The Emergence of University–Private Firm Research and Development Agreements

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Due to declining governmental funding for basic science, public-private research partnerships have played an increasingly important role in supporting innovative university research and development. This article presents an assessment of the changing research and development landscape and the role of such partnerships to empower universities in promoting economic growth.

A major driver of U.S. economic development since the Second World War has been productivity growth. The university research system has played an essential role in fostering productivity growth by consistently generating outputs with public good characteristics that have been reproducible and thus have not lent themselves to private market development and appropriation. Despite the success of this system, the scientific research establishment has come under increasing scrutiny as federal and state research funding (in real dollars) has been on a downward trend since the 1980s.

Specifically, the scientific research establishment has experienced a declining share of the federal budget. Scientific research and development (R&D) received nearly 12% of the federal budget in the mid-1960s, but this share has fallen below 4% in recent years (Figure 1). This decline in federal public research funding has coincided with a slowdown in productivity growth, which has been largely flat since the 2008 Financial Crisis. State and local government research funding has declined along with federal funding.

As the public sector contributions to university research budgets have declined, the need to seek out alternative sources of funding has become increasingly imperative. On a national scale, overall R&D funding from the private sector has steadily grown over the last 50 years, and now accounts for over 70% (Figure 2). In essence, the federal government and private enterprise have essentially switched roles in terms of the execution of R&D funding.

In most universities, researchers have been encouraged to replace federal funding with external research grants, many of which are sourced from private commercial interests. As a consequence, many researchers' marginal research time and the generation of ideas are focused increasingly on specific private interests. This has created an opportunity for private firms to leverage their R&D funds to redirect a larger share of universities' research efforts, gaining increasing influence over a particular university's research agenda.

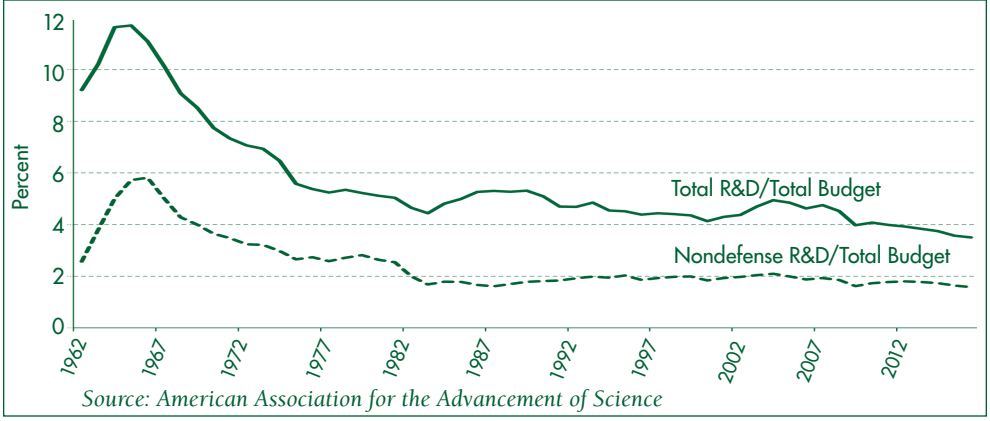
The passage of the Bayh–Dole Act in 1980 dramatically altered the university incentive landscape by structurally changing intellectual property (IP) rights and royalty distributions. Under the Act, IP rights are assigned to the universities where the research takes place, even if the research is federally funded, and it requires that universities share any license revenues with the inventors. This allocation of the royalty stream gives university researchers incentives to select areas of research that are likely to result in commercially valuable innovations.

The Bayh-Dole legislation, when combined with a critically important Supreme Court ruling (Diamond vs Chakrabarty, which allows researchers to patent genetically modified organisms), helped revolutionize the biotechnology field. Over the last few decades, thousands of biotechnology companies have been founded and have spent billions of dollars of private R&D funds. Research conducted in universities has been crucial to the success of the biotechnology industry; many new companies have been started by professors and most employ research professors as consultants.

This court ruling and the assignment of property rights to universities for discoveries funded by the federal government have also led to the rapid emergence of technology transfer offices (TTOs) at research universities. At the time of the Bayh-Dole Act in 1980, there were only 27 TTOs at universities; one decade later, in 1990, such offices had quadrupled.

What these institutional changes have also meant is that universities have actively pursued monetization of their patents. For example, over the years, the University of Wisconsin, a land-grant university, has generated more

Figure 1. Public Sector Research and Development Funding



Source: American Association for the Advancement of Science

than $1.5 billion, which only ranks 10th among U.S. universities. The University of California system, Northwestern University, Columbia University, New York University, and Princeton University all generated more than $100 million in 2011 from patent licensing.

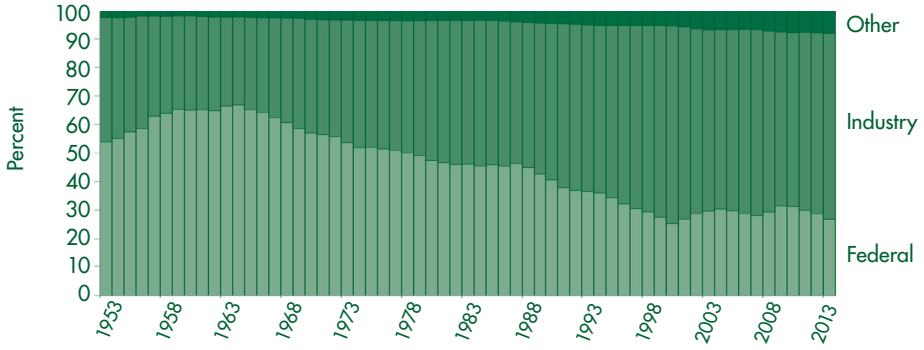
The changing public research landscape exists not only for universities but also for public-sector research conducted at governmental agencies. For example, the President's Council of Advisors on Science and Technology recommended that the U.S. Department of Agriculture research portfolio be rebalanced by the creation of innovation institutes funded through public–private partnerships (PPPs). The justification, in part, for this recommendation was to overcome "congressional constraints" on research funding budgets sourced by the federal government.

Because of the dramatic decline in public sector support for basic science at universities and the changing incentive landscape, the relationships between the private sector and universities have expanded, assuming many different shapes and forms. Some of these relationships are formal, others are informal. For formal relationships, the types of partnerships have included single or multiple sponsored research partnerships, spinoffs or startups, strategic partnerships, open collaborative research, consortia, research units/centers, technology licensing, IP sharing, material transfer agreements, and clinical research and trials.

Regardless of the type of university–industry partnership, three characteristics or dimensions of these partnerships, referred to as PPRPs, are key to understanding research partnerships: size, stage, and assignment of control rights. The size of a research partnership is indicated by such factors as the number of partners involved, the amount of financial resources and other assets exchanged and committed to the research relationship, and the length of the commitment.

The stage of research defines a second key dimension: Partnership agreements fall on different segments of the continuum ranging from early-stage, basic research to late-stage, targeted research focused on the commercialization of innovations.

Figure 2. Trends in Research Funding



Source: American Association for the Advancement of Science

The third dimension may be defined by the consistency between the assignment of control rights with the core values and culture of each research partner. For example, within a specific partnership agreement, the public partner's control rights may locate them somewhere on a continuum representing the tradeoff between academic freedom versus outreach—engaging with the business community to pursue commercial value as defined by the private partner. In fact, this dimension also reflects the tradeoff between basic research representing the long-run culture and core values of most research universities engaged in expanding the frontiers of basic knowledge, and the very focused, applied research traditionally valued by the private partner.

The available evidence shows that PPRPs flourish in an environment in which the paradigm of the research process formally recognizes the non-linearities and the chaotic nature of R&D processes. This framework formally recognizes that there is feedback between both basic and applied research. The often meandering path of innovation occurs through a circuitous route that cannot be codified and many would argue is impossible to measure. This framework, or paradigm, goes so far as to argue that applied research drives basic science as much as, if not more than, basic science drives applied research.

There can be no question that basic science and applied research are closely tied. As Louis Pasteur emphasized, long ago, "There is no such thing as a special category of science called applied science; there is science and its application, which are related to one another as the fruit is related to the tree that has borne it."

In fact, this vision is very much aligned with the original land-grant university legislation and the subsequent Smith-Lever Act, introducing Cooperative Extension. In the original conceptualization, researchers at the university would make discoveries; those discoveries would be transmitted and adopted through the advice and education service offered by Cooperative Extension. Moreover, major problems in the field would be observed by Cooperative Extension and taken back to the basic science investigations that were conducted by university researchers.

The non-linear, chaotic paradigm of scientific research is in sharp contrast to what has been referred to as the "linear decomposition paradigm of scientific research." During World War II, and following the conclusion of that crisis, the U.S. government drew a clear distinction between basic science research and applied science research. During the war, it funded basic science and was instrumental in developing radar,

vehicles, medical treatments, and perhaps most famously, the atomic bomb.

Vannevar Bush, who was head of the Office of Scientific Research and Development, convinced the government to continue funding basic science at universities. He compellingly argued that, just as governmental support of basic science was crucial to military success during the war, government support of university research was similarly critical to promoting economic growth in peacetime.

In Bush's view, basic scientific research is scientific capital. Once basic science discoveries take place, they assume the form of a "public good." Such goods are non-rival and non-excludable. In other words, they are offered to society and all private firms to then take this basic knowledge and attempt to modify and apply it to the research challenges that they face that allow for commercialization.

The most challenging PPRPs are the formal contractual strategic relationships between private firms and universities. Partnerships are complicated by the uncontrollable, unforeseeable nature of scientific research. The partnership's contract must directly address unanticipated events.

Unfortunately, there is no such thing as a complete contract. The contract must contain a set of implementable actions to be taken when unanticipated events occur in the research partnership. The contract must establish the governance structure, which requires the assignment of "control rights." In negotiating such contracts, the bargaining space between the parties must be clearly articulated.

Once the bargaining space is set, the negotiations of the contract emerge with both front-end rights established as well as back-end rights clearly specified with regard to public access to any research discovery, assignment of intellectual property rights that come in the form of codified knowledge (namely patents), and licensing rights. There are several stages in the implementation of the contract, and the attributes and characteristics of each stage of the contract are briefly described in Table 1.

The potential benefits from PPRPs are easily articulated. Complementarities between scientific and practical

Table 1. Research Partnership Structure

Partnership Attributes	Control Rights
Stage 1: Setting the Bargaining Space	
Public partner objectives	
Partner selection process (many vs. single offers)	
Private partner objectives	
Type and size of partners	What are the binding policies of the respective institutions (i.e. what are they willing to accept)?
Type of relationship	What is the intersection?
Proximity of private partner(s) to campus	Is there a Pareto frontier?
Primary location of research	
Repeat relationship	
Limitation on funding percentage	
Stage 2: Negotiating the Contract	
Front-End	
Complementary assets	Right to use proprietary data Background rights
Governance structure: Oversight committee	Control of governing committee Right to expand Right to extend Right to terminate (no cause) Right to terminate projects
Governance structure: Research focus	Right to define research range Right to choose research orientation
Back-End	
Public access to research discovery	Right to control publication delay Right to suppress due to proprietary information No proprietary information
IP rights: Patents	Filing responsibility Ownership Partial ownership Control of patent litigation Right to know-how transfer Ownership of core technology Right to blocking patent
IP rights: Licenses	Initial option (right-to-negotiate vs. right-of-first-refusal) Right to exclusive/non-exclusive license (right to blocking license) Percentage (access option) Third-party option Right to sub-license
Stages 3 and 4: Reviewing and Renewing the Agreement	
Reviewing partnership	Right to transparency
Renewing relationship	Implied right to renew

knowledge have the capacity to generate rapid and far-reaching innovation. Each partner is seeking attributes and assets in prospective partners that complement its own abilities and resources.

Industry is interested in combining its knowledge of markets with information on new research and innovation in order to identify those developments that are likely to lead to commercial applications. This motivation may be obvious, but industry is also interested in other, less obvious assets such as access to academic expertise, networks, and first-hand information about up-and-coming scientists (current graduate students).

And while universities are very clearly interested in financial capital, they are also seeking intellectual capital, cutting-edge research technologies, and proprietary research tools (e.g., databases). Access to these research assets enhances a university's ability to provide a first-rate education to its graduate students and to serve the regional community's economic development goals.

Although the potential benefits of research partnerships are clear, the potential risks to both parties can be substantial. These risks can pose serious obstacles to the successful formation of PPRPs. In addition to the uncertainty inherent in any research process, the differences between university educational objectives and corporate goals are a primary source of risk in these relationships.

With private financing comes the concern that the traditional orientation of the academic research agenda toward basic, public goods research will be directed toward more applied, appropriable research that serves the objectives of the private partner, and that this conflict of interest, in turn, may result in a loss of academic integrity. Certain partnership mechanisms, such as conflict of interest agreements and publication delays that often accompany collaborations with private partners, are seen to create barriers to the traditionally free and open research culture of public universities.

Planning horizons between university and industry partners also tend to differ; university researchers focus on long-term research while companies often seek quick turnaround projects. The difference in university and industry turnaround time can make negotiating and managing research agreements a challenge. In addition, the cultures and values of research partners may simply clash, creating insurmountable blocks to a continuing relationship. University integrity may be questioned if the pressure to secure future research financing and to form future relationships negatively influences behavior under a current collaboration.

Issues concerning IP are especially contentious. Hold-up and background rights are of primary concern to an industry partner interested in commercializing the products of a research partnership. Researchers at universities and other public institutions often use proprietary research tools in their research without obtaining rights. They are blocked, however, from using these tools for commercial purposes.

This is the basis for the collective research model: Generally, one researcher in an institution may freely access another researcher's patented research tool for academic study. Industry partners and researchers doing private research are often excluded from this type of arrangement. Thus, a private institution looking to partner with a particular researcher, for example, may experience hold-up at the commercialization stage because the public research partner did not obtain formal rights to all research inputs (i.e., background rights).

Further, if numerous university researchers and graduate students are involved in a research project, industry risks loss of privacy and protection for proprietary information. In response to this risk, private partners may restrict researchers with confidentiality agreements. Private partners frequently indicate that long-term strategic partnerships provide a more successful mechanism than one-time specific research ventures for reconciling these issues.

Contractual relationships between universities or other public sector entities and private firms to engage in creative research raise a series of critical questions. Does the profit-driven sponsor shift the university's or public sector's mission away from more basic research? Does the industry's desire to exploit IP rights interfere with communication within and between universities to an extent harmful to open science and the pursuit of public good research? Quite naturally, conflicts are an inevitable consequence of the fundamental clash between public systems that encourage openness in science and private sector or industrial systems that focus on financial rewards based on secrecy.

In the final analysis, this all boils down to one core question: Can a university or public sector partnership with industry or private firms be socially beneficial or, more precisely, Pareto improving? In our recent book, we have demonstrated that a collective choice framework for the design and implementation of PPRPs, in the face of conflict between private self-interest versus the public interest, can lead to Pareto optimal cooperative outcomes.

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For additional information, the author recommends:

Rausser G., Ameden H., Stevens R. Forthcoming, 2016. *Structuring Public-Private Research Partnerships for Success: Empowering University Partners.* Cheltenham, UK: Edward Elgar Publishing.