.
- GUELLEC, D., van POTTELSBERGHE de la POTTERIE, B. (2000), Applications, grants and the value concept, *Economic Letters*, 69(1): 109-114.
- HALL, B. H., ZIEDONIS, R. H. (2001), The Patent Paradox Revisited: An Empirical Study of Patenting in the U.S. Semiconductor Industry, 1979-1995, *Rand Journal of Economics*, 20 (1): 101-128.
- HARHOFF, D., SCHERER, F. M., VOPEL, K. (1997), Exploring the Tail of Patent Value Distribution [cited July 26 2004]. Available from <http://skylla.wz-berlin.de/pdf/1997/iv97-27.pdf>.
- HENDERSON, R., JAFFE, A. B. et al. (1998), Universities as a source of commercial technology: A detailed analysis of University Patenting, 1965-1988, *Review of Economics and Statistics*, 80(1): 119-127.
- HSIEH, C. (2004), How can we identify technological opportunities ahead of time? Manuscript, Washington University, St Louis. Paper at the Academy of Management Meeting, New Orleans, LA, 2004. Available from www.econ.upf.edu/docs/seminars/recruiting/chihmaohsieh.pdf
- IVERSEN, E. J., KALOUDIS, A. (2003), *IP Valuation as a Tool to Sustain Innovation*, STEP Report 17-2003, STEP Centre for Innovation Research, Oslo.
- JAFFE, A. B., TRAJTENBERG, M. (2002), *Patents, Citations, Innovations: A Window on the Knowledge Economy*, The MIT Press, Cambridge, Massachusetts.
- JAFFE, A., TRAJTENBERG, M. (1995), Flows of knowledge from universities and federal labs: modeling the flow of patent citations over time and across institutional and geographic boundaries. Paper presented at the National Academy of sciences Colloquium on science, Technology, and the Economy. Cited after Hsieh (2004).
- KORTUM, S., LERNER, J. (1997), Stronger protection or technological revolution: What is behind the recent surge in patenting? Washington, D.C., National Bureau of Economic Research.
- LAMBERT, R. (2003), Lambert Review of Business-University Collaboration, Final Report, H.M. Treasury.
- LANJOUW, J. O. (1998), How to count patents and value Intellectual Property: The Uses of Patent Renewal and Application Data, *The Journal of Industrial Economics*, XLVI (4): 405-432.
- LANJOUW, J. O., PAKES, A., PUTNAM, J. (1998), How to count patents and value Intellectual Property: The Uses of Patent Renewal and Application Data, *The Journal of Industrial Economics*, XLVI (4): 405-432.
- LANJOUW, J. O., SCHANKERMAN, M. (1999), The quality of ideas: measuring innovation with multiple indicators. National Bureau of Economic Research, NBER Working Paper No. 7345.
- LANJOUW, J. O., SCHANKERMAN, M. (2001), Characteristics of patent litigation: a window on competition, *RAND Journal of Economics*, 32 (1): 129-151.

- LANJOUW, J. O., SCHANKERMAN, M. (2001), Enforcing Intellectual Property Rights. Available from <http://sticerd/se.ac.uk/dps/ei/ei30.pdf>.
- LANJOUW, J. O., SCHANKERMAN, M. (2002), An Empirical Analysis of the Enforcement of Patent Rights in the United States. Paper read at New Research on the Operation of the Patent System, at Washington, D.C.
- LERNER, J. (2001), 150 Years of Patent Protection. National Bureau of Economic Research. NBER Working Paper No. 7428.
- MACDONALD, S. (2004), When Means becomes ends: considering the impact of patent strategy on innovation, *Journal of Information Economics and Policy*, 16: 135-158.
- MACHLUP, F. (1958), An Economic Review of the Patent System. Washington, D.C.: U.S. Senate.
- MEYER, M., Du PLESSIS, M., TUKEVA, T., UTECHT, J. T. (2005), Inventive output of academic research: a comparison of two science systems, *Scientometrics*, 63 (1): 145–161.
- MOLAS-GALLART, J. (2004), Measuring and Funding the 'Third Mission': the UK policy Debate. In: R. WINK (Ed), *Academia-business links, European policy strategies and lessons learnt*. Palgrave Macmillan, Basingstoke, pp.74-89.
- MOLAS-GALLART, J., SALTER, A., PATEL P. (2002), Measuring Third Stream Activities: Final Report, the Russell Group in the Russell Group of Universities. Brighton, SPRU, University of Sussex.
- MOWERY, D. C., ZIEDONIS, A. A. (2002), Academic patent quality and quantity before and after the Bayh-Dole act in the United States, *Research Policy*, 31 (3): 399-418.
- MOWERY, D. C., NELSON, R. R., SAMPAT, B. N., ZIEDONIS, A. A. (1999), The effects of the Bayh-Dole act on US university research and technology transfer: an analysis of data from the Columbia University, the University of California, and Stanford University. In: L. BRANSCOMB, R. FLORIDA, (Eds), *Industrializing knowledge*. MIT Press, Cambridge, MA, pp. 269-306.
- OECD, (2003), *Turning Science into Business*, OECD, Paris.
- PAKES, A., SCHANKERMAN, M. (1984), The Rate of Obsolescence of Patents, Research Gestation Lags, and the Private Rate of Return to Research Resources. In: *R&D, Patents and Productivity*, Z. GRILICHES (Ed), The University of Chicago Press.
- PETRUSSON, U. (2004), *Intellectual property and entrepreneurship: creating wealth in the intellectual value chain*. CIP: Gothenburg.
- PRIEST, G. L., KLEIN, B. (1984), The Selection of Disputes for Litigation, *Journal of Legal Studies*, XIII: 1-55.
- REITZIG, M. (2003), What determines patent value? Insights from the semiconductor industry, *Research Policy*, 32 (1): 13–26.
- RIORDAN, B. (2000), What's driving patent and trade mark application filings?, *European Intellectual Property Review*, 22 (8): 349-352.
- SAMPAT, B. N., ZIEDONIS, A. A. (2004), Patent citations and the economic value of patents. In: H. F. MOED, W. GLÄNZEL, U. SCHMOCH (Eds), *Handbook of Quantitative Science and Technology Research*. Amsterdam, Kluwer.

- SAPSALIS, E., van POTTELSBERGHE de la POTTERIE, B. (2003), The Sources of Knowledge and the Value of Academic Patents. [cited. Available from <http://www.iir.hit-u.ac.jp/file/wp03-24bruno.pdf>.
- SHATTOCK, M. (2003), *Managing successful universities*, Society for Research into Higher Education, Open University Press, Maidenhead.
- Tang, P., Paré, D. (2003), Gathering the Foam: Are Business Method Patents a Deterrent to Software Innovation and Commercialization?, *International Review of Law Computers & Technology*, 17 (2): 127-162.
- TRAJTENBERG, M., HENDERSON, R., JAFFE, A. B. (1997), University versus corporate patents: a window on the basicness of inventions, *Economics of Innovation and New Technology*, 5: 19-50.
- TRUNE, D. R., GOSLIN, L. N. (1998), University technology transfer programs: A profit/loss analysis, *Technological Forecasting and Social Change*, 57 (3): 197-204.
- YIN, R. K. (1984), *Case study research*, Sage, Thousand Oaks, CA.