Academia And Technology Transfer In The U.S.

By Mihaela D. Bojin

Universities have made a significant contribution to innovation in the U.S. University research is continuously translated into technologies with an enormous impact on the American economy and society. Technology transfer from 1996 to 2015 has contributed over $1.3 trillion to the U.S. gross industrial output and resulted in millions of new jobs. During the past 25 years, more than 400,000 inventions have been disclosed to over 200 academic technology transfer offices across the U.S., resulting in approximately 80,000 patents. In 2017, for example, universities and research institutions executed about 8,000 license and option agreements and contributed to the creation of 755 products [1]. The wide-ranging influence of technologies created at universities cannot be overstated: technologies such as life-saving therapeutics and medical devices, materials, the computer, the internet, GPS, 3-D printing, genome editing, and artificial intelligence were all originally developed at U.S. universities.

To understand why U.S. universities play a major role in the innovation process, it is important to examine several factors:

1. A unique mission and approach of technology transfer offices (TTOs);
2. A tradition of support for research and development (R&D) from the federal government and industry;
3. An established culture of, and incentives for entrepreneurship; and
4. A robust and engaged private sector that can absorb and translate a diverse and vast pool of discoveries into products.

Next, I will briefly examine each of these factors and conclude by reviewing current trends.

1. Unique Mission and Approach of Technology Transfer Offices

Fundamental, ground-breaking research is expensive and uncertain. It takes very determined faculty and researchers to overcome strings of rejections from granting agencies and scientific journals; these individuals' resilience and institutional support allow them to keep going. Dedication and hard work often result from researchers' passion to benefit society, rather than their desire to become financially successful. In parallel, most technology transfer offices have mission statements that reference such values associated with public good and making technologies available to the public, driven by a desire to better society through research and innovation, to improve local economies, and nurture entrepreneurial endeavors [2].

Additionally, universities seek and reward original and exceptional ideas, which need a long time to be realized. Further, the U.S. academic tenure system encourages original and fundamental research instead of focusing only on discoveries with market potential. Entrepreneurship and/or commercial success typically carry little weight towards promotion, even in larger or wealthier academic institutions. Tenure is the top prize in any academic institution, as it leads to a lifetime position in that institution. If an original academic research project is developed into a product and generates revenue, it's even better! But that project doesn't HAVE to make money in an academic setting; at least not right away. Most of these daring research projects are not ready for commercialization for years, sometimes decades, and they are pursued on shoe-string budgets from internal university seed funds. These projects shatter norms and push technologies in directions not travelled before. The universities' tolerance for ambitious, lengthy projects is an essential ingredient for the type of innovation that requires time and resources to mature into the technology of tomorrow.

2. Support for R&D from Government and Industry

The relationship between academia and the public and private sector has been particularly prolific because of ample financial investment in universities' basic and applied research. In 2018, it is estimated that about $78 billion was invested in research in academia in the U.S. Part of this funding came from the federal government (about $40 billion), industry ($6 billion), universities' internal funding ($20 billion), while the rest came from foundations and other sources [3-6]. Additional funding for innovation and economic development comes from state, local and regional resources, foundations, or university commercialization funds. Support for academic research in the U.S. is larger (in terms of dollars) than the allocated budget for R&D of most countries worldwide [3].

■ Mihaela D. Bojin, PhD, CLP, University of Iowa Research Foundation, Senior Licensing Associate, Iowa City, Iowa
E-mail: mihaela-bojin@uiowa.edu

Federal grants support both incremental progress and exploratory research, carrying a high degree of risk that has potential to develop into revolutionary findings. This investment strategy has led to an exponential growth in academic invention disclosures and the emergence of new generations of inventors. Universities have since become fertile ecosystems of creativity with a practical bent. Federal support impacts early exploration through grants for basic and applied research, and development (*i.e.* R01, R3, R21, etc.) later-stage projects and partnerships with industry and university start-ups are supported through Small Business Innovation Research (SBIR), or Small Business Technology Transfer (STTR) grants. Each year, federal agencies with extramural R&D budgets that exceed $100 million are required to allocate 3.2 percent (FY 2017) of their R&D budget to SBIR/STTR programs. Currently, 11 federal agencies participate in the program [7].

Federal agencies have a significant contribution to the advancement of science and technology: a December 2018 NIST report [8], states that *"[i]n 2017, the Federal Government invested approximately $150 billion in R&D—about one-third at Federal Laboratories across the country and two-thirds at universities and private sector R&D institutions. Federal R&D funding represents about one-third of all U.S. R&D spending."*

However, this support is diminishing. The funding for most federal agencies has dropped; for example, the National Institutes of Health's budget decreased from $33 billion in 2017 to $26 billion in 2018; the Department of Energy, NASA, the National Science Foundation, and others also experienced reductions. The singular outlier remains the Department of Defense, whose allocated budget in 2018 was $85 billion, up by

$9 billion from the previous year, but not enough to make up for an overall decrease for R&D support at the federal level.

In recent years, *industry* has taken an increasingly larger role in supporting early stage innovation through a variety of partnerships and collaborations. This research is the source of countless technologies that have bettered and accelerated society's progress. Few products on the market originated in academia, if any, could have materialized, were it not for vigorous and fruitful partnerships with industry.

This large investment would not be possible without a friendly and simple legal framework that allows universities to own intellectual property (IP) developed with federal money. The U.S. Congress enacted the Bayh-Dole Act in 1980 and has amended it several times since then. This important legislation enabled small businesses and non-profit organizations, including universities that receive federal funding, to elect to pursue ownership of an invention, rather than obligating inventors to assign inventions to the federal government. This legislative act has catalyzed strong partnerships with industry and essentially propelled university innovation to the forefront of commerce.

The partnerships between universities and the private sector are typically facilitated by TTOs, which act as liaisons between universities or research institutions, and industry. TTOs in the U.S. are set up either as separate non-profit corporations, or are part of universities. They take assignment of university IP through institutional policy, often with a mission to bring discoveries to market. These offices support a variety of functions, from technology evaluation, IP protection (using in-house and/or outside counsel), accounting, marketing, negotiation and drafting of a variety of contracts, such as licenses, options, confidentiality agreements, material transfer agreements, joint development, inter-institutional agreements, etc.

3. Established Culture of Entrepreneurship

The barriers between early stage innovations and late stage development are significant, because large companies and venture funds do not have the patience for investment in fundamental or breakthrough innovation; instead, they focus more on shorter term, incremental advances with faster returns. These roadblocks combined with a growing enthusiasm for entrepreneurship among faculty and researchers has led to an exponential growth in the number of academic start-ups in recent years. Federal funding (SBIR, STTR grants) is critical to these start-ups, not only because it is often the only source of funding in many areas, but also because this money is non-dilutive. Alternative funding comes from the private sector as angel investment and venture capital funding; it is more elusive, dilutive, and difficult to obtain; it includes strings and entails ownership participation in the start-up.

Since the late 1990s, universities have created over 11,000 start-ups, most in the biotech and high-tech areas. University start-ups are created as bridges to existing industries or new innovation areas, and they allow faculty to access less traditional funding mechanisms and partnership opportunities. Academia now fosters innovation to an unprecedented degree, by forming and managing business support systems for start-ups, mentorship programs, accelerators, incubators, and research parks. Further, universities are now tapping into alumni groups by engaging them in these entrepreneurial activities. They seek alumni's participation as mentors and advisors to start-ups and as gateways to business networks.

In recent years, universities in the U.S. started to participate in university-backed venture funds, or venture-affiliated venture capital funds that cement relations with their spin-outs. Often, alumni are critical donors or contributors to such funds. The most active universities in this arena are in the Silicon Valley, Boston, New York, or larger urban areas, or universities with wealthy alumni foundations. Separately, large corporations are also becoming increasingly involved in university spin-offs through their corporate venture arms, instead of passively funding joint projects to universities through sponsored research.

An important role in fostering a culture of entrepreneurship is played by state and local governments. Their support for start-ups, particularly in areas without a strong industry presence is often the only lifeline available to university entrepreneurs for years in regions that are economically depressed, or virtually non-existent pertinent entrepreneurial networks. The level of support for such endeavors—as direct or matching funds, backing for incubators, tax incentives, breaks or low interest loans—varies and is an important factor in the number and success of academic start-ups in those areas. States with bold economic development initiatives have more efficient transfer of technologies from their academic institutions to industry and, consequently, more vibrant and diverse economies [9].

4. Robust and Engaged Private Sector

As outstanding as the universities research is, it would have little value to the real world without industry's active commitment to translating great ideas into products. This materializes through various partnerships, from licensing deals, to sponsored research, joint development, or clinical trials at universities. Alliances with larger enterprises tend to be more strategic, focused around specific areas of interest, whereas relations with smaller and medium companies can be more transactional and project-based.

Ultimately, universities in the U.S. are more successful than peers around the world, because of their access to the largest, most dynamic and versatile economy in the world, and established mechanisms to interact and partner with it. Although academic centers outside the U.S. have excellent research programs and gifted scientists, they lack this type of access and relations with world's top corporations. Though globalization has expanded businesses' access to researchers worldwide, export control regulations and restrictions, an assortment of complex national legal and business environments, and fluid trade agreements have diminished the attraction of outsourcing intellectual property outside the U.S.

Within the U.S., success among universities in establishing and growing networks with industry is uneven. While a small percentage of universities located in thriving regions have substantially monetized on their intellectual capital, others struggle to break even. Institutions such as MIT, Stanford, University of California, Columbia, NYU, and University of Wisconsin, have strong ties with corporations due to their remarkable reputations. Others have capitalized on their location and proximity to headquarters of major players in industry. Still, at the majority of universities, relationships with companies are dependent on the reputation of individual faculty, and the university leadership's appetite to cultivate sturdy bonds with industry; these associations require more effort to develop and mature, but can be similarly gainful.

While these coalitions with industry are flourishing, universities must deal with considerable conflicts of interest and ethical considerations. Such concerns sometimes hinder unfettered expansions of these relations. Most of these issues can be effectively managed, but crossing these lines can have damaging con-

sequences for individual faculty and their academic institution.

Conclusion and Current Trends

Sobering recent data indicates that the competitive advantage of U.S. companies is diminishing because emerging Asian economies, particularly China, are heavily investing in developing their own innovative landscapes. There are also concerning signs about the future of governmental support for technology transfer. The overall federal R&D budget relative to GDP has been in decline for over 50 years, falling from nearly two percent of GDP in 1965 to 0.7 percent of GDP in 2010; it has been balanced by a growing support for R&D from industry, a rise of about two percent of GDP in that same period [10-11]. A deterioration of reliable, steady investments in intellectual capital at U.S. universities can lead to a loss of leadership and competitiveness.

In conclusion, a unique mission and approach of technology transfer offices, a tradition of support for research and development from the federal government and industry, an established culture of entrepreneurship, and a robust and engaged private sector underpin American universities' leadership and success in creating technological advances. Nevertheless, continuous support will be needed to ensure that the U.S. retains its reign in the innovation-intensive economy of the future. ■

Available at Social Science Research Network (SSRN):
https://ssrn.com/abstract=3380588

Acknowledgments

I would like to thank Bogdan Vasi and Catherine Koh for their thoughtful comments and suggestions.

References

[1] AUTM 2017 infographic.

https://autm.net/AUTM/media/SurveyReportsPDF/Survey%20Reports%20Images/AUTM_2017_Infographic_1.pdf

[2] Seok-Ho Kim, Alan S. Paau, Bridging The Gap For Public Good, *les Nouvelle*, September 2011.

https://www.lesi.org/news-results/2011/08/29/bridging-the-gap-for-public-good-a-study-on-the-mission-statements-of-u.s.-university-technology-transfer-programs

[3] 2018 R&D Global Outlook—Funding Forecast

https://digital.rdmag.com/researchanddevelopment/2018_global_r_d_funding_forecast/MobilePagedReplica.action?pm=1&folio=5#pg5

[4] How much money do universities get from sponsored industry research?

https://www.google.com/url?sa=t&source=web&rct=j&url=http://www2.itif.org/2018-industry-funding-university-research.pdf&ved=2ahUKEwjQ3KP9m6vfAhUr64MKHWKEBFYQFjALegQIChAB&usg=AOvVaw25_zJ6VgUwIdd9rodK9tdQ

[5] Decline in Federal funding. Supplemental local and regional resources, foundations, internal.

https://www.sciencemag.org/news/2017/03/data-check-us-government-share-basic-research-funding-falls-below-50

[6] UNESCO R&D Data

http://uis.unesco.org/apps/visualisations/research-and-development-spending/

[7] SBIR-STTR

https://www.sbir.gov/about/about-sbir

[8] NIST report

https://nsf.gov/statistics/2018/nsb20181/report/sections/research-and-development-u-s-trends-and-international-comparisons/recent-trends-in-federal-support-for-u-s-r-d

[9] Industry University funding by state.

https://www.google.com/url?sa=t&source=web&rct=j&url=http://www2.itif.org/2018-industry-funding-university-research.pdf&ved=2ahUKEwj95aTz5cbfAhWK64MKHcmTCYwQFjAAegQIARAB&usg=AOvVaw25_zJ6VgUwIdd9rodK9tdQ

[10] William B. Bonvillian, "Reinventing American Manufacturing The Role of Innovation," *Innovations*, Vol. 7, No. 3, Pg. 97-125.

[11] Congressional Budget Office, Estimating the Long-Term Effects of Federal R&D Spending

https://www.cbo.gov/publication/54089