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Inefficiencies in markets for intellectual property rights: experiences of academic and public research institutions

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The formal use of such intellectual property rights (IPR) as patents and registered copyright by universities has increased steadily in the last two decades. Mainstream arguments, embedded in economic theory and policy, advocating the use of IPR to protect academic research results are based on the view that IPR marketplaces work well and allow universities to reap significant benefits. However, there is a lack of evidence-based research to justify or critically evaluate these claims. Building upon an original survey of 46 universities and public research organizations in the United Kingdom, this study analyses the quality of the institutions underpinning the markets for patents and copyright, investigating potential inefficiencies that could lead to underperformance of the IPR system. These include 'IPR market failures' with respect to search processes and transparency; price negotiation processes; uncertainties in the perception of the economic value of IRP and the relationship with R&D cost. Further sources of underperformance may include 'institutional failures' with respect to enforcement and regulation. Particular attention is paid to the role of governance forms (e.g. alternative types of licensing agreements) through which IPR exchanges take place. We find that a high share of universities report market failures in IPR transactions and that the choice of IPR governance forms matter for the obstacles that are encountered. Given the importance of widely disseminating university research outcomes to foster innovation and economic development, the presence of inefficiencies in IPR markets suggests that such objectives could best be achieved by encouraging open distribution of knowledge, rather than privatization of academic knowledge.

Introduction

Since the 1980s, policymakers have increasingly supported the view that protecting the results of academic research through intellectual property rights (IPR) is necessary for university-produced knowledge to be transferred effectively (see, for example, OECD, 2003). It was argued that the possibility to commercialize their own intellectual property (IP) and to derive income from this activity would induce universities to be more proactive in disseminating their knowledge to the economic system, and would in turn allow industry to better exploit scientific discoveries (Eisenberg, 1996; Mowery and Sampat, 2005). Consequently, in many countries, university ownership of IP has been reinforced with a view to encouraging universities to seek IPR protection and to engage in IPR commercialization [see Geuna and Rossi (2011) for an overview of legislative changes in Europe].

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Although there is a growing literature on the nature and effects of university patenting activities, little attention has been paid to exploring how universities exchange IPR with other organizations – that is, how they engage in IPR markets – and the extent to which the institutional features of such markets allow universities to reach their strategic objectives. Understanding these issues, however, is important to assess the effectiveness of the legislation and policy measures that encourage universities to trade knowledge protected by IPR. It is also important in order to contribute to the ongoing debate as to whether academic knowledge is best disseminated through the traditional open science channels or through the use of IPR markets, since the arguments in favour of the latter are often dependent on the assumption that such markets function efficiently.

The present study makes an original contribution to these debates. Building upon data from the EU-funded research project, UKNOW,[1] collected from the technology transfer offices of 46 universities and public research organizations in the United Kingdom (about 27.5% of the considered population), our exploratory analysis examines how efficiently and effectively these institutions use markets for IPR. Previous work (Andersen and Rossi, 2010; Andersen and Rossi, 2011a, 2011b) discussed how universities exchange various types of IP, proprietary and non-proprietary,[2] in order to pursue different types of strategic benefits, and we suggested that non-proprietary forms of IP (such as open source and the exchange of non-patented innovations) are preferred in order to acquire external knowledge for innovation purposes or transfer knowledge to external agents, while proprietary forms of IP (such as patents and copyright) are considered preferable when the objective is purely to obtain financial rewards. It was also found that non-proprietary forms of IP are exchanged at least as frequently as proprietary ones. This study focuses on proprietary IP embedded in patents or registered copyright. In particular, it explores the functioning of markets where patents and copyright are traded by investigating, from the universities' perspective, whether these markets suffer from inefficiencies.

We identify two potential sources of inefficiencies. First, 'IPR market failures' such as search processes and transparency, price negotiation processes, uncertainties in the perception of the economic value of IP and the relationship with R&D cost; and second, 'institutional failures' with respect to enforcement and regulation. The analysis pays particular attention to the role of the governance forms through which IPR exchanges take place (e.g. alternative types of transaction agreements, such as buying and selling, licensing, cross-licensing, pooling). Our findings allow us to explore ways in which the functioning of these markets could be improved, and to contribute further to the debate on the advantages and disadvantages of protecting academic research outcomes through IPR.

The article is structured as follows. First, we review some of the existing literature on academic patenting and on the institutional features of IPR markets that influence their efficiency and their effectiveness in allowing universities to reach their strategic objectives through IPR exchanges. We also discuss our approach to understanding IPR markets as institutions, in which our interest is in investigating the extent to which these markets suffer from market and institutional failure (from the perspective of universities that engage in them). The following section introduces the data underpinning the research, and a later section presents and discusses the results of the empirical analysis before drawing conclusions.

Universities and IPR marketplaces: evidence and research gaps

Involvement of universities in IPR marketplaces

Universities' involvement in patenting has increased steadily in the last 20 years. At least since the 1980s, policymakers have supported the view that intellectual property rights are required for university-produced knowledge to be transferred effectively [see references in Eisenberg (1996)]. It has been argued that the possibility to commercialize their own IP and thereby derive income from these activities would induce universities to be more proactive in disseminating their knowledge to the economic system (Eisenberg, 1996; Mowery and Sampat, 2005). This would allow universities to derive extra income for their research activities (Kenney, 1986), which is especially important in a period of shrinking public budgets for higher education (Geuna and Muscio, 2009).

These and other arguments [reviewed extensively by Mowery *et al*. (2001) among others] have underpinned the introduction of legislation directed at expanding and strengthening the application of IPRs to the outcomes of publicly-funded research, of which the Bayh–Dole Act, implemented in the United States in 1980, is an early and very influential example. The Act gave US universities control of their inventions and other IP resulting from federally-funded research, and encouraged the use of patent protection. This was considered the best mechanism for, among other things, 'providing 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' (Schacht, 2005).

Legislation aimed at similar objectives and including similar provisions has been adopted in many other countries around the world (Geuna and Nesta, 2006). In many European countries, universities have moved away from the 'professors' privilege' model of IPR assignment – according to which IPR on the outcomes of scientific research conducted at universities would be assigned to the professor-inventor, who would then be free either to apply for a patent directly or to let another beneficiary, usually a firm, apply on his or her behalf – in favour of university ownership of IPR. Regulations that assign to universities the ownership of intellectual property arising from government-funded research and the right to commercialize the results obtained have been implemented in Flanders (1998), Denmark (2000), Germany (2002), Austria (2002), Norway (2002) and Finland (2007). Italy is the only country that has bucked the trend, awarding ownership rights to faculty employees (Mowery and Sampat, 2005). In the UK, Cambridge maintained a model of assignment of IPRs based on the professors' privilege until very recently, and there is evidence that this mode of governance for IPR was successful, leading to intense technology exploitation on the part of local firms and supporting lively academic spinout activity [Breznitz *et al*., 2008; see also references in Kenney and Patton (2009)]. Nonetheless, Cambridge also moved to a 'university-owned' model of IPR governance in 2005.

As a consequence of the introduction of legislation assigning universities the right to patent publicly-funded research, and especially thanks to 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; Geuna and Rossi, 2010) and in universities' licensing revenues [AUTM (2002), for the US; Geuna and Rossi (2010), for Europe], indicat-

ing increased engagement of universities in transactions involving patents. This is in line with a broader trend, which involves many sectors other than universities, of increased use of markets for IPRs, often referred to in the literature as 'markets for technology' (Arora *et al*., 2001; Athreye and Cantwell, 2005; Cockburn, 2007). The strategic use of IPR markets has become key to firms' economic success and sustainable corporate competitiveness (Thurow, 1997; Chesbrough, 2003).

Market failures and institutional failures in IPR markets

The increased scale of university patent ownership has attracted criticism from academics, giving rise to an extensive literature on the negative effects of university patenting [recent comprehensive reviews of the debate can be found in Nelson (2004) and Baldini (2008)]. Studies have investigated likely impacts of university patenting on the direction and quality of scientific research (as universities may eschew more risky, long-term basic research in favour of more commercially promising short-term applied research projects), on the dissemination of research results (as universities may restrict the open circulation of scientific knowledge in the form of publications and research tools, limiting the further advancement of knowledge), on the quality and intensity of collaborations with industry (as universities may compete directly with firms for access to markets and litigate with them over the assignment of IPR, leading to a deterioration in their relationships), and ultimately even on the rate of innovation of the economy.

Despite the intense debate about the implications of university patenting, little attention has been paid to the problems that universities encounter when engaging in IPR markets. This is, nonetheless, a very important issue because most arguments advocating increased patenting of academic research results, and increased university ownership of such patents, are based on the assumption that the patent market works well and allows universities to reap significant benefits from engaging in it. There are, however, many indications that this is not always the case. Evidence suggests that universities are often unsuccessful in reaping rewards from the privatization of academic knowledge for several reasons.

First, it has been shown that income from technology transfer is very skewed, with very few universities making money from patents and licences (Charles and Conway, 2001; Bulut and Moschini, 2006): for many universities, the direct costs of IPR exceed revenues (Charles and Conway, 2001) and technology transfer offices struggle to be profitable (Kenney, 1986). It must be noted that, as universities gain experience with patenting and become more selective with their patent applications, the profitability of patent exploitation activity increases [see recent data for the UK presented by HEFCE/PACEC (2010)]. Still, for most universities in the UK, collaborative research projects, including consultancies, are a more important source of income than licensing (D'Este and Perkmann, 2007).

Secondly, much of the patenting effort does not realize value in many universities. For example, Tang *et al*., (2009) discuss the problem of abandonment of university patents, finding evidence that 25–30% of patent applications are abandoned prior to the filing stage because of such problems as low quality of the patent, difficulty in finding a potential investor, and/or the fact that the underlying technology is unsuitable for patenting. Tang *et al.* (2009) suggest that this rate of abandonment does not indicate a failure of the patent system as much as further awareness of the disutility of 'patenting everything that can be patented'.[3]

Several explanations have been proposed for the asserted inability of universities to exploit their IPRs to their full potential. According to Macdonald (2009) one of the key problems that may explain the lack of success of many universities in exploiting the patent system for economic reward is that such a system does not work well in all economic activities. The model of knowledge production and transfer based on intensive patenting works well in the pharmaceutical industry (Levin, 1986; Harabi, 1995), but it is not prevalent in most other industries, such as software and electronics, where firms rely on trade secrets, marketing strategy and lead times to exploit technological advantage, rather than on patents (Brouwer and Kleinknecht, 1999). By adopting a model of technology transfer that is based on the experience of the pharmaceutical industry, university managers tend to overestimate the importance of patents (Rappert *et al*., 1999). The fact that the importance of patents differs by industry (Klevorick *et al*., 1987) suggests that universities need different knowledge transfer procedures, methods and goals for differing industries. It must also be remembered that the sheer variety of university research activities implies that universities produce a wide range of intellectual property, not all of which is suitable for patenting (Baghurst *et al*., 2009).[4]

Even in cases where university patents may hold value for industry, a further problem arises from the naiveté of some university managers in their use of the patent system, seemingly unaware that reaping its benefits requires a more strategic use of the system (for example, by engaging in defensive patenting or in amassing patent portfolios to cover specific areas of technology) or, perhaps, lacking the resources to do so effectively (Macdonald, 2009). More generally, Rivette and Kline (2000) point to managerial myopia, inertia and incompetence as explanations for under-exploitation of IPR.

Besides the factors mentioned so far, this paper seeks to clarify a further reason for universities failing to make the most of the IPR system – that markets for technology face many institutional obstacles and structural challenges. That is, even when patenting of university research outcomes is feasible, universities may still fail to profit from their IPR exchanges because of problems and inefficiencies in the marketplace. Mainstream economics argues that knowledge privatization is necessary in order to remedy the market failure connected to the inherently public nature of knowledge – what has been termed the 'tragedy of commons' (Hardin, 1968) – and assumes that the instantiation of property rights automatically gives rise to markets where they can be traded (Rivera-Batiz and Romer, 1991). For a well-functioning market to emerge, there must be no uncertainty about the quality, characteristics and value of the product that is exchanged; consequently, the transacting parties are able to agree on a market price that regulates the exchange efficiently. Therefore, if well-functioning IPR markets are to emerge spontaneously (Arora *et al*., 2001), it must hold that anyone reading the IPR document should be able to fully understand and value its contents, and to implement the knowledge codified therein (Gans and Stern, 2003). If this is the case, the only requirement for transactions to be sustainable is – as for all market-based contracts (Williamson, 1975) – the presence of adequate enforcement mechanisms to prevent free riders who have not purchased or licensed the IPR from exploiting the knowledge they embed, and the presence of safeguards to punish attempts to deviate from the contract terms.

The experience of actual IPR exchanges, however, suggests that further complications may arise. First, there may be considerable uncertainty around the characteristics of the intellectual asset that is exchanged. Secondly, as empha-

sized in institutional economics (Hodgson, 1988; Hodgson, 1999), processes of exchange are supported by networks of social relationships and by many and complex institutions. The institutions which support and influence exchange processes can be both physical infrastructures and entities (in the case of IPR, examples are patent databases, intellectual property offices, copyright and trademark libraries), as well as, very importantly, institutions in a sociological sense. Differing social norms and rules of behaviour (whether explicitly codified into laws, regulations and codes of practice, or informally held among a community of agents participating in the marketplace) give rise to different types of markets, such as auction markets, price tag markets, medieval-type regional street markets, black or unauthorized markets, and so on. The social relationships through which exchanges take place are underpinned by individual beliefs and expectations (in relation to the other party's trustworthiness, the fairness of the contract and its price, and other aspects), which may influence the outcome and characteristics of the transactions (Bromiley and Harris, 2006). To emphasize the web of social relationships and supporting institutions that are required for processes of exchange to take place, as well as the physical and metaphorical interaction space where they unfold, we prefer the concept of marketplaces rather than the notion of markets used in mainstream economics.

Problems in the marketplace can be of different types. If markets are considered as price clearing mechanisms, they often fail when there are problems of asymmetric information, when the characteristics of the good are not perfectly known by both buyer and seller (Akerlof, 1970), or when there are problems of spillovers and externalities, when one or both parties are not fully able to capture the benefits of the exchange (Arrow, 1969). If marketplaces are considered as platforms of social relationships whose functioning is supported by historically evolving institutions, it is possible to identify, at least in principle, a different kind of failure – the failure of supporting institutions to ensure the efficient functioning of these marketplaces – which can happen even when the goods traded therein fulfil all the standard assumptions.

Both of these sets of problems (which, for simplicity, we call respectively 'market' and 'institutional failures') can occur, at least in principle, when IPR is exchanged. Moreover, different governance forms for the exchange of IPR can be affected by these problems in different ways. Andersen and Konzelmann (2008) bring attention to the relationship between specific governance forms for IPR exchange and different processes of value seeking. For example, a patent cross-licensing agreement may be based upon the ambition to achieve a strategic market position, whereas selling a patent may be used to gain one-off income, and a patent pool may facilitate the development of a common technological standard. Similarly, the processes of selling, buying, out-licensing or in-licensing patents may be affected by market and institutional failures in different ways.

The objective of the empirical investigation presented in this paper is to shed some light on the problems that universities encounter when engaging in the marketplaces for patents and copyright, paying attention to the specificities of the governance forms through which IPR exchanges take place. The analysis is developed in three parts.

IPR market failures. We investigate whether some key assumptions underpinning the emergence of well-functioning marketplaces are reflected in the universities' experience. First, we ask whether it is possible to claim that the parties in the

exchange possess perfect and symmetric information about the good that is exchanged, and whether the market clears rapidly thanks to the identification of potential partners in the transaction and the emergence of a market-clearing price. Secondly, we investigate whether the process of price setting reflects the assumptions underpinning IPR theory; that is the argument that the (temporary) monopoly power guaranteed by IPR confers full appropriability over the invention so that the inventor is able to extract a monopoly price that covers the R&D cost of the invention and reflects its economic value (Arrow, 1962). The conceptual framing of IPR market failure that has informed our data collection is outlined in Table 2 (Part 1) and Table 3.

Institutional failures. We investigate institutional failures in the marketplace by analysing whether the enforcement mechanisms in the marketplace function properly; whether it is possible to rule out opportunistic behaviour either by means of effective contractual safeguards (i.e. by negotiating complete contracts), or thanks to the presence of trust among the parties; whether there are shared social and behavioural norms that facilitate transactions by promoting shared expectations; and finally whether formal IPR regulations are adequately supporting IPR exchanges. Our conceptual framing of institutional failures, which has informed our data collection, is outlined in Table 2 (Part 2).

Role of IP governance. We also investigate the extent to which the various failures are specific to certain IP governance forms within the patent and copyright marketplaces. These include alternative licensing forms, as well as buying and selling of patents and copyright, and they are outlined in Table 1.

The analysis of the problems that universities encounter when exchanging IPR in the marketplace provides interesting suggestions for policymakers, who may wish to remove, as much as possible, obstacles to the efficient exchange of IPR, and allows us to contribute new empirical evidence towards an emerging literature on problems in markets for technology (Arora *et al*., 2001).

Data source and variables

The empirical analysis is based upon survey data from a sample of universities, colleges and public research organizations in the UK, collected between October 2008 and March 2009.[5] The list of relevant institutions and of their respective technology

Table 1. IP marketplaces and governance forms considered in the analysis

IP marketplaces	Governance forms
Patents as a tool for the protection of novel ideas	Selling patents Out-licensing patents Cross licensing patents Participation in patent pools Buying patents In-licensing patents
Copyright as a tool for the protection of original creative expressions	Selling copyright Out-licensing copyright Buying copyright In licensing copyright

Table 2. IPR market and institutional failures considered in the analysis

Type of failure	Assumption tested	Specific obstacle investigated
Part 1: IPR market failures	Perfect information about characteristics and value of IPR	Difficulty in finding the best IPR
		Difficulty in assessing degree of novelty/originality of the IPR
		Lack of clarity of IPR document
		Difficulty in assessing economic value of IPR
	Market clears easily	Difficulty in locating owners of IPR
		Difficulty in locating users of IPR
		Difficulty in negotiating a price for IPR
Part 2: Institutional failures	Presence of enforcement mechanisms	Excessive cost of enforcing contract
		Problems, not related to cost, with enforcing contract
	Possibility of ruling out opportunistic behaviour by negotiating complete contracts or thanks to trust	Difficulty in negotiating the terms, not related to price, of contract
		Trust issues (opportunistic behaviour, free-riding, or similar)
	Shared behavioural norms and expectations	Different practices of firms
	Presence of adequate supporting regulations	Regulations allow too exclusive rights
		International IPR regulations do not fit needs of different local markets

Table 3. Further IPR market failures considered in the analysis

Type of failure	Assumption tested	Choice options
IPR market failures	IPR confers (temporary) monopoly power	Price is usually set by the buyer
		Price is usually set by the seller
		Price is usually jointly negotiated between buyer and seller
		Price is usually set by third (independent) party
		Depends on circumstances: no usual way in which price is set
	IPR renders knowledge perfectly appropriable and makes it possible to cover R&D costs	Price of IPR usually correctly reflects economic value of invention
		Price of IPR is usually able to cover research and development (R&D) costs of invention

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. The details provided by UNICO are: each member organization's name and website, as well as name, email and telephone number of their contact person. This list was then integrated with the set of institutions that responded to the HE-BCI 2004–05 and 2005–06 surveys of the Higher Education Funding Council for England, which includes 162 universities, colleges and public research organizations in the United Kingdom. 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 15 December 2008 and 28 February 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 online, returning the questionnaire by email, or returning the questionnaire by post or fax. We obtained 46 valid responses (a 27.2% response rate). Universities were asked questions concerning several types of IP protection mechanisms (patents, copyright, open source and non-patented technology), and several governance forms for the exchange of such IP (selling, buying, out-licensing, in-licensing, cross-licensing, pooling and so on). They were asked about:

- the extent and intensity with which they participated in each marketplace and each governance structure (stock of IP held and number of transactions in the previous two years);
- the strategic benefits they seek when trading IP;
- the obstacles they encounter when trading IP; and
- the way in which the price of patents and copyright is determined.

Finally, universities were requested to provide some general information: location, ownership (independent or subsidiary), size (current number of employees, current yearly turnover), research intensity (yearly expenditure on 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] The present analysis builds upon the respondents' answers in relation to their experience with the exchange of patents and copyright, considering the governance forms listed in Table 1.

The answers analysed here are those relating to participation in IPR marketplaces, obstacles found in IPR marketplaces and the efficiency of the price setting mechanisms used. Table 2 lists the possible obstacles (grouped according to whether they indicate failures in the assumptions of IPR theory – which we term 'IPR market' failures – or failures in the institutions that support the marketplace – which we term 'institutional' failures). For each marketplace and governance form, universities were asked to tick the five most important obstacles that they experienced. Universities were also presented with several statements concerning the price setting process and the efficiency of the IPR price (both indicative of possible market failures), and asked to express their agreement or disagreement (Table 3).

Empirical analysis

Context: respondents and their participation in IPR marketplaces

The sample includes several sorts of organizations. Most are universities, some are university colleges, others are institutions of higher education (such as music conservatoires and arts colleges), and a few are public research organizations. Table 4 compares the distribution of institutions in the sample and in the set of respondents, across several main characteristics: location, size (in terms of academic staff employed), institutional type (distinguishing among universities, other higher education institutions and public research organizations, and further subdividing universities into five categories according to the period in which they were founded[7]). The distribution of respondents by location, institutional type and size in terms of total staff is representative of the overall sample.

Of the 46 respondents, 13 do not exchange any form of IP, while 29 exchange patents and 15 exchange formally registered copyright materials. Of the 29 organizations that engage in the patent marketplace, most (28) engage in out-licensing patents, and more than half (17) are active in selling patents, while comparatively few engage in in-licensing (five), buying (four), cross-licensing (five) or participating in patent pools (four). Of the 15 organizations that exchange formally registered copyright, most are active in selling copyright (12) and in out-licensing it (nine), while fewer are active in buying (six) and in-licensing (three) copyright. Thus, selling and out-licensing are the most frequently used governance forms for the exchange of both patents and copyright. This is confirmed by the data on IP transactions: the total stock of in-licensed patents is a small fraction (about 7%) of the total stock of owned patents, suggesting that universities tend to file their own patents rather than in-license them from other organizations. On average, in the previous two years, each university out-licensed 11 patents, sold 3.6 patents and engaged in 3.3 patent

Table 4. Structure of sample and respondents

		Sample (169) %	Respondents (46) %
Location	England	82.2	89.1
	Wales	5.3	4.3
	Scotland	11.2	6.5
	Northern Ireland	1.2	0.0
	Total	*100*	*100*
Type	Old universities	5.9	8.7
	Red brick universities	17.8	26.1
	Plate-glass universities	13.6	15.2
	Former polytechnics	20.7	19.6
	Modern universities	16.6	8.7
	Colleges of higher education	16.6	8.7
	Public research organizations	7.7	13.0
	Other	1.2	0.0
	Total	*100*	*100*
Size (total staff)	Fewer than 500	10.7	4.3
	500–1000	13.0	10.9
	1000–5000	47.3	56.5
	Over 5000	24.3	28.3
	Missing	4.7	0.0
	Total	*100*	*100*

pooling agreements. No universities reported engaging in the purchase of patents in the previous two years, while each university engaged on average in 1.4 in-licensing transactions and 1.2 cross-licensing agreements. These results are in line with the conventional view of universities as original research performers, active in developing IP and transferring it to other organizations rather than in acquiring IPRs from the outside.

Moreover, the overall number of patents sold, out-licensed, cross-licensed and pooled in the previous two years constitutes only 11.4% of the university's overall stock of own patents (excluding those that have been in-licensed), confirming that most of the universities' patents are not commercialized. Table 5 details the shares of different types of organizations that engage in the exchange of patents and/or copyright.

Public research organizations, old universities founded before the nineteenth century and former polytechnics that have become universities in 1992, are the institutions that engage the most in exchanging patents. Conversely, colleges of higher education and modern universities founded after 1992 engage least in patent exchange. Public research institutions and old universities are most active in the exchange of registered copyright, while colleges of higher education, red brick and modern universities exchange copyright the least. Greater size of institution in terms of total staff is associated with greater engagement in patent exchange. This is consistent with other evidence which suggests that most patenting activity is done by larger, research-oriented universities (old universities in the UK tend to be more research-oriented, and so are public research organization) (Charles and Conway, 2001; UNICO, 2003). At the same time, the intense engagement in patenting on the part of former polytechnics is consistent with some evidence suggesting that less research intensive universities, which are less successful in obtaining research grants, can also be strongly engaged in patenting: in order to raise funds from industry, they turn to performing more applied research, leading to more patentable results (Thursby and Kemp, 2002).

IPR market failures

We first investigate whether the assumptions of mainstream economic theory about the characteristics and functioning of IPR markets are reflected in the universities' experience, and whether the exchange leads to efficient outcomes. We ask whether

Table 5. Participation in IP marketplaces by type of organization

		N	patents %	copyright %
Type	Old universities	4	75.0	75.0
	Red brick universities	12	50.0	16.7
	Plate-glass universities	7	57.1	42.9
	Former polytechnics	9	88.9	44.4
	Modern universities	4	25.0	0.0
	Colleges of higher education	4	25.0	25.0
	Public research organizations	6	100.0	83.3
Size (total staff)	Fewer than 500	2	50.0	50.0
	500–1000	4	50.0	25.0
	1000–5000	24	62.5	37.5
	More than 5000	16	68.8	43.8

the assumptions about the transactional nature of IPR are satisfied (in particular, whether it is possible to claim that the parties in the exchange possess perfect and symmetric information about the IP that is exchanged, and whether the market clears rapidly by allowing the identification of a partner for the transaction and the emergence of a price), and whether the IPR system is successful in conferring a temporary monopoly power which allows the inventor to set an efficient price that correctly reflects the economic value of the invention and that is able to cover the R&D cost of the invention. Several questions in our survey allow us to assess whether universities have perfect information about the IPR that they exchange. Table 6 reports the shares of universities that consider the obstacles reported in the left column as important. Shares are computed with respect to the number of universities that answered each question.

The universities' answers show that the content of the IPR is generally clear and it is not too difficult for universities to identify the best patents to exchange.[8] This indicates that the patent system is successful in codifying the knowledge embedded in the patent documents so that it can be clearly understood and transmitted.[9] However, it is quite difficult to assess the originality of patents, especially when selling and out-licensing them (this problem is less important in the case of copyright, where the requirements for creative expressions to be original are much less stringent than in the case of patents). A possible explanation for this is that, as knowledge is increasingly patented, it becomes increasingly common to patent inventions with smaller inventive steps and it becomes more difficult for patent examiners to certify the effective novelty of the invention with respect to the state of the art, sometimes leading to bad patents (Moore, 2006). Hence, universities may find it hard to persuade potential buyers and licensees of the novelty of the knowledge embedded in their patents.

By far the most serious problem for universities is the difficulty in assessing the economic value of the IPR (particularly when out-licensing and selling it). This may be linked to the fact that academic knowledge is often quite basic in nature, and therefore it is characterized by high uncertainty in terms of the type and volume of resulting implementations and the time it will take for those to emerge (Nelson, 1959). Therefore, it may be difficult to persuade potential buyers or licensees of the value of this knowledge in order to obtain a fair price. Moreover, the patent's value usually depends on its intended utilization (Merges and Nelson, 1990), which makes it difficult to reach an objective valuation. Another reason may be lack of information (Monk, 2009); in order to arrive at an accurate valuation, the potential buyer would need to know the details of all the licenses granted on a patent, but

Table 6. Information failures

Assumption tested	Specific obstacle investigated	Patents	Copyright
	Number of universities that answered question	14	11
Perfect information about characteristics and value of IPR	Difficulty in finding the best IPR	28.6%	n.a.
	Difficulty in assessing degree of novelty/originality of IPR	64.3%	27.3%
	Lack of clarity of IPR document	0.0%	n.a.
	Difficulty in assessing economic value of IPR	92.9%	72.7%

existing licenses are frequently subject to confidentiality agreements. Consequently, the potential buyer may be unable to value the patent correctly, because it would not know if its main competitors already have licenses.

The difficulty in identifying potential partners for IPR transactions and in negotiating prices are discussed in Table 7, which reports the share of universities that considers the obstacles reported in the left column as important. Shares are computed with respect to the number of universities that answered each question. In the case of patents, almost 60% of universities that answered this question find it difficult to identify potential users of their patents. This may be linked to the nature of academic patents, which are often at an early stage of development and costly to commercialize, and hence few firms are willing to invest in them (Jensen and Thursby, 2001), but it may also indicate prohibitively high search costs caused by the time and expense associated with identifying and researching niche markets and communicating the features and benefits of the technology (Cockburn, 2007), despite the existence of such tools as searchable patentable databases. According to Monk (2009), the desire on the part of buyers to maintain anonymity also limits the market. Often, interested buyers prefer to remain anonymous to avoid disclosing to industry competitors information about what technology and product lines they are pursuing. Consequently, the seller may not know the identity of the potential buyer and the reasons why they are interested in the patent or license, and this may make it more difficult to negotiate the transaction.

These search-related problems do not appear to be of great relevance in the copyright marketplace, where buyers and sellers are found quite easily. In the case of both patents and copyright, negotiating a price proves difficult. This is probably because of the problem of assessing the economic value of the IPR, which gives rise to contrasting valuations of the good (Mansfield *et al*., 1981; Hall and Ziedonis, 2001). Because it is often difficult to identify potential buyers or sellers and, even when these are found, it is difficult to negotiate the price, the market does not clear easily. Cockburn (2007) finds similar results for patent licensing deals in the US and Canada: in about a third of cases, the would-be transactor was unable to identify even a single potential licensor or licensee to approach (in the case of our set of universities, this problem appears to be even more serious as close to two-thirds of respondents find it difficult to identify potential users). Where firms were able to identify a potential licensor/licensee, substantive negotiations over a licensing deal commenced in only some one-third of cases, and of these negotiations about half failed to reach an executed agreement.

As most negotiations prove to be difficult, it is interesting to further examine the process through which a price eventually emerges. Tables 8 and 9 report the distribution of universities agreeing with the statements reported in the column on

Table 7. Market clearing failures

Assumption tested	Specific obstacle investigated	Patents	Copyright
	Number of universities that answered question	14	11
Market clears easily	Difficulty in locating owners of IPR	14.3%	18.2%
	Difficulty in locating users of IPR	57.1%	9.1%
	Difficulty in negotiating price for IPR	57.1%	63.6%

the left; shares are computed with respect to the number of universities that answered each question, and averaged across governance forms. When buying or in-licensing patents, universities perceive themselves as being the weaker party in the exchange, with the seller able to set the price. That is, they buy or in-license patents for which there may be many potential buyers, and hence the seller is in a stronger bargaining position. When universities sell, out-license, cross-license or pool patents, the situation is akin to a bilateral monopoly, with a seller/licensor and a buyer/licensee negotiating to obtain a favourable price. This is probably because academic patents are either very basic and far from potential implementation and/or embed very specialized and advanced knowledge, so that few firms look to acquire them, which puts the potential buyer in a stronger bargaining position.

When selling, out-licensing, cross-licensing or pooling patents, universities are not able to exploit their monopoly over patented knowledge in order to extract a high price, but rather bargain the price with the other party. So, it is not surprising to find that few universities agree that the price negotiated correctly reflects the value of the invention and covers the cost of the R&D that produced it. That is, universities express the belief that they are not fully able to appropriate the economic benefits from the sale of their knowledge via the use of the patent system. Instead, when universities buy or in-license patents, they find they pay a high price (usually set by the seller) which allows the seller to cover its R&D costs (and which possibly is higher than the value of the invention).

The market for copyright is also one where the price is negotiated between the parties rather than set by one of them. Having a monopoly on the knowledge

Table 8. Patent appropriability failures

Assumption tested	Choice options	Buying or in-licensing patents	Selling or out-licensing patents	Cross-licensing or pooling patents
IPR confers (temporary) monopoly power	Price is usually set by buyer	12.5%	6.1%	0.0%
	Price is usually set by seller	62.5%	1.3%	0.0%
	Price is usually jointly negotiated between buyer and seller	25.0%	44.1%	100.0%
	Price is usually set by a third (independent) party	0.0%	0.0%	0.0%
	Depends on the circumstances: no usual way in which price is set	0.0%	15.1%	0.0%
IPR renders knowledge perfectly appropriable and allows to cover R&D costs	Price of IPR usually correctly reflects economic value of invention	37.5%	23.9%	50.0%
	Price of IPR is usually able to cover R&D costs of invention	62.5%	27.6%	12.5%

Table 9. Copyright appropriability failures

Assumption tested	Choice options	Buying or in-licensing copyright	Selling or out-licensing copyright
IPR confers (temporary) monopoly power	Price is usually set by buyer	0.0%	10.1%
	Price is usually set by seller	33.3%	23.7%
	Price is usually jointly negotiated between buyer and seller	58.3%	41.4%
	Price is usually set by a third (independent) party	0.0%	0.0%
	Depends on the circumstances: no usual way in which price is set	8.3%	24.7%
IPR renders knowledge perfectly appropriable and allows to cover R&D costs	Price of IPR usually correctly reflects economic value of invention	41.7%	17.1%
	Price of IPR is usually able to cover R&D costs of invention	12.5%	17.4%

exchanged, thanks to the ownership of copyright, does not ensure that the seller has the ability to set the price unilaterally. Rather, probably because there is a limited number of potential buyers for copyrighted knowledge, buyers also have some market power, and the price is the outcome of a negotiation. This leads most universities to refute the statement that the price of copyright reflects the economic value of the invention and that it allows the inventor to cover R&D costs. It appears that the use of registered copyright does not guarantee full appropriability of the economic returns from the knowledge that is exchanged.

Institutional failures

We then investigated institutional failures in the marketplace. We asked whether enforcement mechanisms in the marketplace function properly, whether it is possible to rule out opportunistic behaviour (either by means of effective contractual safeguards or thanks to the presence of trust among the parties), whether there are shared social and behavioural norms which facilitate transactions by promoting shared expectations, and finally whether formal IPR regulations adequately support IPR exchanges. Table 10 reports the shares of universities that agree that the statements reported in the column on the left identify important obstacles to exchanges in the patent or copyright marketplace. Shares are computed with respect to the number of universities that answered each question.

The results suggest that the institutions of the marketplace are perceived as hampering IPR exchanges by only a minority of respondents. The exception, in the case of patents, is the difficulty in negotiating the (non-price) terms of the exchange contract, which is perceived as relevant by 64.3% of the universities that answered the question. This suggests that it is very difficult for universities to write contracts that guarantee terms of use perceived as fair by both parties. Interestingly, enforcement

Table 10. Institutional failures

Assumption tested	Specific obstacle investigated	Patents	Copyright
	Number of universities that answered the question	14	11
Presence of enforcement mechanisms	Excessive cost of enforcing contract	21.4%	27.3%
	Problems, not related to cost, with enforcing contract	14.3%	0.0%
Possibility to rule out opportunistic behaviour by negotiating complete contracts or thanks to trust	Difficulty in negotiating the terms, not related to price, of contract	64.3%	18.2%
	Trust issues (opportunistic behaviour, free-riding, or similar)	7.0%	9.1%
Shared behavioural norms and expectations	Different practices of firms	21.4%	9.1%
Presence of adequate supporting regulations	Regulations allow too exclusive rights	0.0%	0.0%
	International IPR regulations do not fit needs of different local markets	7.1%	18.2%

costs and other difficulties are not perceived as being very important by most respondents, and it seems that shared norms of behaviour prevail. Similar patterns emerge in the case of copyright, with the difference that only 18.2% of respondents indicate difficulty in negotiating the non-price terms of the copyright contract as an important obstacle. However, the enforcement cost of copyright is considered a problem by 27.3%.

IPR governance forms

We now turn to individual governance forms within each IPR marketplace (selling, buying, licensing, pooling, etc.). We investigated the extent to which each type of IPR market and institutional failure (as highlighted in Tables 2 and 3) is specific to certain governance forms (outlined in Table 1). We do so by computing, for each statement investigated (highlighted as assumption tested in Table 11), the coefficient of variation of the percent of respondents agreeing with the statement across all IP governance forms. Higher values of the coefficient of variation listed in Table 11 indicate greater variability (or greater disagreement) in the importance of that type of failure across governance forms.

In the case of patents and institutional failures, there appears to be great variability across governance forms with respect to the cost of enforcing the contract (found particularly when selling and out-licensing patents); problems with enforcing the contract, not related to cost (found particularly when selling and out-licensing patents); trust issues (found particularly when buying patents); different practices of firms (found particularly when selling and out-licensing patents); and dealing with international markets (found particularly when cross-licensing and pooling patents). IPR market failures seem to occur to a similar extent in all governance forms, denoted by a relatively small coefficient of variation.

Table 11. IPR market and institutional failures: variability across governance forms

Type of failure	Assumption tested	Specific obstacle	Patent governance forms: coefficient of variation	Copyright governance forms: coefficient of variation
IPR market failures	Perfect information about characteristics and value of IPR	Difficulty in finding the best IPR	0.8	n.a.
		Difficulty in assessing degree of novelty/originality of IPR	0.7	1.17
	Market clears easily	Lack of clarity of IPR document	0.0	n.a.
		Difficulty in assessing economic value of IPR	0.6	0.14
		Difficulty in locating owners of IPR	1.1	1.62
		Difficulty in locating users of IPR	0.8	1.21
		Difficulty in negotiating price for IPR	0.6	0.38
Institutional failures	Presence of enforcement mechanisms	Excessive cost of enforcing contract	1.6	0.29
	Possibility to rule out opportunistic behaviour by negotiating complete contracts or thanks to trust	Problems, not related to cost, with enforcing contract	1.6	0.00
		Difficulty in negotiating contract terms, not related to price	0.6	2.00
	Shared behavioural norms and expectations	Trust issues (opportunistic behaviour, free-riding, or similar)	2.4	1.31
	Presence of adequate supporting regulations	Different practices of firms	1.6	2.00
		Regulations allow too exclusive rights	0.0	0.00
		International IPR regulations do not fit needs of different local markets	1.6	0.87

For copyright, in the case of institutional failures, there is great variability across governance forms with respect to difficulty in negotiating the terms of the copyright contract not related to price (particularly found when out-licensing copyright); trust issues (particularly found when out-licensing copyright); and different practices of firms (particularly found when selling copyright). In the case of IPR market failures, there is great variability across governance forms with respect to difficulty in assessing the originality of copyright (particularly found when selling and out-licensing); difficulty in locating the owners of copyright (particularly found when buying); and difficulty in locating the users of copyright (particularly found when selling and out-licensing).

Conclusions

Our investigation into the obstacles that universities encounter when exchanging formal IPR – patents and copyright – allows us to shed some light on the functioning and efficiency of IPR marketplaces. The main findings can be summarized as follows.

Universities report a high degree of IPR market failure when exchanging patents and copyright. They reject the assumption of perfect information about the value of IPR, which they find difficult to assess. Furthermore, probably because of the difficulty in agreeing on the value of the IPR, there are substantial difficulties in the negotiation of the price, so that the market does not clear very easily. In the case of patents, this is compounded by the difficulty in finding potential buyers for academic patents. While, in the case of patents, market failures are equally found across all IP governance forms, in the case of copyright, certain problems are specific to governance forms (for instance, locating the users of copyright is a relatively important problem when out-licensing and selling, locating the owners of copyright is a relatively important problem when buying, and difficulty in assessing the originality of the copyright is a relatively large problem when out-licensing and selling).

The price that emerges from IPR transactions does not allow the university to appropriate the full financial benefits: incentives to trade IPR reside in other strategies. The price is usually the outcome of a negotiation between buyer and seller, both of which have some bargaining power. Consequently, the IPR seller or licensor is unable to extract a monopoly price from the transaction of the IPR. Consistent with this result, universities also find that the price that emerges from the negotiation does not make it possible to cover the R&D costs of the invention and does not reflect its perceived financial value. Thus, the incentives to exchange IPRs in the marketplace must be partly non-financial (such as knowledge transfer, interactive learning processes, strategic positioning, etc.). In the case of patents, universities consider these problems to be particularly important when they are on the supply side of a transaction; that is, when they sell, out-license, cross-license or pool university patents. In the case of copyright, these problems are considered quite important across all governance forms.

Universities consider institutional failures to be relatively unproblematic. In the case of patents, most problems having to do with the institutions that support the marketplace are considered important by only a minority of respondents. The only exception is the problem of negotiating the non-price terms of the patent, whose importance is considered quite high across most governance forms. This suggests

that it is difficult for universities to agree on terms of use that are perceived as fair by both parties. Other problems are specific to certain IP governance forms, such as the cost and other difficulties of enforcing the patent contract, trust issues, different norms of behaviour, and problems with international regulations.

In the case of copyright, most types of institutional failures are considered important by relatively few respondents. A notable exception is the cost of enforcement of copyright, which is considered quite high relative to the value of the intellectual property being exchanged (given that infringements are difficult and costly to detect and to litigate, and the compensation for such infringements is generally low). Other problems, which are specific to certain IP governance forms, include the difficulty in negotiating the non-price terms of the contract, trust issues and different behavioural norms.

These findings have several implications for policymakers interested in addressing the issues hampering IPR marketplaces. On the one hand, some of the obstacles reported could be mitigated by interventions aimed at increasing transparency in the marketplace by enhancing the circulation of information about the characteristics of IPR. Examples include better public reporting of IP transactions and their economic impact, greater disclosure of the true ownership status of patents and licences, and provision of more information in public patent databases (e.g. ownership and assignment, licensing and litigation status, whether a patent is available for licensing), and greater use of standardized contracts [see Cockburn (2007) for a discussion of possible interventions to increase the transparency of IPR marketplaces]. In order to improve market clearing processes, some interventions could be aimed at facilitating the identification of potential partners in IPR transactions and at improving negotiations between the parties; for example, provision of more information about university patents and copyright available for sale or licensing, and greater use of intermediaries to help both parties assess the value of the IPR and negotiate contracts.

On the other hand, it appears that some problems are caused by the nature of academic knowledge and cannot be solved by privatizing it via patents or copyright. As university knowledge tends to be quite basic in nature, it is likely to involve substantial uncertainty in terms of its scope of application (which often leads to firms' inability to value such knowledge and to appropriate fully its economic returns) and time to market (which would require firms to invest substantially in further development activities). These features of academic knowledge make IPR negotiations particularly difficult and lead to prices which do not correctly reflect the value of the underlying knowledge. Even though IPR prices are not directly used to guide the allocation of resources to invention within universities, it still follows that incorrect price signals could have important consequences. The prospective returns obtained from patent sales and royalties may, in theory, influence the allocation of individual effort on the part of scientists, leading to insufficient or excessive scientific effort in certain areas. Whether the incentives of academics are stimulated by patent grants is debatable. However, prices in the patent marketplace may have an indirect effect on the allocation of funds to university research. In fact, indicators of economic impact (including revenues from patenting activity) have gained increasing weight in the assessment of the performance of academic departments and research centres, which in turn affects their likelihood of obtaining public research funds.

Furthermore, if universities are unable to appropriate fully the financial value of the knowledge they produce by turning it into a private good, this implies that the private firms that purchase or license this good are appropriating a relatively large share of the financial benefit from academic knowledge. That is, public funds are used to subsidize the production of private goods that are enjoyed by a limited number of firms rather than collectively. This could introduce distortion in the market. These problems strengthen the argument that allowing academic knowledge, especially when general and widely applicable, to be openly disseminated may be less distortive and more socially beneficial.

Further research into universities' participation in, and use of, markets for technology would be helpful in order to understand whether the problems identified are specific to certain types of academic research disciplines or to certain types of institutions. Research should, in particular, be carried out with larger samples and with focus on different units of analysis (not just technology transfer offices, but also individual academics). Alternatively, looking at the demand side of the flow of academic knowledge, and in particular investigating firms' specific difficulties when engaging in IPR market transactions with universities, would also enrich our understanding of these processes.

Notes

1. The UKNOW database was developed as part of European Commission research project 'Understanding the Relationship between Knowledge and Competitiveness in the Enlarged EU (UKNOW)', Work Package 3.2: *An IPR Regime in Support of a Knowledge Based Economy*, a project of the EU 6th Framework Programme.
2. In the following analysis, we use the term 'proprietary IP' [or, equally, 'intellectual property rights' (IPR)] to identify IP upon which restrictions on use, sharing, copying and modification are enforced by legal means, and 'non-proprietary IP' for IP on which some or all of these restrictions are relaxed.
3. The problem of under-exploitation of IPR is common in commercial firms as well. Rivette and Kline (2000) identified 'a staggering $1 trillion in [ignored] intellectual property asset wealth' in the USA, while the PATVAL survey of European inventors found that while 11% of a random sample of European Patent Office patents had been licensed, an additional 7% could have been licensed, but were not, and a study by consulting firm BTG International found that 35% of patented technologies (valued at $115 billion) were ignored by the firms that developed them. A survey of US firms found that more than a third of total IPR inventory rated as available for licensing but unlikely to be licensed (Cockburn, 2007).
4. Examples are non-software copyrighted materials (articles, reports, books, lecture notes, presentations); software (source level code as well as executable programmes developed by researchers in the course of their research work); materials (synthesized by researchers working in the fields of chemistry and materials); database rights; cell lines; new plant or animal varieties; registered and unregistered designs; photographs and videos; research questionnaires; and finally, tacit knowledge (know-how), which is hard to codify and transfer, but which is nonetheless valuable to third parties (Baghurst *et al*., 2009).
5. Throughout this paper, we refer to this sample as 'UK universities', for the sake of simplicity. Higher education colleges and public research organizations comprise less than 25% of the sample and of respondents, as evidenced in Table 4.
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 supplied by the Higher Education Statistics Agency. The year of foundation of the technology transfer office and the number of staff employed (relative to 2007) within were drawn from the HE-BCI survey.

7. The categories are the following: old universities (founded before the mid-nineteenth century); red brick universities (founded between the mid-nineteenth century and the mid-twentieth 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); and modern universities (founded after 1992, not formerly designated polytechnics).
8. This is consistent with results discussed by Cockburn (2007) when studying patent licensing deals in the US and Canada: here, only about 10% of survey respondents cited uncertainty about the strength or scope of IP rights, and less than 5% cited other structural issues, such as there being too many parties involved in the negotiation. What really matters is the ability to reach agreement on financial and non-financial terms of the licensing contract; again, this is consistent with results found in our survey.
9. Universities were not asked to agree with the statements 'difficulty in finding the best IPR' and 'lack of clarity of the IPR document' with reference to copyright as these obstacles were not considered relevant to the case of copyright.

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