Agricultural Biotechnology and University-Industry Research Relationships: Views of University Scientists and Administrators and Industry[1]

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In 1998 the pharmaceutical/agricultural biotechnology firm Novartis (which has since created the agricultural biotechnology company Syngenta) signed an agreement with the Department of Plant and Microbial Biology of the University of California at Berkeley. Novartis provided $25 million over 5 years to the department to fund research into plant genomics and offered UCB scientists access to Novartis's proprietary technology and molecular databases. In turn, Novartis gained representation on the department's research committee and obtained rights of first refusal to negotiate exclusive licenses for up to a third of discoveries made in the department by faculty members who signed the agreement. The agreement created a controversy on the UCB campus. Some faculty spoke against the agreement while other faculty and many administrators supported it. Press and Washburn (2000) reported that a survey of faculty of the College of Natural Resources found deep divisions over the benefits of the agreement (Busch *et al.*, 2004). An external review of the "Novartis-Berkeley deal" recommended, among other things, that UCB should avoid industry funding arrangements that involve large numbers of faculty with academic units; and to ensure that such deals do not impinge on regulatory relevant research such as risk assessment (see Busch *et al.*, 2004).

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One result of the agreement was that civil society groups critical of agricultural biotechnologies have become more focused on the relationship between the biotechnology industry and university scientists' research agendas. This is also a controversial topic on many campuses, especially those of land-grant universities. Land-grant universities have long maintained close ties with various sectors within the agricultural industry, but they are also publicly supported institutions with a mission to serve the public good. A host of scholars debate the ability of a public institution to serve public interests while also serving specific private organizations (Lacy, 2001; Krimsky, 2003; Busch *et al.*, 2004).

Appropriate Links

Three related developments lie at the center of the debates concerning the appropriate links between universities and private firms:

- legislation such as the 1980 Bayh-Dole Act;
- the decrease in state and federal support for agricultural research relative to private sector investment; and
- the increasing emphasis on university biotechnology research as an engine of innovation that will lead to regional and national economic development through the commercialization of technologies by industry from university discoveries (Slaughter and Leslie, 1997; Busch *et al.*, 2004).

Bayh-Dole enables universities to patent the results of federally funded research in order to provide incentives, through royalties, for universities to link with industry to commercialize technologies and scientific knowledge. Meanwhile, as public money for agricultural research declines, private-sector firms become more attractive to university scientists and administrators as sources of operating funds, research facilities and proprietary knowledge and technology. And with the protection of patents and the potential for licenses, including exclusive licenses, university-based science becomes more commercially attractive to firms. These changes are couched within an evolving view of universities as critical centers of knowledge and talent that can generate economic growth if the right public policy and institutional capacities are in place (Etzkowitz, 2001). In many cases, remaining public funds—especially state funds—are contingent on university scientists identifying industry partners and a potential economic development outcome, such as increases in jobs through the creation of private companies "spun-off" from university research efforts.

Regarding university-agricultural biotechnology industry relations, these types of changes have resulted not only in increased scrutiny of university-industry relationships (UIRs) by civil society organizations and the scientific and popular press (*e.g.*, Press and Washburn, 2000; Nature, 2001), but also in shifts in rewards structures and scientific cultures within academic departments. University scientists are more often evaluated according to private-sector criteria, such as developing a self-sustaining or profitable laboratory through patent activity, licensing revenues and external funding (Kleinman and Vallas, 2001; Kleinman, 2003).

Analytical Frameworks

Researchers who analyze UIRs often examine the broader institutional consequences of the relationships. They assume that the industry and the university play overlapping but different roles in society, and question whether those roles might be compromised when the individuals from these two organizations increase their interaction in particular ways. For example, Hackett (2001) found that society increasingly sends an ambivalent message to universities. That is, universities should perform their traditional (less business-oriented) role while also responding to national economic imperatives.

In this vein, Slaughter and Rhoades (1996; 2004) and Slaughter and Leslie (1997) provided an informative framework for understanding the changing societal role of universities. They argued that we are witnessing the emergence of an "academic capitalism." Academic capitalism refers to the role universities have adopted as the knowledge economy has emerged over the past three decades. The knowledge economy refers to the set of intellectual property policies and practices that convert advanced knowledge into the raw material for commercialized products and services. Because much of the advanced knowledge in the United States is contained in research universities, a central component of the construction of the knowledge economy has been to integrate the research university into the intellectual property process [see also Kenney (1986) and Busch *et al.* (1991)]. Global economic restructuring, whereby states find it increasingly difficult to raise revenue from mobile firms, drives this change. In addition, the end of the Cold War removed the dominant rationale for state funding of universities and state sponsoring of university-industry links: national defense. These authors document a bipartisan political shift toward a "competitiveness agenda" and away from a Cold War or defense agenda. The competitiveness agenda entails the focus on universities as engines of innovation and potential growth, and an emphasis on competitive grants for allocating federal funds [see also Croissant and Restivo (2001)].

In addition, Slaughter and Leslie (1997) asserted that, as a professional class, academics have shielded themselves from the vagaries of labor markets by maintaining a monopoly control over specific kinds of knowledge in exchange for a tacit social contract: do research to benefit society, not to maximize private gain. However the policy changes to overcome the economic crises of the 1970s and 1980s have led universities and professors to adopt market-like behavior, using goods, services and labor to pursue profit. Slaughter (1990) has also noticed the rise of a new "institutional class" comprised of university presidents and industry CEOs. They claim they need unlimited authority and resources to produce this common good. They define that common good as funding universities to promote entrepreneurialism among faculty and the commercialization of scientific knowledge to inspire economic growth [see also Croissant and Restive (2001), Etkowtiz (2001), Slaughter and Leslie (2001), Krimsky (2003) and Busch *et al.* (2004)].

Owen-Smith and Powell (2001) found that some scientists tended toward an "old school" orientation, skeptical of increasing ties between universities and private-sector firms. Other university scientists embraced the blurring of traditional lines between the university and the for-profit sector. And still other scientists fell somewhere in the middle between the two extremes. That is, some "old schoolers" felt compelled to move into commercial science in order to develop a research program and to retain cutting-edge faculty. Meanwhile some entrepreneurs recognized that the breakthroughs generated from new arrangements threaten important aspects of the university.

Data and Methods

We are building on this study, and others, by developing and analyzing three complementary databases:

- in-depth interviews with eighty-four scientists and sixty-six research administrators at five major land-grant universities (LGUs), supplemented by interviews from two private universities, a small LGU, and one public non-LGU;
- interviews with sixty-three scientists and managers at thirty agricultural biotechnology companies; and
- a national survey of academic bioscientists.

The interviews generated qualitative information regarding the motivations, constraints, advantages, and limitations of UIRs. Insights from the case studies informed our behavioral model and the design and enumeration of the national survey as well as fostered our understanding of the survey results.

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Our national survey is the first random sample of US academic scientists conducting research with implications for biotechnologies in agriculture, forestry, and aquaculture. A response rate of approximately 60% (859 of 1441) was achieved. Contrasting the respondents who received industry support with those who did not, permitted inference about UIR effects on academic research programs. Econometric methods were used to estimate the marginal effects of industry support while controlling for such other influences as the scientists' human capital, research field, and views about the proper role of public science.

Results

Turning to the interview data, we found that university scientists seek out industry partners to access a number of important resources. These include:

- Funding
- Equipment
- Knowledge

- Materials
- Expertise
- Access to databases
- Technology
- Opportunities to place graduate students
- Institutional legitimacy

In their turn, industry personnel establish working relationships with universities to gain access to the following items:

- University scientists
- Graduate students/future employees
- Increased credibility/legitimacy
- Enhanced regulatory success
- Strengthening marketing possibilities
- Leveraging resources and structural linkages (extension)
- Increased research efficiency
- Lower infrastructure costs
- Decreased labor costs

In addition, we asked university scientists and administrators, as well as industry partners, to rate the perceived advantages and disadvantages of UIRs. All three groups were complimentary of UIRs. However, administrators were the most optimistic group, industry second and university scientists were the least positive. In general, industry viewed UIRs as vehicles for:

- Leveraging research money
- Taking advantage of a natural division of labor: basic/applied research
- Facilitating regulatory approval of new technologies.

The most insistent concern on the part of industry was that the division of labor between public/private sector is fading. For example, one industry informant argued:

> What we typically find though is that basic research, less and less of it is being done, and we find we're competing against university labs for the same technologies, *so it's like funding your competitor*. And Bayh-Dole has caused some changes in the way that universities protect IP, and some of them are very, very aggressive, so you've got to be careful (emphasis added).

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Administrators viewed UIRs as essential, bringing with them a number of advantages. These include:

- Accelerating product development which leads to economic growth
- Leveraging additional scientists through wider networks
- Provision of additional research funds

And administrators saw a focus on biotechnology and ties with industry as partially driven by public policy and state funding of the land-grant system:

> Another thing that helps is…for example,…the fact that the state recognizes biotechnology as an important component of their economic growth also helps identify biotechnology as a university priority area because it meshes well with the state vision for itself.…We always use leveraging as part of our case to the state…

The main concern raised by administrators was that UIRs could create haves and have-nots among their faculty, leading to problems with morale and collegiality. For example, one administrator argued that:

> . . . in some instances you run the risk of faculty becoming too jaded by the money that industry might throw at them, by the prestige they might get by working in the industry . . .

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While university scientists were the least favorably disposed toward UIRs, they tended to see more positives than negatives. Positives included:

- Leveraging research money
- Wider scientist network
- Financial support for graduate students and post-docs

But scientists also had concerns about communication and publication restrictions and the manner in which universities often handle IP issues:

> …there may be more constraints than what a university scientist is used to; we're used to open access, discussing your research results at meetings, publishing, talking with others about it...[depending on the research] a company can tell you, No, you can't go to this meeting, you can't disclose any of this information.…
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> The university wants to patent, big time. It has almost become more important…than publications. …it's status for the university… I think more and more universities are being judged on how many patents they [produce].

Turning to the survey of university bioscientists, our intent was to address one central question and two guiding questions.

- Central question—Does industry support lead to more applied and excludable research, diminishing basic and publicly accessible knowledge about ag biotechnology?
- Guiding questions—What factors affect the "basicness" of scientists' research and the "excludability" of their discoveries?

We measured "basicness" by having the scientists estimate the percentage of their research identified as basic (*vs* applied). We measured "excludability" by having the scientists estimate the percentage of discoveries that may be withheld from public use through proprietary tools and strategies such as patenting.

Basicness

Using National Science Foundation (NSF) funding as a base, sources that led to more applied research were, in order:

- Industry
- State
- USDA
- Other federal and miscellaneous
- Non-profit foundation

In addition, important factors that influenced the basicness of scientists' research agendas were the values of the scientists themselves. In general, the more importance a scientist attributed to making theoretical contributions as part of his or her research program, the more basic the scientist's research. Also, if a scientist develops a research agenda in part for its potential to publish scholarly articles the research agenda is more basic. Contrariwise, if a scientist thinks it important to patent research results, the research program tends to be more applied.

Excludability

Again, using NSF funding as a base, sources that led to more excludable research were, in order of importance:

- Industry
- NIH
- State

Scientists' values continued to be important determinants of the profile of scientists' research programs. Regarding excludability, the more importance scientists attributed to providing nonexcludable benefits through their research, the less excludable the program. Also, if scientists believed that it was important to make significant theoretical contributions, their research program was less excludable or proprietary in nature. And if scientists believed that it was important to patent discoveries, their research programs had a more proprietary or excludable character to them.

Conclusions

In general, industry funding brings modestly less basic and more excludable (*e.g.* patentable) research than does NSF or NIH funding. Industry is wary of the decline in the level of basic research at universities, but contributes to this decline through its funding relationships. This finding points to the importance to a number of parties of continuing to publicly fund basic research at universities. This argument also holds true for public-versus-private biotech research. Industry funding tends to lead to more excludable or proprietary agendas as designated by the scientists themselves. To generate a broad array of biotech interventions, *e.g.* minor and major crops and traits (Welsh and Glenna, 2006), diverse sources of support appear to be important.

Professional values exert stronger effects on research basicness and accessibility than do funding sources.

In addition, professional values exert stronger effects on research basicness and accessibility than do funding sources. This final finding points to the importance of "selection" of academic scientists by schools and departments in order to maintain a distinction from the private sector and to provide balance in the research portfolios of university scientists.

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