Privatizing the intellectual commons: Universities and the commercialization of biotechnology

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Abstract

This paper analyzes universities’ recent attempts to adapt their policies and organizational arrangements in order to accommodate the commercialization of university biotechnology research. We argue that these attempts have been severely hampered because internal and external parties have sought to enforce universities’ adherence to their historic commitment to create and sustain an ‘intellectual commons’ for the benefit of society at large. The standardized organizational arrangements universities maintain to administer this intellectual commons have also served to impede adaptive efforts. We conclude that social–contractual commitments and organizational standards can significantly affect the shape and outcome of negotiations over property rights, and can place important limits on the scope of organizations, potentially leading to the generation of new organizational forms. © 1998 Elsevier Science B.V.

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1. Introduction

Since the passage of the Bayh–Dole Act in 1980 (Public Law # 96–517), a gradual but halting privatization of intellectual property has been occurring in U.S. universities. The Bayh–Dole Act expanded the range of government-funded research in which universities could own patents, and encouraged universities to pursue opportunities to become more involved in the commercialization of the research conducted by their faculty through patent licensing and other means. Biotechnology and related biomedical technologies...
have shown the most potential for profitable commercialization, since basic research in these areas often has immediate and significant commercial value. This paper seeks to explain why universities have had such difficulty designing effective technology transfer programs to commercialize biotechnology. The broader goal, however, is to gain insight into a fundamental question about the limits to organizations, namely, why do organizations have difficulty simultaneously managing activities that have fundamentally different characteristics (such as academic- and commercially-oriented research), and which therefore require different governance arrangements to be managed efficiently?

This question arises in evolutionary economics, in which organizations are said to rely on routines that are developed over time through search, selection and repetition; they therefore face difficulty adding activities which do not rely on these routines (Nelson and Winter (1982)). The question is also implicit in Williamson’s (1985) argument that activities requiring high- and low-powered incentives are difficult to maintain within a single organization because central management cannot credibly commit to support high-powered incentives. In this paper, the limits to the organizations in question –universities – arise, instead, from historical commitments made by them to society, and by the internal organizational standards they maintain that are designed to uphold these commitments. These standards govern the activities of university faculty and the economic use of research they produce. As a result, when new economic opportunities emerge from ongoing organizational activities, the limits imposed by social–contractual commitments and organizational standards prevent a rapid and smooth process of institutional adaptation from taking place.

U.S. universities have sought to adapt their organizational arrangements in a number of ways to accommodate the commercialization of biotechnology research. First, university policies have been adapted to facilitate the privatization and sale of university technology through patenting and patent licensing; to strengthen the rights to ownership and use of these technologies in order to enhance their value in exchange; and to allocate these ownership and use rights in exchange contracts with private firms which take better account of firms’ private interests. Second, universities have made some unprecedented attempts at organizational adaptations in order to stimulate the commercialization of research and generate income. Direct investment in commercialization has been attempted, special technology transfer offices have been established, and new types of research institutes have been created. But despite these efforts, income from technology transfer to industry has not made a significant impact on the budgets of major research universities (Feller (1990)). And in virtually every instance, these efforts have been met by criticism and resistance from university faculty, and from external parties such as Federal and State governments, professional societies, and social commentators. In many instances the opposition has organized to block implementation of proposed changes altogether. In other instances, opposition has been more moderate, but has nonetheless had a significant impact on the direction and timeliness of adaptive efforts.

We understand the widespread difficulties faced by universities’ commercialization efforts as arising from the organizational arrangements-in-place, arrangements which were created to uphold their social–contractual commitment to society to create and sustain an ‘intellectual commons’ – a knowledge archive openly accessible to all members of society. We argue that to maintain this commitment, universities have
standardized those organizational arrangements that govern faculty conduct across academic departments. In turn, these organizational standards are enforced by the internal organization of decision rights, and by potential sanctions levied by external parties should universities fail to honor their social contract to sustain the commons.

Since there is no rivalry in its use, and it is often non-excludable, university research is usually treated as an open access public resource. Note, however, that this ‘intellectual commons’ is not a commons in the usual sense; it is not a finite, exhaustible resource like a pasture or a mineral deposit, where common ownership can result in inefficient use.¹ The analogy to an exhaustible commons is appropriate, however, for university research which is fundamental yet also promises valuable commercial application. Biotechnology is an example of such research, in which private returns to investment can be very high (even if the social returns are even higher) provided they are secured by intellectual property rights which exclude others’ use. Such rights have been established in landmark legal cases such as Diamond v. Chakrabarty, which allowed the patenting of micro-organisms, and by decisions of the U.S. Patent and Trademark Office, such as the issuing of the Cohen–Boyer patents on processes of genetic manipulation. Thus, the emergence of biotechnology led to a situation where a portion of the intellectual commons, though retaining its public goods character, has increased dramatically in private value. This has raised the opportunity cost for universities to maintain the intellectual commons as a public, rather than a private, enterprise. Yet, as we are arguing, the standardization of universities’ governance arrangements, required by their social–contractual commitments to practice open science, limits their ability to maintain separate incentives and contracting policies for biotechnology on the one hand, and for the rest of the intellectual commons on the other.

Some scholars of property rights might view delays in the privatization of at least the biotechnology portion of the intellectual commons as leading to inefficiency. For example, according to the well-known ‘prospect theory’ of Edmund Kitch (1977), efficiency requires that intellectual property (IP) rights be defined broadly to provide incentives for pursuing different directions of inquiry during the commercialization process. Without broad rights, uncertainty about the most promising directions of commercialization will lead to underinvestment by potential inventors. Thus, according to this view, universities’ unwillingness to extend broad property rights to private interests (firms) might be understood as being inefficient. On the other hand, others have argued that granting broad IP rights to private interests risks grantees holding up further development, a type of anti-competitive behavior which is most costly when research is sequential in nature (Nelson and Merges (1994)).² Therefore, whether the social constraints which bind on universities are efficient depends on the optimal breadth of IP

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¹ When the resource in question is finite, the alternative to privatization and open access is some sort of common property arrangement based on controlled access and use. Some such schemes governing land, water, forests and fisheries have persisted for long historical periods, and, it has been shown, can be efficient (Weitzman (1974), Dahlman (1980), Field (1989), Ostrom (1990), Stevenson (1991), Lueck (1994)).

² Klemperer (1990) shows that broad patents can be optimal if they discourage substitution away from the patented product by making alternative products less attractive to buyers. Scotchmer and Green (1990) show that narrower patents in the form of weaker novelty requirements for patenting dominate strong requirements when technical advance is sequential.
rights. If, as many have argued, university research is efficiently kept as an intellectual commons, then the organizational standards put in place to ensure its maintenance may be efficiency-enhancing.

Regardless of the efficiency consequences, the evidence we present here illustrates that social–contractual constraints must be taken into account when predicting changes in the scope of property rights that might occur in response to shifts in technology or preferences, as well as changes in the distribution of those rights across organizations. Demsetz (1967), for example, hypothesized that private property rights to an exhaustible resource will efficiently emerge when the benefits of such rights (in terms of limiting overuse and underinvestment) exceed the costs of defining and enforcing them. North (1991) and Libecap (1991) have shown, however, that distributional struggles between winners and losers from particular privatization schemes affect final allocations of property rights. We suggest instead that organizations’ historic social–contractual commitments and supporting internal standards affect property rights assignments to resources with a public goods aspect by leading to narrow definitions of such rights, or by preventing their emergence altogether.

The paper is organized as follows. Section 2 develops the concepts of social–contractual commitments and organizational standards as they apply to modern research universities. Section 3 outlines the new economic opportunities represented by biotechnology, and the regulatory and legal provisions that facilitated the creation of these opportunities at the university level. In Section 4 we discuss the social debates surrounding privatization of university research in general, and show how university policies concerning patenting and patent licensing have been influenced by efforts to enforce social–contractual commitments. Section 5 discusses a variety of attempts by universities to adjust their organizational structures to stimulate the commercialization of biotechnology research, while Section 6 focuses on universities’ attempts to control faculty behavior. Section 7 argues that as social constraints began to bind, pressures have arisen for the generation of new organization forms. These new forms, and their associated contractual commitments and organizational arrangements, in turn affect the directions of future institutional development, in a dynamic process of co-evolution.

2. Social commitments and standards in universities

2.1. Mission and governance

In 1945 Vannevar Bush, a member of the Roosevelt administration, wrote a report on the role of universities in scientific advance which helped build the postwar consensus supporting massive Federal funding of basic research in universities (David et al. (1997)). The report emphasized that, “[u]niversities are uniquely qualified by tradition and by their special characteristics to carry on basic research. They are charged with the

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3 Barzel (1990) argues that it is often efficient for property rights to an asset to be unbundled, with different rights held by various parties. In the case of university research, this might imply that firms should possess rights to portions of the intellectual common with immediate commercial value. Our argument is that such unbundling of rights is difficult to achieve in the face of universities’ social–contractual commitments and internal standards.
responsibility of conserving the knowledge accumulated by the past, imparting that knowledge to students, and contributing to new knowledge of all kinds” (Bush (1945), p. 19). This mission – creating and sustaining an intellectual commons on behalf of society – has been widely accepted by U.S. universities for more than a century (Hofstadter (1955)).

Pursuing this mission requires universities to support the practices of ‘open science.’ This has meant ensuring that university scientists completely disclose all new discoveries to the worldwide, or at least nationwide scientific community. Disclosure furthers the university’s mission by allowing for the evaluation and potential replication of findings by other scientists, which is necessary to ensure the quality of research, and to facilitate further discovery (Merton (1973), Nelkin (1984)). Private firms, on the other hand, often keep new discoveries secret in order to gain competitive advantage over rivals. Universities can be thought of, then, as having made a partly-implicit, partly-explicit contract with society to store, create and disseminate knowledge in exchange for financial support. This contract involves an historical commitment by the university to provide knowledge as an open access resource, and therefore, a commitment to the practices of open science.

The governance arrangements of universities broadly reflect this commitment. For example, to win promotion to tenure in research universities, faculty typically must demonstrate that they have made contributions to public knowledge through academic research, and faculty appointments are won on the expectation that such achievements will be made. While different universities maintain different levels of required achievement, all universities reward academic research achievements and not commercial ones, and faculty whose research has not had commercial impact are not penalized. Universities attempt to insure that these standards for faculty appointments and promotion are maintained by devolving rights to make such judgments to the faculty themselves. Self-governance, or at least significantly shared governance between faculty and administration, does much to institutionalize academic values. In addition, university faculty, unlike scientists in many private firms, are accorded a high degree of autonomy in choosing research projects and collaborators. Moreover, the separation of hiring and promotion processes from basic budgetary processes (which are generally managed by administrators) isolates faculty hiring to some degree from commercial considerations. As suggested by agency theory, these arrangements are consistent with incentives to pursue fundamental discovery research, an activity so uncertain and informationally specialized as to preclude direction and detailed evaluation from above (Jensen and Meckling (1992)). Finally, faculty are usually prohibited from entering into private

4 Merton (1973) named four standards by which modern open science proceeds: accepting or rejecting findings based only on the merits; disinterestedness by researchers; organized skepticism; and communism. By ‘communism’ Merton meant that, “Property rights in science are whittled down to a bare minimum... The scientist’s claim to ‘his’ intellectual ‘property’ is limited to that of recognition and esteem” Merton (1973) pp. 267–78. For an economic analysis of the origins and evolution of open science practices, see David (1994).

5 Few dispute the fact that scientists sometimes fail to practice open science, by, for example, keeping research results or methods secret in order to ensure that they are awarded priority in discovery (Eisenberg (1987)). The point here is that open science serves as an important ideal which acts as a constraint on the actions of universities and scientists, so that policies which exacerbate the secrecy problem will be seen as abrogations of social commitments, and will be opposed.
contracts to produce and sell knowledge with private third parties without a university’s prior consent.

What is important to our argument is that universities’ internal governance arrangements (like those of other organizations) are generally highly standardized across the university’s activities, so that it is rare to observe multiple sets of arrangements, each openly tailored to the requirements of a different type of activity. For example, it is unusual to observe faculty being promoted to tenure in recognition for university service, rather than for research, or in recognition for research which is not made public and thereby is not subjected to peer review. Even if local conditions within a university may sometimes justify such actions, they cannot be rewarded within the tenure system if the university’s social commitment to open science is to be upheld. Hence, tenure and promotion at universities are controlled at the university level, and uniform standards are applied across academic departments.6

There are alternative reasons that have been offered for why one observes standardized governance arrangements in organizations. As we argue below, some of these apply to universities. One of them is economies of scale in administration; incorporating specialized arrangements may entail fixed costs too high to make them attractive. Equity and envy are other reasons; certain activities may require compensation levels that are seen as unfair by current organization members, or are likely to provoke envy among them, so that these activities are difficult to sustain (Frank (1985), Mui (1995)). But the causes of organizational standardization we mainly emphasize and develop in this paper lie in the demands made by social–contractual commitments.

2.2. Enforcement

Universities’ standardized faculty governance arrangements are enforced by external parties in a variety of ways. For example, the behavior of both private and public universities is monitored and conditioned by alumni and donors. If a university were to begin promoting faculty based on non-academic criteria, or were otherwise perceived by these external parties to be violating the practice of open science, it would likely suffer both declining financial support and direct intervention through trustees or other governance agencies. In addition, private and public universities would lose the prestige and impartiality required to attract students and potential faculty interested in general (as opposed to organization-specific) knowledge. For public universities, the commitment to the practice of open science is further enforced by intervention at the state level. Public or private universities receiving Federal research funds are required to comply with far-reaching Federal regulations governing their practices. Those most relevant for this study concern the ownership and disposition of intellectual property stemming from Federally-funded research. Violations of any of these regulations would be sanctioned by reductions

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6 One common exception to this rule is clinical faculty in U.S. medical schools. These faculty hold a special class of ‘quasi-academic’ position, and are rewarded and promoted for performance in treating patients and teaching patient treatment to medical students. Moreover, even clinical faculty appointments and promotions are commonly governed by the same university-level bodies that are responsible for the appointments and promotion of regular tenure-track faculty. For example, promotions of clinical faculty are still reviewed by other faculty at the university-wide level.
In addition, Federal regulations make the university the responsible institution for administering IP, rather than the department or school. This ensures that universities apply standardized Federal compliance arrangements across all of their activities that are financed by Federal monies, and that all faculty, including tenure-track and clinical faculty, are bound by such arrangements. In sum, external parties’ powers of sanction help ensure that universities continue to create and sustain common access to a pool of impartial knowledge, and avoid pursuing private knowledge.

Nonetheless, the more frequently-used checks on university actions are arguably internal ones. Departmental and school-level committees are charged with ensuring that faculty conduct meets university standards. Other faculty institutions such as the academic senate also monitor faculty behavior, and act as a check on the actions of the university administration which may threaten academic standards or the practices of open science. At most universities faculty senates have been particularly concerned with establishing and maintaining academic standards. Thus, internal governance structures, as well as external social enforcement mechanisms, help ensure that universities abide by the commitments they have made to the public and its governments, and therefore to the standards of open science.

3. Biotechnology

Biotechnology is a group of technologies based on molecular biology which enables scientists to genetically manipulate and replicate living cells, with a host of applications in areas such as medicine, agriculture, food processing, and energy. One aspect of biotechnology that is important in relation to our discussion here is that it has been characterized by a ‘collapsed’ discovery path; scientists who conduct basic research have been the most likely to discover new substances that constitute patentable, commercially-valuable inventions (Orsengo (1989)). Thus, in the survey conducted by Levin et al. (1987), biotechnology was reported by firms to be the area of university scientific research most relevant to their operations. For example, recombinant DNA technology was developed at Stanford University and the University of California (UC), San Francisco. Other fundamental but highly commercially-valuable discoveries have been made at the other UC campuses and at the Universities of Washington and Pennsylvania; Harvard

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7 For example, Stanford University was recently sanctioned by a large reduction in the overhead it received on Federal grant monies after it was discovered that ineligible items (such as flower arrangements for the President’s home) had been charged by the university to its Federal overhead budget.

8 Evidently, it is difficult for firms to replicate the organizational environment offered by universities for conducting basic research (Werth (1995)). Zucker et al. (1994) find that, of a total of 213 ‘star’ (highly productive) biotechnology scientists in the United States between 1974 and 1989, 163 (76.5 percent) were located in universities and other non-profit research institutes. The failure of firms to attract and retain ‘star’ scientists may be due to restrictions on publishing research that could lead to commercial products (Dasgupta and David (1987), Hicks (1995), Oliver (1995)), conflicting with the professional norms and career advancement of those scientists who value professional prestige as well as monetary rewards. Firms may also restrict scientists’ attendance at meetings, or collaboration with outside scientists on sensitive projects (Werth (1995)). However, new biotechnology firms, which imitate many aspects of universities (Oliver (1995)), have become an increasingly important locus of innovation (Zucker et al. (1994)).
University; MIT; and Washington University in St. Louis. With the exception of Stanford and MIT, most of these major research universities were relatively inexperienced in the ‘formal’ commercialization of science at the time that biotechnology was developing as a commercially-valuable technology. Moreover, these universities have historically been among those most dedicated to the sustenance of the intellectual commons through academic research.

According to Demsetz (1967) and Libecap (1991), pressures to contract or recontract for property rights emerge in response to changes in the underlying values of assets over which property rights can be established. Libecap (1991) argues that the key conditions for the emergence of pressures to recontract are changes in (1) relative prices; (2) production and enforcement technology; and (3) preferences and other political parameters. In the case of biotechnology, conditions (1) and (3) were present at the time of its emergence. The most important factor precipitating recontracting efforts over biotechnology knowledge was a dramatic increase in its value, especially after the discovery of gene-splicing technology by Cohen and Boyer (1973) – the discovery that launched industrial biotechnology. At the same time that these scientific advances were taking place, U.S. universities found themselves under increasing pressure to produce research that was immediately socially useful. During the 1940s, 1950s and 1960s, agencies of the Federal government engaged a number of major research universities in defense-related research, producing outputs such as nuclear science and computing advances that were critical to the Cold War effort (Rosensweig and Turlington (1982), Feller (1990), Lowen (1996)). During the 1970s and 1980s, however, national priorities shifted, and universities became increasingly viewed as institutions that could (or should) assist the United States in resolving its global competitiveness problems (David (1994). Cohen and Noll (1994) have argued that biotechnology commercialization offered universities the promise of significantly increasing their incomes at a time when Federal and other grant monies were increasingly constrained, and public support for Federal research funding was waning. Feller (1994) emphasizes the enhanced university role envisioned by the Federal and state governments in stimulating economic growth, and a bureaucratic interest by university administrators in taking up this role. Health care reforms have put additional pressure on medical school research budgets. In any case, universities were under pressure to adapt their organizational arrangements to facilitate the commercialization of biotechnology.

Before biotechnologies could be commercialized, however, a number of regulatory changes were needed. In particular, the question arose as to who would own rights to intellectual property produced by Federally-funded research. Traditionally, it had been the Federal government, and obtaining rights to inventions from Federally-funded research was difficult, costly, and frequently disallowed. Since most inventions in biotechnology were discovered by scientists in universities which were financed by Federal funds, it was unlikely that these inventions would ever be commercialized without reform in the rules governing ownership or transfer to IP rights. This was achieved in 1980 with the passage of the Bayh–Dole Act, which allowed ownership rights to intellectual property generated by Federally-funded research to be devolved to the universities where the discoveries were made. In 1984, the ownership rights of universities were further expanded under Public Law 98–620. These two pieces of
Federal legislation made universities largely responsible for contracting over IP rights in biotechnology.

4. Adaptive efforts: Privatization of intellectual property

Incentives to commercialize new knowledge depend critically on the existence of property rights to that knowledge on the part of the investor. Thus, the intention of the Bayh–Dole Act was to facilitate the commercialization of university-generated knowledge by allowing for the formation of IP rights to that knowledge, and their transfer to private parties. However, the task of establishing, allocating and administering IP rights in biotechnology represented a significant deviation from universities’ historic mission, requiring them to significantly adapt their existing policies and organizational arrangements. In the discussion that follows, we discuss universities’ attempts to accommodate the privatization of IP in relation to four main areas: – (a) formation of IP rights; (b) ownership of privatized IP; (c) licensing of IP; and (d) royalties and royalty distributions from IP ownership. As our discussion will show, universities’ adaptive efforts in these areas were frequently delayed, diverted, and even forestalled, by parties seeking to enforce universities’ historic social–contractual commitment to maintain the intellectual commons.

4.1. Privatization

The passage of the Bayh–Dole Act in 1980 served as a lightning rod for public debate on the potential effects of privatizing and commercializing IP on the role of universities in society. Voices were raised in a variety of societal forums opposing any change that would endanger the intellectual commons and the practices of open science. These forums included Federal and State government hearings;9 special reports of professional societies and social interest organizations;10 commentaries in professional journals;11 scholarly publications;12 meetings and their proceedings;13 public statements by university officials and other concerned individuals; and commentaries and investigative reports in the national press and other media. Critics were concerned that greater

9 For example, Congressional hearings were held in 1981 and 1982 about whether or not private firms were profiting unduly from research financed by U.S. taxpayers. In 1992, hearings were held related to the agreements between Scripps Research Institute and Sandoz Corporation and in 1993, hearings were held regarding the patentability of gene fragments.


13 The Pajaro Dunes conference of 1981 brought together top administrators and faculty from Stanford, the University of California, MIT, Harvard, Caltech and Washington University to discuss policies relating to technology transfer and faculty conflict-of-interest.
privatization of rights could lead to an erosion of the standards of open science. Thus, while it is generally recognized that competition for academic prizes and grants can lead to secrecy, commercially-motivated privatization has been seen as adding a powerful new incentive to withhold knowledge. For example, the Nelkin (1984) report to the American Association for the Advancement of Science expresses considerable concern about the effects of ‘biocommerce’ on the workings of universities:

If ties to industry encourage secrecy, divert faculty away from university-centered research and education, bring external control of the direction of research, and allow profit motives to enter discussions about hiring or promotion, then such ties may indeed erode what is left of the image of the university as a detached institution able to provide relatively impartial, independent, and therefore credible expertise (Nelkin (1984), p. 26).

Academic science has been a public resource, a repository for ideas, and a source of relatively unbiased information. Industrial connections blur the distinctions between corporations and the university, establishing private control over a public resource. Problems of secrecy and proprietary rights are inherent in these new relationships and hold serious implications for both academic science and the public interest (Nelkin (1984), p. 29).

Despite intense public debate, empirical evidence provided by Henderson et al. (1994) indicates that universities increasingly took out patents on research produced by their faculties during the 1980s. The authors find that between 1978 and 1988, the rate of increase in annual patent filings was almost four times the rate of growth in the previous decade. One reason for the rapid increase in privatization of IP among universities may have been that the Bayh–Dole Act had already de facto legitimized the privatization of IP financed by the Federal government. However, permission to privatize is not the same as an obligation to privatize; under the Bayh–Dole Act, universities are free not to patent new knowledge that has patentable value (Williams (1994)). Nonetheless, most universities now require faculty to report inventions to them promptly, and the decision rights regarding whether or not to patent inventions are usually held by university administrators, rather than faculty (Matkin (1990), Williams (1994)). This suggests that

14 Concerns about redirecting research efforts of faculty away from more fundamental, and hence more public projects, have been partly justified by some survey results. For example, Blumenthal et al. (1986) found that faculty members whose research was supported by industry were four times more likely than faculty without such support to report that their choices of research topics had been affected by the chance that the results would have commercial application. However, faculty with industry support were also found to publish scholarly research at higher rates than those without support. This result is likely due to selection bias by firms in their choices of scientists to support.

15 Nobelist James Watson, co-discoverer of DNA, described the intensity of this competition in The Double Helix.

16 Similarly, the National Science Board (1987) reported that the rate of increase in patents granted to universities during 1980–1985 was more than twice that in 1975–1980. Henderson et al. (1994) find that in 1978, university patent filings represented about 9 percent of all patent filings in the United States; by 1988, this proportion had increased to about 14 percent. In 1978, universities were issued about 40 patents per billion dollars of R&D expenditures; by 1988, this had risen to 70 patents per billion R&D dollars.
financial motives have also impacted universities’ ownership policies. Universities may prefer to retain the option to privatize, rather than allow faculty to decide whether or not property should be placed in the public domain, in order to increase university income from IP, as well as to mitigate agency problems with faculty. Indeed, universities, especially public universities, may themselves be under pressure from their constituents to increase their non-tax-derived income through patenting and licensing.  

Another possible motive for privatization of university IP is more idealistic, namely, to serve the public interest by facilitating the transfer of scientific knowledge into products useful to society. According to this view, patenting and licensing by universities is required to provide adequate incentives for firms to commercialize technology, and to forestall opportunistic privatization by inventing faculty. However, active patenting by universities by itself cannot ensure full disclosure (Bok (1981)). Furthermore, while most university policies essentially enforce public release of information by establishing strict limits on the timeliness of faculty disclosures, and on the time taken to file for patents, idealism is clearly not the sole motive for these policies. At least for fundamental technologies, commercialization can occur without patents, as occurred with the Kohler–Milstein hybridoma technique, and arguably, would have been the case with the Cohen–Boyer gene-splicing technology had it not been patented first.

4.2. Ownership

If the IP of university faculty is privatized, a second issue is raised; who should have ownership to the private rights? For research funded by the Federal government, universities have no discretion; under the Bayh–Dole Act, ownership cannot be assigned to third parties. In the case of commercially-sponsored research, however, universities could potentially assign IP rights to firms funding the research that produced them. In the case of research funded by other methods, faculty themselves could potentially become the owners of the associated IP. For several state-funded universities, these options were foreclosed by state legislation. However, most universities, including those not under the jurisdiction of state legislation, now have policies that foreclose assignment of ownership of faculty-generated IP to third parties, be they firms or faculty, no matter how research is funded (Matkin (1990), Williams (1994)). This arrangement is generally justified by the consideration that assigning IP ownership to third parties places universities in the position of ‘selling’ rights – acting as commercial suppliers of knowhow – rather than receiving research monies without any taint of a commercial quid pro quo.

Additional insight into the motives for establishing a standardized rule that universities will have title to faculty inventions is provided by debates at Stanford University. At Stanford, ownership rights to IP not otherwise governed by regulation or contract belonged until recently to inventing faculty, rather than to the university. However, in 1994, after two years of debate in the Committee on Research of the Faculty Senate, this

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18 Eisenberg (1995) has recently questioned the wisdom of encouraging patenting of any government-funded research, as well as the arguments made in support of the Bayh–Dole Act.
policy was reversed. The apparent reason for the change was conflict of interest – faculty ownership of IP was deemed to be incompatible with the preservation of the intellectual commons. In a statement approved in April 1994, the Senate of the Academic Council of the University made the following observations:

Faculty ownership of inventions created in the course of their University activities or with more than incidental use of University resources creates conflicts of interest. . . . First, . . . for faculty members to decide ownership of intellectual property based on source of support when they stand to gain financially from such decisions constitutes a serious conflict of interest. Second, for faculty members to claim ownership of an invention resulting from their University activities calls into question whether they are using University resources for personal financial gain. Third, the opportunity for a faculty member to assume ownership of an invention and then grant exclusive access to it to a sponsor or potential sponsor of his or her university research creates an incentive to inappropriate relationships. . . . To the extent that financial interests of a faculty member and a corporate sponsor become intermingled, the scientific objectivity of the faculty member can be called into question (Stanford University Faculty Policy on Conflict of Commitment and Interest, Senate of the Academic Council, April 14, 1994).

Thus, faculty ownership of IP rights results in both a standard agency problem and one unique to universities. First, the arrangement provides incentives for faculty to appropriate university intellectual property. Second, faculty ownership of IP would shift incentives so that faculty would have interests in pursuing commercial activities at the expense of fundamental research, which is seen as being incompatible with the objectives and standardized governance arrangements of universities. There was also concern that scientific objectivity would be threatened because such objectivity is a critical way in which the university pursues its mission to provide knowledge, and yields social value which other institutions like firms cannot easily provide. 19 Thus, organizational standards and social constraints have motivated university choices to limit privatization by avoiding, or, as in the Stanford case, overturning, rules which extend the privatization of IP rights to the individual level.

4.3. Licensing

Given that universities uniformly adopted policies of university ownership of IP, the question of balancing the interests of the intellectual commons on the one hand, and private interests on the other, devolved onto licensing policy. As in the case of ownership, licensing policy was also impacted by universities’ standards and social–contractual commitments, with the outcome that privatization has been limited by considerations relating to the preservation of the commons.

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19 See Dasgupta and David (1987). Concerns about objectivity in biotechnology were also heard in Congress. In 1987, hearings were held on legislation banning scientists with equity stakes in biotechnology firms from performing drug trials for the FDA.
License exclusivity. For many technologies which, like biotechnology, do not display
network externalities, rents from IP will be highest – and therefore the willingness to pay
for it will be highest – when it is owned or rented exclusively.20 Yet, university policy
makers have resisted exclusive licensing, reflecting a number of concerns expressed by
various university constituencies. First, there was a concern that licensees could ‘choke
off’ university research if they obtained exclusive rights. The careers of both faculty and
students could be disrupted this way, and the intellectual commons would be diminished
by having certain avenues of inquiry blocked. Consequently, universities have generally
adopted licenses that include ‘bench rights’ – rights allowing universities to use the IP
contained in the license to pursue research, but not to use it for commercial ends or
transfer it to other parties.

Second, there was concern that firms would seek to influence individual faculty
members in order to obtain exclusive rights in ways that would undermine the intellectual
commons. For example, a firm might sponsor a faculty member’s research project on the
understanding that any discoveries were to flow to the firm. In such agreements, a faculty
member becomes essentially a supplier to the firm, with motives that are inconsistent
with open science practices and maintenance of the intellectual commons. For example,
discussing research findings with colleagues would endanger the IP rights of the firm,
resulting in a loss of funding. To protect against such mis-incentives for faculty, many
universities do not allow clauses in sponsored research agreements that provide for the
allocation of licensing rights to inventions ex ante. For example, UCLA only permits
research sponsors ‘exclusive rights to negotiate’ for an IP license in sponsored research
agreements. However, some universities will compromise by allowing sponsors very
general upfront rights provisions, and negotiate more specific licensing rights ex post
(Matkin (1990)).

Breadth of licensing rights. A second concern regarding licensing was the breadth of
rights granted to firms. Firms usually prefer broad-based licensing rights because
knowledge can spill over from one research project to the next, and from one generation
of research to the next. The value of narrowly-based rights could be undermined by
owners of rights to ‘adjacent’ technologies. However, universities have restricted the
granting of broad-based rights, once more reflecting the influence of standards and
social–contractual commitments relating to the preservation of the intellectual commons.

Two well-known instances in which social–contractual commitments and standards
were brought to bear on restricting broad-based granting of rights are the agreements
between Massachusetts General Hospital (MGH), a teaching hospital affiliated with
Harvard Medical School, and Hoechst, a major pharmaceutical firm, struck in 1980, and
the agreement made between the Medical School of Washington University in St. Louis
and Monsanto in 1982. In the first agreement, Hoechst put up $67.6 million in research
and building funds to establish a Department of Molecular Biology at MGH. In return,
Hoeschst received exclusive worldwide rights to license any IP emanating from the
research it funded, as well as rights to review research results before publication and to
disallow research projects or research collaborations that it did not deem in its own

20 In some cases where the technologies are very basic, yet practical (such as the Cohen–Boyer gene-splicing
technology), higher rents may be generated through nonexclusive licensing.
interests. The agreements created a furor in Washington, DC, resulting in hearings by the Congressional Committee on Investigations and Oversight. At these hearings concerns about the erosion of the intellectual commons were raised with respect to both agreements. For example, the Committee Chairman, Al Gore, made the following statement:

We provided $25 to $26 million a year in direct Federal aid to Mass General. I think it’s fair to say that the current biomedical research capabilities at Mass General are indebted in part to Federal support of basic biomedical research over the last 20 years. Now, isn’t it a little unfair to the American taxpayers . . . to give the cream of the results to a foreign company that gets exclusive licensing rights? (quoted in Twentieth Century Fund Report (1984), p. 47).

The General Accounting Office pointed out that the Hoescht agreement was in potential contravention of the Bayh–Dole Act, and the Federal government subsequently required MGH to establish a separate accounting system in order to establish that no IP rights would flow to Hoescht from Federally-funded research. The Twentieth Century Fund nevertheless later noted that, “When it comes to a researcher’s allegiance, little is required to tip the balance in favor of one or other of his two masters. Members of the Department of Molecular Biology at Massachusetts General might well come to believe that they work for Hoescht” (p. 48).

Possibly as a result of this governmental opprobrium, and the sanctions imposed on MGH following its agreement, few other universities have sought to grant broad licensing rights to third parties. For example, a technology licensing official at UCLA whom we interviewed stated that the university seeks to license ‘as narrowly as possible’ to avoid conflicts in rights between the Federal government and research sponsors, and to avoid foreclosing the generation of additional downstream rights that might otherwise flow to the university. As a result, UCLA grants exclusive licenses only to sponsors who can demonstrate that an invention was both discovered, and first brought to practice, exclusively during the course of research that they, and they alone, have funded.

While such narrowly defined rights help preserve the intellectual commons, they are far less desirable from the point of view of firms. Even though university–industry transfer of biotechnology has been substantial, issues of licensing exclusivity and breadth apparently underlie dissatisfaction with technology transfer programs in general at many universities. For example, over half the executives interviewed by the accounting firm Coopers and Lybrand complained of problems in relationships with universities, including: ‘a faculty culture not receptive to business’ and ‘faculty disinterest in designing programs and resources for business’ (Investor’s Business Daily, February 6, 1995, p. A4). The firm of Peat Marwick (1981) reported executive discontent with the degree of access and services offered in university technology transfer programs.

21 However, in 1992, the Scripps Institute and Sandoz made an agreement that also granted Sandoz broad rights. Congressional hearings following such contracts forced Scripps to renegotiate its agreement, greatly curtailing Sandoz’s ex ante rights to license. Bernadine Healy, head of the National Institutes of Health at the time, told the Congressional committee that the agreement was "contrary to the spirit of science, and possibly, illegal."
generally. In terms of agency theory, the problem is that for a given invention, there may be no contract which is simultaneously ‘incentive compatible,’ in that it is consistent with the university’s mission and a sponsor’s profit goals, and ‘individually rational,’ in that it induces a firm to participate.

4.4. Royalty interests

An important way in which universities have sought to stimulate technology transfer is through policies governing the allocation of royalty income from licensed research. The choice of these policies is regulated by Bayh-Dole Act; universities that elect to take title to IP are required to share a minimum of net royalty income from that IP with the inventors, and are directed to use the remainder to cover the costs of IP administration and to fund further research. However, these provisions allow considerable variation in interpretation. In addition, only seven states have laws governing royalty payments for research that is not Federally-funded (Williams (1994)). As a result, universities have considerable latitude over royalty allocations, and policies at various universities vary considerably (Heathington et al. (1986), Matkin (1990), Williams (1994)).

Incentive provision. Although universities have adopted policies that universally grant them rights to faculty-generated IP, it is still feasible for inventing faculty to withhold inventions from university administrators by publishing research findings before any patent can be filed, or by transferring them to third parties in violation of university policies. To completely prevent such infractions, universities would need to monitor faculty activities closely. However, it would be extremely costly for a university to monitor faculty members’ research outputs because of the highly specialized nature of the knowledge involved. More importantly, monitoring of faculty research progress and output by university administrators would effectively constitute interference with academic freedom, a violation of open science practices (Merton (1973)). As a result, universities have relied almost exclusively on royalties as an incentive for faculty to report inventions.22 In this instance, then, standardized governance arrangements and social-contractual commitments led, in part, to increased privatization – down to the individual level – in order to forestall even greater privatization that might occur through withholding of inventions from the intellectual commons, were more communal standards of IP ownership to be adopted.

Equity and envy. The choice of royalty policies has also been constrained in important ways by concerns about equity, and fears about the consequences of envy. One traditional tenet of universities, embodied in their governance institutions, has been that no one type of knowledge should be considered “superior” to others (Merton (1973)). This tenet serves to protect universities’ knowledge-creating processes from becoming tainted by commercial motives, and encourages the creation of all types of knowledge. Consistent with this tenet, faculty from all departments are involved in the formulation of university policies, and differences in faculty pay have traditionally been circumscribed. The norm of faculty equity in rewards has traditionally been the weaker of the two norms. For

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22 The University of California, for example, found that raising the inventing faculty member’s share of royalties from 25 percent to 50 percent of net earnings produced a sharp and sustained increase in the number of disclosures during the late 1970s (Feller (1990)).
example, the pay of faculty in professional schools is invariably higher than of faculty in Colleges of Letters and Science (although pay differentials are often only achieved by imaginative adjustments to uniform pay scales). Still, the norm is arguably held more strongly in universities than in private firms. Thus, the earning of substantial royalty income by some departments, or by some members of some departments, threatens to create income disparities so large as to approach market-generated outcomes. This would upset the norm of equity.

The development of inequities involves the additional danger of motivating envious retaliation by faculty. University settings are particularly fertile ground for such retaliation because the structure of decision rights within universities provides ample opportunities for such actions. For example, Salancik and Pfeffer (1974), and Salancik and Pfeffer (1978) showed how academic departments exert influence at the university level to redirect resources such as research funds and faculty appointments away from other departments and towards their own. This influence can be used to ‘punish’ departments with high levels of commercially-oriented research activity. Faculty may also retaliate by withholding collegiality and refusing departmental teaching or service assignments. Of course, these activities can be stimulated by simple self-interest rather than envy per se. However, in universities there are many actions that faculty take which punish entrepreneurial faculty without benefiting the punisher economically. For example, faculty can use their positions on conflict-of-interest committees to restrict faculty involvement in commercially-oriented research and consulting activities, without economic gain to themselves. Moreover, faculty decision rights, especially the rights conferred by tenure, protect faculty retaliators by limiting the extent of sanctions that can be applied to them. These committees provide significant scope for envy-driven action because they often both define and enforce university regulations.

Mui (1995) analyzes a model in which an innovator makes an innovation that benefits her, but causes an envious agent to retaliate, imposing costs on her. The agent retaliates because he cares about his income relative to the innovator’s. If the benefits exceed the costs, innovation with retaliation will be observed; otherwise, innovation will not occur because of the threat of retaliation. Also, innovations which produce large-enough positive spillovers to the envious agent can tip the balance in favor of innovation. In universities, it is common to observe innovation with retaliation, and it may also be that the threat of retaliation has stifled entrepreneurial impulses. Innovation in biotechnology, however, does not naturally improve the study of areas such as the humanities, and so universities have had to “create” positive spillovers though the sharing of royalty income with other (especially non-science) departments. Matkin (1990) and Williams (1994) report that 84 percent and 100 percent (respectively) of the universities they surveyed reallocated royalty income between departments, with the reallocated shares reaching as high as 85 percent of net royalty income. As the Mui (1995) model suggests, this redistribution may in part be an attempt to mitigate the negative effects of envy on commercialization efforts.

In sum, universities’ attempts to privatize what was partly public-funded IP in order to take advantage of new opportunities and meet new budget constraints has generated an ongoing social debate. This debate can be seen as a series of negotiations over property rights to the intellectual commons, writ large. Faculties and their professional
organizations, the media, and State and Federal governments typically seek to uphold universities’ social–contractual commitments to sustain an intellectual commons and to see that supporting internal standards governing faculty behavior are maintained. University administrators, on the other hand, attempt to find ways to meet new exigencies while addressing the concerns of these groups. In some cases faculties and their professional societies have succeeded in limiting efforts at privatization. In other cases, negotiations have been escalated to involve government agencies, state legislatures, and Congress. The result has been a process of privatization of rights that has been slowed by extended debate, and highly circumscribed in terms of the breadth and exclusivity of licensing rights that have been offered to private parties.

5. Adaptive efforts: Commercialization

While the debate over privatization of intellectual property created in universities has by no means been resolved, as mentioned above, most major research universities did make moves in that direction at least by the early 1980s. But even after Federal restrictions on exclusive licensing of patents from government-funded research were lifted in 1984, universities’ royalty earnings remained meager as a fraction of their total budgets.\(^{23}\) In response, universities began seeking ways to facilitate the commercialization of their technology through other types of organizational adaptations, leading to debates about the appropriateness of these organizational changes.

University administrators understand disappointing royalty revenues as resulting from the fact that commercializing patented technology can be very costly to potential licensees. This is because significant further innovation and investment are generally required to bring patented technology to market, and because start-up biotechnology firms typically face capital constraints (Matkin (1990)). Consequently, universities have considered, intensively debated, and enacted a number of organizational changes aimed at lowering these costs. Each of these adaptations has been criticized, however, by individuals and groups who see such changes as compromising the university’s mission and tainting the motives of both faculty and administrators.

5.1. Technology transfer offices

One adaptation universities have made in response to new commercial opportunities has been to adopt new organizational arrangements for governing technology transfer. These new arrangements often involve significant changes in the roles of patent officials. These roles have traditionally included applying for patents, protecting the university against legal liability, negotiating license agreements, etc. In the early 1980s, more explicit policies were developed by government agencies and universities, and officials

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\(^{23}\) A survey of 20 major research universities revealed average royalty income for 1990 of $2.6 million, while average corporate research support averaged $19.81 million. These numbers are quite small, considering that the U.S. leader in royalty income, Stanford, had licensing revenues which accounted for less than 11 percent of its research budget and less than 4 percent of its total budget in 1994. The survey also found that corporate sponsorship averaged only 7.3 percent of total research funding (AUTM, 1992).
have been increasingly involved in ensuring compliance with these policies, as well as with state and Federal laws. For example, more traditional offices (such as UCLA and USC) are largely preoccupied with problems of co-mingling of government and private funds, allocation of intellectual property rights to inventions at different stages, transfer of sensitive materials, restricting limits on publication, and ensuring that property rights are not so broad as to limit university research. In the terms of this paper, these activities are aimed directly at upholding the university’s commitment to provide knowledge to society.

However, in the mid-1980s, MIT, followed by Stanford, UC Berkeley, the Pennsylvania State University and others, created new “offices of technology transfer” to replace their older “offices of patent administration.” These new offices go beyond patent and license administration to active marketing of faculty inventions to private firms, and active solicitation of faculty to disclose and patent their inventions. The offices are staffed by professional marketers and led by individuals with business experience. Together with inventing faculty, marketing professionals help conceive applications, identify potential licensees, and develop sales packages for presentation to potential customers (Sandelin (1994), Kaghan (1997)). These activities can be thought of as being aimed at addressing problems of valuation under information asymmetry in the market for inventions (Akerlof (1970), Arrow (1971)). More aggressive marketing may have contributed to the increase in total licensing revenues from $1 million in 1980 to $259 million in 1991 (AUTM (1992)).

Setting up new technology transfer offices, and establishing their missions, was the subject of intense debate on many campuses. For example, according to Stanford officials, members of the faculty senate debated over a period of a year about whether ‘generating income for the university’ should be added as an objective for the office on a par with ‘technology transfer for society’s use and benefit.’ Another barrier to establishing offices with expressed commercial goals is that some public universities, including UC Berkeley, have been subject to state laws limiting the compensation payable to state employees of various rank. This has made it difficult to attract highly motivated marketing staffs, since private firms generally pay marketing professionals on a commission basis. Universities’ unwillingness to allow commission-based pay reflects equity concerns enforced by state mandate. In addition, many universities have been unwilling to authorize more than a handful of staff positions, arguing that faculty should receive funding priority.

Some university technology transfer efforts emphasize negotiation of long-term contracts with individual firms, which receive rights of first refusal to exclusive patent licenses arising from research funded by the firm in question. This approach involves lifting constraints traditionally imposed by universities on contracts with private firms. The MGH±Hoescht and Washington University±Monsanto agreements fall into this category. As discussed earlier, such broad-based agreements have been forestalled by government opposition. Recently, however, UC Irvine has pioneered a related approach in which firms sponsor research in narrow, specified areas in exchange for exclusive licenses and rights to sponsor related new research. Importantly, firms must continue to provide funds to university researchers in order to continue using the technology, and to receive valuable follow-on research by inventing faculty. This arrangement can be interpreted as a double-bonding mechanism. The firm posts a bond to commit it to ongoing research sponsorship and good-faith efforts at commercialization, while the university posts a
bond to commit it to support ongoing faculty collaboration. The approach recognizes that technology commercialization is a process with frequent feedback loops between invention and application, so that follow-on research can be of significant value to collaborating firms (Rosenberg (1976)). Finally, arrangements under this approach offer inventing faculty certain research support upfront in lieu of uncertain royalty income ex post. This provision recognizes that funds for sponsored research generally far exceed prospective royalties for a given project in biotechnology, and helps meet the mission of the university to sustain the intellectual commons through continuous research. This approach, then, clearly has some incentive advantages over other approaches, while recognizing social constraints to some degree. However, it too has been criticized for compromising the mission of the university by introducing commercial goals into research. Some Irvine faculty have argued that long-term contracts encourage secrecy among faculty, and provide too many incentives for them to slant research in ways that respond to the private research interests of the sponsor, at the expense of the public interest. The media have also expressed opposition. This has slowed implementation of the long-term contracting approach at Irvine. Other universities generally avoid linking private research sponsorship with licensing, by, for example, maintaining separate offices for each function.

5.2. University-owned ventures

A second type of organizational adjustment aimed at facilitating commercialization involves universities proposing to invest, or actually investing, in start-up firms formed to commercialize university technology, sometimes with the participation of the inventing faculty. Debate over the appropriateness of such a policy reached a high pitch in 1980 when Harvard University proposed taking equity in a start-up firm founded to commercialize the research of a Harvard molecular biologist who was himself to be a major stockholder. The proposal met with negative articles in the New York Times and other media outlets. It also met opposition by Harvard faculty and alumni, many of whom were concerned that it was improper for a university to become directly involved in a profit-making enterprise. For instance, a Harvard biologist, Otto Solbrig, worried about the threat to scientific practice:

A very fundamental value is the freedom to speak to the issues that are of concern to society as impartial experts...I fear that the credibility of the University could be seriously hurt if we were to be seen not as impartial experts, but as interested parties likely to benefit financially from the exploitation of new technologies (quoted in Kenney (1986), pp.80–1).

In December 1992, the television program 20/20 conducted a highly critical investigative report on the relationship between the UC Irvine and Hitachi Chemical Corporation. The two have an agreement whereby Hitachi pays to share space in a university laboratory building and earns exclusive licensing rights to joint research, while excluding Irvine faculty and students from its laboratories.

25 University ownership in new ventures preceded the public debate ignited by Harvard’s proposal by many years. As early as 1972, MIT formed the MIT Development Foundation (MITDF) with donations from the MIT Corporation and several private firms to acquire equity positions in companies commercializing technology developed at MIT. It was terminated in 1977 after complaints were heard in Congress that these companies were being favored with licenses to government-sponsored research (Matkin (1990), pp. 281–2).
Only weeks after it had put forth the proposal, Harvard announced it was not going to proceed. Derek Bok, then Harvard’s president, explained the university’s reticence:

...any effort to go into business with professors will expose the administration to almost certain disagreements...with professors who feel envious or upset that their own cherished schemes have not received comparable support...Suppose an assistant professor is also working for a university-owned venture on a matter of major importance. How is the administration to judge his qualifications for tenure? How will a president or dean respond to any of the university’s faculty partners when they ask for an extra leave, or larger laboratory space, or more graduate students? (Bok (1981), pp. 29–32)

The concerns here are that ownership in new ventures could create problems of envy, and strain the university’s standardized arrangements for evaluating and rewarding faculty. Note that these concerns are linked, since the administration’s judgments about faculty tenure qualifications can be influenced, positively or negatively, by envious faculty through their positions on tenure and promotion committees. Thus, envy and equity considerations serve to reinforce universities’ social–contractual commitments and the associated organizational arrangements.

One possible solution to the standardization problem is to create a second, parallel set of standards for evaluating faculty involved in university ventures; this would be a way to customize governance arrangements for activities which have fundamentally different objectives. That is, the university could attempt to intervene selectively to suspend standard governance arrangements for ‘special fields.’ As an analogy, professional schools can been seen precisely as attempts by universities to maintain somewhat different sets of incentives for faculty whose research leans in a more practical direction. Williamson (1991) has argued, however, that in the end such ‘selective intervention’ lacks credibility and is difficult to sustain over time. Thus, professional schools have arguably evolved toward internal standards, especially promotion criteria, that are similar to those of traditional academic departments. One reason is that faculty at professional schools are usually evaluated for tenure and promotion by the same university committees that evaluate faculty in academic departments.

Derek Bok’s remarks about university ownership of new ventures involve a clear application of the argument that selective intervention is impossible:

Enterprising administrators will quickly begin to think of organizational structures to insulate academic officials from the university’s new technology ventures so that commercial and academic considerations can be kept strictly separate...[But] it will be hard to convince the outside world, or even the rest of the faculty, that commercial considerations have not subtly begun to infect what have always been regarded as academic decisions. Since the reputation for integrity is so essential in matters such as

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promotion, and since the faculty’s confidence in that integrity is so important to its morale, even the appearance of impropriety could be extremely damaging (Bok (1981) pp. 32–33).\textsuperscript{27}

These comments constitute a rare piece of evidence that decision-makers’ concerns over the credibility of commitments can actually impact their choices of organizational structure.

Despite Bok’s concerns, however, UC Berkeley and Stanford attempted to create just such an ‘administrative separation’ to assist in commercializing biotechnology in 1982. The universities together set up a non-profit Center for Biotechnology Research, which would fund the research of faculty members at the two schools. The Center owned 30 percent of the shares of a for-profit company, Engenics, which would contract with private firms to pursue specific programs. The key faculty of the Center also owned 35 percent of Engenics’ shares and sat on its board of directors. The two universities would own all patents from research contracts Engenics entered into, on an exclusive basis. Importantly, the members of the Center’s governing board would have no affiliation with Engenics or its sponsoring companies (Kenney (1986), pp. 48–49). The idea behind these arrangements was to allow university faculty to be involved in commercialization, and to attract capital for it, without (at least overtly) compromising the university’s mission. The arrangements would enable contracts to be written that were both ‘incentive compatible’ and ‘individually rational.’ Since funding decisions would be made by the putatively independent Center, conflicts of interest associated with faculty entrepreneurs funneling private funds to their own projects would be avoided. The arrangement could also deter faculty from using public facilities and past publicly-funded research for private gain. In the end, however, Engenics was unable to attract the private funds necessary to produce its first products (Matkin (1990), p. 240). In 1987, Engenics’ relationship with the Center was severed, and the company was sold to another firm.\textsuperscript{28} The organizational arrangement had not lost faculty or public support, although if revenues had begun to flow it is conceivable that the credibility of the arrangement might have been questioned. Moreover, the fact that some of the technology licensed from the Center continues to find commercial applications suggests that low demand for the technology was also not the cause of the termination.\textsuperscript{29} What is most likely is that potential investors perceived the IP rights arrangements to be unsatisfactory.

University-owned ventures, then, have yet to be successfully institutionalized as an organizational mechanism for transferring university research to industry, despite over 20 years of sporadic experimentation. Most universities have eschewed such arrangements,

\textsuperscript{27} A recent report of Harvard’s University Science Policy Committee is more optimistic, suggesting the possibility of “creating an impermeable barrier between financial and academic management” (August 1995, p. 20).

\textsuperscript{28} A longer-lived example of a ‘buffer’ organization is the Wisconsin Alumni Research Foundation (WARF), a fully independent entity formed in the 1920s to administer and license patents on the research of University of Wisconsin faculty. The WARF model has not been replicated by other universities, however, perhaps because few such offices can be self-financing over long periods.

\textsuperscript{29} As of this writing, applications of the technology were being produced by Enzymall of Columbus, Ohio.
or have limited themselves to accepting equity in start-up firms only in lieu of upfront licensing fees. By and large, these attempts have been stymied or have failed either because they have been opposed by faculty and other parties seeking to uphold the university’s social–contractual commitment (e.g. Harvard) or because the types of organizational arrangements deemed acceptable by universities were insufficient to attract private investment (e.g. Engenics).

5.3. University-based research institutes

Universities have long formed research institutes, but since the 1980s, the number of such institutes has grown dramatically (Cohen, Florida and Goe (1994)). These institutes can also be seen as attempts to overcome the standardization problem by selective intervention – in the form of adjustments to the university’s contracts with researchers and outside funding bodies – in order to attract private funding. These adjustments include special restrictions on the flow of research results, changes in rules on outside work and faculty workload, and possibly changes in evaluation criteria and rewards. For example, over 40 percent of the institutes surveyed by Cohen, Florida and Goe (1994) reported that information-sharing between institute faculty and the general public is ‘sometimes restricted,’ and about 35 percent reported that participating companies can insist that information be removed from research papers prior to publication.

Recently, some ambitious attempts at institute-building in the biotechnology field have been made by universities such as Cornell, the University of Texas and MIT. These new institutes have attempted to attract private research sponsorship at significant levels by offering privileged access to research results. An instructive example is the Whitehead Institute for Biomedical Research at MIT. This institute was formed in 1981 through a large donation by Edwin Whitehead. While it has been claimed that the donation was purely philanthropic, Whitehead was a large stockholder in Revlon (a company interested in biotechnology at the time) and also owned a venture capital firm which specialized in financing new biotechnology firms. A unique feature of the Whitehead Institute has been that, while it is administratively separate from MIT, its governing board has the right to appoint up to twenty members of the MIT biology department, which in 1981 had some 40 members. Promotion decisions for these appointees, however, are made according to usual university procedures, and the scientists employed by Whitehead enjoy the usual academic autonomy in research. A minority of MIT representatives sit on the institute’s governing board, with the majority of board members is associated with various firms (including one from the venture capital firm). The university also adjusted its normal patent policy to allow the institute to own all patents on inventions made by its researchers with funds from Whitehead’s endowment (Twentieth Century Fund Report (1984) p. 49). Thus, the Whitehead Institute can be understood as an attempt to create an inter-penetrating system of public and private research within a university setting.

The Whitehead institute attracted immediate criticism from faculty members in 1981, 33 of whom signed and circulated a letter opposing the arrangement. The letter complained that “the unequal method of appointing new faculty could lead to a distortion in both the teaching and research programs of the Biology Department” (quoted in
Kenney (1986), p. 52). Some faculty also lamented the increasing atmosphere of secrecy in the department, even before the institute was initiated. Biology Professor Jonathan King, for example, expressed concerns about the intrusion of commercial motives, testifying before Congress that “the atmosphere around the biology department coffee pots has changed in the last few years. It is clear this is a new element coming in here” (quoted in Kenney (1986) p. 122).

The Whitehead Institute proposal was adopted by the MIT Corporation over these objections, and with little delay. This was possible because MIT regulations do not give faculty veto power in such decisions (Kenney (1986)) and because MIT has historically maintained closer-than-average ties to industry, a result of a more practical interpretation of its mission to produce and disseminate knowledge than other universities follow Matkin (1990). Yet, the institute has not conducted research that is substantially more commercially-oriented than that of the Biology Department. Members’ research has garnered prestigious academic awards, and several have been promoted to tenure at MIT. For several years, the Institute’s annual income from NIH funding has been more than three times its income from the Whitehead endowment, and funding from other private sources has been limited. Perhaps correspondingly, neither Revlon nor the Whitehead venture capital firm have participated in efforts to commercialize the institute’s technology. The Whitehead Institute’s experience could therefore be interpreted as a process by which selective intervention has given way to conformance with the university’s standardized governance arrangements (perhaps partly spurred by the early opposition among faculty). According to an institute official, the main difference that remains is that the institute’s day-to-day efforts at commercialization are free from the immediate scrutiny of faculty concerned about such efforts. Thus, while Whitehead had been very successful in producing high-quality fundamental research, the arrangement appears to have achieved only minor organizational differentiation.

6. Reactive adaptation: Controlling faculty behavior

In addition to adaptations aimed at promoting biotechnology commercialization, universities have also undertaken ‘reactive’ changes aimed at protecting the intellectual commons by enforcing pre-existing organizational standards more vigorously, or by establishing new standards. One important example of such reactive adaptation is the formalization and formalized enforcement of universities’ conflict of interest rules governing outside activities of faculty. This adaptation has come about despite complaints that it will slow the transfer of technology. In particular, outside management and consulting have recently come under greater scrutiny.

Outside management. The conflict of interest issue which has been given most attention by universities has been the problem of faculty members holding management positions in firms that are involved in commercializing the faculty member’s technology. Many universities, including UC, Harvard, Stanford and MIT, now explicitly prohibit faculty from taking managerial roles in outside ventures, and from owning equity in firms which also provide them with research funds. Thus, some schools have added statements like the following to their standard contracts with faculty:
Faculty must not allow other professional activities to detract from their primary allegiance to Stanford. For example, a faculty member on full-time active duty must not have significant outside managerial responsibilities nor act as a principal investigator on sponsored projects that could be conducted at Stanford but instead are submitted and managed through another institution.

These changes have come partly as a result of adverse publicity caused by some high-profile cases of faculty conflict of interest. One of these involved Ray Valentine, a professor of agricultural biochemistry at UC Davis whose research was sponsored by Allied Chemical Corp. In 1981, Valentine launched a start-up firm to commercialize his research, and Allied purchased a 20 percent equity stake in it. Valentine also received government-funding for his research, and employed graduate students in his university lab. After the situation was brought to the public’s attention by a state government commission, Valentine removed himself from the Allied contract, and changed his position at the start-up to a non-managerial one (Kenney (1986), pp. 66–67). Here, the university’s social–contractual commitment was effectively enforced by the state government, illustrating how public universities can often be subject to scrutiny that private universities escape.

Consulting. Faculty consulting has historically been the single most important mechanism for transferring technology of all kinds to industry (Matkin (1990)). But since the emergence of biotechnology, concerns have resurfaced concerning conflicts of interest and commitment which may arise in some consulting relationships. For instance, consulting contracts that are combined with agreements to license faculty-developed technology from the university engender close collaboration between inventing faculty and firms. Such relationships can divert faculty attention from teaching and service duties, and may even provide the conduit through which university rules on disclosing inventions are bypassed. Traditionally university conflict-of-interest rules regarding consulting activities were either largely unwritten and unenforced, or nonexistent, with universities relying on norms of ‘collegiality’ to control faculty behavior. But recently, rules that were once only informally-understood began to be codified in policy statements or in explicit contracts with faculty, and new rules were laid down. For example, the University of California and Stanford University have recently re-emphasized their rule limiting outside work to one day per week during the academic year. Rules limiting leaves of absence from university service for long periods are increasingly being written down and enforced. Nevertheless, new restrictions on consulting have been limited because changes attract significant faculty opposition. In addition, some rules may be unenforceable since faculty are not usually legally considered as full-time employees. Thus, the university’s power to govern faculty activities is more limited than its power to govern activities on campus, despite the extensive spillovers between the two.

7. Conclusion

In this paper we have shown that the privatization and commercialization of biotechnology research conducted in U.S. universities has been delayed and diminished
in scope by parties seeking to uphold the tradition of open science practices, and thereby sustain the intellectual commons for the use of society at large. Liberal technology transfer policies have been slow to diffuse. University ownership in new ventures remains controversial. Attempts at significant organizational differentiation have failed. Conflict-of-interest rules have been tightened and enforced. In each of these areas, social–contractual commitments and supporting organizational standards were important constraints on university action.

The paper treats the modern U.S. research university as a single organizational form. However, some universities are arguably less socially constrained than others. For instance, MIT, Georgia Tech, and some land-grant universities interpret their social–contractual commitments somewhat differently, emphasizing technology transfer as an important way in which they contribute to society’s knowledge base. In addition, faculty play a less active governance role in some universities than in others (McCormick and Meiners (1988), Masten (1996)). Particular faculty may also acquire special decision-making power due to their academic reputations or university service, and can more strictly enforce (or evade) organizational standards. Public universities are often more constrained than private ones. Despite these differences, the basic commitment to support open science has acted as an important constraint on major research universities generally – one that distinguishes them from other institutions such as firms, government agencies and research institutes. One reason for this is that the organizational arrangements that govern faculty hiring and promotion vary little from one university to another. Also, a significant degree of self-governance by faculty is an important feature of most all major research universities.

The evidence presented suggests that barriers to privatization of a commons which has features of a public good can arise from historical social–contractual commitments and supporting internal standards of organizations seeking or possessing property rights. This argument suggests that social constraints may be an important source of ‘inertia’ in organizations generally. Moreover, this inertia may result in the generation of new organizations, and perhaps even new organizational forms. For example, in the case of biotechnology, evidence of limits in the administrative capability of universities has been the fact that many faculty members have left universities to form or join ‘new biotechnology firms’ (NBFs) or other hybrid research organizations. Indeed, the emergence of NBFs can no doubt be attributed in part to outcomes at the university level. NBFs often combine institutional characteristics of universities and private firms; scientists typically enjoy greater autonomy in their choices of research topics than do their counterparts in large established firms, and they publish widely while benefiting financially from their research through substantial equity ownership (Orsengio (1989), Zucker et al. (1994), Oliver (1995)). Thus, the notions of internal standards and social–contractual commitments provide insight into the conditions under which new organizational forms are generated, as opposed to marginal adjustments to existing forms. Indeed, one can predict that the emergence of new industries based

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30 This is not to deny, however, that distributional struggles have occasionally played a role in determining such assignments between universities, firms, and governments. For an example, see Eisenberg (1995).
on university-developed technology will also be dependent on the evolution of new organizational arrangements that compensate for the social constraints on privatization which universities face.

Some economists continue to express concern about the potentially detrimental effects of aggressive technology transfer programs on basic research in the US (Dasgupta and David (1987)). They argue that basic research is crucial to long-term economic growth and is largely a public good. Incentives for private firms to undertake such research are therefore inadequate, so that if universities significantly reduce the level of basic research they support, growth will suffer. This paper’s arguments suggest reasons for concern which are rooted more in organization theory. Universities, like other organizations, are discrete structures, and find it very difficult to support multiple social goals simultaneously. Universities’ institutional mechanisms have been designed to develop and protect the intellectual commons, not to exploit it. Weakening these institutional mechanisms to any significant degree may rob the university of its unique identity and function as a social institution, and end with its capture by private interests.

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