Dynamics of Institutions and Markets in Europe is a network of excellence of social scientists in Europe, working on the economic and social consequences of increasing globalization and the rise of the knowledge economy.
http://www.dime-eu.org/

DIME Working Papers on

INTELLECTUAL PROPERTY RIGHTS

http://www.dime-eu.org/working-papers/wp14

Sponsored by the 6th Framework Programme of the European Union

Emerging out of DIME Working Pack:

'The Rules, Norms and Standards on Knowledge Exchange'

Further information on the DIME IPR research and activities:

http://www.dime-eu.org/wp14

This working paper is submitted by:

Birgitte Andersen* and Federica Rossi**

*University of London, Birkbeck College:
b.andersen@bbk.ac.uk
** University of Torino and University of London, Birkbeck College: rossi.federica@unito.it

Beyond Bayh-Dole: Universities and the use of Proprietary and Non-Proprietary Intellectual Property (IP) marketplaces

This is Working Paper
No 90 (March 2010)

The Intellectual Property Rights (IPR) elements of the DIME Network currently focus on research in the area of patents, copyrights and related rights. DIME's IPR research is at the forefront as it addresses and debates current political and controversial IPR issues that affect businesses, nations and societies today. These issues challenge state of the art thinking and the existing analytical frameworks that dominate theoretical IPR literature in the fields of economics, management, politics, law and regulation- theory.

Beyond Bayh-Dole: Universities and the use of Proprietary and Non-Proprietary Intellectual Property (IP) marketplaces

Birgitte Andersen[*] and Federica Rossi[**]

Abstract

Building upon an original survey of universities in the United Kingdom, this paper brings an original perspective to the debate on the motivations and effectiveness of academic patenting, and on the exchange of intellectual property (IP) using different protection mechanisms. It seeks to analyze the extent to which the assumptions underlying the legislation that encourages the patenting of academic research outcomes on the part of universities (such as the much debated Bayh-Dole Act in the US) are justified. It does this by exploring the motivations (related to finance, innovation, strategic relationships, competitive advantage) underpinning the universities' choice to engage in IP marketplaces. The paper also explores whether universities support the view, implicitly held by mainstream economics, that the patent marketplace is efficient or works automatically. It does this by investigating the obstacles (related to market search, transparency, contract negotiation and enforcement, as well as regulation problems) that are encountered when exchanging IP.

By considering a wide range of IP marketplaces (patents, copyright, open source and non-patented technology) and IP governance forms (e.g. alternative licensing forms), the paper builds a more complete picture of the activities and experiences of universities than that provided by the existing literature on university knowledge transfer, which usually focuses on just two main channels for IP transfer, namely patents and publications. This approach allows us to investigate questions such as: are patent rationales related to enhanced knowledge transfer and income generation also applicable to other non-proprietary IP? Do problems underpinning the patent marketplace also affect other forms of IP? Does the use of different IP marketplaces and of different IP governance forms confer specific advantages or obstacles to universities?

Key words: intellectual property rights (IPR), universities, academic patenting, Bayh-Dole, institutional economics.

JEL classification: O34, O31, O32, D23, D02.

[*] Professor of the Economics and Management of Innovation, University of London, Birkbeck College, email: b.andersen@bbk.ac.uk. Address for correspondence: School of Business, Economics and Informatics, Department of Management (Room 210, Clore Management Centre), Birkbeck, University of London, Malet Street, Bloomsbury, London WC1E 7HX.

[**] PostDoctoral Researcher at University of Torino and University of London, Birkbeck College, email: rossi.federica@unito.it.

Introduction

Since the 1980s, a consensus has emerged in science and technology policy that universities should play a more direct role in fostering economic growth and national competitiveness. This has been driven by theoretical developments in economic thinking, which have justified the interpretation of universities as key agents sustaining national competitiveness, as well as by historical circumstances, such as the push for an increase in the number of higher education students thought to be essential for the knowledge economy. At the same time (because of processes such as the reduced drive to finance university research for military reasons and the move towards reduced government intervention in the economy) governments have begun to look for ways to encourage universities to become less dependent on public budgets (Geuna and Muscio, 2009).

Such trends have sustained the approval of legislative measures such as the Bayh-Dole Act in the US (1980), which has allowed universities to patent the results of federally-funded research, and of similar legislation in other countries (Crespi et al, 2006). Since then, there has been an increase the number of patents filed by universities, even in countries which had a tradition of assigning university-invented patents to firms (Geuna and Nesta, 2006).

It has been pointed out that the main motivations underpinning these reforms in university legislation were to favour knowledge dissemination and effective knowledge transfer to the economic system (Lee, 1995; Feldman et al, 2006; Schacht, 2005), building on the assumption that patents are more effective means of transferring knowledge than other channels such as academic publications (for an overview of the rationales behind this assumption see Andersen, 2004), and to ensure additional income to universities from the commercialization of their discoveries (Eisenberg, 1996). A key assumption underpinning this view is that intellectual property rights (IPR) marketplaces function effectively, or automatically, and are able to guarantee the encounter and efficient exchange of knowledge between firms that demand innovations and universities that supply them.

This article, building upon an original survey of universities in the United Kingdom, brings an original perspective to the debate on the motivations and effectiveness of academic patenting, and on the exchange of other intellectual property (IP). It seeks to analyze the extent to which the assumptions underlying the legislation that encourages university patenting are justified, by exploring the motivations underpinning the universities' choice to engage in IP marketplaces.

The analysis extends the literature in several ways. First, building on the economic and management literature on patent rationales, it analyzes motivations concerning (i) financial gains, (ii) innovation, (iii) strategic relationships and (iv) market positioning. Second, it explores whether universities support the view, implicitly held by mainstream economics, that the patent market functions smoothly and efficiently. In doing so, the paper analyzes market obstacles relating to (i) search problems, (ii) lack of transparency, (iii) contract negotiation problems, (iv) contract enforcement problems, and (v) regulation issues. Third, it allows that the benefits of patents, and the obstacles experienced when exchanging them, may vary according to the specific governance forms through which patent transactions take place (Andersen and Konzelmann, 2008): thus, the analysis of benefits and obstacles encountered by universities is performed at the level of specific governance forms. Another original aspect of the analysis concern the adoption of a comparative perspective. The

investigation into benefits and obstacles of IP exchange on the part of universities is not limited to patents but involves a wide range of other proprietary and non-proprietary IP[1]: copyright, open source and non-patented technology. This way, the paper builds a more complete picture of the activities and experiences of universities than that provided by the existing literature on university knowledge transfer, which usually focuses on just two main channels for IP transfer, namely patents and publications.

The paper is structured as follows. In section 2, we recall the debate on the rationale, advantages and drawbacks of academic patenting, and on the benefits and obstacles associated with IP marketplaces in general. In section 3, we describe the data and the methodology used for the analysis. In section 4, we present the results of the empirical analysis, focusing on four main themes: (1) to what extent do universities engage in the various IP marketplaces considered; (2) what benefits do universities seek from engaging in these marketplaces; (3) what obstacles, if any, prevent IP marketplaces from functioning smoothly and efficiently; and finally, (4) to what extent are these benefits and obstacles specific to certain governance forms within each marketplace. Section 5 discusses the results obtained and concludes.

2. Universities and the exchange of intellectual property

The emphasis on the economic role of the university as a producer of knowledge that feeds into innovation processes builds upon the broader economic debate on knowledge-driven economic growth: since the late 1980s, models of growth driven by increases in human capital have been developed, showing that increasing the stock of knowledge embodied in skilled workers increases the productivity of capital and labour, and hence leads the economic system to higher levels of per-capita output (Lucas, 1998); while endogenous growth theory has further emphasized the role of disembodied knowledge as a non-excludable and non-rivalrous production factor capable of generating increasing returns to scale in the production function and hence of driving the economy towards higher rates of aggregate output growth (Romer, 1990). The key economic role of universities has also been emphasized by the broader discourse on the features of the "knowledge economy", which is supposed to be characterized by faster rate of technological progress and by greater economic importance of industries which produce and trade knowledge products (Quah, 1998). The debate in regional economics, where it has been argued that universities play a key role in regional economic development through collective learning processes (Lawton-Smith, 2007), has also contributed to fostering a view of universities as agents whose "third mission" of transferring productive knowledge to the economic system is equally important as their two traditional missions of teaching and research.

While the important role that universities play in the production and dissemination of new knowledge is now widely shared and acknowledged, the best way in which knowledge transfer should take place is still debated. At least since the 1980s, policymakers have supported the view that IPR protection is required for university-produced knowledge to be transferred effectively. The arguments that support a more widespread use of the IPR system on the part of universities, are slightly different

[1] The terms 'proprietary' and 'non-proprietary' became popular in relation to software. We define as 'proprietary' those forms of IP protection where restrictions on using, sharing, copying and modifying intellectual property are implemented by legal means; while non-proprietary IP is such that some or all of these restrictions are relaxed.

from the traditional justification for the enforcement of IPR, which is to provide incentives for sufficient private investment in innovation (Dasgupta and David, 1994). First, it is believed that the IPR system provides negotiated incentives to disclose ideas in libraries. Patents (and copyright when filed) provide immediate information to others who can incorporate such information into their own knowledge bases, even though they cannot use it commercially. Therefore, patents are thought to induce inventors to disclose their new knowledge instead of keeping it secret (see references in Andersen, 2004). Second, it has been argued that IPRs provide direct incentives for sharing ideas and expressions through trade. Because IPRs allow the creator of an idea to exclude others from using it, they are in principle able to create a market for technology and creative expressions, and, as ideas and expressions face increasing return to scale by nature, this gives rise to increasing rent or profit as markets expands (Rivera-Batiz and Romer, 1991). In turn, the expansion of such markets is thought to lead to diffusion of knowledge, which in the absence of IPR enforcement may not have been commercialized. Another way in which licensing and trade of IPR is thought to speed up knowledge diffusion is via information spillover effects (David and Olsen, 1992). It has also been argued that the possibility to commercialize their own IP and to derive income from these activities would induce universities to be more proactive in disseminating their knowledge to the economic system, especially at a time of shrinking public budgets for higher education; and that the gains to be derived from IPR protection should induce universities to produce knowledge that is more relevant to the needs of businesses, which would in turn facilitate development and commercial exploitation on the part of firms, including academic start-ups (Eisenberg, 1996; Berman, 2008).

These are the main arguments underpinning the policy measures directed at expanding and strengthening the application of IPRs to the outcomes of public research (see Mowery et al, 2001, for an extensive overview of the background to such interventions). The best known of these is the Bayh-Dole Act, implemented in the United States in 1980, which gave US universities control of their inventions and other IP resulting from federally-funded research, and encouraged the use of formal IP protection in the form of patents. This was believed to be the best mechanism for (among other things) "provid[ing] an economic incentive for companies to pursue further development and commercialization of government sponsored R&D through corporate ventures between and among the research community, small businesses and industry" (Schact, 2005). Similar legislation has later been adopted in other countries (Crespi et al, 2006).

Data show that - following the introduction of legislation assigning universities the right to patent publicly-funded research, and the establishment in most institutions of technology transfer offices that often pursue aggressive patenting policies - there have been increases in the number of university-owned patents (Geuna and Nesta, 2006) and in universities' income from royalties (AUTM 2002; Feller 1990). Nonetheless, the success as well as the implications of these measures have been controversial.

Critics have begun to worry about the actual and potential negative effects of such a marked legal and cultural emphasis on the enforcement of proprietary IPRs on academic knowledge, on issues such as the balance between basic and applied research, the dynamic incentive to innovate and pursue scientific progress (Florida, 1999; David, 2001), the incentive for industry to invest in private research activities. It has also been suggested that the increased privatization of research results may raise the cost of use of scientific knowledge and restrict its dissemination (Mowery et al,

2001), through restrictions on disclosures, on data sharing and on the use of research tools (Blumenthal et al, 1986; National Research Council, 1997) which in turn may lead to less diversity in experimentation on the part of scientists (Murray et al, 2009), or induce them to forsake the use of protected knowledge inputs in favour of non-protected ones (see David, 2008, for a discussion of the problems of raising costs in connection with privatization of knowledge product). Some economists are explicitly advocating a move away from Bayh-Dole-type legislation in favour of alternative mechanisms based on non-exclusive licensing or on the assignment of IPRs directly to individual academic inventors, in order to remove the obstacles to the flow of scientific information (Mowery and Sampat, 2005; David, 2008; Kenney and Patton, 2009)[2].

On the other hand, some empirical research has showed that increased patenting of research outcomes has not led to a quantitative or qualitative decline in the knowledge produced by universities (Azoulay et al, 2006), and that there is a positive relationship between intellectual eminence and success in research commercialization (Zucker and Darby, 1996; Elfenbein, 2007). It has been suggested that the increase in patenting activities has owed more to the evolution of scientific disciplines – namely the emergence of biotechnology and ICT, fields that are rich in potential commercial applications – than to the legislative changes in themselves (Mowery et al, 2001). In fact, high patenting is mainly confined to a few disciplinary fields (Henderson et al. 1998; Geuna and Nesta, 2006), and most knowledge dissemination from academia to industry still takes place through the traditional, non-protected "open science" channels (Meyer-Kramer and Smooch, 1998). Consequently, it has been that argued the effects of Bayh-Dole-type legislation have not been radical and that universities have not significantly changed their mix of basic and applied research activities (Rafferty, 2008).

This article contributes to the debate on the advantages, limitations and drawbacks of the use of IPR on the part of universities, in several ways.

First, it builds a broader picture of universities' attitudes towards IP, by focusing not only on patented academic knowledge (which, together with the use of openly disseminated publications according to the so called "open science" system, is the main channel considered by the literature on university knowledge transfer) but on a wide rage of IP marketplaces, both proprietary and non-proprietary, to which so far the economic literature has not paid much attention. There have been some studies on the complementary use of different forms of IP protection, but generally in sectors other than universities. For example, in the case of software, some case studies have aimed at uncovering how firms use both open source and patents as part of their commercial strategy (Campbell-Kelly and Garcia-Swartz, 2008). However, studies on firm populations have mostly focused only on proprietary IP. Greenhalgh and Rogers (2006) and Munari and Santoni (2009) have studied complementarity in the use of patents and trademarks, while Amara et al. (2008), Graham and Somaya (2006) and Ramello and Silva (2006) have focused on patents, design registrations, trademarks. When non-proprietary forms of IP protection are considered in the literature, the focus is generally on trade secrets, i.e. IP that by its very nature is kept within the company (Levin et al, 1987). Here instead we specifically consider non-proprietary IP that is exchanged, namely open source and technology without IPR protection. Moreover,

[2] For comprehensive reviews of the debate on the negative effects of university patenting, see Baldini, 2008 and van Zeebroeck et al, 2008.

with some exceptions, most of the literature that focuses on the use of different IP protection mechanisms assumes that they are substitutes rather than complements, despite the lack of evidence in this respect[3].

Second, the article investigates the rationale for universities to engage in different kind of IP exchanges. In the economic literature, motivations for engaging in holding and exchanging IP have been investigated mostly with respect to patents. It has been argued that patenting promotes innovation because IPR protection allows the inventor to invest more resources in research (Arrow, 1962), thus developing more and better technology; and conversely, the acquisition of patents allows the buyer to use the best technology available. Patent licensing enables standardization and compatibility among technologies (Merges and Nelson, 1990; Plant, 1934), while patent exchanges in general allow to build strategic relationships with or within industry (Jaffe et al, 1993; Teece, 1986), which furthers innovation diffusion. Patents also have a wide range of direct and direct economic benefits. Not only the exchange of patents can be a direct source of income, but patents can be held or exchanged for strategic purposes, in order to influence the process of competition (Mazzoleni and Nelson, 1998). According to Graham and Sichelman (2008), there are at least ten economic reasons why firms file or acquire patents. Firms can file patents for defensive purposes, in order to stop others from imitating their product (Rivette and Kline, 2000; Cohen et al., 2000; Granstrand, 1999), but they can also use them offensively, in order to block competitors from using certain technologies, or as bargaining chips in cross-licensing negotiations. Other ways in which patents can increase one's market share at the expense of competitors include the attempt to drive up the competitors' costs, to gain access to their technologies, to prevent them from acquiring patents on the same inventions, or even to push them out of the market. Patents are also used for financial purposes, for example to increase one's chances to secure investment, to be acquired or taken public in an initial public offering, or just to increase the value of one's assets in bankruptcy (Coriat and Orsi, 2002; Rivette and Kline, 2000); for signalling purposes, in that patents can be interpreted as a proxy for internal capabilities and assets; and for reputation purposes, since patents can serve as assets that increase the value of the firm and of its brand (Grassman, et al 2009). On the other hand, the registration and maintenance of IPRs require the payment of fees that can constitute a significant financial burden especially for small enterprises: forms of non-proprietary IP therefore can confer economic benefits in terms of ability to cut costs. There is no overall consensus on which of the many reasons proposed for exchanging patents are the primary drivers of these processes (Graham and Sichelman, 2008). Also, there are few analyses of the motivations underpinning the exchange of other forms of IP, proprietary and non-proprietary. Some studies have looked in detail at the determinants of engagement in open source development (David and Shapiro, 2008) but very few have investigated motivations in a comparative perspective.

Third, the benefits of IP may vary considerably according to the governance forms under which transactions take place. Andersen and Konzelmann (2008) suggest that specific governance forms for IP exchange within each marketplace are associated with different processes of value seeking. For example, a cross licensing agreement may be due to the expectation to achieve strategic market positioning, whereas selling a patent may be due to gaining one-off income, and a patent pool may be due to the

[3] For example, Nelson (2006) and Teece (2006) have suggested that there is a lack of empirical research about the complementarity of the different protection mechanisms in predicting the profitability of innovation.

development of a common technological standard. Thus, when investigating how and for what objectives IP is exchanged by universities, it is appropriate to focus not only on different IP marketplaces, but also on the specific IP governance forms within each marketplace.

Finally, another key assumption underlying Bayh-Dole-type legislation is that IPR marketplaces function well. However, in an institutional economics perspective, all markets are institutions characterized by specific norms and bargaining forms, where, for trade to take place, social relations need to be underpinned by trust and similar expectations (in relation to prices, contracts and other aspects) between buyer and seller (Hodgson 1988, 1999). According to this approach, IP marketplaces cannot be reduced to simple price-clearing mechanisms representable through supply and demand curves; rather, they are platforms of social relations in which value is created[4]. The understanding of IP marketplaces as institutions opens up the possibility that marketplaces may not function as smoothly as assumed when they are conceptualized as simple price-clearing mechanisms. Several problems with the functioning of IP marketplaces have been identified by the empirical literature, usually relating to patents and other proprietary IPR. These often concern the negotiation and enforcement of IPR contracts: it is difficult to value patents and to define their boundaries (Merges and Nelson, 1990), and the patent's value usually depends on its intended utilization, thus making it difficult to negotiate an appropriate price for it (Mansfield et. al., 1981; Hall and Ziedonis, 2001). Negotiations are complicated also by unbalanced bargaining power, asymmetric information and lack of trust, since opportunistic behaviour is common in business dealings (Bachmann, 2006). Even when contracts can be made, enforcing them is costly, both in terms of direct legal costs and in terms of business costs of litigation. Enforcement problems have also been studied with respect to open source, where it has been pointed out that difficulties rise when the licensee fails to comply with the terms and conditions set by the licensor, for example by appropriating and closing up the source code (merging it with new code and releasing it in a proprietary way, such as "all rights reserved") or by failing to apply the same terms and conditions to derivative works (Montagnani, 2009). Other problems, which have been identified for example with respect to the software industry (IBM 2006) have to do with lack of transparency in the marketplace (difficulty to identify the owner, uncertainty as to what the right price is, impossibility to make sense of text and diagrams in patent documents; see Bessen and Meurer, 2005), lack of integrity (poor behaviour and unjust court cases), and low patent quality (too many similar patents with no inventive step, which in turn makes it difficult for firms to assess their degree of novelty and understand their economic value). By investigating the obstacles that university encounter when exchanging IP in the marketplace, this paper contributes new empirical evidence towards an emerging literature on problems in markets for technology and their implications for organizational strategy (Arora et al, 2001).

3. Data and methodology

The empirical analysis is based upon survey data on a sample of universities, colleges and public research organizations based in England, Scotland, Wales or Northern

[4] Throughout this paper, we explicitly refer to the notion of "marketplaces" (rather than "markets") in order to denote the space, actual or metaphorical, in which a market operates, and to emphasize the web of social relationship and institutions that are required for processes of exchange to take place.

Ireland (although, for simplicity, we sometimes refer to this sample as to "UK universities"), collected between October 2008 and March 2009. It draws upon the UKNOW-survey database comprising data collected from German Pharmaceutical firms, UK firms in the information and communication technology (ICT) sector, and UK universities[5].

The list of relevant institutions and of their respective technology transfer offices was drawn from the website of the University Companies Association (UNICO), which represents the technology exploitation companies of UK universities. The list of 120 members of UNICO was downloaded in October 2008. This list was then integrated with the set of institutions that responded to the HEBCI 2004-05 and 2005-06 surveys (HEFCE, 2007), which includes 162 universities, colleges and public research organizations. Since no addresses or contact names were included in this list, such information was retrieved from each institution's website.

The two lists were merged and, after correcting different spellings and eliminating double entries, a final population of 169 different organizations was assembled. A mass mailing was sent out in mid November 2008, followed by three rounds of personal emails sent out between December 15th 2008 and February 28th 2009. In order to reach the target response rate, questionnaires were posted out at the beginning of March. Respondents had a choice of different options through which they could answer the survey: filling in the questionnaire available online; returning an electronic copy of the questionnaire by email; returning a copy of the questionnaire by post or fax. We obtained 46 complete responses (27.2% response rate).

The questions in the survey referred, separately, to four proprietary and non-proprietary marketplaces governing the exchange of IP: patents, copyright, open source and non-patented technology. In turn, for each marketplace, the questions referred to different IP governance structures, as detailed in Table 1.

Table 1. Marketplaces and governance forms investigated through the UKNOW survey

IP marketplaces	**Governance structures**
Patents as a tool for the protection of novel ideas	Selling patents
	Buying patents
	Out-licensing patents
	In-licensing patents
	Cross licensing patents
	Participation in patent pools
Copyright as a tool for the protection of original creative expressions	Selling copyright
	Buying copyright
	Out-licensing copyright
	In licensing copyright
Open source' IP as a tool for the protection of original ideas and creative expressions	Participating in open source software development
	Participating in open source pharmaceutical projects
	Participating in other open source communities

[5] The database was developed at Birkbeck College (under the coordination of Birgitte Andersen) under Work Package 3.2: "An IPR Regime in Support of a Knowledge Based Economy", as part of the UKNOW *(Understanding the Relationship between Knowledge and Competitiveness in the Enlarging EU')* project of the EU 6th Framework Programme (contract number CIT 028519).

'Non patented' ideas	Releasing not patented product or process innovations to the public
	Releasing not patented product or process innovations to private firms
	Using not patented product or process innovations
	Collaborating with universities without patent restrictions

A first set of variables allowed us to collect information on the extent and intensity with which universities participate in the various IP marketplaces and governance structures. Respondents were asked about their stock of patents owned and licensed, whether they engaged in each patent governance form, and if so the number of transactions they performed in the last two years. With respect to open source, non-patented technology and copyright, universities were asked whether they engaged in each governance form, and if so the number of transactions they realized in the last two years.

A second set of questions referred to the benefits that universities seek when trading IP. For each marketplace and governance form, respondents were presented with a list of strategic benefits among which they were asked to tick up to five that they deemed most important. These included four broad benefit-types related to 13 different variables:

- Benefits relating to financial gain. Variables include (1) direct income from market transaction; (2) cost cutting, e.g. via savings on royalties or patent administration; (3) increasing ability to raise venture capital;
- Benefits relating to competitive advantage. Variables include (4) increasing market share, e.g. building broader user base or securing market protection; (5) professional recognition or brand recognition; (6) competitive signalling;
- Benefits relating to innovation. Variables include (7) being able to use the best inventions, innovations, creative expressions; (8) setting common standards / making or using compatible technology or creative expressions; (9) innovation methodology: developing better technology or creative expressions; (10) benefiting from user or supplier involvement as a development strategy;
- Benefits relating to the building of strategic relationships leading to enhanced knowledge transfer. Variables include (11) building informal relationships with industry networks; (12) increasing ability to enter collaborative agreements, e.g. joint ventures, strategic alliances, etc.; (13) giving something to the community.

Universities were then asked about the obstacles they encountered when trading IP. They were presented with a list of obstacles among which they were asked to tick up to five that they deemed of highest impact. These included five broad types of obstacles related to 14 different variables:

- Obstacles relating to search problems. Variables include (1) difficulty in locating the owners of IP; (2) difficulty in locating the users of IP; (3) difficulty in finding the best IP);
- Obstacles relating to lack of transparency. Variables include (4) difficulty in assessing the degree of novelty/originality of the IP; (5) lack of clarity of the IP document; (6) difficulty in assessing the economic value of the IP;
- Obstacles relating to contract negotiation. Variables include (7) difficulty in negotiating a price for the IP; (8) difficulty in negotiating the terms, not related to price, of the contract;

- Obstacles relating to contract enforcement. Variables include (9) excessive cost of enforcing the contract; (10) problems, not related to cost, with enforcing the contract; (11) trust issues, e.g. opportunistic behaviour, free-riding, or similar); (12) different practices of firms;
- Obstacles relating to excessive or too rigid regulation. Variables include (13) regulations allow too exclusive rights; (14) international IP regulations do not fit the needs of different local market.

Finally, respondents were requested to provide some general information about the organization: geographic localization, ownership (independent or subsidiary), size (current number of employees, current yearly turnover), research intensity (yearly expenditure in R&D), geographic extension of the organization's main market (domestic or international), and sector of activity. A few additional variables relating to organizational characteristics were derived from other sources[6].

4. Analysis

4.1. Sample representativeness

The organizations in the sample possess different institutional and historical features. Most are universities, some are university colleges or other institutions of higher education (such as music conservatoires and arts colleges), and a few are public research organizations. The set of respondents reflects the sample composition. Table 2 compares the distribution of institutions in the sample and in the sets of respondents and non-respondents, across several main characteristics: geographical localization, size (in terms of academic staff employed), institutional type, both with respect to status and to historical origin (distinguishing between universities, other higher education institutions and public research organizations, and further subdividing universities into 5 categories according to the period in which they were founded[7]).

The distribution of respondents by geographical localization, institutional type and size in terms of total staff (academic, non-academic and atypical) is representative of the overall population.

Table 2. Structure of sample and respondents

		sample (169)	respondents (46)	non-respondents (123)
		%	%	%
geographic localization	England	82.2	89.1	79.7
	Wales	5.3	4.3	5.7
	Scotland	11.2	6.5	13.0

[6] The number of academic staff and total staff (academic, non-academic, atypical) of the institution (relative to 2007/08), the share of academic staff employed in scientific fields (engineering and technology, medicine and natural sciences, in the same period), and the income of the institution were drawn from HESA's (the Higher Education Statistics Agency) database. The year of foundation of the technology transfer office and the number of staff employed within were drawn from the HE-BCI survey (relative to 2007).

[7] The categories are the following: "old" universities (founded before the mid-XIX century); "red brick" universities (founded between the mid-XIX century and the mid-XX century); "plate glass" universities (founded between the 1960s and the end of the 1980s); "former polytechnics" (institutions formerly designated "polytechnics" which changed their status to universities in 1992); "modern" universities (founded after 1992, not formerly designated "polytechnics").

	Northern Ireland	1.2	0.0	1.6
	Total	100	100	100
type	“old” universities	5.9	8.7	4.9
	“red brick” universities	17.8	26.1	14.6
	“plate-glass” universities	13.6	15.2	13.0
	“former polytechnics"	20.7	19.6	21.1
	“modern” universities	16.6	8.7	19.5
	colleges of higher education/university colleges	16.6	8.7	19.5
	public research organizations & councils	7.7	13.0	5.7
	Other	1.2	0.0	1.6
	Total	100	100	100
size (total staff)	<500	10.7%	4.3%	13.0%
	500-1000	13.0%	10.9%	13.8%
	1000-5000	47.3%	56.5%	43.9%
	>5000	24.3%	28.3%	22.8%
	Missing	4.7%	0.0%	6.5%
	Total	100	100	100

4.2. The universities' participation in IP marketplaces and IP governance forms

Of the 46 respondents, 13 do not participate in any of the four IP marketplaces. Of the respondents that participate in IP marketplaces, only 10 (30%) are involved in one marketplace, while most (23, that is 70%) are involved in two or more (9 engage in two different marketplaces, 10 engage in three, and 4 engage in all four). In particular, 9 organizations (27%) only engage in proprietary IP marketplaces (patents and/or copyright), two organizations (6%) engage only in non-proprietary IP marketplaces, while most use a combination of proprietary and non-proprietary forms of protection of their IP (22 organizations, or 67%). This clearly indicates that for most universities participation in proprietary and non-proprietary IP marketplaces represent complementary rather than alternative strategies of knowledge acquisition and transfer.

According to a Probit regression (results are shown in Appendix 1), the choice as to whether to engage or not in IP marketplaces is significantly affected by size (the larger the university in terms of total number of staff, the higher its likelihood to engage in at least one IP marketplace); also being a university (as opposed to a college of higher education) and particularly being an old university founded before the mid-XIX century significantly affects the likelihood to engage in IP marketplaces. The number of staff engaged in engineering and other technical disciplines has a positive effect on the likelihood to engage in IP marketplaces, while the number of staff engaged in scientific disciplines (such as medicine and the natural sciences) has a negative effect. This may be explained on the basis of the more basic nature of the research performed in these fields. Finally, the number of staff dedicated to technology transfer and the age of the institution do not significantly affect this choice.

Considering the subset of 33 universities that engage in IP marketplaces, the number of marketplaces in which they engage is - according to a Poisson regression (whose results are reported in Appendix 2)- positively affected by size (the bigger the institution in terms of total staff, the more marketplaces it is likely to engage in) and by the number of staff dedicated to technology transfer (that is, although this variable does not significantly impact the choice whether to engage or not in IP marketplaces, for those universities that do engage in them a larger amount of technology transfer staff allows them to broaden the scope of their IP activities) . Being a university, and particularly a former polytechnic, has a positive effect on the number of marketplaces one is engaged in, while being a recently founded university has a negative effect. Involvement in science has a negative effect too, indicating that staff in those disciplines focus on a smaller number of different forms of IP.

Table 3 details which types of organizations are more likely to engage in the exchange of patents, copyright, open source and non-patented technology. The rows do not sum to 100% since each organization can participate in more than one marketplace.

Table 3. Participation in IP marketplaces by type of organization

		number	patents	copyright	open source	non-patented technology
			%	%	%	%
type	"old" universities	4	75.0	50.0	50.0	75.0
	"red brick" universities	12	50.0	33.3	25.0	16.7
	"plate-glass" universities	7	57.1	28.6	14.3	42.9
	"former polytechnics"	9	88.9	44.4	33.3	44.4
	"modern" universities	4	25.0	25.0	25.0	0.0
	colleges of higher education/university colleges	4	25.0	0.0	50.0	25.0
	public research organizations & councils	6	100.0	33.3	0.0	83.3
size (all staff: academic, non-academic, atypical)	less than 500	2	50.0	0.0	50.0	50.0
	500-1000	4	50.0	0.0	0.0	25.0
	1000-5000	24	62.5	33.3	25.0	37.5
	more than 5000	16	68.8	43.8	31.3	43.8

We find that public research organizations, old universities founded before the XIX century, and former polytechnics that have become universities in 1992, are the types of institutions that engage the most in exchanging patents. Public research institutions and old universities are also most active in the exchange of non-patented technology, showing, once again, that proprietary and non-proprietary IP marketplaces are complementary rather than substitute.

With respect to size in terms of staff (academic, non-academic, atypical), the data suggest that the organizations that engage in open source are over-represented in the smaller size categories (less than 1000 staff) and under-represented in the larger size categories (more than 1000 staff), while those that engage in patents are over-represented in the latter.

Table 4 summarizes the average values of several variables with respect to three groups of respondents: those that engage only in proprietary marketplaces, those that engage only in non-proprietary ones, and those that engage in both.

Table 4. Distribution of university characteristics according to participation in proprietary and non-proprietary IP marketplaces

	average income	**average number of staff**	**year of foundation**	**average number of TT staff**	**average share of academic staff in science**
only proprietary (n=9)	12,286,669	1,745.56	1884	24.00	0.31
t-test (p-value)	0.00***	0.19	0.15	0.22	0.37
only non-proprietary (n=2)	48,114	880.00	1932	16.00	0.18
t-test (p-value)	0.227	0.3	0.57	0.44	0.08*
both proprietary and non-proprietary (n=22)	21,646,031	5,526.36	1879	43.09	0.38
t-test (p-value)	0.36	0.47	0.07*	0.34	0.06*

Organizations that use only proprietary marketplaces are significantly larger, in terms of income, than the other organizations in the sample. Those that use only non-proprietary marketplaces are significantly less involved in the sciences (their share of academic staff in medicine, engineering and technology and natural sciences is significantly smaller); while those that use both proprietary and non-proprietary marketplaces are significantly older and more oriented to scientific disciplines than the rest of the sample.

4.3. The strategic benefits of participation in IP marketplaces

Table 5 summarizes the answers given by respondents with respect to the benefits that they derive from engaging in the various IP marketplaces. The shares are computed by aggregating benefits into four categories ("financial gain", "competitive advantage", "innovation", "strategic relationships") and by aggregating responses at the level of marketplaces. Columns do not sum to 100% since universities could tick benefits in more than one category.

Table 5. Benefits from participation in IP marketplaces (% of universities in each IP marketplace that seek a certain benefit type)

	Patent	**copyright**	**open source**	**non-patented technology**
respondents in each IP marketplace	29	15	12	18
	%	%	%	%
financial gain	65.5	66.7	0.0	50.0
competitive advantage	27.6	66.7	16.7	44.4
innovation	31.0	46.7	58.3	61.1
strategic relationships	65.5	66.7	83.3	72.2

Respondents seek all kinds of benefits in all marketplaces, but with different intensity. Building strategic relationships with industry and with other partners is the main reason for universities to engage in all marketplaces, and particularly to engage in non-proprietary ones. Organizations that engage in open source and non-patented technology are particularly likely to seek benefits relating to building of strategic relationships (83.3% and 72.2% respectively) and to improving their innovation processes (58.3% and 61.1% respectively). Organizations that engage in the patent and copyright marketplaces are particularly seeking financial benefits (65.5% and 66.7% respectively) and benefits relating to strategic relationships (65.5% and 66.7% respectively).

Table 6 reports the shares of respondents which have ticked, for each marketplace, each specific benefit (the shares do not sum to 100% since respondents could tick up to 5 benefits). In the case of patents, most respondents select benefits that have to do with the pursuit of financial gain (direct income from market transaction) and with the building of strategic relationships that allow universities to engage in knowledge transfer (building relationships with industry networks and increasing ability to enter collaborations), consistently with the results presented in Table 5. In the case of copyright, the pattern is very similar to the case of patents, highlighting that universities seek similar benefits from both kinds of proprietary IP.

In the case of open source, no universities chose benefits relating to financial gain; benefits are instead primarily related to the building of strategic relationships (building informal relationships with industry networks, increasing ability to enter collaborative agreements, giving something to the community, were each chosen by 58.3% of respondents). Finally, in the case of non-patented technology, both social benefits (increasing ability to enter collaborative agreements, giving something to the community) and innovation benefits (providing an opportunity to make or use compatible creative expressions) are selected by the majority of respondents.

Table 6. Specific benefits from participation in IP marketplaces (% of universities in each IP marketplace that seek a certain benefit)

benefit category	**Benefit**	**patent**	**copyright**	**open source**	**non-patented technology**
	number of respondents	29	15	12	18
		%	%	%	%
financial gain	direct income from market transaction	58.6	60.0	0.0	44.4
	cost cutting	6.9	13.3	0.0	5.6
	increasing ability to raise venture capital	37.9	13.3	0.0	11.1
competitive advantage	increasing market share	10.3	40.0	0.0	5.6
	professional recognition or brand recognition	17.2	33.3	16.7	27.8
	competitive signalling	6.9	6.7	0.0	11.1
innovation	being able to use the best creative expressions	6.9	6.7	33.3	22.2
	benefiting from user or supplier involvement as a development strategy	0.0	33.3	25.0	16.7

	providing an opportunity to make or use compatible creative expressions	20.7	6.7	41.7	55.6
	innovation methodology: developing better creative expressions	13.8	13.3	33.3	16.7
strategic relationships	building informal relationships with industry networks	58.6	53.3	58.3	0.0
	increasing ability to enter collaborative agreements	48.3	40.0	58.3	50.0
	giving something to the community	17.2	20.0	58.3	55.6

4.4. Obstacles to effective and efficient exchanges in IP marketplaces

In their use of different marketplaces, universities may encounter obstacles that prevent them from obtaining the benefits they seek. Table 7 summarizes the answers given by respondents with respect to the obstacles they encounter when engaging in the various IP marketplaces. The shares are computed by aggregating obstacles into five categories ("search", "transparency", "contract negotiation", "contract enforcement", "regulation") and by aggregating responses at the level of marketplaces. Columns do not sum to 100% since universities could tick obstacles in more than one category.

Table 7. Obstacles to participation in IP marketplaces (% of universities in each IP marketplace that experience a certain obstacle type)

	Patent	**copyright**	**open source**	**non-patented technology**
respondents in each IP marketplace	29	15	12	18
	%	%	%	%
search	37.9	13.3	33.3	33.3
transparency	48.3	60.0	33.3	44.4
contract negotiation	41.4	46.7	8.3	38.9
contract enforcement	27.6	26.7	33.3	27.8
regulation	3.4	20.0	8.3	5.6

Although all obstacles are found in all marketplaces, the intensity with which they are experienced varies. In proprietary IP marketplaces, the most frequent obstacles involve lack of transparency, followed by contract negotiation issues . While in the theoretical literature IPR exchange is often assumed to be perfectly transparent and characterized by a perfect flow of information, it seems that in real IPR marketplaces organizations encounter numerous problems. This is consistent with results from the empirical literature (Cockburn, 2007). In the non-patented technology marketplace, universities mostly find problems relating to lack of transparency and contract negotiation, while in the case of open source universities indicate problems with search, lack of transparency and contract enforcement (although the distribution of answers across obstacle categories is not significantly different from that of the overall set of respondents).

Table 8 reports the shares of respondents which have ticked, for each marketplace, each specific obstacle (the shares do not sum to 100% since respondents could tick up to 5 obstacles).

Table 8. Specific obstacles to participation in IP marketplaces (% of universities in each IP marketplace that seek a certain obstacle)

obstacle category	Obstacle	patent	copyright	open source	non-patented technology
	number of respondents	29	15	12	18
		%	%	%	%
search	difficulty in locating owners of IP/ technology developers who do not enforce IP	6.9	13.3	8.3	11.1
	difficulty in locating the users of IP/technological solutions	27.6	6.7	16.7	27.8
	difficulty in finding the best IP or technological solution	13.8	0.0	25.0	5.6
transparency	difficulty in assessing the degree of originality of the IP or technological solution	31.0	20.0	0.0	22.2
	description or drawing in the IP document is not clear / difficulty in understanding non-patented technological solutions as they are not formally documented	0.0	0.0	8.3	16.7
	difficulty in assessing the economic value of the IP or technological solution	44.8	53.3	25.0	33.3
contract negotiation	difficulty in negotiating a price for the IP or technological solution	27.6	46.7	0.0	38.9
	difficulty in negotiating the terms (not related to price) of the exchange contract	31.0	13.3	8.3	16.7
contract enforcement	excessive cost of enforcing the exchange contract	10.3	20.0	0.0	16.7
	problems (not related to cost) with enforcing the exchange contract	6.9	0.0	8.3	5.6
	trust issues (e.g. opportunistic behaviour, free-riding, or similar)	0.0	6.7	25.0	11.1
regulation	differences in practices of firms	10.3	6.7	16.7	0.0
	regulations allow too exclusive rights	0.0	0.0	8.3	5.6
	international IP regulations do not fit the needs of different local markets	3.4	13.3	8.3	5.6

In the case of proprietary IP, the most relevant obstacle relates to the difficulty in assessing the economic value of IPR (44.8% of respondents engaged in the patent marketplace, and 53.3% of respondents engaged in the copyright marketplace); this, in the case of copyright, leads to difficulties in negotiating a price for the IPR (46.7%). Assessing the economic value of IP and negotiating a price for it are also quite important to universities that exchange non-patented technology (33.3% and 38.9% respectively), while in the case of open source universities find it difficult to find the best open source projects (25%), to assess their economic value (25%), and to trust the other parties involved (25%). Thus, the risk of opportunistic behaviour in the open source marketplace appears to be quite high.

4.5. Value seeking and IP governance

We have also collected information on the specific IP governance forms that, within each marketplace, universities engage in. Of the 29 organizations that engage in the patent marketplace, most (28) engage in out-licensing patents, and many (17) are active in selling patents, while comparatively few engage in in-licensing (5) buying (4) cross-licensing (5) or participating in patent pools (4). These results are in line with the conventional view of universities as performers of basic research, active in developing IP and transferring it to other organizations rather than in acquiring protected IP from the outside.

The organizations using copyright were not requested to detail their involvement in the various governance forms for copyright, but simply to state whether they engaged in registering their copyright. From their choices of benefits and obstacles in each governance form, however, we find that at least 9 are active in selling copyright, at least 3 in buying copyright, at least 12 in out-licensing copyright and at least 6 in in-licensing copyright. As in the case of patents, selling and out-licensing are the most frequent forms of engagement in this kind of proprietary IP marketplace. All of the 12 organizations that are active in open source do so in the field of software, while 3 are also active in open source pharmaceuticals and 3 in other open source communities. Of the 18 organizations that engage in markets for non-patented technology, most are active in many if not all the different governance forms: releasing non-patented technology to the public (15) or to private firms (12), using non-patented technology (16) and collaborating with other universities without patent restrictions (15). It appears, therefore, that when universities and public research organizations engage in non-proprietary IP marketplaces they tend to be active in several governance forms at the same time, while when they engage in proprietary IP marketplaces they particularly focus on selling or out-licensing.

Universities were also asked some quantitative information on the stock of patents owned and in-licensed and on the volume of transactions in the last two years. Universities tend to file their own patents rather than in-license them from other organizations, since the total stock of in-licensed patents is a small fraction (about 7%) of the total stock of owned patents. On average, the number of patent transactions in the previous two years equals 24.6% of the universities' total portfolio of owned patents. Universities have been particularly active in out-licensing patents (on average, each university out-licensed 11 patents in the previous two years), in selling patents (3.6 transactions on average) and in cross-licensing them (3.5 transactions on average). Universities have participated, on average, in 2.3 open source software projects. The number of non-patented technology transactions shows that universities are engaged in this marketplace with remarkable intensity: on average, each university has engaged in 11.25 transactions involving the release of non-patented technology to the public, in 23.25 transactions involving the release of non-patented technology to private firms, in 12.5 transactions involving the use of non-patented technology, and in 25 collaborations with other universities.

It is possible to compare the "relative advantage" of particular IP governance forms with respect to conferring a certain type of benefit, by developing an index which measures the extent to which organizations that take part in a certain governance form "specialize" in seeking a certain benefit when compared with the set of organizations that take part in the marketplace in general. Because this index is constructed exactly as the widely used Revealed Technological Advantage index, we refer to it as the index of "Revealed Governance Advantage" (RGA). For a certain governance form, the revealed governance advantage index is:

$RGA = (x_{ij}/\sum_i x_{ij})/(\sum_j x_{ij}/\sum_i\sum_j x_{ij})$

Where x_{ij} is the number of times that benefit i is chosen in governance form j, $\sum_i x_{ij}$ the number of times that all benefits are chosen in governance form j, $\sum_j x_{ij}$ the number of times that benefit i is chosen in all governance forms, and $\sum_i\sum_j x_{ij}$ the total number of benefits chosen in all governance forms (that is, the index is the ratio between the share of benefit i in governance form j and the share of benefit i in all governance forms). This index only assumes positive values: a value that is smaller than 1 indicates that governance form j is relatively under-specialized in benefit i, while a value greater than 1 indicates that governance form j is relatively over-specialized in that benefit.

The same index can be computed at the level of marketplaces, rather than governance forms. The 'Revealed Marketplace Advantage' (RMA) index is computed as

$RMA = (y_{ij}/\sum_i y_{ij})/(\sum_j y_{ij}/\sum_i\sum_j y_{ij})$

where y_{ij} is the number of times that benefit i is chosen in marketplace j, $\sum_i y_{ij}$ the number of times that all benefits are chosen in marketplace j, $\sum_j y_{ij}$ is the number of times that benefit i is chosen in all marketplaces, and $\sum_i\sum_j y_{ij}$ is the total number of benefits chosen in all marketplaces (that is, the index is the ratio between the share of benefit i in marketplace j and the share of benefit i in all marketplaces). This index allows us to compare the relative advantage of the various marketplaces in allowing organizations to reach certain benefits.

Table 9 provides an overview of results of RMAs and RGAs, computed for the four main categories of benefits[8].

Table 9. 'Revealed advantage index' for the various benefits

Marketplace / governance form	**RMA / RGA index**			
	Financial gain	**Competitive advantage**	**Innovation**	**Strategic relationships**
Patents	***1.38***	***0.23***	***0.63***	***0.64***
Selling patents	1.21	1.20	0.51	0.95
Buying patents	0.00	6.81	0.00	0.00
Out-licensing patents	1.04	0.80	0.90	1.10
In-licensing patents	0.54	1.24	2.09	0.80
Cross licensing patents	0.65	0.76	1.91	0.98
Participation in patent pools	0.98	0.00	1.91	0.98
Copyright	***1.08***	***0.42***	***0.72***	***0.50***
Selling copyright	1.21	0.91	0.63	1.06
Buying copyright	0.58	1.16	2.43	0.58
Out-licensing copyright	0.98	0.98	1.14	0.98
In licensing copyright	0.87	1.16	0.61	1.16
Open source	***0.00***	***0.17***	***1.41***	***0.97***
Participating in open source software development	n.a.	1.21	0.94	1.01
Participating in open source	n.a.	0.00	2.56	0.00

[8] In order to compute the RGA and RMA indexes, the universities' responses with respect to benefits have been aggregated into the four main categories ("financial gain", "competitive advantage", "innovation" and "strategic relationships").

pharmaceutical projects				
Participating in other open source communities	n.a.	0.00	0.85	1.28
Non-patented technology	***0.88***	***0.31***	***1.03***	***0.59***
Releasing not patented product or process innovations to the public	0.77	1.40	0.92	1.01
Releasing not patented product or process innovations to private firms	1.35	0.93	0.92	0.90
Using not patented product or process innovations	0.77	0.93	1.31	0.90
Collaborating with universities without patent restrictions	1.00	0.61	1.02	1.17

Universities particularly seek financial gain in the patent and copyright marketplaces, and particularly when selling IPR, and out-licensing patents. Instead, universities particularly seek innovation benefits in the non-patented technology marketplace (especially when using non-patented technology and collaborating with other universities), and innovation and strategic relationships in the open source marketplace.

To measure the extent to which specialization in seeking a certain benefit is concentrated in one or a few governance forms, or whether a benefit is equally sought in different governance forms, we use an "index of governance specialization" constructed as the coefficient of variation of the RGA ($\sigma_{RGA}/\mu_{RGA} \cdot 100\%$) and an "index of marketplace specialization" constructed as the coefficient of variation of the RMA ($|\sigma_{RMA}/\mu_{RMA}|$).

Table 10. Coefficients of variation across governance forms and marketplaces

Index of governance / marketplace specialization	**Financial gain**	**Competitive advantage**	**Innovation**	**Strategic relationships**
Patents: $\lvert\sigma_{RGA}/\mu_{RGA}\rvert$	59.68	138.45	71.57	50.37
Copyright: $\lvert\sigma_{RGA}/\mu_{RGA}\rvert$	28.77	*12.21*	71.01	26.90
Open source: $\lvert\sigma_{RGA}/\mu_{RGA}\rvert$	n.a.	173.21	66.14	88.38
Non-patented technology: $\lvert\sigma_{RGA}/\mu_{RGA}\rvert$	28.07	33.71	*17.83*	*12.83*
All marketplaces: $\lvert\sigma_{RMA}/\mu_{RMA}\rvert$	71.12	39.70	37.26	30.72

There is high variability in the index (the standard deviation of the coefficient of variation is, with few exceptions indicated in italics, at least 20% of the mean), showing that most categories of benefits are quite specific to certain marketplaces, and to certain governance forms within each marketplace.

We can also investigate which obstacles are relatively more prevalent in certain governance forms (or marketplaces) if compared to all the other governance forms (or marketplaces). If that were the case, IP marketplaces would appear to suffer from certain types of "institutional failures" of which policymakers seeking to improve the smooth functioning of these institutions should be aware.

Thus, we compute indexes similar to the "revealed governance advantage" and "revealed marketplace advantage" indexes mentioned earlier, only this time with respect to obstacles. Hence, we call them "revealed governance disadvantage (RGD)"

and "revealed marketplace disadvantage (RMD)" respectively[9]. The RGD index measures the extent to which organizations that take part in a certain IP governance form experience a certain obstacle, relative to the overall experience of this obstacle in all IP governance forms. Similarly, the "revealed marketplace disadvantage" index (RMD) is the ratio between the importance of an obstacle in a certain marketplace and the importance of the same obstacle across all marketplaces. The results are reported in Table 11.

Table 11. "Revealed disadvantage index" for the various obstacles

***Marketplace* / governance form**	***RMD* / RGD index**				
	Search	**Transparency**	**Contract negotiation**	**Contract enforcement**	**Regulation**
Patents	***1.16***	***0.97***	***1.08***	***0.93***	***0.41***
Selling patents	0.78	1.20	0.82	1.64	0.00
Buying patents	0.00	0.00	0.00	8.20	0.00
Out-licensing patents	0.92	1.11	0.96	1.21	0.00
In-licensing patents	1.30	0.57	1.64	0.00	0.00
Cross licensing patents	1.30	0.85	1.09	0.00	3.42
Participation in patent pools	1.30	0.76	1.09	0.00	4.56
Copyright	***0.39***	***1.15***	***1.16***	***0.85***	***2.24***
Selling copyright	0.80	0.91	0.98	1.06	1.59
Buying copyright	2.55	0.97	0.78	1.13	0.00
Out-licensing copyright	1.16	0.99	1.25	0.77	0.58
In licensing copyright	0.00	1.21	0.49	1.42	1.59
Open source	***1.39***	***0.91***	***0.30***	***1.52***	***1.33***
Participating in open source software development	1.07	0.86	1.07	1.07	1.07
Participating in open source pharmaceutical projects[10]	n.a.	n.a.	n.a.	n.a.	n.a.
Participating in other open source communities	0.00	3.00	0.00	0.00	0.00
Non-patented technology	***1.08***	***0.95***	***1.08***	***0.99***	***0.69***
Releasing not patented product or process innovations to the public	1.13	0.83	1.00	1.00	1.88
Releasing not patented product or process innovations to private firms	1.20	1.11	1.33	0.53	0.00
Using not patented product or process innovations	0.92	0.77	0.92	1.54	0.00
Collaborating with universities without patent restrictions	0.75	1.25	0.75	1.00	1.88

At the level of marketplaces, contract negotiation issues are relatively more prevalent in the case of proprietary IP and non-patented technology. These are particularly found when in-licensing, cross-licensing and pooling patents, when out-licensing copyright, and when releasing non-patented innovations to private firms.

[9] In order to compute the RGD and RMD indexes, the universities' responses with respect to obstacles have been aggregated into five main categories ("search", "transparency", "contract negotiation", "contract enforcement", "regulation").

[10] Since firms have not ticked any obstacles in the open source pharmaceuticals governance form, the RGD index cannot be calculated.

Transparency problems are particularly important in the copyright marketplace (particularly when in-licensing copyright), and so are regulation problems (particularly when buying and selling copyright). Search problems are relatively more important in the patent, open source and non-patented technology marketplaces (particularly when in-licensing, cross-licensing and pooling patents, and releasing non-patented innovations to the public and to private firms). Contract enforcement issues are relatively more importance in the case of open source. In the case of open source, most of the obstacles reported concern open source software, which is probably the area where universities have the greatest experience.

Finally, the coefficients of variation of the RGD and RMD indexes allow us to assess the extent to which obstacles are specific to certain governance structures and marketplaces.

Table 14. Coefficients of variation across governance forms and marketplaces

Index of governance / marketplace specialization	**Search**	**Transparency**	**Contract negotiation**	**Contract enforcement**	**Regulation**
Patents[11]: $\lvert\sigma_{RGD}/\mu_{RGD}\rvert$	54.62	57.74	57.29	173.56	157.27
Copyright$\lvert\sigma_{RGD}/\mu_{RGD}\rvert$	94.57	*12.97*	36.49	24.12	83.80
Open source: $\lvert\sigma_{RGD}/\mu_{RGD}\rvert$	141.42	78.57	141.42	141.42	141.42
Non-patented technology: $\lvert\sigma_{RGD}/\mu_{RGD}\rvert$	20.34	22.98	24.42	40.36	115.47
All marketplaces: $\lvert\sigma_{RMD}/\mu_{RMD}\rvert$	42.89	*10.64*	45.02	28.47	69.66

Obstacles are generally specific to IP governance forms and IP marketplaces (the standard deviation of the coefficient of variation is, with few exceptions indicated in italics, at least 20% of the mean).

5. Conclusions

While most of the analyses of the ways in which universities transfer knowledge to the economic system focus either on their use of patents or on their use of traditional knowledge dissemination channels based on publications, the empirical analysis developed in this paper clearly indicates that universities use a whole range of different channels in order to acquire and transfer knowledge. Such channels are more often used in a complementary rather than alternative way. Therefore, better understanding of the processes of knowledge transfer from academia to other economic agents such as industry (and conversely also of knowledge transfer from industry to academia) requires to take into account a much a greater range of IP marketplaces than have been considered so far.

The fact that universities use different IP marketplaces at the same time suggests that they derive specific and different benefits from each of them. This is confirmed by the data, since economic benefits relating to financial income and competitive advantage are mostly sought from the exchange of patents and copyright, while benefits relating to innovation are mostly sought from the exchange of non-proprietary IP. It must also be observed that benefits relating to the building of strategic relationships, which in

[11] The calculation of the coefficient of variation does not include the RGD index for the patent pool governance form since firms have not ticked any obstacles in relation to this governance form.

turn facilitate knowledge transfer and dissemination, are widely sought in all IP marketplaces.

As discussed in the introduction, the underlying rationale for the implementation of regulations creating incentives for universities to protect their IP through patents and copyright was to encourage dissemination of knowledge as well as to increase the universities' income from non-governmental sources. However we found that also non-proprietary marketplaces offer universities important opportunities to build and strengthen relationships with industry and with the wider community. Indeed, the exchange of non-patented technology and the engagement in open source projects allow universities to build strategic relationships to a greater extent than patents and copyright. Hence, it makes sense to question whether patents are actually the best tool for knowledge dissemination (as suggested in by Bayh-Dole) or whether instead it would be more appropriate to encourage universities to use non-proprietary marketplaces more intensively than proprietary ones. Since universities very often choose to embed their knowledge outcomes in forms of IP that are different from both patents and publications, like open source and non-patented technology, and they do so in order to build strategic relationships with industry, these forms of non-proprietary IP cannot simply be assumed to be less efficient than patents in knowledge transfer: the results of the survey suggest that these channels' role and success in facilitating knowledge dissemination merit further study. Typically, information on the engagement in open source projects and on the exchange of non-patented technology is not collected by those surveys that seek to quantify the amount of knowledge transfer performed by universities: by neglecting these channels, however, they risk missing an important share of this phenomenon.

Focusing more specifically on the use of IP marketplaces for economic purposes, we find that universities mainly rely on the sale and out-licensing of patents and copyright in order to derive income; but that also the release of non-patented technology to private firms and collaborations with other universities allow them to gain financially. Therefore, the exchange of non-patented technology also plays a role in universities' commercial strategies.

Moreover, non-proprietary IP marketplaces enjoy a definite advantage when it comes to exchanging IP for innovation purposes. Universities exchange non-proprietary IP in order to access better knowledge and technology, to improve their own innovation processes, and especially to produce technology that is compatible and accessible to a wide user base. These results suggest that when it comes to acquiring knowledge from external sources many universities still prefer to rely on knowledge that is non-proprietary and freely available. This allows them to avoid many of the problems inherent in patent acquisition, which can be a slow, laborious and time-consuming process; not to mention the delays in the circulation of knowledge that result from enforced secrecy while the patent is being approved. Universities also seem to think that the quality of non-proprietary IP is at least as good as that of proprietary IP; in fact, greater shares of respondents have selected developing better technology and using the best innovations as key benefits in the case of open source and non-patented technology, than in the case of patents and copyright.

While the fact that universities still seem to patent only a small part of their discoveries is sometimes attributed to their lack of awareness and to their inability to use these instruments, these results suggest that alternative channels for the transfer of

IP are used because they confer specific advantages that are not obtainable by patenting.

Finally, universities encounter many obstacles that prevent the IP marketplaces from functioning smoothly. Rather than insufficient or excessive regulation, the obstacles encountered concern the nature of academic knowledge, whose economic value is difficult to assess, and this in turn generates difficulties in the negotiation of contracts. These problems are particularly relevant in the patent and non-patented technology marketplaces (where benefits relating to financial gain are most relevant, hence the issue of correctly assessing the economic value of IP is particularly important) highlighting the difficulties in assessing the values of technologies that have potentially broad applications but that may be at an early stage of development. Such problems are not easily solved by interventions aiming at strengthening the market institutions, but may be intrinsic to marketplaces where knowledge goods are traded. There are also issues having to do with lack of transparency (common to all marketplaces) and search problems with finding the relevant IP or the relevant agents in the marketplace. Contract enforcement problems, concerning excessive costs of enforcement and/or lack of trust, are particularly felt in non-proprietary IP marketplaces. Removing these obstacles would require specific interventions fine-tuning the institutions that underpin transactions in the different marketplaces and introducing ways to promote information diffusion in the marketplace. Because obstacles are very often IP marketplace-specific and IP governance-specific, these interventions should not be "one size fits all" but tailored to specific forms of IP and to specific types of transactions. Therefore, more specific analyses of the obstacles that hamper the smooth functioning of marketplaces for university IP would be timely.

References

Amara, N., Landry, R., Traore, N. (2008) Managing the protection of innovations in knowledge-intensive business services. Research Policy, 37(9): 1530-1547.

Andersen, B. (2004) If intellectual property rights is the answer, what is the question? Economics of Innovation and New Technology, 13(5), pp. 417–442.

Andersen, B., Konzelmann, S. (2008) In Search of a Useful Theory of The Productive Potential of Intellectual Property Rights, Research Policy, 37, 12-28.

Arora, A., Fosfuri, A., Gambardella, A. (2001) Markets for Technology: Economics of Innovation and Corporate Strategy, Cambridge, MA: MIT Press, December 2001

Arrow, K. (1962) Economic Welfare and the Allocation of Resources for Invention. In R. Nelson (ed.) The Rate and Direction of Inventive Activity, Princeton, NJ: Princeton University Press, 609-25.

AUTM, 2002. Licensing Survey: FY 2000. Baltimore University, The Association of Technology Managers Inc.

Azoulay, P., Ding, W., Stuart, T. (2006) The impact of academic patenting on the rate, quality and direction of (public) research, NBER Economic Papers, Working Paper w11917.

Bachmann, R. (2006) Trust, Power and Control in Trans-organizational Relations, in R.M. Kramer (Ed.) Organizational Trust. A Reader, Oxford: Oxford University Press

Baldini, N. (2008) Negative effects of university patenting: Myths and grounded evidence, Scientometrics, Vol. 75, No. 2, 289–311.

Berman, E.P., 2008. Why did universities start patenting? Institution-building and the road to the Bayh-Dole Act. Social Studies of Science 38, 835–871.

Bessen, J., Meurer, M. (2005) The Patent Litigation Explosion. Working Papers 0501, Research on Innovation

Blumenthal, D., Gluck,. M., Seashore Louis, K., Stoto, M., Wise, D. (1986) University-Industry Research Relationships in Biotechnology: Implications for the University. Science, 232/4756: 1361-1366.

Campbell-Kelly, M., Garcia-Swartz, D.D. Pragmatism not Ideology: IBM's Love Affair with Open Source Software, 2008. Available at SSRN: http://ssrn.com/abstract=1081613

Cockburn. I. (2007) Is the Market for Technology Working? Obstacles to Licensing Inventions, and Ways to Reduce Them. Paper prepared for the Conference on Economics of Technology Policy, Monte Verità, June.

Cohen, W. Nelson, R., Walsh, J. (2000). Protecting Their Intellectual Assets: Appropriability Conditions and Why U.S. Manufacturing Firms Patent (or Not). NBER Working Paper, No.w7552

Coriat, B. and Orsi, F. (2002) Establishing a New Intellectual Property Rights Regime in the United States. Origins, Content and Problems. Research Policy, 31, 1491–1507.

Crespi, G., Geuna, A., Verspagen, B. (2006) University IPRs and Knowledge Transfer. Is the IPR ownership model more efficient? SPRU Electronic Working Paper Series Paper 154.

Dasgupta, P., David, P.A. (1994) Toward a new economics of science, Research Policy, 23: 487-521.

David, P. Olsen, T. (1992) Technology adoption, learning spillovers, and the optimal duration of patent-based monopolies, International Journal of Industrial Organization, 10: 517–543.

David, P.A., Shapiro, J.S. (2008) Community-Based Production of Open Source Software: What Do We Know about the Developers Who Participate?, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1286273

David, P. (2001) Will Building 'Good Fences' Really Make 'Good Neighbours' in Science. Report to European Commission (DG-Research) STRATA-ETAN workshop on IPR aspects of internal collaborations.

David, P. (2008) New moves in 'Legal Jujitsu' to combat the Anti-commons. Mitigating IPR constraints on innovation through a 'bottom-up' approach to systemic institutional reform, Dime Working Papers on IPR, n. 14.

Eisenberg, R.S., 1996. Public research and private development: patents and technology transfer in government-sponsored research. Virginia Law Review 82, 1663–1727.

Elfenbein, D. W. (2007) Publications, patents, and the market for university inventions, Journal of Economic Behavior & Organization, 63, 688–715.

Feldman, M., Stewart, I. (2006) Knowledge Transfer and Innovation: A Review of the Policy Relevant Literature, Paper Prepared for the Ontario Ministry of Research and Innovation.

Feller, I. (1990) Universities as engines of R&D based economic growth - they think they can, Research Policy, 19, 335-348.

Florida, R., 1999. The Role of the University: Leveraging Talent, Not Technology, Issues in Science and Technology, 15/4.

Geuna, A., Muscio, A., 2009. The governance of university knowledge transfer: A critical review of the literature, Minerva 47(1): 93-114.

Geuna, A., Nesta, L.J.J. (2006) University patenting and its effects on academic research: the emerging European evidence. Research Policy 35, 790–807.

Graham & Sichelman (2008), Why Do Startups Patent? , University of California Berkeley Working Paper

Graham, S.J.H and Somaya, D. (2006) Vermeers and Rembrandts in the Same Attic: Complementarity between Copyright and Trademark Leveraging Strategies in Software. Georgia Institute of Technology TIGER Working Paper.

Granstrand, O. (1999) Economics and Management of Intellectual Property. Cheltenham: Edward Elgar.

Gassmann, O; Rumsch, WC; Ruetsche, E, et al. (2009) R&D Reputation and Corporate Brand Value, Research-Technology Management, 52 (4): 16-19

Greenhalgh, C. and Rogers, M. (2006) The value of innovation: The interaction of competition, R&D and IP, Research Policy, 35(4), pages 562-580.

Hall, B.H. and. Ziedonis, R.H (2001) The Patent Paradox Revisited: An Empirical Study of Patenting in the US Semiconductor Industry, 1979-95, Rand Journal of Economics, 32(1): 101-128

Henderson, R., Jaffe, A.B., Trajtenberg, M. (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.

Hodgson, G. (1988) Economics and Institutions: A Manifesto for a Modern Institutional Economics. Oxford: Polity Press.

Hodgson, G. (1999) Economics and Utopia: Why the Learning Economy is not the End of History, Economics as Social Theory series. London and New York: Routledge .

IBM (2006) Building a New IP Marketplace: A Global Innovation Outlook 2.0, Innovation Outlook Report, IP marketplace

Jaffe, A.B., Trajtenberg, M. and Henderson, R. (1993) Geographical Localisation of Knowledge Spillovers, as Evidenced by Patent Citations. Quarterly Journal of Economics, 58(3), 577–598.

Kenney, M., Patton, D. (2009) Reconsidering the Bayh-Dole Act and the Current University Invention Ownership Model, Research Policy, 38: 1407-1422.

Lawton Smith, H. (2007) Universities, innovation and territorial development: A review of the evidence, Environment and Planning C: Government and Policy, 25 (1): 98–114.

Lee, Y. (1995) The academic climate and technological innovation, Final report to the NSF, Research on Science and Technology Program, SBR 9314.

Levin, R., Klevorick, A., Nelson, R., Winter, S., Gilbert, R., and Griliches, Z. (1987). Appropriating the returns from industrial research and development, Brookings Papers on Economic Activity, 3.

Lucas, R. (1988) On the Mechanics of Economic Development, Journal of Monetary Economics, 22:3-42

Mansfield, E., Schwartz, M., Wagner, S. (1981) Imitation costs and patents:An Empirical Study, Economic Journal, 91:907-918

Mazzoleni, R., Nelson, R. R. (1998). The Benefits and Costs of Strong Patent Protection: A Contribution to the Current Debate. Research Policy, 27(3): 273-284.

Mergers, R. and Nelson, R. (1990) On the complex economics of patent scope, Columbia Law Review, 90 (1), 839-961.

Meyer-Krahmer, F., Schmoch, U., 1998. Science-based technologies: university–industry interactions in four fields. Research Policy 27, 835–852.

Montagnani, L. (2009) Open source software, patents and royalty-free licensing , paper prepared for the 4th Annual Conference of the EPIP Association – 24-25 September 2009

Mowery, D., Sampat, B. (2005) The Baye-Dole Act of 1980 and University-Industry Technology Transfer: A Model for other OECD Governments?" The Journal of Technology Transfer, 30: 115-127.

Munari, F., Santoni, S. (2009) Exploiting complementarities in IPR mechanisms: the joint use of patents, trademarks and designs by SMEs, paper prepared for the 4th Annual Conference of the EPIP Association – 24-25 September 2009.

Murray, F., Aghion, P., Dewatripont, M., Kolev, J., Stern, S. (2009) Of Mice and Academics: Examining the Effect of Openness on Innovation, NBER Working Paper No. w14819.

National Research Council (1997) Intellectual Property Rights and Research Tools in Molecular Biology. National Academy Press, Washington, D.C.

Nelson, R.R. (1959) The simple economics of basic scientific research, The Journal of Political Economy, 67/3: 297-306.

Nelson, R. R. (2006) Reflections of David Teece's Profiting from technological innovation, Research Policy, 35(8): 1107-1109.

Plant, A. (1934) The Economic Theory Concerning Patents for Inventions. Economica, 1, New Series, 30–51.

Quah, D. (1998) A weightless economy, UNESCO Courier, December,18-21.

Rafferty, M. (2008) The Bayh–Dole Act and university research and development, Research Policy, 37/1.

Ramello, G. B. & Silva, F. 2006. Appropriating signs and meaning: the elusive economics of trademark. Industrial and Corporate Change, 15(6): 937-963.

Rivera-Batiz. L. and Romer, P. (1991). Economic integration and endogenous growth, The Quarterly Journal of Economics, May.

Rivette, K. and Kline, D. (2000) Rembrandts in the Attic: Unlocking the Hidden Value of Patents. MA: Harvard Business School University Press.

Romer, P. (1990) Endogenous Technological Change, Journal of Political Economy, 98

Schacht, W. (2005) The Bayh-Dole Act: Selected Issues in Patent Policy and the Commercialization of Technology, CRS Report for US Congress.

Teece, D.J. (1986) Profiting from Technological Innovation: Implications for Integration, Collaboration, Licensing and Public Policy. Research Policy, 15, 285–305.

Teece, D. J. (2006) Reflections on Profiting from Innovation. Research Policy, 35(8): 1131-1146.

van Zeebroeck, N., van Pottelsberghe de la Potterie, B., Guellec, D. (2008) Patents and academic research: a state of the art, Journal of Intellectual Capital, 9/2.

Zucker, L.G., Darby, M.R. (1996), Star scientists and institutional transformations: patterns of invention and innovation in the formation of the biotechnology industry, Proceedings of the National Academy of Sciences, 93 (23), 12709–12716.

Appendix 1. Results of Probit regression explaining the choice to engage in IP marketplaces

	Coefficient Estimates	Std. Error	z value	Pr(>|z|)	
(Intercept)	2.2700	1.8010	1.2610	0.2074	
AGE	-0.0009	0.0052	-0.1790	0.8580	
TOTSTAFF0708	0.0004	0.0002	2.2060	0.0274	*
TTOSTAFF	-0.0450	0.0313	-1.4370	0.1506	
UNIVERSITY	4.3070	1.7480	2.4630	0.0138	*
ENGLAND	-1.4720	1.4750	-0.9980	0.3185	
POLY	2.6750	1.9060	1.4030	0.1606	
PLATEGLASS	0.7515	1.2670	0.5930	0.5530	
REDBRICK	0.5543	1.0790	0.5140	0.6075	
OLD	8.2220	4.1980	1.9590	0.0502	.
ENGTEC	16.2200	8.9250	1.8180	0.0691	.
SCIENCE	-15.7700	6.3890	-2.4690	0.0136	*

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Appendix 2. Results of Poisson regression on the number of marketplaces universities are engaged in

	Coefficient Estimates	Std. Error	z value	Pr(>|z|)	
(Intercept)	-0.0235	1.3400	-0.0170	0.9860	
AGE	-0.0018	0.0019	-0.9560	0.3389	
TOTSTAFF0708	0.0001	0.0000	3.3920	0.0007	***
TTO	2.0990	0.8180	2.5660	0.0103	*
UNIVERSITY	2.7050	1.4250	1.8980	0.0577	.
ENGLAND	-1.9840	0.5934	-3.3440	0.0008	***
POLY	1.0030	0.5555	1.8060	0.0709	.
POST92	-1.7490	0.9485	-1.8440	0.0651	.
REDBRICK	-0.3949	0.4711	-0.8380	0.4019	
OLD	0.1797	0.8034	0.2240	0.8231	
SCIENCE	-2.7590	1.2350	-2.2330	0.0255	*

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1