University-Industry Research and Development Relationships: The University Perspective

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I. Introduction

The "ivory tower" -- the unencumbered pursuit and dissemination of knowledge through research, publication, and teaching -- has a strong cultural attraction for many faculty and administrators at major universities and colleges in the United States. A possible implication, often reinforced by some academics' distrust of the profit motive and fears of corporate influence, is that university-industrial contacts should be minimal or non-existent.

Reality for universities is, and probably always has been, otherwise. Higher education does not and cannot exist in a vacuum. The following is a list, probably not exhaustive, of the ways in which universities and the private sector interact:

-- Buying inputs. Universities need buildings, classrooms, computers, paper clips, soft drink vending machines, etc., all of which are purchased from the private sector.

-- Placing graduates. Most matriculating undergraduates and masters students, and even many Ph.D.s, are hired by the private sector.

-- Donations. Universities routinely solicit contributions from private-sector donors, to help support buildings, programs, and ongoing expenses. Though alumni are a prime target, non-alumni corporate executives (and their foundations) are also frequent targets.

-- Portfolio investments. Universities maintain and invest their portfolios, much of it in private-sector stock holdings.

-- Adjunct faculty. Extra, ad hoc faculty who can bring special expertise to the classroom are often hired as adjunct professors, usually with the permission of the individual's primary (private sector) employer. This practice is most common for the professional schools within universities.

-- Disseminating technological information. Especially for land-grant universities, the dissemination of agriculturally oriented technological information, in cooperation with state and federal government extension services, remains a strong tradition.[1]

-- Private consulting by faculty. "On their own time" consulting for the private sector (and for governments) is a common practice by faculty in many specialties; universities often make modest efforts to place limits on such consulting.[2] Formal split-time teaching and consulting arrangements have also arisen.

-- Formal joint efforts for research and dissemination. Formal involvement by both a university and a private-sector company (or industry) in a joint research and dissemination effort, embodied in specific projects or centers, are becoming increasingly common.[3]

-- University encouragement of spin-off enterprises. Where university faculty have made major technological discoveries that have lucrative practical uses, universities have sometimes encouraged or

[1] Indeed, "service" (to the community), as a third element of the mission of the university, along with "research" and "teaching," appears to have developed as part of the culture of the land grant institutions.

[2] A common, loosely enforced limitation, is a maximum of one day a week that can be devoted to consulting.

[3] See Stahler and Tash (1994), Brooks and Randazzese (1998), and Cohen et al. (1998).

even invested in spin-off enterprises involving the same faculty.

Accordingly, the non-involvement of universities with the private sector is hopelessly unrealistic as well as clearly inoperative. University-industry interactions are extensive and are likely to increase. Nevertheless, the attraction of the ivory tower as an element of university culture should be understood by anyone who wants to comprehend the tensions and problems that can arise on campuses in the wake of university-industry relationships.[4]

This essay will focus one major aspect of involvement, university-industry research and dissemination interactions that are both formal and informal in nature, with special emphasis on the New York metropolitan area. This essay should be considered preliminary and exploratory. Throughout we will approach the topic from the university perspective. Thus, we will take as a given that these relationships can be beneficial for industry participants[5] and for community economic development more generally.

In Section II we will discuss the major advantages and disadvantages of such interactions for the university. Section III will survey some dimensions of recent arrangements in the U.S. In Section IV we will offer a brief discussion of the current arrangements in the New York/New Jersey/Connecticut tri-state region and suggest paths for future data collection. And Section V will offer some concluding remarks.

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[4] As an expression of the tensions that can arise, the agricultural technology research and dissemination mission of the land grant universities was largely unquestioned until critics began to notice that some of the beneficiaries were large, "agri-business" enterprises.

[5] See Jaffe (1989), Adams (1990), Mansfield (1991, 1992), Tornquist and Kallsen (1994), Tornquist and Hoenack (1996), and Cohen et al. (1998).

II. The Advantages and Disadvantages of University-Industry Relationships

There are both advantages and disadvantages to more extensive research and development (R&D) relationships between universities and industry.[6]

A. Advantages

A1. University-industry R&D relationships can add to the resources available to universities to fund research and to carry out the other functions of the university (such as teaching and more general service to the community). The extra resources can take the tangible form of additional facilities, personnel, or materials. The extra resources may arise through the direct funding of the research by the private sector and/or through an ownership interest and subsequent revenues (e.g., through licensing) of the discoveries (intellectual property) that arise from such research.

A2. These relationships may allow different kinds of research than could have occurred in their absence. University researchers' access to industrial information, ideas, personnel, and facilities may stimulate lines of research that simply would not have been possible without the university-industry contact. The same possibilities hold true also for the more informal consulting opportunities that can arise for individual faculty.

A3. A favorable research collaboration experience may allow the university subsequently to pursue other important relationships with its industrial partner: e.g., placing graduates, pursuing donations, hiring adjunct faculty, etc.

[6] The discussion in this section and the one that follows draws heavily on Fairweather (1988).

B. Disadvantages[7]

B1. University-industry R&D relationships may push university-based research away from basic research and more toward applied research and development. Individual companies generally are less inclined to support basic research, since the outcomes tend to be more uncertain and risky and less appropriable.[8] But basic research is the broad kind of research that universities should conduct and have excelled at (and where social payoffs can be quite high). It is universities' general area of comparative advantage (even though many university researchers may excel at applied research). Private funding and pressures can clearly create new tensions.

B2. As a related point to #B1, industry funding may discourage the unhindered pursuit of the twists and turns of research. Difficult choices may arise in the middle of a research program when a researcher's instincts might be to pursue one path while the industrial partner's interests may lie in a different direction.[9]

Some commentators[10] have characterized such restrictions as impingements on "academic

[7] In addition to Fairweather (1988), a number of the points discussed below are recognized by Geiger (1992), Brooks and Randazzese (1998), and Cohen et al. (1998).

[8] Industry consortia may be more inclined to fund basic research. And there have been exceptions -- e.g., AT&T's Bell Labs; IBM -- to the general pattern of individual company reluctance.

[9] Ashford (1983) offers a variant on this theme:

"Take the case of a toxicologist who has reason to believe that two chemicals could be significant human resources, but who has the resources to pursue a study of only one. If she knows that chemical A is manufactured by a company that is about to give a large technology/development grant to her university, and that chemical B is not, will her choice be unaffected by that fact? Is it not fair to say that fear of upsetting a potential funder may provide an incentive to investigate B rather than A?"

[10] E.g., Ashford (1983), Caldert (1983), Tatel and Guthrie (1983), Fairweather (1988), Scott

freedom." But "he who pays the piper calls the tune" surely is an understood proposition among research faculties, and researchers always have the option of refusing to enter a sponsored research program in the first place. So a rallying cry of "academic freedom" seems excessively dramatic. Nevertheless, research choices may well be affected. And in a university setting where freedom of inquiry is highly valued, the acceptance of funding that also contains significant restrictions does pose significant "culture" and "values" questions.

B3. Since industry participants are likely to be aiming for proprietary gain vis-a-vis their rivals, traditional academic openness in research and publication may be replaced by confidentiality and delays in publication.

B4. Industrial funding opportunities may shift faculty attitudes and activities in subtle ways toward the greater pursuit of their private gain and a lesser pursuit of general research and of the university's wider interests. They may focus more on consulting that has no direct research or publishable product; they may focus more on the development of technologies at the expense of deeper research and publications. But in an era where major research discoveries can yield sizable gains to the owner of the subsequent intellectual property, such dangers may be present for some research ventures regardless of the funding source.

C. A summing up

As is true for most activities, there are few (if any) free lunches for universities in R&D relationships with industry. The benefits may well exceed the costs and thus make such relationships

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(1998).

worthwhile.[11] But acknowledgement and proactive management of the potential costs will surely help contain them and increase the benefit/cost ratio.

[11] But for a cautionary tale of a university-industry relationship that went badly sour, see Senter (1996).

III. Recent Patterns in the United States

There are no good or precise ways to summarize the entirety of university-industry R&D relationships in the U.S. Nevertheless, some important trends can be highlighted.[12]

A. The trends

First, the number of formal university-industry has grown substantially over the past two decades. As of 1990 there were 1,056 university-industry R&D centers in the U.S.; almost 60% of them were established during the decade of the 1980s. These centers spent $2.9 billion on R&D, which was more than double the $1.3 billion in support provided by the National Science Foundation (NSF) for all academic research.

Second, the share of academic research supported by industry has also increased. In 1970 that share was 2.6%; in 1980 it was 3.9%; and by 1990 it had grown to 6.9%, or over double the percentage of two decades years earlier.

Third, on the development and applications side, the patents awarded to major research universities has increased dramatically. During 1974, the leading 100 research universities received 177 patents; by 1984 that annual figure had increased to 408; and in 1994 the annual number of patents awarded had risen sharply to 1,486.[13]

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[12] This section draws heavily on Geiger (1992) and Cohen et al. (1998).

[13] For the same years the total numbers of patents granted in the U.S. were (approximately) 81,300, 72,700, and 113,600, respectively. University patenting clearly increased much more sharply than did overall patenting in the U.S. Even if the focus is on only the patents granted to U. S. entities -- 45,600, 42,200, and 64,200, respectively for the three years -- the relative story is the same.

Fourth, as another manifestation of development and applications, in 1980 there were 25 formal offices administering technology transfer and licensing in American universities; in 1990 that number had grown to 200. As of 1996 there were 275 such offices in all non-profit institutions, including non-university research centers and hospitals.

Fifth, as a support organization for the personnel of these offices, the Society of University Patent Administrators was formed in 1974; the organization subsequently changed its name to the Association of University Technology Managers (AUTM) and is "a nonprofit professional and educational society created to assist administrators of patent and copyright programs at universities to license technologies, encourage the production of inventions, and to make appropriate recommendations to assure the effective transfer of technology to the public." As of 1996 AUTM had 1,500 individual members, with over a third of its members joining the organization within the previous five years. The AUTM web page (http://autm.rice.edu/autm/) lists 186 hot links to the web pages of university technology offices (which in some cases include specialized research centers or hospitals within universities and also include some overseas institutions).[14] AUTM publishes a journal, which is now in its tenth year of publication, and conducts annual surveys of university activity in the area of technology transfer.

B. The reasons

There are a number of reasons for this increase in university-industry R&D relationships. First, from the early 1970s onward federal government funding for university research declined in real terms

[14] The listing of a link is voluntary on the part of an individual member, so the number of institutions represented by the 1,500 members of AUTM exceeds the 186 hot links provided.

per academic researcher and as a percentage of academic research performed. Universities faced fiscal pressures to look elsewhere for research support.

Second, from the late 1970s onward the NSF was encouraging the formation of "science and technology centers" and "engineering research centers" that would involve industry collaboration.

Third, public policy, beginning with the Patent and Trademark Act of 1980 (the Bayh-Dole Act), has encouraged universities to obtain patent rights to the outcomes of federally sponsored research and to profit directly or indirectly by assigning the rights to others, such as industrial co-researchers.

Fourth, public policy has more generally strengthened intellectual property rights, by lengthening the terms of patents and copyrights, broadening the scope of patents, and providing greater legal protection for the enforcement of these property rights.

Fifth, information-based technologies have generally become more important and more valuable in the U.S. economy of the 1990s. The returns for both universities and their industrial partners from successful research outcomes are higher.

Sixth, industrial partners, recognizing these same trends, have been more open to university linkages. And surveys have found that industrial research in the 1980s and 1990s has been more influenced by university research than was previously the case.[15]

In sum, the increased levels of university-industry R&D relationships have not occurred in a vacuum. There are sensible reasons why these relationships have grown.

[15] See Cohen et al. (1998, pp. 172-182).

C. Some other patterns[16]

Some other information can shed light on some of the potential drawbacks to university-industry R&D relationships. First, the picture with respect to the pressures on universities to move away from basic research and toward applied research and development is decidedly mixed. Surveys show that greater faculty interaction with industry tends to be associated with more applied research; similarly, research centers whose mission is improving industry's products and processes tend to do less basic research than do centers without that mission. But it is unclear whether these patterns are indicative of industry pressures on academics to do less basic research or whether instead the faculty who are already doing applied research simply attract more industry funding.

The National Science Board (NSB) reports that the following percentages of university R&D were devoted to basic research:

1970-73:	77%
1980-83:	67%
1990-93:	66%
1994-95:	67%

At first glance these data may seem to support the claim that industry pressures have caused academics to do less basic research. But the large decline occurred in the 1970s, before the substantial strengthening of university-industry ties that began in the late 1970s and that accelerated in the 1980s and 1990s. Since the early 1980s, despite the acceleration of involvements, the percentage has been stable. Something else was likely responsible for that decline in the 1970s.

Second, the pressures for greater confidentiality and secrecy are real. Both anecdotal evidence

[16] This section draws heavily on Cohen et al. (1998).

and survey evidence support this statement.[17]

Third, for university-industry R&D centers with a mission of improving industry's products and processes, researcher productivity measured in terms of inventions disclosed, patent applications, new products, or new processes tends to be higher than in R&D centers that do not have this mission; but there also tends to be a decline in scholarly paper productivity. In essence, in these centers there may be a short-run boost to productivity but a longer-run drag, since scholarly papers provide the wider and deeper basis for technological advance.[18]

[17] See Cohen et al. (1998, pp. 188-190).

[18] See Adams (1990).

IV. A Few Patterns in the Tri-State Region, and the Need for Data

Compiling a picture of university-industry R&D relationships for the New York/New Jersey/Connecticut tri-state region is yet more difficult. There are no surveys or published sources for reference that this author is aware of. Further, practices surely differ among parts of large, somewhat sprawling and somewhat federally organized institutions. Professional schools, such as medical schools, business schools, and law schools, will tend to have different types of contacts and different arrangements (formal and informal) with the private sector than do the arts and sciences faculties.

All of the major research universities in the tri-state region have offices for intellectual property and technological transfer. The AUTM web site lists the following hot links to university technology offices in the tri-state region (in alphabetical order):[19]

Albert Einstein College of Medicine
Columbia University
Cornell University
Memorial Sloan-Kettering Cancer Center
Mount Sinai Hospital
New York University
Princeton University
Rutgers University
SUNY Albany
SUNY Binghamton
SUNY Stony Brook
Syracuse University

[19] Missing from this list are CUNY and its constituent colleges, some of the SUNY campuses, and some of the smaller universities in the tri-state region, such as Hoftsra, Adelphi, Long Island University, Seton Hall, University of Hartford, New Jersey Institute of Technology, etc. Again, the listing of a university web site that is linked to the AUTM site is a voluntary action that is undertaken by AUTM's individual members; the absence of a web site link need not imply the absence of a technology office at a campus.

University of Connecticut
University of Rochester
Yale University

These technology office web sites typically have descriptions of the respective university intellectual property policies, listings of inventions and technologies, listings of personnel, and other material.[20]

In addition, all of the tri-state institutions have offices of sponsored research (or an equivalent title). Most of their web sites can be found through hot links from the web page (http://www.ncura.edu/) of the National Council of University Research Administrators (NCURA).[21]

It would be extremely useful to compile detailed information (including informal administration as well as formal rules) on the specifics of intellectual property policies, faculty rewards systems for interactions with industry, and the extent of industry involvement in university R&D for institutions in the tri-state region. Such information could be used to compare practices across the institutions as well as to compare the tri-state institutions with other major research universities across the U.S. Also, information on practices could address the issues of basic/applied research and confidentiality/secrecy that were discussed above.

Unfortunately, the undertaking of such compilations is substantially beyond the scope of this

[20] It is worth noting that the NYU technology office is run from the NYU Medical School, and its web site is bannered with the medical school and not with NYU more broadly; the research discoveries listed have a very strong medical school orientation. The University of Connecticut site is just for that university's health center.

[21] In addition to the institutions linked from the AUTM web site, the following institutions in the tri-state region are linked to the NCURA web site: Brooklyn College, New Jersey Institute of Technology, the New School, Rensselaer Polytechnic Institute, Rockefeller University, SUNY Health Science Center at Brooklyn, SUNY Health Science Center at Syracuse, SUNY Buffalo, SUNY New Paltz, University of Hartford, and the Weizmann Institute of Science. Missing from the links to the NCURA web site are Albert Einstein, Memorial Sloan-Kettering, Mount Sinai, and Princeton.

paper and will have to await future research efforts.[22]

[22] Such investigations should not be restricted to the engineering, medical, and sciences areas, which are the fields commonly associated with industrial-linked R&D and technology transfer, but should also encompass areas such as business school research and dissemination, which can affect important industries in the tri-state area, such as financial services.

V. Conclusion

Expanded R&D links between universities and industry in the tri-state area can clearly be beneficial to economic development in the area as well as to the universities involved. But there are serious issues of culture, process, and research substance that must be addressed and actively managed in order to enhance the likelihoods of favorable outcomes. A thorough survey of current practices within the tri-state area, with appropriate comparisons to other leading research universities and their R&D relationships elsewhere in the U.S., would be an excellent place to start.

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