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PUBLIC / PRIVATE ALLIANCES

Gordon Rausser[1]

The traditional research paradigm represents discoveries flowing linearly from basic science conducted in public institutions to applied research and commercialization undertaken largely by private industry. This characterization fails to accurately portray the nonlinear and chaotic nature of research and development (R&D) processes. Recent United States (U.S.) legislation aimed to promote economic growth through supporting research acknowledges the "blurring of lines" between public and private research activities. Moreover, incentive alignments have recently emerged between public and private interests in life science R&D. In this context, the Berkeley/Novartis strategic alliance is shown to be a collaborative public/private relationship that is sourced in such incentive alignments. It is also argued that this alliance is consistent with the fundamental complementary relationships that formed some of the principles structuring the original foundation for Land Grant universities.

Key words: Bayh-Dole Act; research alliance; Land Grant university; technology transfer; licensing; basic research; knowledge generation

As some private firms have restructured themselves into lifescience companies, their culture and values have become a bit more like those of a research university. Similarly, as research universities have responded to the Bayh-Dole Act of 1980, expanding their technology transfer activities, they too have become a bit more like private companies. The fundamental science conducted at research universities stretches over a very long run planning horizon. Now that a number of companies have moved forcefully into long term R&D in the field of life science, their planning horizons have become more aligned with those of research universities. With few exceptions, this alignment is enhanced by research universities having little, if any, expertise in capturing the market value of their discoveries. Hence, at some stage in the R&D process, research universities must turn to private companies that have greater expertise in the commercialization process. Still another layer of incentive alignment arises because of the complementarities in intellectual capital; the similarities but yet the distinct and differentiated culture and values that exist at research universities versus private companies provides the opportunity for pursuing synergies in the discovery process, especially in functional genomics. Moreover, the incentives that both organizations are prone to offer to their creative researches are another source of alignment. In both institutions, high power incentives are frequently offered to researchers to move an embryonic or "proof of concept" patent to a position of capturing market value through inventor output based sharing of royalties and revenues.

[1]*Gordon Rausser is the Dean of the College of Natural Resources and the Robert Gordon Sproul Distinguished Professor at the University of California – Berkeley.*

Alternative Paradigms

If the widely accepted paradigm for the distinction between public good research and private good research is rejected, the alignment of the incentives between private agricultural biotechnology companies and research universities is even more pronounced. For some years the general belief has been that there exists a linear evolution from public good, or basic science, to private applied research. The simplicity of this perspective allows analytically tractable representations. The presumption that innovation processes follow a straight line from basic research (conducted in governmental laboratories and mainly at research universities) through to applied R&D (conducted mainly by firms) is attractive to governmental policy makers and university administrators, and some would argue self-serving.

Does the basic/applied research decomposition paradigm admit the fundamental complementarities that form the foundation for the biotechnology revolution? I think not. Instead, an alternative paradigm is required that admits non-linearities and recognizes the chaotic nature of R&D processes. Many analysts have documented the meandering flow of innovations into the wider economy. These analysts have demonstrated that innovations emerge through a circuitous path; this path can not be codified, and many would argue is impossible to measure. An extreme variant of this view has been proposed by Kealey (1996) who goes so far as to argue that innovation tends to drive basic science, not the other way around. Regardless, this alternative paradigm blurs the distinction that governments often make between basic and applied science. As a result, it also blurs the boundary between the research university and the outside world.

Of course, the path from innovation to the marketplace is not linear but circular. Economic growth is generated by innovation; quality research required for innovation does not happen with top-flight faculty without adequate research funding. Industries cluster around universities that produce usable research and then supply the highly trained graduates needed for business success. Informed students know this, and elite universities integrate it into their curriculum as demonstrated by the invitation to corporate sponsors to provide input into the graduate education process and ensure that universities continue to produce the needed highly skilled workforce. The cooperative exchange with industry not only allows universities to compete for the best faculty and students, but also to contribute to their own discretionary support by generating licensing revenues.

The research engine at major universities requires increasingly expensive fuel. In almost all sciences, library research is simply inadequate to advance the frontiers of knowledge. Without modern laboratory facilities and access to commercially developed proprietary databases (such as the gene expression profiles and genome mappings) we can neither provide first-rate graduate education nor perform the fundamental research that is part of the university’s mission.

Just as the economic course of innovation is circular, we now know that the process of generating knowledge is itself a series of feedback loops. In many cases, curiosity-driven investigation may be the product rather than the progenitor of a technological adaptation developed in the marketplace. Brick by brick models for the advancement of knowledge have been rejected by empirical evidence. Private companies often prove more open-minded and creative in this process than their government and university administrative counterparts. When Cambridge University's computer science head Royce Needham agreed simultaneously to run Microsoft's new $80 million laboratory at the campus, he observed that government subsidized research generally requires a commercial justification and "you do not get asked that sort of question by companies." Arguing last year for more university/industry/government partnerships, Representative Ehlers cited Monsanto’s direct funding of faculty who do basic research at Washington University in St. Louis and said, “Monsanto is not

buying researchers and telling them what to do; it is providing grants in the hope that someday that research will pay off for that company."

Economic Growth And The Bayh-Dole Act

New growth theorists argue that up to 50% of all U.S. economic growth over the last 50 years is due to investment in R&D. Future growth will depend on future research investment. It is unrealistic to expect that private industry will underwrite all of the necessary basic research. However, even if there were unlimited tax dollars for pure research at universities, the resulting discoveries would do little good for the economy or consumers if not effectively ushered into commercial application. Most university patents represent discoveries that are remote from any commercial viability. Accomplishing "technology transfer" has always been one of the most powerful reasons for a bridge to private industry. If it were not for public/private research partnerships, it is unclear when or even if critical technologies such as lasers, protease inhibitors, and bioengineering would have made their way into the marketplace.

The motivation for the Bayh-Dole Act of 1980 is the linkage between discovery and innovations at research universities and the capture of commercial market value that ultimately promotes U.S. economic growth. Supporters of this legislation successfully argued that unless universities have the right to license patentable inventions, many discoveries from federally funded research would never become commercialized. Put simply, the act creates the incentives needed to bridge the creation of value with its capture. The Bayh-Dole Act is, in effect, a transfer of intellectual property much the same as the rights allocated by the Land Grant Act that established public universities in each and every state. An indication of the success of the Bayh-Dole Act is revealed by the results of a recent survey of university technology managers; licenses executed by universities increased 75% between 1991 and 1996, with 13,807 executed over the entire period (Association of University Technology Managers [AUTM], 1997). Furthermore, patent royalties accruing to universities have more than doubled over a period of five years. In 1997, universities and research institutions received $611 million in licensing fees, up from $248 million in 1992.

A survey conducted by Jensen and Thursby (1998) found that most inventions that take place at universities are in an embryonic stage. One of the more interesting results was that most university inventions are little more than a "proof of concept" when they are licensed. Specifically, Jensen and Thursby (1998) state:

> . . . at the time of the license, most university inventions are at such an early stage of development that no one knows if they will eventually result in a commercially successful innovation or not. Moreover, they are so embryonic that further development with active involvement by the inventor is required for any chance of commercialization.

This analysis argues that due to a moral hazard problem, unless the inventor is actively engaged in the value capture process, the probability of commercialization declines dramatically. Accordingly, incentives must be provided for the inventor or faculty researcher to participate in the development process. Thus, the usual prescription of auctioning-off licenses is a mistake. Instead, the prescription is for an output-based payment (royalties or equity) to provide incentives for the inventor to expend further effort in the development process.

An overwhelming majority of university research discoveries are licensed at a stage where significant further R&D is required. The typical presumption that the licensee knows the value but the inventor does not is usually false. As Jensen and Thursby (1998) note, "The problem for university inventions

is not that one agent knows the value and the other does not, but that at the time the license is executed no one knows the invention's commercial value. Indeed, the commercial value is endogenous, and a function of the license contract."

Berkeley/Novartis Research Alliance

In the above setting, U.C. Berkeley's College of Natural Resources recently entered into a research agreement with Novartis, a newly emerged lifescience company. On the front end, not the back end after some discovery has occurred, the right to support research at U.C. Berkeley was offered to many companies under an auction design. Essentially, basic principles of negotiation and economics were applied to extract maximum value for the university. Rather than waiting to be approached by a company with a specialized agenda, the College of Natural Resources articulated its expectations and requirements in a Request for Proposals circulated to nine biotechnology companies internationally. Five responded with written proposals. After lengthy negotiations, Novartis was selected from the field of candidates in part because of its R&D strategy as well as its cultural compatibility. Although the size of the dollar commitment was a major factor, it was far from the only consideration. Academic freedom, ownership of discoveries, and adherence by Novartis to university professional standards were all key components of the negotiations.

The initial $25 million commitment of Novartis comes to the College of Natural Resources without strings attached. It will be allocated to meritorious research proposals through a faculty peer-review process, which is considered the best governor of academic freedom. This approach differs radically from most privately sponsored university research where the funds may be used only for projects selected by the corporate donor. Even taxpayer research funding comes with some strings attached. Faculty almost never receive open-ended grants to indulge their curiosity; they usually receive limited funding for specified projects. The beauty of the Novartis alliance is that it places the choice of research projects under faculty control, rather than leaving critical decision making to legislators, bureaucrats, or corporate employees.

What Novartis receives for its $25 million contribution is the right to *negotiate* to acquire at fair market value *a percentage* of discoveries that *may* result from research it helps fund. In other words, if there are no marketable discoveries, or the University does not accept Novartis's offer to license them, Novartis will receive no commercial rights at all. Even without this agreement, Novartis — as a member of the business community — could approach the Office of Technology Transfer to negotiate licenses on any of U.C. Berkeley's proprietary rights. On the other hand, the university will be a winner regardless of outcome, having obtained not only needed cash and possible intellectual property ownership but also, and perhaps most importantly, access to Novartis's proprietary genomic databases which are essential to Berkeley's cutting-edge research in plant and microbial biology.

To suggest that our approach to public/private research alliances was without controversy would be misleading. Early on, the College of Natural Resources decided to expose the Novartis agreement to as much public scrutiny as possible. Unfortunately, many private research contracts are performed off campus with no supervision or oversight and little financial benefit to the university. The Novartis agreement was designed to change this. Faculty and students were kept informed through a special website and a number of Town Hall meetings. The Academic Senate conducted its own exhaustive inquiry, and submitted one hundred and fifty questions to which the College responded. The negotiations were heavily reported in the press all the way through to the final contract signing, complete with the apparently obligatory pie throwing. Perhaps no other Berkeley private research agreement has been so openly discussed.

Land Grant Universities

Commercial collaborations are part of the heritage that has allowed the University of California to thrive. We are, after all, one of the original Land Grant universities whose stated purpose was to marry scientific insight with practical knowledge to improve agricultural productivity. This might not sound like commerce, but it was and still is. One of the reasons U.S. agriculture is the most efficient in the world is that the Land Grant university system recognized and capitalized on the complementarities between scientific and practical knowledge. The wisdom of this approach has been demonstrated in many other fields including biotechnology and telecommunications.

Close working relationships with the private sector have been the norm throughout the last century for any American research university that wanted to avoid "institutional Darwinism". Indeed, these collaborative efforts are the envy of most other democratically based market economies. The Bayh-Dole Act recognized that the lines between pure and applied research had long ago faded and that universities must help spawn commercial applications that stimulate the economy and generate other public benefits. Recognizing that financial ownership incentives are key to stimulating useful research, U.C. Berkeley and other research universities grant their faculty a percentage interest in any royalties flowing from the licensing of their patents and discoveries. The California Legislature went a step further and in 1996 increased from 12% to 24% the tax credit for business investments in university research. The success of these incentives is demonstrated by the fact that the University of California has over 700 patents in active development and more than 500 patents pending. It received a gross licensing revenue of $88.5 million last year alone.

None of this is new, and all of it was deeply embedded in the U.C. Berkeley culture long before Novartis came on the scene. In the contemporary setting, the University of California aggressively courts private-sector partners to fund its research through a number of programs under the umbrella of Industry-University of California Cooperative Research (IUCR). One of IUCR's component programs, MICRO for microelectronics research, dates back to 1981 and has generated more than $100 million in private-sector investments. The similarly structured BioSTAR program uses the marketing slogan, "When it comes to biotechnology, UC means business." In its first year, BioSTAR distributed $11.4 million for specific research projects, sourced $4.6 million from the University of California, and $6.8 million from private industry sponsors. Grant proposals are submitted by pairings of a private-sector scientist with a University of California scientist and funded projects give the sponsoring company rights to negotiate for future licensing.

Conclusion

Land Grant universities pioneered the synergies between practical knowledge and fundamental science. Hence, when the College of Natural Resources desired to ensure a first-rate graduate education for its students in plant and microbial biology – secure infrastructure, graduate fellowships, and research assistantship support for a newly established program in microbial biology; and access to intellectual and financial capital that would complement, preserve, and enhance the free research activity choices of individual faculty – it turned to where much of the current practical knowledge in plant and microbial biology exists; namely, the lifescience companies. Without access to information technologies, databases and gene sequences, it is difficult, if not impossible, for any public institution to be actively engaged in pushing out the frontiers of fundamental knowledge.

To be sure, Land Grant universities are public assets of immense value. So long as our culture is maintained this value will be enhanced, not diminished, when we work creatively in collaboration with other institutions including private companies.

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