

Introduction

Property and the pursuit of knowledge: IPR issues affecting scientific research

The origins of this special issue lie in the international Workshop, *Digital Collaboration Technologies, the Organisation of Scientific Work and the Economics of Knowledge Access*, which was held at the International Institute for Applied Systems Analysis (IIASA) in Laxenburg, Austria, 3–5 December 1999. During that Workshop, it became apparent that there was tension between the advances in information and communications technologies that were facilitating more spontaneous, ‘bottom up’ organization and conduct of scientific research collaborations on a global scale, and the effects of international trends in the extension and enforcement of intellectual property rights (IPR) protections affecting scientific and technical data and information. Sometime following this Workshop, it was decided to organize two journal symposia: one that would focus on collaboration technologies and the economics of collaborative research in general, and a second that would address the theme of the impact of IPR on scientific research involving public research organizations. After soliciting revisions and extensions of a selected number of the IIASA Workshop presentations on the latter theme, the editors of this symposium became aware that much new and interesting empirical work was underway that was shedding significant light on the topic. As a result, both the dimensions of the symposium, and the length of time to bring the larger group of invited papers to completion, increased beyond the original intentions. Yet, we believe readers of this special issue will share our view that the extra efforts entailed have been rewarded by the high quality of the contributions, their collective coverage of the topic’s many distinct facets, the diversity of the disciplinary approaches and viewpoints that they bring to the analysis of the question, and the important policy issues that it raises.

A central theme that has emerged from the exploration of intellectual property rights in relation to scientific

research is the potential and actual conflict that arises on the boundary between research conducted in public and non-profit institutions (including universities), and research performed by firms and individuals in the private sector. The research findings of the former tend to be revealed rapidly, disseminated widely and (until lately) freely, whereas the information gained through private sector R&D is selectively disclosed and, when it is disclosed (however incompletely), its use typically remains restricted by one or another form of intellectual property right protection. Baldly stated, we have two distinctive regimes or environments for the conduct of research: the actors in the realm of ‘open science research’ expect reciprocal sharing of discoveries among themselves and the rest of the world, while those in the world of private profit-oriented and proprietary R&D expect to receive payment for the right to use their inventions (and to pay others for the use of theirs). It is therefore not surprising that exchanges across the boundary between the two are sometimes difficult to negotiate, and also that the boundary itself may move depending on the availability of public funding (or private patronage) to support research in the ‘open science mode’, as well as shifts that may occur in the opportunities for direct commercial exploitation of the research results produced in one sphere or the other.

Institutional policy changes during the past quarter century have considerably widened the gap between the foregoing highly stylized schema and the realities of the current research scene. Once upon a time, there was a reasonably tidy line of separation between the kinds of organizations that were associated with those two systems of research: academic institutions and government institutes and laboratories for the most part were engaged in non-defence research operated under the ‘open science’ rules that left them dependent on public research funding, whereas the world of propri-

etary R&D was populated by private enterprises that only very rarely might put their latest research results into the public domain. Today, however, universities, research institutes and government laboratories in many parts of the world have become concerned to acquire intellectual property rights based upon the discoveries, inventions and creative cultural works of their employees. Reciprocally, to varying extents in different places and departments of those institutions, some faculty and staff-members (and students) are coming to view the rewards for their scientific efforts as naturally including a share of the income streams derived from the commercial exploitation of those property rights. In the private sector as well, diverse policies have emerged regarding the sharing of research results with customers and with potential rivals: some firms that systematically acquired extensive patent portfolios have begun, on a selective basis, to license them freely; in other instances, software that had been protected under copyright and the source code for which formerly was not revealed is being released without royalty charges under open-source licenses. Elsewhere, business firms have opted not to patent their new inventions, nor to protect them as trade secrets, but instead to ostentatiously place the information in the public domain where, without having to go to the expense of acquiring an intellectual property right and defending it against infringers, they can hope to forestall others from filing patents that would block their own future access to free use of the information.

Several papers in this special issue look at the experience of relationships across this boundary and the ways in which these difficulties may or may not be ameliorated. Bhaven Sampat sets the stage by providing a historical review of changes in American universities' patenting policies, procedures and practices throughout the twentieth century, including an assessment of the effects of the Bayh-Dole Act of 1980. He shows that, during much of the history of academic research in the United States, the primary means of disseminating knowledge and discoveries to industry was via open science, with only a very minor role for patenting, primarily because universities were reluctant to get involved in an activity that appeared to compromise their mission. Patenting in some areas began to increase during the 1970s in response to various administrative decisions on the part of the U.S. federal government that culminated in the Bayh-Dole Act of 1980. The Act introduced a uniform federal patent policy towards inventions generated by universities and small businesses that were the result of federally funded research.

In the final part of his paper, Sampat assesses the changes in academic research that may have flowed from

the effects of this Act. He documents the increases in university patenting and technology-transfer activities that both preceded and followed its introduction, but finds that there is no systematic evidence that increased privatization of some academic research is affecting either the conduct of, or the returns to, public science. He also presents some preliminary evidence (based on patent citations to the scientific literature) that is consistent with the hypothesis that the rise of biotechnology and biomedical science has facilitated the movement of university patenting upstream into the appropriation of 'scientific discoveries' and 'research tools'—a development that some observers have found unwelcome. Thus, one could argue that the boundary between public and privatized knowledge production had moved, due to a shift in public institutions' policies. These simply took advantage of increased opportunities for appropriating commercial gains through patent licensing or equity-holding in 'start-up' companies, rather than reflecting universities being driven in the direction of privatization by the necessity of introducing a new and costly management style for (academic) research projects, or in an effort to attract expertise away from the private sector, or to commit substantially greater resources to product development, testing and marketing.

Complementing Sampat's study of the genesis and workings of the Bayh-Dole regime on its U.S. 'home ground' are two papers, one by Aldo Geuna and Lionel Nesta, who review the growing use of IPRs (and specifically patents) by universities in Europe, and the other by Clemente Forero-Pineda, who draws out the implications of these changes for academic research in developing countries, especially those in Latin America. Geuna and Nesta find that recent developments in Europe with respect to patenting by universities are similar to those in the U.S., albeit rather less extensive. Much of the growth in university patenting can be attributed to an increase in importance of the biological and biotechnology research areas, and also to the fact that some universities have become more aggressive in demanding patent rights. Possibly even more than in the U.S., patents arising from academic research in Europe formerly were either assigned to the firms that may have funded the researchers, or were taken out by the academic inventors. The authors present an interesting discussion of the costs and benefits of the expansion of university patenting, stressing that very few quantitative and scientific analyses of its consequences for the rate and direction of scientific research exist, despite the amount that has been written on the topic in the policy arena. The only fact that has emerged conclusively from the research to date is that at the level of individual researchers, patenting does not

necessarily crowd out publication. However, lack of precise information on the nature of the research published precludes an assessment of whether researchers are now working in more applied areas, where patent protection for their results is more available.

The paper by Forero-Pineda tackles a different but related topic: what are the implications of the changes we have observed in the patent systems of developed countries during the past quarter century for developing countries—especially when these changes are combined with the TRIPS agreement, which calls for an (essentially) uniform IPR system throughout the world? Forero-Pineda reviews the literature on the effects of strengthening IPR systems in less-developed countries, much of which is theoretical rather than empirical; most of the models presented reach the not-too-surprising conclusion that the consequences are welfare-enhancing for developed countries and welfare-decreasing for developing countries, with the overall welfare effect usually but not always negative. But Forero-Pineda highlights a second and no less important conclusion of the models: because stronger IPR will often lead to greater specialization in the traditional sector on the part of developing countries, there is a dynamic consequence for these countries in the presence of learning by doing. The result can be greater divergence in development levels among countries.

The final sections of Forero-Pineda's paper focus on an issue directly related to the topic of this special issue—the potential consequences of changes in the IPR environment in the academic sector of developed countries for researchers in developing countries. As is so often the case in evaluating the impact of these changes, little hard evidence is yet available, but there is a potential for disruption of an already fragile scientific research environment. There are at least two problems highlighted by the author: the increase in transactions costs associated with undertaking joint projects with researchers at universities that take a strong IP stance towards their output, and the increase in the costs of access to necessary research tools. Examples of both problems in the Latin American setting are presented and their significance is discussed.

The foregoing contributions have as their primary perspective the engagement of public research institutions with the intellectual property rights system. Yet the transfer of technologies for private sector development and commercial introduction was ostensibly the purpose of the institutional changes that have encouraged university patenting. Henry Hertzfeld, Albert Link and Nicholas Vonortas contribute a view of the working of the Bayh-Dole regime as it has been experienced by a sample

of large, research-intensive firms that were involved in forming research partnerships (or alliances) with other firms and with universities. The authors review research joint-ventures and alliances in general, and document the specific problems encountered by firms in industry when they attempt to form research partnerships with universities, in comparison with their experience in building multi-firm research alliances. They report that, although patents are the most commonly used mechanism to protect intellectual property in research alliances between firms, and between firms and universities, it is only when negotiating the latter type of alliance (with universities) that firms find disagreements over patent rights to be an obstacle to the project's formation—a 'showstopper', in the language of the survey respondents.

Almost all of the 23 firms interviewed reported very negative experiences (from their perspective) in negotiating with university technology-transfer offices over IP rights. The offices were described as inexperienced and lacking business knowledge and authority to conclude an agreement; the view was that the situation had worsened during the past 20 years, presumably as a result of the Bayh-Dole regime and the pressure on university officials not to settle for anything less than the 'best possible terms' when licensing their intellectual property rights. It is possible that at least some part of the high proportion of U.S. universities that (according to the data presented in Sampat's paper) are unable to license any of their patents is attributable to what their would-be industrial partners see as excessively adamant bargaining positions, taken by inexperienced university officials. The explanation of why inexperienced university negotiators should have been 'too tough' rather than not tough enough, remains a subject for further investigation. Yet, it is plausible to suppose that this bias could stem from having unrealistic expectations of the value of exclusive licences (due to the salience of the very few cases of lucrative university patents), and from being worried by the prospect of granting an exclusive license too cheaply in a case where the patent turned out to be really very valuable to the licensee. Unlike the latter outcome, the failure to conclude any agreement could always be attributed to the excessively adamant stance of those on the other side of the negotiation.

The potential difficulties of arriving at contractual agreements between representatives of the worlds of 'open' academic science—in the form of university researchers seeking commercial gains, and business firms engaged in proprietary R&D are fully displayed in the paper by Stephen Maurer. This is a fascinating 'insider' account, written by a central participant in the initiative to form an innovative public-private arrange-

ment that would fund the construction of a central public database for genetic mutations data, effectively federating numerous specialized databases that had been created by scientists in public research organisations. Although the proposed contractual arrangement envisaged that a biomedical firm would finance and host the new database facility for the community of publicly funded researchers, the initiative ultimately collapsed. Nevertheless, the anatomy of this failure is enormously instructive, as it exposes the nature of the diverging and, in some respects, incommensurable goals among the parties, as well as the arduousness of the process of trying to reconcile them.

Maurer views the lack of success with the Human Mutations Database Initiative (MDI) as an illustration of the kind of ‘anticommons’ problem that arises when many players from the different worlds of industry and academic research try to reach agreement on sharing research results in order to create a whole that is greater than the sum of the individual parts. His richly detailed narrative describes an unfolding situation in which the attainment of a socially efficient cooperative solution is frustrated by high transaction- and negotiation-costs. The latter frequently are found to be problematic when ownership rights to the use of complementary information are distributed among numerous private parties and the shared use of those rights must be regulated by legal contract. Yet commercial contracting, with its possibilities of monetary side-payments among parties all of whom are seeking payoffs in that dimension, is shown by this case study to be a straightforward matter compared with the resolution of conflicts between individuals seeking rewards of different kinds that cannot be rendered commensurable by the measuring rod of money; or in dispelling distrust among groups of actors who are operating under quite different norms of research-sharing behaviour.

Being an ‘insider account’ by a central actor in the story who is experienced in both the legal and the economic analysis of intellectual property and contract issues, this paper necessarily differs from the ‘outsider analyst’ academic research style of the other contributions to this special Issue. By the same token, it offers valuable testimony ‘from the trenches’, providing insights into the complexities of negotiating collaborative undertakings across the shifting boundaries of open and proprietary research, and a vividly concrete depiction of a phenomenon that is too often glossed over by economists’ anodyne references to ‘transactions costs’. The lessons offered by Maurer’s account of the MDI may be useful not only for non-governmental actors who may seek to form that sort of public–private database con-

sortia in the future, but also for corporate negotiators who, like those surveyed by Hertzfeld, Link and Vonortas, have encountered unaccustomed difficulties when engaging with university researchers and administrators, and with their representatives, in an effort to arrive at IPR licensing agreements.

The next paper also deals with tensions between private commercial incentives and public interests in databases, but it focuses on questions raised specifically by the sui generis intellectual property right in databases that was created 1996 by the European Union’s Directive on the Legal Protection of Database Rights, and its implications for the work scientific and technical research communities. Anselm Kamperman Sanders provides a review of the legal and economic arguments that both justify intellectual property protection for investment in the creation of databases, on the one hand, and call for access to their contents at low cost on the other. Kamperman Sanders offers economists and other social scientists a legal expert’s introduction to the provisions and ambiguities of the European database directive, its implementations in national statutes, and a particularly valuable commentary on the implications of its evolving interpretation in the courts. His paper concludes by calling for the development of an equitable licensing practice and suggests various rationales for terms of access to database content that will correctly balance the interests of both creators and users of publicly funded data.

The possibilities of utilizing the rights afforded owners of intellectual property in ways that support cooperative as well as rival modes of research are examined from a more formal analytical perspective in the contribution by Alfonso Gambardella and Bronwyn Hall. They step back from the specifics of institutional settings and national policies to look at incentives in the ‘two worlds’ of research in a quite general and highly stylized setting, and present a simple model of two forms of knowledge exchange and production (informal and reciprocal on the one hand, and IP-protected and market-mediated on the other). With this apparatus they demonstrate that the reciprocal exchange of information is an unstable equilibrium where there is an option for individuals to exploit their knowledge for private profit under IPR protection. The authors go on to point out, however, that social norms that discourage participants from privatization, and/or the ‘lead’ user/researchers who signal appropriate behaviour, may be able to sustain cooperative sharing of information when norms are reinforced by legal contracts. The General Public License (GPL) and other ‘copyleft’ devices provide contracts that may be deployed (and in principle enforced at law) by intellectual property owners.

Gambardella and Hall's analysis of their model shows that the equilibrium involving agreements to freely share research results or research tools such as software and databases will tend to break down when the potential private returns are high, when market demand from those other than researchers/developers is large, and where norms are weak (and unenforceable). All of these factors are especially present for some classes of research software and databases; this phenomenon is illustrated by a particular example of specialized software produced primarily in an academic environment, which has often been privatized and moved out of the academic world as it matures and the potential market grows. Among the conditions that tend to encourage such a transition is the ability of vendors of individual computer programs (and of specialized database services—even in the absence of IPR protection) to set prices that yield high profit margins; the demand for their wares is not sapped by the effect of the same pricing policy being pursued by other vendors of research tools that are gross complements of their own wares. In the presence of strong complementarities in tools that were used as inputs as well as sold as outputs, the profit incentives for individual exploitation of individuals' IPR would be weaker, and different pricing strategies that moved more in the direction of the cooperative sharing equilibrium might therefore emerge.

Gambardella and Hall take account of this latter possibility and conclude their paper with a discussion of the application of the price discrimination solution (within a system of IPR ownership) to the problem of providing these types of research tools to industry without increasing their cost to academia. The patenting and licensing of research tools described by Sampat may be another example of this solution. One also can see the latter, differential pricing solution being used to mitigate the problems that developing countries face in accessing research results in printed journals, namely by providing special subscription prices for researchers resident in such countries.

It is to the other contributors in this special Issue, first of all, that the Guest Editors wish to express their gratitude, especially those whose papers were completed in the early phase of this project and who subsequently displayed great patience while awaiting publication. *Research Policy's* Editor, Ben Martin, has been both liberal in accommodating the expansion of the size of

the special issue, and tolerant of a slow and sometimes halting process of submitting completed manuscripts in a copy-edited state fit for publication. It is due to his patience in this regard that these papers appear within a single issue, and on that account, we venture to say, the readers as well as the contributors are in his debt. We take this occasion also to remember our friend and colleague, the late Keith Pavitt, who, as Editor of the journal up to his untimely death, warmly endorsed the original proposal of a guest-edited special Issue on this subject.

We wish also to express our appreciation of the many participants in the IIASA Workshop who offered comments and suggestions for revision of earlier drafts of these papers, both during the Workshop and subsequently. That event was organized under the sponsorship of the European Science Foundation (ESF), the U.S. National Science Foundation (NSF) and IIASA, and was a sequel to the IIASA-initiated International Workshop on 'The Global Science System in Transition', held on 23–25 May 1997. Its programme and organization were prepared by Paul A. David, Dominique Foray, John MacDonald (then Director of IIASA) and W. Edward Steinmueller, and it received very significant encouragement from Thomas Schelling (who was an IIASA Fellow at that time). The post-Workshop preparation of selected papers for this special Issue (and another journal symposium) drew financial support from the National Science Foundation (Award IIS 99124477); in addition to that material support, the role played in this undertaking by Dr. Suzanne Iacono of NSF (CISE) was essential in 'making it happen'.

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