
PRODUCTIVE RELATIONSHIPS IN RESEARCH AND DEVELOPMENT BETWEEN GOVERNMENT, INDUSTRY, AND UNIVERSITIES

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I approach this interesting and worthwhile topic from the perspective of someone focused primarily on helping universities to serve society in the best ways possible. There are other ways of considering the matter (naturally enough, from either the perspective of better government or that of benefits to industry), but I believe that each is very likely to reach similar conclusions and to create similar statements of principle for success. I also write optimistically, in the firm belief that productive and mutually beneficial research and development* relationships between government, industry, and universities can be developed and maintained, and that when they are developed well, they create broad economic, social, educational, and health benefits.

The benefits of productive relationships between the parties do not immediately accrue to universities, although universities may receive some benefits over time. Instead, the benefits fall primarily to the society that sustains the overall process and to the entrepreneurial individuals or groups who succeed in creating new business enterprises. If the relationships are appropriately structured, those benefits can substantially outweigh the costs.

*By “research” I mean the creation of new knowledge. By “development” I mean the social and commercial exploitation of new knowledge for economic and other social benefit.

As I see it, the ground rules for success in creating such beneficial relationships are not complex but in some cases may at first appear counterintuitive. However, many societies have now clearly shown that establishing and maintaining a strong set of enduring relationships, and therefore ensuring continuing success, is definitely achievable. This chapter will begin with a brief historical view of the development of productive relationships in research and development in two countries, Germany and the United States, and will then describe some ground rules that are likely to ensure success in the present day and near future.

UNIVERSITIES, GOVERNMENT, AND INDUSTRY: HISTORICAL BEGINNINGS IN PRUSSIA

Before the nineteenth century, universities in Europe and elsewhere principally functioned as communities of scholars devoted to personal intellectual development. University research, when it occurred, focused largely on the testing and refinement of ideas. Universities had, up to that point, played very little direct role in the creation or evolution of agriculture, mining, or industry. They were not expected to do so. That changed markedly, beginning in the early 1800s.

Prussia's early defeats in the Napoleonic Wars led to a desire to improve government, education, and industrialization within a society that was both relatively affluent, because of agriculture, and relatively well organized. In 1809, Prussia's Minister of Education, Wilhelm von Humboldt, initiated comprehensive educational reforms and in 1810 established Berlin University with the support of the King of Prussia. Humboldt had strong and, as it turned out, highly influential personal philosophies regarding education. He considered that university education should be centered on the discovery of knowledge—by students as well as by professors—something that was at that time a revolutionary concept. He stated as his ideal, “The university teacher is thus no longer a teacher and the student is no longer a pupil. Instead the student conducts research on his own behalf and the professor supervises his research and supports him in it.”* This strong focus on research was a profound change from the accepted model and led to the development of what are now called research-intensive universities.

In large part, because of the effects on industrial and social development to be described later, the new paradigm proved to be influential first in Prussia, then elsewhere in Germany, and then in other countries. At about the same time, Wilhelm's brother, Alexander von Humboldt, pioneered, in many senses, quantitative scientific methodology in several fields. This advancement gave valuable substance to his brother Wilhelm's educational and research philosophies.

Berlin University,[†] and then others, added the relatively new fields of physics, chemistry, and biology. Professors in those disciplines and others were expected to be

*Quoted in Clark, C. *Iron Kingdom: The Rise and Downfall of Prussia, 1600–1947*. Belknap Press; 2009, p. 333.

[†]In 1949, the name of Berlin University was changed to Humboldt University in honor of the two brothers.

active in research, were required to educate and train both undergraduate and graduate students in research methodology, and were empowered both with financial support for their research and with a high degree of freedom of inquiry. The universities created both research-capable individuals and new knowledge. These products (the creatively trained people and the new intellectual property) became available to a society that, in the case of Prussia, was ready to adopt them in the development of new business enterprises, and that had the will and ability to invest in risk enterprises.

The result, within only a few decades, was not only the creation of new industries within Prussia and then in other societies that followed Prussia's example, but also the creation of a vibrant diversity within such new industries. Foremost among these were the development and industrial manufacture of chemicals, dyes, and pharmaceuticals. Similar advances occurred in precision manufacturing, mining, and metallurgy. A high level of capability and international competitiveness in aviation, weapons production, and automotive manufacturing followed. The strength of these areas of the German economy has continued since that time.

REFINEMENT AND BROAD ADOPTION: THE UNITED STATES

Other European countries began to follow the German example, but it was the vibrant, creative, and rapidly developing United States of America that most rapidly adopted the new German model and that has maintained and refined it ever since. Although many other countries now work to emulate what the United States has achieved, it is instructive to consider the key elements that have led to this nation's success.

Rather than tracing in full historical detail the interesting development of the government–university–industry research ecosystem in the United States over the last 140 years, I will describe what I see as three key government actions that underpinned and continue to underpin its success. I will not describe or analyze the attempts, many of them successful, by other (usually smaller) nations and local economies to emulate the Prussian and U.S. models.

Land Grants

First, a system of “land grant” universities was established through federal legislation known as the Morrill Act in 1868 and in follow-up legislation in 1890. The purpose of the legislation was to establish universities that would “teach such branches of learning as are related to agriculture and the mechanic arts, in such manner as the legislatures of the States may respectively prescribe, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life.”* This would be accomplished through grants of federal land to each of the states, revenues from which would support the universities. The effects on industrial and social

*First Morrill Act, 1862, Section 4, as amended April 13, 1926. Available at <http://www.ans.iastate.edu/history/link/morrill1862.html>.

development in the states that took advantage of the legislation (and almost all did) were profound and have continued up to the present time.

Investments in Research

The second factor contributing to success in the United States has been ongoing investments in research, on the order of 2–3% of the gross domestic product, through the National Science Foundation, the National Institutes of Health, and other agencies of the federal government, combined with additional research investments by individual states.

It became evident that those investments were most productive when the funds were awarded through competitive processes, where funding decisions are based on the outcome of peer review of the quality of proposals submitted in response to requests for such proposals by the respective agencies, with those requests in turn being responsive to priorities identified in consultation with government. The alternatives (i.e., allocation through “earmarking” based on personal or political considerations, or allocation based on institutional entitlement) resulted in lower quality research outcomes and therefore less social and commercial benefit.

It is clear that full and open competition among institutions and researchers is the most productive approach. As an example, within the constraints of national security considerations, the United States even follows this model in the design and continuing refinement of the reliability and safety of its nuclear weapons.

Intellectual Property

The third enabling factor has been legislation related to the ownership and exploitation of intellectual property derived from research supported by the federal government. It is, in my view, initially counterintuitive but both brilliant and highly effective.

In 1980, two U.S. Senators, Birch Bayh (a Democrat) and Robert Dole (a Republican), authored and carried an additional piece of federal legislation. The Bayh–Dole Act reversed the presumption of ownership (title) for intellectual property from the funding body (the federal government) to the entity supported (the university, nonprofit entity, or for-profit company or individual). Bayh–Dole allows such bodies to pursue and exploit ownership of an invention resulting from federally funded research rather than vesting such ownership in the federal government. This has proven to be a masterstroke, something that has been and continues to be highly beneficial to the U.S. economy. This assignment of title has conditions, but the conditions have proven to be productive rather than restrictive. The conditions are as follows:

- The funded entity must file for patent protection of intellectual property resulting from the supported research.
- The entity must report each disclosed invention to the funding agency.
- The entity must elect to retain title to such inventions in writing within a defined timeframe.

- The entity must grant the federal government a “non-exclusive, non-transferable, irrevocable, paid-up license to practice or have practiced on its behalf throughout the world.”*
- The entity must undertake actively to promote and attempt to commercialize the invention but must not assign the rights to the technology, with some exceptions.
- The entity must give preference to U.S. industry and small business in commercial exploitation.
- The entity must share royalties with the inventor, and in the case of universities, use any remaining income for education and research.

Impact on U.S. Economy

As was the case in Prussia in the 1800s, the overall nature of the U.S. economy has provided individuals and groups with resources that might be used in the exploitation of new ideas, and with incentives (in the form of potential financial and social rewards) to bear some risk in attempting such exploitation.

In the United States over the last 150 years, these beneficial factors have led to substantial advances and commercial and social successes in such areas as agriculture (including most notably that of the Midwest and of California’s Central Valley), mining, precision manufacturing, automotive manufacturing, electrical goods, and most recently, in information technology, telecommunications, and biotechnology. The pattern is likely to continue in new areas of materials science and nanoscience.

Research-intensive universities have proven to be very productive centers for the creation of high-level human capability as well as new intellectual property, and there are several geographic areas in the United States where substantial development of new industry has occurred close to successful universities in consequence.[†] Examples are California’s Central Valley (in agriculture); the Boston Corridor (information technology and biotechnology); Silicon Valley (information technology and telecommunications); the North Carolina Research Triangle; Austin, Texas (information technology, pharmaceuticals); and San Diego (wireless telecommunications).

Universities can serve as training grounds for other parts of the beneficial ecosystem, such as intellectual property law and deal making, and can bring the different parties together. A great recent example is University of California, San Diego CONNECT®,[‡] which has helped to create communications and broker relationships

*Bayh–Dole Act, 37 CFR 401.14.

[†]It should be noted that universities are not “the only game in town” when it comes to research, and that they are generally not the best place for commercial development of new ideas or technologies to occur. In some cases, industry also invests directly in research, such as research being carried out either internally to companies or through contracts to universities or other research-capable entities. In that case, the company owns the resulting intellectual property, as it should.

[‡]See <http://connect.org>.

between scientists, entrepreneurs, and intellectual property lawyers, contributing significantly to the success of new industrial development in Southern California.

In summary, two pieces of U.S. federal legislation, and continuing federal government investment through the creation and support of federal research funding agencies, have promoted the development of new industry in the United States. Combined with the size and strength of the U.S. economy—and it is not unreasonable to say that the size and strength of the U.S. economy are in some part a consequence of the success of the relationships—productive relationships between government, universities, and industry in research and development have evolved, have succeeded, and continue to succeed.

GENERAL PRINCIPLES FOR SUCCESS

The following are the key elements for success:

1. Universities, whether privately or publicly funded, other not-for-profit entities, and private individuals or groups (often in the form of corporations) should be able to compete for government funding for the support of research. This will create new intellectual property.
2. The intellectual property should be available for transfer through open, market-place competition to entrepreneurial individuals or groups prepared to put their capital and labor at risk, for use in the development of new industrial activity. This will create new goods and services.
3. The revenues resulting from the sale of the goods and services should accrue primarily to the benefit of the entrepreneurial individuals or groups.
4. Part of the revenues generated by the success of such exploitation should be returned to the government through taxes. This will allow further investments in research.
5. Part of the revenues generated should be returned to the inventor or inventors.

Governments

Governments should invest public funds on the order of 2–3% of gross domestic product in competitive research in areas of national or local priority. The full costs of research that the universities perform should be paid. Follow the example of the Bayh–Dole Act and aim to get revenues back from income tax, corporate tax, or tax on successful new enterprises, but not from the up-front sale or licensing of intellectual property. Be bold. It works.

Universities

Universities should be quick and be generous in licensing intellectual property to local or national entrepreneurial entities. It pays off; entrepreneurial entities can exploit new

ideas better than universities can. Again, universities should not try to make money from licensing or selling intellectual property. Look after the interests of the inventor, but other than that, be as helpful as possible to outside parties who are likely to succeed. Successful businesses will be generous and attentive in return and will also provide continuing political support. Stick to doing what you do best.

Industry

Do what industry does best: take risk, be creative, and test and refine the value of new ideas in the real world of the marketplace. Pay taxes and employ people in the local economy rather than outsourcing to other countries. Remember that it was the local taxpayer who paid for the new intellectual property in the first place. And when you succeed, remember the benefits that the university gave to you, and give back in return. (Take a tax deduction for doing so, that's okay.)

