University-Industry Research Partnerships and Intellectual Property

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Abstract

The tradeoff between providing incentives for the production of new ideas and information and ensuring that spillovers from that research flow to others is likely to lead to different methods of organizing research efforts in different spheres depending on the relative importance of "appropriability" versus the benefits of full and costless knowledge diffusion. In particular, as Paul David has often argued, the "open science" community has evolved a rather different approach to rewards for and spillovers from the production of information goods than that suggested by a conventional economic property rights analysis, one based on rapid publication and dissemination in order to achieve a prior claim as the inventor. Because this kind of system for securing rewards to investments in research is so different from that to which most industrial firms operate, it is not surprising that tensions arise in settings where the conventions of one world (private industry) come up against the conventions of another (public R&D and university science). The paper reviews the evidence that this is the case and then discusses the case of cumulative innovation, where the IP problem is particularly salient.

1. Introduction

The topic of this workshop is intellectual property (IP) protection mechanisms in research partnerships. In Hall (1999), I suggested that the tradeoff between providing incentives for the production of new ideas and information and ensuring that spillovers from that research flow to others is likely to lead to different methods of organizing research efforts in different spheres depending on the relative importance of "appropriability" versus the benefits of full and costless knowledge diffusion. In particular, as Paul David (David 1998; Dasgupta and David 1992; David 1992) has argued, the "open science" community has evolved a rather different approach to rewards for and spillovers from the production of information goods than that suggested by a conventional economic property rights analysis, one based on rapid publication and dissemination in order to achieve a prior claim as the inventor.[2]

Because this kind of system for securing rewards to investments in research is so different from that to which most industrial firms operate, it is not surprising that tensions arise in settings where the conventions of one world (private industry) come up against the conventions of another (public R&D and university science). The remainder of the paper reviews the evidence that this is the case and then discusses the case of cumulative innovation, where the IP problem is particularly salient.

[1] University of California at Berkeley. This paper is based on presentations at an EC/DG-Research Workshop on the "IPR Aspects of Integrated Internet Collaborations" held in Brussels on January 22-23, 200 and an ESF-IIASA-NSF Science Policy Workshop entitled "Building the Virtual 'House of Salomon': Digital Collaboration Technologies the Organization of Scientific Work and the Economics of Knowledge Access," held at the International Institute for Applied Systems Analysis in Laxenburg, Austria on 3-5 December, 1999.

[2] Also see Arora, David, and Gambardella (1994) for empirical evidence on the "increasing returns" nature of the reward system in science, sometimes known as the "Matthew" effect.

2. The growth of university-industry research partnerships

The tension between IP protection and the desire for the promotion of spillovers in the "open science" culture exemplified by university research can be seen in a couple of examples (described below) from the recent U.S. experience with policy efforts to increase the ties between academic university science and industry. This attempt has been somewhat successful: Table 1 shows a tripling of the share of university research funding that is paid for by private industry in the United States between 1970 and 1999 (although the fraction is still fairly low, just above six percent). Another indicator is that the number of Research Joint Ventures with at least one university member that were registered with the federal government as a consequence of the 1984 National Cooperative Research Act averaged 8 percent between 1984 and 1992, but 17 percent between 1992 and 1999.[3]

Table 1
R&D Performance in Universities and FFRDCs

Funding for University R&D	**1970**	**1980**	**1992**	**1999 (est.)**
% Government funded	76.8	60.7	68.0	64.7
% Industry funded	2.1	2.4	5.4	6.2
% Other (non-profit & Univ.)	21.1	16.9	26.6	29.1
Total spending ($1987B)	**9.05**	**15.05**	**21.25**	**24.69**

In a survey of both the university and industry participants in approximately 400 research joint ventures, Lee (1996) found that industry participants ranked their reasons for participating in these alliances in the following order:

- Access to new research
- Development of new products
- Maintaining a relationship with the university
- Obtaining new patents
- Solving technical problems

Improving products and recruiting students were viewed as less important than these other reasons.

On the other hand, university participants placed a high priority on two things: obtaining funds for research assistance, lab equipment, and their own research agenda; and obtaining insights into their own research by being able to field test theory and empirical research. They viewed acquiring practical knowledge useful for teaching, student internships and job placement and obtaining patentable inventions and business opportunities as less important motivations for entering into research alliances with industry.
Thus although neither group rated obtaining patents very highly, the university partners thought they were even less important than the industry partners did. Taken at face value, the replies to the survey indicate that these transactions are driven by simple supply and demand: the university partners are selling the output of their research and development in return for the funds to do it. The transaction is structured as an alliance because of uncertainty and the need of industrial firms to monitor the progress of the research in order to make full use of its output.

[3] See Figure 1, drawn from Hall, Link, and Scott (2000).

3. IP Issues on the Boundary[4]

The first example of IP tension in these alliances is that of university-industry research centers in the United States. Cohen, Florida, and Goe (1994) conducted a survey of 437 universities that covered more than 1000 University-Industry Research Centers (UIRCs) in 1991. These centers are the principal vehicle for industry support of academic science and engineering in the United States. One of the findings from their survey was that industrial participants were often able to restrict information flow and delay publication of the results from the academic research that they were supporting, suggesting a conflict between the university's open science goals and those of industry. Whether we should be concerned about this deviation from the cultural norm of science depends somewhat on whether the research conducted in these centers was "additional" to that normally conducted by the university.

Hall, Link, and Scott (2000, 2001, 2002) surveyed 38 industry participants in projects funded by the Advanced Technology Program of the federal government, 13 of which had a university as a research partner. The remaining 25 were asked why they did not have such a partner and 12 of these (approximately half) reported that IP issues were an insurmountable barrier to partnering. Comments by these firms included the following:

- "believe we own the IP developed for us under sponsored research. This view is often not shared by potential university partners."
- "many universities want to publish results prior to IP protection, and sometimes will not grant exclusivity."

The second example concerns the effects of attempts to increase the commercialization of the research discoveries of universities by granting them the property rights to their discoveries. In the United States, most basic scientific research is conducted within universities or within federal laboratories managed by universities. The Bayh-Dole Act of 1980 allowed universities to obtain patents on technology developed using federal research funds so that the technology could be licensed to private firms for development. One might expect that adding such a goal to the university agenda would have an impact on university behavior and there is some evidence that it did. First, Henderson, Jaffe, and Trajtenberg (1998) found that universities increased their overall patenting per R&D dollar rate, with an apparent drop in patent quality, suggesting the harvesting of lower quality outputs of their research. Second, much of this increase and lowering of quality came from universities that formerly did not patent at all.[5] It is not yet clear whether there has been any real impact on the conduct of the research itself however. Mowery and Ziedonis (1999) suggest that it has not, at least at the two universities that they studied. Although links to industry, especially the biotechnology industry, have been increasing, the increase predates Bayh-Dole.

In contrast, Argyres and Liebeskind (1998) found that university efforts to commercialize biotechnology innovations following the Bayh-Dole Act of 1980 were impeded by the academic institution's traditional commitment to the "intellectual commons" and absence of secrecy, suggesting that the tension goes both ways. Yet Mowery and Ziedonis do report that the majority of technology licenses granted by UC Berkeley and Stanford are exclusive. As alluded to earlier, Hall, Link, and Scott (2001) found that intellectual property issues were one of the main areas of conflict between the

[4] The examples in this paper are largely drawn from the U.S. experience, with which I am more familiar and for which there have been a number of policy experiments and attendant studies in the recent past. See Cassier and Foray (1999a, 1999b) for a discussion of this issue in Europe.

[5] Mowery and Ziedonis (1999) provide indirect evidence on this point – they find no drop in importance or generality of the patents taken out by the University of California and Stanford University following the passage of Bayh-Dole. These two universities were two of the heaviest patenters both before and after the passage of this act and therefore dominate the statistics on non-entrants.

universities and industry partners, although in this case the dispute was over the allocation of rights rather than the diffusion of the information.

In general, the conclusion from research on university-industry partnerships in the United States and the effects of changes in IP protection during the past 15-20 years is that "harvesting" of patents from inventions has increased greatly in the university, but with relatively little effect on actual research (this is similar to the trends in industry, see Hall and Ziedonis 2001 and Ziedonis and Hall 2001). At the same time, the growth in partnerships with industry has led to increased tension over IP rights and the ability to publish freely. However, it is likely that the current trends in patenting (especially in software and genomics) and in database protection are probably more threatening to the university research environment than the effects of 1980s policy changes in joint venturing and university patenting.

4. *Cumulative Innovation*

Cumulative innovation is a major challenge both for the economic theory of "the allocation of resources to invention," to use Arrow's (1962) expression, and for the structure of intellectual property rights. Recent trends in biotechnology (gene sequencing) and information technology (the internet) have brought to the forefront a set of issues that were first brought to the attention of economists by Scotchmer (See Scotchmer 1996 for a survey of this work). These issues have to do with the problem of rewarding multiple inventors in a setting with cumulative innovation. That is, is it possible to provide optimal incentives for innovation simultaneously to the producer of a first generation product and a second generation product that builds on it? The answer in general is no. At least two problems arise:

1. The first invention creates an externality for the second inventor and therefore may be worth developing even if the expected cost exceeds its value as a stand-alone product. However, broad patent rights for the first inventor to ensure innovation do not leave enough profit for the second inventor. One solution to this problem is "internalizing the externality" via licensing. Scotchmer (1996) shows the following:
   - *Ex post licensing agreements*, entered into after the cost of first innovation is sunk can increase the profits available for the two innovators, but cannot not achieve the first best, because it is impossible to give the total surplus to each party separately using this (or any other) mechanism, and this is what would be required.
   - *Ex ante cooperative R&D investment (RJVs)*, entered into before the R&D cost sunk generally will achieve a more efficient outcome (in terms of total welfare), but it is very difficult to identify potential partners *ex ante* in practice.[6]

2. Where the first invention is the pure outcome of scientific research, that is, where the value is only the information, it cannot be sold without revealing it, which makes a sale moot unless extremely strong IP protection is in place. In this case Anton and Yao (1998) show that a signaling equilibrium exists with partial disclosure of the idea, which essentially means that the inventor will receive a "lemons" discount for his innovation. This discount, which can be large, will clearly reduce the provision of ideas unless non-financial motivations come to the fore (such as priority).

The insights of Scotchmer and Anton and Yao suggest the difficulty of contract design for optimal cumulative innovation in a setting where each innovation builds on the last, and where subsequent

[6] See Headley (1995) for an interesting discussion of the political/legal history of the idea of extending *droit de suite* to cover scientific inventions during the earlier part of the twentieth century. This idea essentially foundered on a reluctance to impose compulsory licensing on inventors into the far future and the consequences such a move might have for the publication the results of scientific research.

innovators are many, geographically diffuse, and hard to identify. This description characterizes the production of both software and databases in the scientific research community. The origins of database and software packages in common use are often "lost in the mists of time."[7] See Maurer (1999) for some examples. In other cases, they are public and non-protected, but have been developed and augmented by private researchers or research firms.

The implication is that it pays to be extremely careful when considering the creation of new forms of property rights for these goods. An admirable desire to ensure the creation of the "first" version may inhibit the production of any recombinations or enhancements, in addition to restricting access for a set of users that may well be the most productive of potential users: new entrants, whether new researchers or new firms.

5. Concluding Thoughts

The central issue highlighted by this paper is the tension between the two worlds of commercial innovation and scientific research with respect to the twin goals of appropriating and diffusing knowledge. Recent developments in the protection of Intellectual Property, especially in the U.S., together with the increasing closeness of public and university research to commercialization in several major research areas have heightened this tension, causing concern in the academic community and elsewhere that in the race to ensure that the incentives to create new forms of information such as databases and software are in place, we may have also slowed their diffusion in ways that will harm the very enterprise that was responsible for generating the innovations that underlie the IT revolution to begin with (the "digital boomerang," in Paul David's (1999) phrase).

Of course, from an economic theory perspective, the policy question and remedy are relatively simple and not new: if society benefits from researchers having access to some forms of information at low cost, and there exists private sector willingness to pay for that information, then subsidies to researchers so that they can acquire the information would be socially beneficial, and at the same time, would leave the incentives to produce the information intact. Because private sector firms would still be charged the "market" price, these subsidies would not have to be as large as they would need to be if the government funded the entire activity.

The problems with the simple economic solution in this situation are manifold:

1. The politics of government granting organizations usually exhibit considerable reluctance to finance the acquisition of easily reproducible software and/or databases at prices above marginal cost. In practice, there seems to be a bias towards funding the creation of new databases rather than simply purchasing them on the open market.
2. The transactions costs of this kind of solution can be substantial. In the software case, consider the difficulties faced by participant(s) in a small computer science research project with little administrative overhead that might have to license various pieces of software from a series of organizations in order to pursue its research agenda.

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[7] One widely diffused statistical package for the social sciences with which the author is familiar was originally developed by a set of graduate students in their spare time in the 1960s. The approximately 50,000 lines of code now contained in the package probably include at most 100 lines of the original code, but the basic design of the syntax has changed little over the years and its origins are clear. Some of the earlier development was financed on research grants, but most of the value added in the past twenty years has been financed by sales of the product. In spite of this, the package retains a strong link to the academic community and is typically sold to them at a substantial discount from the commercial price. This type of situation is very common in the scientific software world, where the primary product being sold back to the academic community from the private sector is service and support rather than programming code. Were the algorithms in the code protected by strong patents, it is likely that these packages would command much higher prices than they do now.

3. Imposing administrative and pecuniary costs on researchers who wish to use others' research tools as inputs, even if reimbursement is theoretically possible, tends to discriminate against new and young scientists without grants and also against "outsiders" with radical ideas who cannot get past a peer review. It is hard to quantify this idea, but there are repeated historical examples which suggest that the unpredictability of the sources of new ideas means that they are best encouraged when the costs of entry into the research or innovation endeavor are kept as low as is practicable.

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Figure 1