The Entrepreneurial University In a Global Context

A Report to NEDO

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Preface

The study underlying this report was commissioned by the Washington, D.C., office of Japan's New Energy and Industrial Technology Development Organization (NEDO). Its authors, working together as the firm of Technology Policy International (TPI), have undertaken the study as independent consultants, although it should be noted that each has other professional affiliations and activities (see "About the Authors"). The opinions expressed in this report do not necessarily reflect the views of NEDO or the institutions with which the authors are affiliated.

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1. INTRODUCTION

The roles of the university are in the midst of dramatic and profound change—in the U.S., in Japan and throughout the world. What have generally been seen as its traditional roles—teaching and research, underwritten, in most countries, by generous state support—are giving way to phenomena as diverse as privatization of national universities, research partnerships with industry, a for-profit sector, and global expansion. It seems fair to say that the U.S. university sector stands in the vanguard of these trends. U.S. universities have become "entrepreneurial" entities. That is, they think strategically and globally, they are increasingly oriented toward an economic role in society, and they give birth to new ventures, both intellectual and commercial.

This report focuses on two of the current features of the American research university: (1) its increasingly visible and important role in economic development and (2) its increasing globalization, both in education and research. Many American universities have long had economic and global roles, but those roles have expanded dramatically over the past three decades. In terms of economic development, today's professors at U.S. research universities not only provide consulting and technical advice but also perform corporate-sponsored research and start new companies. Many universities advertise their ability to help boost their local, state, and national economies, and political leaders now sometimes expect these schools to help revitalize local economies. In terms of globalization, U.S. research universities now recruit both undergraduate and graduate students from around the world, provide overseas experiences for American students, solicit research funds from international companies, and sometimes start joint or cooperative university campuses in other countries.

The report asks several questions about these recently expanded activities.

- What exactly are U.S. research universities doing in these two areas, and why are they doing it? American universities vary a great deal, but many have embraced economic development and globalization. Why?

- How are they able to be "entrepreneurial" and expand their activities in these two areas? After all, universities around the world appear to be decentralized and slow to change. For example, what organizational and management features—what this report calls "governance structures"—and what other factors allow American universities to attract large amounts of corporate money?

- What are the advantages, disadvantages, and management problems associated with these expanded activities of economic development and globalization? For

example, does the goal of helping local economic development conflict with the goal of raising money from international companies and helping them? And while recruiting large numbers of international students from China, India, and other countries adds to the quality of the student body, does it hurt the U.S. economy by, in effect, training people who will compete economically with American companies and workers?

- Do major American research universities offer any "lessons" to other universities, both in the United States and in other countries that may want to expand their economic development and globalization activities?

Therefore, the climate of "entrepreneurialism" in the U.S. university sector is the subject of this report. Its analysis explores the deep historic roots of entrepreneurialism in academe, considers the current elements of the "economic" and "global" roles that U.S. universities have assumed, and reflects on the policy issues that these developments raise, both for universities and society. One theme of this report is that the U.S. research university and other organizations involved in economic development, such as government funding agencies and companies, must be understood as a "system"—what some scholars call a national innovation system. Just changing one part of the system may not be enough to get the results one desires. Another theme is that the various roles of today's university can conflict; as result, universities must manage these activities carefully in order to minimize problems.

Financial support for the project was provided by the Washington, D.C. office of NEDO—the New Energy and Industrial Technology Development Organization of Japan—an independent administrative agency of the Government of Japan. It was undertaken by Technology Policy International, an independent research and consulting organization in the U.S.

The five subsequent chapters flow as follows: Chapter 2 begins with an overview of the evolving roles of universities in the United States, noting from the outset that universities have long had multiple roles. It discusses how the community of universities has responded to changing local and national needs by developing new kinds of instructional and research programs as well as by organizing and conducting many other sorts of activities. It also discusses sources of change and change processes within higher education.

Chapter 3 discusses how universities support the economic development of their regions, states and nation, with a focus on the increasingly explicit expectation that they turn their ideas and research results into new products and processes; companies; and jobs, profits and wealth in the private sector.

Chapter 4 explores how universities respond to the globalization of the U.S. economy, as well as the demands for education and for life experiences that reflect a wide range of cultures and nations. It focuses in particular on support of U.S. academic research by firms located in other countries.

Chapter 5 discusses tensions that have arisen in the conduct and management of universities when their roles in economic development and in globalization are, or appear to be, in conflict.

Chapter 6 offers some broad conclusions and discusses possible “lessons” from the experience of major U.S. research universities.

2. EVOLVING ROLES OF HIGHER EDUCATION IN THE UNITED STATES

This chapter examines the roles and activities of U.S. research universities, and particularly how they have evolved over time, why they have changed, and how the particular governance structure of American universities allows and encourages professors to be entrepreneurial. After a brief description of their place in the world, we turn to a presentation of the historical roots of the research universities. The point of this presentation is that the present U.S. system is very much a product of its particular history. That is, the path of its development goes a long way toward explaining why it is what it is. It is not necessarily the system one would devise *de novo* in the present-day world. We then turn to an analysis of the evolving role of U.S. universities, going from teaching, to research, to economic development, to global engagement. We close with a discussion of the governance of U.S. research universities, with a focus on how the faculty and administrators work—sometimes together, sometimes at cross-purposes—to introduce change into what universities do and how they do it.

The U.S. University System in an International Context

The United States is endowed with a large number of post-secondary higher education institutions, including several thousand that offer a bachelor's degree or higher and more than three hundred that offer the doctorate in at least one field. In addition, several thousand additional institutions offer professional, technical, or vocational education and training beyond the high school level, but generally do not offer bachelor's degrees or graduate programs. In this report, we focus largely on the doctoral institutions, which include nearly all of those considered "research universities."

Universities around the world are increasingly moving beyond their traditional roles in education and knowledge creation to contribute to the commercialization of knowledge and the development of firms. Such "economically engaged" universities are increasingly important components of regional and national innovation systems. Leading universities are also increasingly becoming global rather than regional or national institutions. They attract students, faculty, and philanthropic and corporate funding from around the world. They often engage in partnerships with other universities or establish branch campuses in locations around the world.

U.S. universities have generally been the leaders and the models for both the economically engaged and global universities. Indeed, U.S. universities tend to be at the vanguard of many trends, adapting to changes in the environment and new opportunities more rapidly than universities in other countries.

The U.S. universities are generally respected for their:

- **Overall quality & research.** U.S. universities fill the top of most rankings, such as the Times Higher Education and the Academic Rankings of World Universities (Shanghai) rankings. In both of these, U.S. universities represent approximately three quarters of the top 25 universities, and over half of the top 100 universities in both of these rankings.1
- **Contributions to innovation and economic growth.** Many innovative companies can be traced directly to universities. Google, Netscape, Facebook, Microsoft, Dell, and Genentech are all spinouts from universities or were founded by people immediately out of universities.
- **Globalization.** U.S. universities attract faculty, students, and corporate investment from around the world. U.S. universities have expanded their presence internationally through satellite campuses and collaborations.
- **Flexibility and adaptability.** Relative to other universities, U.S. universities respond quickly to changing environments and opportunities, such as moving into new fields or finding new sources of funding.
- **Flexibility for Students.** U.S universities give students opportunities to change directions and create individualized education and skills, which is important in an era with rapidly changing careers.

On the other hand, it must be acknowledged that U.S. universities also have characteristics that are not so favorable. The U.S. system imposes high costs on students and their families, especially for education in private liberal arts colleges or elite private universities. The U.S. system also takes longer to produce graduates with professional credentials, such as law or medical degrees, compared to universities in Europe.

These weaknesses notwithstanding, many countries have attempted to copy aspects of the U.S. university system, both by building new universities or attempted to reform existing ones in ways that are modeled at least partly after U.S. universities. Examples include KAIST in

[1] See http://www.timeshighereducation.co.uk/world-university-rankings/2010-2011/reputation-rankings.html; http://www.timeshighereducation.co.uk/world-university-rankings/2010-2011/top-200.html; http://www.arwu.org

Korea, the Cambridge-MIT Institute at the Cambridge University,[2] the King Abdullah University of Science and Technology in Saudi Arabia, and many others. Europe, through the Bologna Process, is attempting to move the European University system in many ways closer to the U.S. system.

But while the U.S. university system is widely admired and copied, most countries have found it difficult to re-create the full characteristics of the U.S. system. The thesis of this report is that U.S. universities must be understood as a system. The characteristics of the U.S. university system are a function of not only specific policies and programs, but also of broader institutional, historical, and cultural factors. Furthermore, the U.S. university system developed over a substantial period of time and in response to a rapidly evolving set of expectations and demands. And, it did so during a time when the United States was rapidly growing in terms of area, population and wealth. Change during periods of rapid growth is nearly always easier to accomplish than during periods of stagnation or decline.

To explore how these aspects of U.S. higher education emerged over time and how they influenced its roles, we turn now to a discussion of its historical roots.

Historical Roots of U.S. Higher Education

Higher education, or at least its foundational institution, dates from the establishment of Harvard College in Cambridge, Massachusetts, in 1636, less than two decades after the first permanent European settlement in northern North America.[3] A few other noteworthy institutions were established during the Colonial period in what became the United States including the College of William and Mary in 1693, Yale in 1701, the University of Pennsylvania in 1740, Princeton in 1746, and Dartmouth College in 1769. However, the newly established agricultural colonies on the east coast of North America had limited need for persons with advanced education, and higher education grew slowly in the 17th and 18th centuries—few colleges and universities were established during this period. Furthermore, higher education was limited largely to sons of wealthy families, and many of them returned to Europe for advanced education in such fields as philosophy and theology. The "learned professions" such as teaching, medicine, engineering and science had not advanced to the point at which they were thought to be appropriate subjects for the higher education curriculum until well into the 19th century.

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[2] http://www.cmi.cam.ac.uk/

[3] The brief history presented here highlights the fact that universities are among the oldest surviving institutions of any kind in the United States, just as they are in many parts of Europe. Universities are generally highly stable organizations, not because they rigidly oppose change, but because they are able to respond flexibly, if not rapidly, to changing needs and circumstances. Much of this report is, in fact, a story of how American universities have adapted to changing demands for their roles in economic development and in globalization.

The early 19th century witnessed an explosive growth in the number and size of institution of higher learning, and the numbers of students and graduates grew accordingly. After 1789, the newly established United States needed larger numbers of college graduates to work in government, business, trade, law and the military establishment. Religious colleges were set up to prepare men for the clergy and many teaching colleges were created to prepare the large number of teachers needed to help achieve the national objective of universal literacy. In the early 19th century, natural philosophy gave birth to the various natural sciences and universities began to offer instruction in fields like physics, chemistry, mathematics, biology and geology. In recognition of the growing importance of university preparation to success in agriculture and manufacturing, the Morrill Act of 1862 provided grants of federally-owned land to the several states to support establishment of state universities focused on agriculture and manufacturing and open to attendance by persons not necessarily from the wealthier classes. (These are the so-called "land grants colleges and universities.") The 19th century also witnessed the creation of colleges intended to serve the educational needs of women, and a few adventurous institutions began to experiment with educating men and women together—so called "coeducation" was first instituted at Oberlin College in 1833.

Higher education in the United States was characterized almost from the beginning by its diversity of organizational forms and by its relative independence from the national government.[4] Many higher educational institutions are agencies of or creatures of the states in which they are located—these are referred to commonly as "public universities." They typically receive direct financial support from the states, although that support is not usually sufficient to cover all of their costs of operation, so they must also charge tuition and fees to their students and seek other forms of income such as external research support, profit from student services such as serving meals and providing rental housing, and gifts from alumni and other supporters. In such institutions, students may pay tuitions and fees that are on the order of 20 to 50% of the full costs of their education. With one or two exceptions, the land grant colleges and universities are state institutions and include many of those with international reputations such as the Universities of Illinois, California, Wisconsin, and Texas as well as others such as Pennsylvania State University, North Carolina State and Ohio State.

Many other institutions of higher education are privately organized and funded. This is true of nearly all religiously-affiliated institutions as well as of many institutes of technology such as MIT and Carnegie Mellon University and most of the highly prestigious universities such as Stanford, Duke and the University of Chicago, including those in the "Ivy League" (Harvard, the University of Pennsylvania, Brown, Yale, Princeton, and others). There are also large

[4] Other than its military academies associated with the various branches of the armed services, such as the United States Military Academy at West Point for the Army and the United States Naval Academy at Annapolis for the Navy, the United States has never supported a "national" university as such.

numbers of well-respected four-year private colleges such as Williams, Swarthmore, Mt. Holyoke, Grinnell, Hendrix, and Reed.[5]

The Evolving Roles of U.S. Research Universities

This section reviews how the roles of U.S. research universities have evolved over time, from their earliest sole focus on education for upper-class men, through the emergence of their research responsibilities, the addition of economic development activities, and, finally, to the present concern with global engagement.[6]

Early U.S. universities were founded to educate young people (principally males) to prepare them for service as clergy, military officers, lawyers, and gentleman-citizens. In this role, the universities taught largely the classics and put substantial emphasis on both intellectual preparation and preparation for life. As the nation grew and as the complexities of modern life created demands for more people with advanced education and for a wider variety of educational backgrounds, both enrollments and the scope of educational offerings by U.S. colleges and universities grew apace. A few faculty members were engaged in scientific inquiry in the physical and agricultural sciences and in other forms of scholarship in fields such as history and philosophy. Nonetheless, throughout most of the 19th century (and into the 20th for many institutions), teaching was by far their most important role.

It was not until the late 1860s that the first doctoral degree was conferred by a U.S. university, and few doctorates were awarded throughout the balance of the 19th century. The essence of the doctorate is the engagement of the student and his or her faculty mentors in research and scholarship, not just to learn what was already known but to contribute new information and new insights to the body of systematic human knowledge. Drawing heavily on models of the research university developed in Europe, leading U.S. institutions slowly expanded their engagement in research throughout the first several decades of the 20th century. Until the mobilization of universities to contribute to the war effort at the outbreak of

[5] It should be apparent from these brief lists of the names of prominent institutions of various types and forms of ownership that the name of the institution is not a reliable guide to its form of organization or its source of funding. Even the words "college" and "university" have lost much of their distinction as between four-year bachelor's degree-granting institutions and those that offer education beyond the bachelor's degree. The presence of the word "state" in the name of an institution does not guarantee that is it owned by a state, and "state" never connotes the national state in the U.S. Furthermore, many higher educational institutions have undergone significant reorganization and reform, so that, for example, some which were once prominently associated with religious denominations have essentially lost such linkage (e.g., Princeton was once, but is no longer, a training institution for Presbyterian clergymen, as was American University in Washington DC for Methodists.)

[6] U.S. universities play other roles not considered in this report. These include sponsoring major intercollegiate athletic events; mounting artistic events such as concerts, plays, and exhibits; serving as a reservoir of experienced and talented people who can take leadership positions in government as presidential appointees; acting as observers and critics of society for the specialized and popular media; and hosting civic and political events.

World War II, most university research was relatively modest in scope and was conducted using financial support from the institution or from a few charitable foundations. Federal funding of university research was quite limited until that time—under the pressure to produce results of military significance, the federal government's funding grew dramatically during the war and gave impetus to the maturation of research and scholarly inquiry as the second major role of U.S. universities.

In parallel with the emerging engagement in research in the late 19th century, a few universities, especially public institutions supported through federal land grants, began to set up formal mechanisms for transferring new knowledge of agricultural techniques to practicing farmers. So called "agricultural extension" programs to perform this function were given great impetus by the passage of the Hatch Act in 1887 that set up programs of agricultural research at land grant universities and by the Smith-Lever Act of 1914 that set up the Cooperative Extension Service. Embedded in these acts of Congress were several important concepts. First, they recognized that organized research could contribute purposefully to the improvement of agricultural techniques. Second, they recognized that there would be in practical terms a significant gap in understanding between researchers in universities and largely unschooled farmers working their fields—a gap that could most effectively be closed by training a corps of specialists who could understand the academic research but also communicate effectively with working farmers. Third, by creating agricultural research and extension programs in each of the states, these acts recognized the enormous diversity of farming practices, crops, and natural ecosystems that characterize agriculture in the United States—local research and adaption is key to effective research and its application. And, fourth, they recognized that farmers themselves were often in possession of local knowledge of conditions and of methods that could be of value to their neighbors if effective mechanisms were in place to facilitate sharing of such knowledge. Hence, the agricultural extension "agents" who were the translators of academic research results to practitioners also became the facilitators of networks of farmers to help them share good farming practices among each other.

It should not go without mention here that this model of agricultural extension practice underlies much of the more recent policymaking that seeks to engage academia in offering industrial assistance to industry in such areas as manufacturing and new business formation. That said, the application of the agricultural extension model to other domains proceeded quite slowly in the United States. The first federal effort of this kind was formalized in the State Technical Services Act of 1965. This act empowered and funded the Department of Commerce to provide grants to the individual states to set up programs to provide technical assistance to industry on the agricultural extension model. It was based on the realizations that firms differ widely in their levels of productivity and performance and that bringing low performing firms

up to the levels of the best could lead to substantial improvement in performance of the economy as a whole. Unfortunately, for a variety of reasons this act received only modest funding and that for only a few years. By 1969, the program it set up was effectively finished. It had, however, funded programs in several states that later were early leaders in the new wave of technology-based economic development agencies that emerged in the 1980s. Among other mechanisms, these new wave agencies sought to mobilize university resources directly in support of regional and local economic development. As discussed in much greater detail below, these efforts have led to university engagement in a third important role—supporting economic development.

U.S. higher education has long had an important international dimension. Earliest American higher education institutions emphasized fields such as the classics, languages, history and fine arts, which were of necessity almost entirely derivative of European learning. After the Scottish Enlightenment of the mid-18th century, Americans made close study of the philosophies and theories of governance of leading philosophers from the British Isles and Europe more generally such as Locke, Hutchsinson, Montesquieu, Descartes and Priestley. Until well into the 20th century, Americans who wished to study at advanced levels most often took doctoral studies at the leading universities of the British Isles, Germany and Sweden. In keeping with Europeans, Americans interested in the fine arts made study pilgrimages to Florence, Rome and Paris. The mark of an educated man (and, very occasionally, woman) was that he had studied for some time overseas.

As the United States ascended to world leadership at the end of World War II, there was a sharp increase in the nation's need for in-depth understanding of the languages, cultures, histories, geographies, political systems, and advances in science and technology of other parts of the world. The United States naturally turned to its institutions of higher education to prepare a new generation of experts who were prepared to serve in diplomatic missions, in the intelligence services, and in the private sector in firms doing business internationally. In addition, the United States took on substantial responsibilities in a host of developing nations that were newly established after the war as the old European foreign empires were dismantled. We assumed responsibilities for training cadres of students from overseas in fields such as agricultural science, medicine, nursing, business and engineering that could be useful to their nation-building enterprises. Federal support was provided to nurture new university programs in foreign languages and cultures as well as in "area studies" focused on regions of the world such as Latin America, South Asia and the Middle East. As may be apparent from this brief summary description, these sorts of efforts tended to be motivated and supported either in pursuit of U.S. foreign policy objectives or in support of the ambitions of the developing

nations for modernization and development. Often, of course, both sorts of motivations drove U.S. initiatives.[7]

It must also be mentioned that because universities and their faculties tend to be more interested in and open to diverse experiences than the general population, universities somewhat naturally emerged as places in American society that are most accepting and, indeed, celebratory, of cultural and national differences.

Finally, owing to the manifest success of leading universities in preparing students and conducting important research, they have drawn faculty and students from all over the world. In recent decades, universities have sought to capitalize on their reputation—on their "brand," as it were—by establishing branch campuses and programs in nations around the world. In earlier times, many institutions had opened offices overseas to facilitate foreign visits by students and faculty, as well as overseas research activities and so-called "study abroad" programs for students enrolled in the United States. It was a relative small step in practical terms to set up satellite degree offerings at those overseas locations, although obtaining host nation approvals to offer degree programs has not always been straightforward.

All of these forces and trends have resulted in the present circumstance in which universities have increasingly seen one of their roles as "engagement" with the world; i.e., the encouragement of international ties between their students, faculties, and programs with those of other countries. At its richest expression, universities have begun to see themselves as leading the nation toward "globalization," through global engagements in all levels of activities from student recruitment to setting up full comprehensive campus in other countries.

The next two chapters of this report will discuss the expanding roles of U.S. research universities—especially in economic development and globalization. Before turning to them, however, we next discuss one more important topic: the "governance" of research universities and how the American style of university governance has given faculty members enough autonomy and resources to be "entrepreneurial" as they seek new funding sources and develop new activities.

[7] Yet, another more pedestrian motive drove U.S. support for food exports to developing countries. High domestic agricultural productivity often left the United States with large inventories of so-called "surplus commodities," such as wheat, milk, butter, and meat. The growth of such inventories was further incentivized by domestic agricultural price support policies that promised that the government would buy such commodities from farmers if the private market demand was not large enough to consume all that was produced. The history and politics of domestic agricultural price support programs are very complex, but suffice it to say here that providing food aid to developing countries experiencing food shortages was often as much motivated by supporting U.S. farmers as it was by feeding the destitute.

Governance of U.S. Universities

Overview of Actors in Governance

Most universities around the world have decentralized "governance structures"—decentralized decision-making and management structures. University presidents are often weak, faculty members are influential but differ among themselves about priorities, boards of trustees may want to exert control, and government funding agencies also are powerful. One might expect, therefore, that universities would be slow to change, because power is diffuse and agreement is hard to reach. And yet American universities and their professors are often "entrepreneurial." They seem to have the autonomy and flexibility to do new things. Why does this happen? What features of university governance in the United States—and what features of other key actors such as government funding agencies—have led to this flexibility?

One of the hallmarks of U.S. university governance is the large number of actors that seek to influence what the university does and how it does it. The most influential of these actors are the faculty, the administration and the board of trustees.[8] But, many other actors also influence university governance, including political, business, and community leaders; alumni associations; organizations devoted to supporting intercollegiate athletic activities; major contributors of cash or property such as land or buildings; students as individuals or as members or officers of student associations; labor unions representing faculty, staff and, occasionally, graduate students; disciplinary professional associations; associations of administrative professionals such as financial officers or registrars; regional and disciplinary accrediting bodies; and opinion leaders of all kinds. Further, in some states, the boards of trustees of public universities are elected by the people of the state in regular elections, which means that the public in general plays a role in governance. And, in some states that support more than one public university, there may be both boards of trustees for each institution and a "super-board" that oversees the entire system of multiple universities. The super-board may also have administrative officers who are generally, but not always, seen as senior to the chief administrative offers of the individual institutions.

One might add to this list the growing number of federal government agencies that have a direct role in university governance, even of institutions that are ostensibly fully privatized in their organization and conduct. The federal influence is felt through its substantial role in helping individual students finance their educations through grants and loans, through its oversight of how universities administer federal R&D funds that are granted to the institution for work by its faculty and students, and through a myriad of other federal requirements related to equal opportunity, classroom safety and security, protection of both human and

[8] Members of the governing boards of universities are called "members" at some institutions and "trustees" at others. In this report we use the word board "member."

vertebrate animal subjects of research, national security classification of certain types of research, and so on.

Finally, this overview of governance would not be complete without noting that the internal divisions of universities among schools, colleges, departments, laboratories, centers and programs is manifest in a complex array of local administrative officials who each seek to influence how the university is governed and how it spends and invests its resources.

As may be apparent from this list of actors in governance, the job of leading a university, especially a major research university of the sort that is of greatest interest to this report, is a highly complex and often highly political one. The various actors often see themselves as having competing interests as they seek to determine and guide the university's activities. It is important to distinguish processes of university governance in the United States from the processes of governing under the republican form of governance that is practiced at the state, local and federal government levels. The principal difference is this: in government, a relatively few public officials are empowered through election or appointment to play formal roles in governance; everyone else and all other organizations are viewed within the republican framework as "interests" to be taken into account by the public officials who have the power to govern. It is the job of these public officials to make decisions among competing alternative supported by citizens and diverse interests and to see that those decisions are carried out.[9] In the academic setting, however, each of the actors listed in the opening paragraph of this section has one or more formal roles to play in the governance process. Depending on their areas of competence and concern, each may have a right to be consulted and to make inputs into both decision-making and policy implementation within the university.[10]

The participation of so many diverse actors in university governance has at least four important implications. First, decision-making can take a long time as all of the actors play out their responsibilities; it can be difficult to get anything done. Second, it is difficult to hold any one of the actors responsible for their decisions because so many will have had a hand in the decision process. Third, decisions, once made, can often easily be reopened for further discussion and potential revision, especially if any one of the actors has not been adequately consulted. And, fourth, the process creates many opportunities for those who seek to make change in the institution to do so outside the domain of formal governance.

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[9] Clearly, these few sentences do not do justice to the complexity of public governance in the United States.

[10] As one rather remarkable example, federal rules governing treatment of human subjects of research require that institutions convene standing committees to review and approve any research project carried out by the university that involves human subjects. These committees are typically made up of faculty experts and a few others. The decisions of such committees about whether a research project can go forward and about any changes that might be required before it can proceed are made by the committees alone and are not subject to review or reversal by any university administrator or other governing party.

Focus on the Faculty and the Administration in Governance

A full examination of how the various actors discussed above work to influence university governance is well beyond the scope of this report. We focus here on the three parties that are most directly engaged in university governance: the faculty, the administration, and the board. These three parties are traditionally said to be engaged at best in a process of "shared governance"—a process that most faculty[11]; many, but not all, administrators; and some, but not all board members, are committed to as a matter of principle.

The American Association of University Professors, the largest organization of faculty in the United States, has long taken the lead nationally in articulating the principles of shared governance.[12] It has established mechanisms through which it can call attention to the failure of institutions (boards and/or administrations) to implement shared governance effectively. The general concept is that faculty, administrators and board all have legitimate roles in defining what an institution does and how it does it. It ensures that faculty hiring, promotion and tenure decisions are made by faculty and administrators, and sometimes by boards, in concert. The curriculum and standards of student success are set by faculty. Boards are responsible for ensuring the overall health of the institution, for setting strategic direction and for making certain that resources are available. Boards also typically hire and fire senior administrators, especially presidents.

In practice, boards under ordinary circumstances tend to leave the routine operation of the university to the administrators and the faculty. Generally, faculty members work with administrators to define curricula and course descriptions, to set expectations for student performance, to review applications for admission, and to carry out routine administrative activities. Grading is solely in the hands of the faculty. There is a typically a hierarchy of academic administration. At the top of this hierarchy is the chief academic officer, often called the provost or the vice president for academic affairs. The deans of schools and colleges report to the provost, and the department heads report to the deans. Modern universities also have a large number of specialized non-faculty administrators responsible for such functions as human resources, legal affairs, facilities, financial accounting, research administration, technology transfer, student non-academic activities, athletics, public relations, libraries, information technology infrastructure, and so on. On some campuses the number of non-faculty administrators may exceed the number of faculty.

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[11] A substantial proportion of faculty members does not participate in governance of the institution, preferring to focus instead on their own scholarly pursuits. They may be indifferent as to whether the institution is governed on a shared basis or by the administration alone.

[12] See, American Association of University Professors, Statement on Government of Colleges and Universities, 1966. On line at: http://www.aaup.org/AAUP/pubsres/policydocs/contents/governancestatement.htm

Entrepreneurism, Change, and University Governance

As we have been able only to hint at here, many hands are engaged in every piece of university governance, ranging from the design of campuses logos to the strategic direction for the university's long-term development. Committees of faculty, committees of administrators, and committees of both proliferate constantly. Every important decision must be reviewed and often concurred in at several levels and by bodies with different interests at stake. Such a system of governance ensures that decision-making can take a long time, that there are numerous opportunities for key actors to say "no," and that decisions, once arrived at, are often revisited soon after they are made.

The key question, then, is, how do universities manage to change?

Arguably, it is individual faculty members, acting often in concert with their peers and with sympathetic administrators, who are the principle agents of change in universities. That this should be so reflects a fundamental paradox of academic life. On the one hand, universities are the repositories of a society's knowledge of itself and of others. Faculty pass down that knowledge to new generations of students, reflecting the best of what has been learned throughout all of history. On the other hand, faculty are also engaged, with students, in processes of scholarship, research and discovery, sometimes to learn more and sometimes to improve upon what was known before. Thus, they do not simply pass on what is known; they also contribute actively to knowing more and to correcting errors in what was known previously. So, while the tasks of preserving and disseminating existing knowledge are profoundly antithetical to change, the task of discovering new knowledge is absolutely committed to making change.

The research and scholarship of the faculty and their advanced students constantly pushes at the boundaries of old disciplines and established methods. New knowledge compels reconsideration of courses and curricula. To remain relevant to modern scholarship, institutions must often renew their faculty by recruiting new faculty from other institutions who have played a role in defining new fields of endeavor.

At the same time, the world outside the university applies pressure to institutions to prepare students for life in the ever-changing future world of work and endeavor. Employers may suggest new kinds of courses that they would like university graduates to have experienced. Changing cultural norms and expectations may create demands for expansion in some areas (e.g., nursing, engineering, computer science, video game design, Chinese language and literature; and molecular biology have been growth fields in recent years) and may reduce demands in others (e.g., classical languages and literatures, Russian language training, botany and zoology, have recently experienced less demand.)

One of the most important roles played by external research funding agencies, whether they be governmental or private, is in stimulating university faculty and, ultimately, institutions themselves to change to meet new societal needs and expectations. The American system of funding most academic research through competitively awarded project grants to support specific faculty members or teams of faculty members at universities creates a very strong incentive for faculty to focus their research activities in areas in which funds are available. When new challenges arise, new grant programs are established. Inevitably, faculty members submit proposals to those new programs in hopes that their project ideas will prove attractive and win funding awards. These awards are valuable because they can support graduate and postdoctoral research associates, they can help pay for equipment and the logistics of research, and, in some cases, they can pay part of the salaries, especially summer salaries, of faculty members.[13]

For more than five decades, the principal sources of funds to support university research have been the federal government's agencies, such as NSF, NIH, NASA, DoD, and DoE. Approximately ten percent of the funds have come from private industry, which generally follows the same rules and procedures for on-campus funding as does the federal government. State governments, private foundations, and foreign companies and governments also support research at U.S. universities.

To some critical observers, the pursuit of research funds by faculty is unseemly, especially when faculty members are drawn by new programs to seek funding in areas on which they had not previously worked. On the other hand, the core methods of academic research are extremely powerful and easily exported from one domain to another.[14] Faculty members are specialists in learning new things, and it is not unusual for a faculty member to change research directions several times during a career as the funds available shift from one area of interest to another.

What we have described here briefly is a U.S. research university system in which faculty members are constantly encouraged, incentivized, and rewarded for trying new things—for

[13] Most university faculty members are paid for teaching only 9 or 10 months of the year; an artifact of the semester system of education. This creates incentives for faculty to find ways to bring money into the university that can be used in part to pay their salaries during the summer months. While there are some exceptions, generally external research funds are not paid directly to the faculty member by the funding organization. Instead, the grants are made to the researcher's employing university, which then distributes them for the use of the faculty member. Some portion of such external funds is used to help defray the "indirect" costs of the research incurred by the institution itself.

[14] The science journalist, Daniel S. Greenberg, has written satirically of the exploits of the fictional Dr. Grant Swinger, Director of the Center for the Absorption of Federal Funds at a mythical university. Dr. Grant Swinger is devoted to winning and spending as much federal money as possible in whatever field it is most generously available, regardless of his ability to use those funds effectively. See, for example, Greenberg, Daniel S., "Grant Swinger: Getting on in Hard Times," Science, 298, page 1299, 15 November 2002.

acting in entrepreneurial ways to explore new opportunities and create new "business" for themselves in the university context. As entrepreneurs, university faculty members have a great deal in common with their more widely celebrated counterparts in the business world. Entrepreneurial faculty must discover or create new ideas and new opportunities; they must prepare a proposal to a potential funding agency—a process that has a great deal in common with preparing a business plan for a potential financier or venture capitalist; they must recruit a staff of graduate and post-doctoral students to help them do the work; they must network with colleagues around the world in search of ideas, talent and resources; and, above all, they face the very real possibility of failure. In today's competitive world of externally funded research, the odds of any given proposal receiving funding are on a par with the odds that a venture capitalist or other source of funds will invest in a start-up, entrepreneurial business.

It is reasonable to ask what roles administrators play in overseeing the changes in scholarship and research activities by their faculty members. One answer to this is that administrators are generally pleased when entrepreneurial faculty members seek to start new endeavors, begin new lines of research, or pursue new sources of funding. Such activities bring practical benefits to the host institution. They have also become part of the culture—the ethos, if you will—of American higher education. Thus, administrators encourage faculty to pursue new things and even condition some aspects of job reward, including salary levels and local administrative support infrastructure, on their success. One of the key tenants of academic freedom in U.S. universities is that faculty members should be free to pursue any line of research and inquiry, as well as any line of teaching, for which they are qualified.[15] But, put another way, it is sometimes the role of administrators to say to a faculty member who comes up with a brilliant new idea for something the institution itself might do something like, "Yes, that's a good idea, but…." Administrators generally need to pay attention not only to the merits of new ideas taken one by one, but also to try to steer the institution in strategic directions that build strength and respond to societal demands in the long run. Therefore, not all changes, even good ones, that originate with faculty members can be adopted. Furthermore, administrators have responsibilities to ensure that new activities are pursued in ethical, financially responsible ways; that they contribute to the educational as well as the research mission of the university; and that they do not detract unduly from mission accomplishment or interfere with the ability and freedom of other faculty to pursue their interests.

These concepts about university governance will prove central later in this report to our discussion of how universities have engaged in economic development and in globalization and about the issues that these new directions have raised for higher education.

[15] Determining who among the faculty is qualified to teach or do research in a given area or to espouse what points of view is a delicate and complex social process that we do not address further here.

In addition to the central role played by faculty members in bringing about change in research universities, administrators also can be agents of change. Presidents, provosts, deans, department heads and other administrators are selected for their positions in part because they have demonstrated abilities not only to manage their areas of responsibility but also to be creative in coming up with new directions for the university to follow. They may see the potential of new fields of inquiry, new teaching programs or new forms of organization to attract students and to create the conditions under which external funds may be raised. To realize their visions for change, however, administrators must successfully cross one very high barrier—they have to find faculty members who are interested, qualified, and willing to carry out the new ideas that the administrators wish to put into practice.

Management of universities is generally not a top-down affair. That is, administrators generally do not have the power to assign or direct faculty members to teach new courses, develop new programs, or pursue new lines of research or other support. Instead, they have two options. Their first option is to create incentives that will make it worthwhile for some number of faculty members to enter the proposed new endeavor. Administrators, for example, might excuse faculty members from teaching a regular course if they will use the time to develop the new endeavor. Or, they might offer extra summer pay to faculty willing to do so.

The second option is for the administration to hire new faculty members who are interested in and willing to work on the new endeavor. This is a difficult option to implement. It is difficult because the existing faculty usually has a say in who is hired onto the faculty. Another difficulty is that faculty hired by the administration directly may face resentments from the existing faculty that can make it challenging for the new faculty members to succeed. One key to a successful "new hire" strategy is for the administration to raise a new source of external funds that enable them to pay for new faculty without cutting into the budget that supports the existing faculty.[16]

It would not be going too far to observe, in closing this section on sources of change, that "leadership toward change" has come to be one of the key characteristics that universities look for when they set out to recruit and hire a new senior administrator at the level of dean or higher. In fact, the phrase, "entrepreneurial leadership ability," is often a central part of the job descriptions of today's research university presidents.

[16] Over the past few decades, a number of university administrations have used the "new hire" strategy to build new programs and to raise their status among the nation's institutions. This strategy has been followed successfully and prominently, for example, by the University of Texas at Austin, by the University of California at San Diego and other state universities in California, by George Mason University, and by Arizona State University.

3. THE ROLE OF U.S. UNIVERSITIES IN ECONOMIC DEVELOPMENT

Introduction

Universities in the U.S. are exhibiting an ever-increasing focus on their role as engines of economic development, at the local, regional and national levels. In doing so, they are allying themselves with new partners – both private companies and public agencies – and they are undertaking dramatically new activities – from real estate development to venture capital investments. While such activities do indeed move the university far beyond traditional teaching and research, it is important to recognize that, in historical terms, a focus on economic development is far from unprecedented. Indeed, both the diverse missions that U.S. universities have assumed over time, and their flexible governance structure, have created the preconditions for today's economic development role to an extent greater than is generally recognized.

As is true for nearly all of their activities, the university role in economic development has evolved and grown more complex over time. In this chapter, we discuss the historical antecedents of the present-day university role in economic development. We also review some of the ways in which that role has evolved and focus on what may be the most significant stage in that evolution to date; namely, the emergence of universities as full strategic partners in the process of "open innovation." This evolution has not happened in a vacuum, and we discuss some of the elements of public policy that have operated as incentives to greater university engagement in economic development.

Historical Antecedents for an Economic Development Role

As indicated in the second chapter of this report, throughout the history of U.S. universities, a few critical turning points can be identified when universities moved to embrace important elements of an economic development role. One of the most important changes occurred in the mid-19th century, when a program of land grants to universities from the government was coupled with the development of agricultural "extension" services. The purpose of these activities in universities – sponsored both by the Federal and state governments – was to diffuse productivity-improving technology throughout the principal industry of the day: agriculture. The technology-intensive character of American agriculture even today draws heavily on these historical roots. Certainly, the extension service model of

the 19th century put U.S. universities securely in the mode of reaching out to non-academic constituencies and of tailoring programs to suit their needs. This program – and this orientation – continues today.

The mid-19th century also saw the establishment of a new type of school of higher education that focused on teaching a variety of technical disciplines of practical economic use, as well as doing research that would be important to economic development. Many of these schools were originally called "polytechnics." Many now characterize themselves as "technical universities," but they usually retain a more practical than scholarly orientation, at least when compared to the traditional universities, whose organization is based around academic fields of study. Most polytechnics are highly conscious of the need to educate students to be employable in business and industry, and they often advertise their degrees as having high economic value, rather than a more intellectual orientation. Involvement of the faculty of polytechnics in industrially oriented research has long been common.[17] Prominent private institutions of this type include MIT, Rensselaer Polytechnic Institute, Carnegie Mellon University (formerly Carnegie Institute of Technology), Stevens Institute of Technology, and Illinois Institute of Technology. There are also some excellent public institutes of technology, including Virginia Polytechnic and State University, Georgia Institute of Technology, and Texas Technological University.

Another important aspect of the relationship of U.S. universities is their early development and embrace of university-level studies and research in engineering during the final third of the 19th century. In addition to lying at the core of the polytechnics, engineering was quickly taken up and integrated into the curricula of a number of the land grant colleges and universities, several of which rose to prominence in engineering at an early date, including the Universities of California, Illinois, Michigan, Minnesota, and Wisconsin. Engineering also

[17] One of the best known of the early polytechnics is Massachusetts Institute of Technology (MIT), which was founded in Boston in 1861 under the direction of William Barton Rodgers. MIT moved to Cambridge, Massachusetts, in 1916. There, under the rotunda of the main building, is inscribed MIT's enduring mission: "Established for advancement and development of science, its application to industry, the arts, agriculture, and commerce." Note that this mission is in sharp contrast to the stated purpose of Harvard College, the original undergraduate institution at Harvard, MIT's neighbor. Harvard's purpose is unchanged since its charter of 1650: "The advancement of all good literature, arts, and sciences; the advancement and education of youth in all manner of good literature, arts, and sciences; and all other necessary provisions that may conduce to the education of the ... youth of this country...." http://www.harvard.edu/siteguide/faqs/faq110.php Harvard sees itself as educating the "youth of this country," whereas MIT is devoted to advancing, developing and applying science to industry. Arguably, this puts education first and research second at Harvard, and the reverse at MIT, although MIT's original plan made it clear that education was to be an important part of the Institute's work. See Objects and Plan of an Institute of Technology…Proposed to be Established in Boston, 1861. On line at: http://libraries.mit.edu/archives/mithistory/pdf/objects-plan.pdf

found a home in a number of leading private universities such as Stanford, Washington University in St. Louis, Northwestern, and Vanderbilt.

Toward the end of the 19th century, U.S. universities pioneered the development of schools of business—the Wharton School at the University of Pennsylvania being the first, in 1881. The idea of training business leaders with systematic academic study quickly gained popularity in the U.S., and remains so to the present. Indeed the "American business school paradigm"—that is, a graduate degree of two years' study, focused not on scholarship but on management responsibility in the private sector—is a unique feature of the U.S. educational system. This business school tradition does much to orient U.S. universities more toward economic development issues than is the case in most other countries. Among business school faculties, consulting to industry on matters of strategy is commonplace, and the research most faculty undertake is focused on understanding business phenomena rather than on doing abstract scholarship.

Another important historical precedent for engagement of universities with business and industry is the early practice of faculty members seeking ways to profit from their discoveries. For example, Benjamin Silliman, the first professor of chemistry at Yale and one of the most prominent American scientists of the early 19th century, was one of the first, if not the first, persons to commercialize carbonated water beverages in the United States. Charles F. Burgess, who founded the department of chemical engineering at the University of Wisconsin in 1905, also operated a consulting business on the side and became one of the principals in a foundering manufacturer of batteries. He later founded the Burgess Battery Corporation. Arthur D. Little, who founded in 1909 the consulting and research company that bears his name, also served as a professor of chemistry at MIT. He was involved in starting several chemistry-related businesses.

At the University of Wisconsin, Professor Harry Steenbock discovered a method of artificially enhancing the Vitamin D content of milk via ultraviolet irradiation. This discovery led to the elimination of rickets as a childhood disease. Steenbock patented his method, but, rather than profit personally from licensing it to a corporation, he turned the patent over to the University for licensing. In 1925, the University formed a separate organization, the Wisconsin Alumni Research Fund (WARF) to commercialize Steenbock's patent. WARF became in essence the first technology transfer office at an American university. It has since returned many millions of dollars in licensing revenues to the university. WARF's experience was significant in helping Congress formulate the Bayh-Dole Act of 1980s, discussed below.

U.S. universities have long been hosts to research consortia sponsored by multiple companies, typically formed around a single industry. Today, these sorts of consortia are commonplace. Early examples of such consortia included the Institute of Paper Science and

Technology, formed as an independent research and education organization serving the paper industry in 1929, and associated with Georgia Institute of Technology since 1989; and the Institute of Gas Technology, formed at Illinois Institute of Technology in 1941. Lessons learned at consortia like these played an important role in the rapid growth of such consortia in the United States during the 1980s.

How Universities Contribute to Economic Development Today

Universities contribute to economic development today via a plethora of routes and mechanisms. Here we identify those that are in our judgment the most important, and, where it might be useful, we provide specific examples of those routes and mechanisms.

Contributions of Alumni to the Productivity of the Region

The principal contribution of universities to economic development, but also the most elusive, is that their alumni are better prepared to engage in productive economic activity than they would have been without the benefit of an advanced education. University leaders often point to this effect as the largest of all the kinds of economic benefits of an educational institution. It is well known that, on average, college graduates earn substantially higher life-time incomes, pay more taxes, and start more companies that employ more people than do non-graduates. Owing to the absence of appropriate counterfactual situations, however, it can be quite difficult to quantify this effect in analytical terms. By casual observation, at national level there is a clear correlation between the general level of education and the dynamism and growth of the national economy.

Immediately Associated Economic Activity

Universities are large institutions, often enrolling tens of thousands of students and employing thousands of faculty and administrators, as well as thousands more people in support positions. Their operating budgets can account for several billion dollars in annual economic activity, and their capital improvements may employ hundreds more in construction projects. They are often major owners of real estate and other properties and may have quite substantial investment portfolios based on their endowments. For example, according to a recent study, the fourteen major universities in the Washington, D.C., metropolitan area contributed $11.2 billion to the Gross Regional Product (GRP) of the region, which was equivalent to 2.8 percent of the area's GRP.[18] They enrolled some 155,000 students and

[18] Stephen S. Fuller, "The Impact of the Consortium of Universities of the Washington Metropolitan Area on the Economies of the Washington Metropolitan Area and District of Columbia," Research Summary report for the Consortium of Universities of the Washington Metropolitan Area, Center for Regional Analysis, George Mason University, May 2011, 10 pages. http://policy-cra.gmu.edu/studies_presentations/Economic%20Impacts%20of%20Washington%20Consortium%20Universities.pdf

directly employed more than 68,000 full- and part-time workers. They invested some $575 million in construction outlays during the year. This estimate of impacts does not include the important, but difficult-to-measure economic effects of the universities such as the enhanced regional productivity of a highly trained work force or industrial impacts of spin offs from the universities' research programs.

Entrepreneurial Effects of the University on the Region and the World

Taking a different approach to the impact of a university on its region and the world, Roberts and Eesley recently reported on a new study of the entrepreneurial impact of MIT.[19] Based on a survey of all living MIT alumni, as well as on other established business data sources, Roberts and Eesley estimated that MIT alumni have established some 25,800 active companies that employ about 3.3 million people and generate annual world-wide sales of $2 trillion. Their report breaks down these impacts by states and countries and provides background on their methodology. MIT is well-recognized to be unusually successful in producing graduates who go on to start companies; nevertheless, this is an astoundingly large impact of a single institution's graduates on the world.

Direct Outreach to the Private Sector

As discussed earlier, many universities provide various forms of technical, business, educational and advisory services to the private sector. The land-grant universities typically understand these kinds of services to be a central part of their charters as public institutions. However, in the past few decades many other universities have become engaged in this manner. Much of this direct outreach is funded by special federal and state government programs or by fees charged to the participating firms.

The Mason Enterprise Center at George Mason University offers an interesting example of this kind of activity. Quoting from the Center's own description:

> *Specializing in the areas of small business services, government contracting, international business, entrepreneurship, technology ventures, and telework initiatives, the Center offers a unique combination of programs, services, and resources.*
>
> *Through a broad array of activities that include business counseling, seminars, publications, sponsored research programs, and information services, the Center*

[19] Edward B. Roberts and Charles Eesley, "Entrepreneurial Impact: The Role of MIT," Executive Summary report, February 2009, 10 pages. http://entrepreneurship.mit.edu/sites/default/files/files/ExecSummary_Entrepreneurial_Impact_The_Role_of_MIT.pdf

strengthens the decision-making and operations of businesses, governments, and other institutions throughout the Greater Washington region.[20]

Technology Transfer: Licensing Deals and University-Based Start-ups

Since the passage of the Bayh-Dole Act in 1980, universities have become major players in the world of patenting the inventions made by their faculty and employed students. The Association of University Technology Managers (AUTM) annually surveys its member academic institutions regarding their technology transfer activities. According to the 2009 AUTM survey, its member institutions introduced 658 new commercial products, entered into 5,328 licensing and option deals, and were involved in formation of 596 new companies.[21] Over the past decade, U.S. academic institutions, primarily research universities, have been awarded about three thousand U.S. patents annually, which accounts for approximately four percent of all U.S. patents awarded to U.S. owners.[22]

There is a very recent cloud on the horizon of university technology transfer under the Bayh-Dole Act. On June 6, 2011, the United States Supreme Court issued its opinion in a case in which Stanford University had sued Roche, a pharmaceutical company, over a highly technical matter involved in ownership and assignment of intellectual property rights developed by a Stanford professor who was a consultant to a firm that Roche later bought.[23] The effect of the Supreme Court decision may be to call into question the validity of a wide range of university policies governing the duty of faculty inventors to assign title to their inventions made with federal funds to their employing university. The decision may undercut the functioning of university technology transfer as it has evolved and matured since 1980. On the other hand, much remains unclear about the full impact and reach of the Court's decision. Later on the day of the decision, a number of leading organizations issued a joint statement expressing concern about the Court's decision.[24]

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[20] http://www.masonenterprisecenter.org/

[21] AUTM U.S. Licensing Activity Survey Summary: FY2009. On line at: http://www.autm.net/AM/Template.cfm?Section=Licensing_Surveys_AUTM&CONTENTID=5879&TEMPLATE=/CM/ContentDisplay.cfm

[22] U.S. National Science Foundation, Science and Engineering Indicators-2010, Appendix Table 5-45. On line at: http://www.nsf.gov/statistics/seind10/append/c5/at05-45.pdf

[23] The Court's decision and a brief "syllabus" (summary) prepared by Court staff for the public in the case can be read at http://www.supremecourt.gov/opinions/10pdf/09-1159.pdf

[24] Joint Statement of BIO, AAU, ACE, APLU, AUTM and COGR on the Supreme Court Decision in *Stanford v. Roche, June 11, 2011.* http://www.autm.net/AM/Template.cfm?Section=Documents&Template=/CM/ContentDisplay.cfm&ContentID=5902

Other University Contributions to Economic Development

Universities make many other kinds of contributions to economic development. Some host incubators for start-up companies. Some host regular conversations between inventors or new small firms and potential investors such as angel investors or venture capitalists. Some universities with large investment portfolios have been able to invest in their own venture funds or to set up funding mechanisms to help faculty inventors move an idea from the conceptual laboratory stage to a full-fledged invention ready for commercialization. At the educational level, many universities have recently instituted formal entrepreneurship studies; some to analyze entrepreneurship and others to teach and mentor it among students. Some universities participate actively in local or regional economic development activities and stand ready to offer specialized courses, for example, if potential new firms in the region need workers with special skills.

A Stronger Role for Universities in Providing the Seeds for Future Growth

Industry in the United States has long looked to universities for production of highly trained researchers and for generation of new basic understanding that can help companies improve on the products they already make and processes they already use and that can be the foundation for new innovative products and processes. These private-sector expectations of universities continue.

An important addition to these expectations in recent years is that universities will be the well-spring of new product and process ideas and concepts that industry can mature and take directly to market. What is new here is not that the phenomenon exists but rather its scale and the depth of the expectation.

What accounts for this change? One factor is the desire of universities for new sources of funding as well as the additional political support that comes when they are seen as contributing to the economy. But changes in industry are also important. In particular, this new attitude toward university contributions is part of a larger trend in industry toward what Henry Chesbrough calls "open innovation."[25] Under open innovation, firms seek ideas and options for new technologies not only through their own internal activities but also from the wider world around them of competitors, other firms, universities, government laboratories, independent inventors, and anyone else with a good and useful idea. Within the open innovation model, firms shift from being highly internally focused and often very secretive about technological directions toward sharing their needs and opportunities with customers, suppliers, competitors and the greater world.

[25] Henry W. Chesbrough, Open Innovation: The New Imperative for Creating and Profiting from Technology, Harvard Business School Press, 2003.

The embrace of open innovation in much of American industry has had a number of interesting effects. One is that many firms have exited the business of doing fundamental research and are now depending entirely on external sources for such knowledge. Open innovation has stimulated the market for acquisitions of start-up firms by established firms; for the former it is key to an exit strategy—for the latter it is key to sourcing new technologies.

Another effect of the open innovation movement is that many firms have become quite attentive to university technology transfer opportunities. Evidence for this can be found, for example, in the joint statement of the Biotechnology Industry Association with five leading higher education groups issued on June 6 in response to the Supreme Court decision in *Stanford v. Roche* discussed above. Companies have come to depend on the basic research done at universities to supply the new ideas and understanding for their future innovations, especially in biotechnology, pharmaceuticals, and medical devices, but also in chemicals, new materials, electronics and other areas. Evidence for this intense interest in academic research on the part of some companies can be seen in the decision of the Swiss firm, Novartis, to move its core research activities to a building adjacent to the MIT campus, and Novartis' earlier agreement with the University of California at Berkeley, discussed in this report's later chapter on tensions among university roles. The international energy company, BP, has made a very large investment in supporting research on clean energy at a consortium consisting of the University of California at Berkeley, Lawrence Berkeley National Laboratory, and the University of Illinois. More modest, but still significant investments in university research of direct interest to industry, have been made at the NSF-sponsored Engineering Research Centers (ERCs) since the program began twenty-five years ago. As noted in a study by Jonathan Tucker, firms have been willing to make very significant investments in ERCs when their research agendas are focused on technological problems of immediate importance to the companies' main lines of business.[26]

Given the increasing pressure on corporate performance owing to world-wide competition, as well as the dependence of many companies and industries on academic research performance, we can only expect that strategic alliances of many degrees of involvement will continue to be a prominent feature of the 21st century American research university.

Public Policy's Impact on the University Economic Development Role

Public policies at both the federal and state levels have focused for the past three decades on encouraging closer linkages between universities and industry. We noted earlier, of

[26] Jonathan C. Tucker, An Analysis of Industry Support for the NSF's Engineering Research Centers, PhD Dissertation, School of Public Policy, George Mason University, May 2003. (This research was done under the direction of Prof. Christopher T. Hill, a co-author of the present report.)

course, that such linkages were already in place owing to policies adopted in the mid-19th century, such as the land-grant university system and the agricultural extension model. However, the explosive growth of federal government support for academic research during and after World War II had the effect of "crowding out" university interest in industry problems and funding. The simple fact was that federal funds tended to come in greater amounts, with less application effort, with less oversight, and with fewer specific expectations of usable results than did private funding. It is not surprising that faculty and universities turned away from industry except as a place in which their students might work after graduation and as a source of occasion lucrative personal consulting opportunities. Adding to the sense of a gap between industry and universities—in fact, to a sense of an estrangement between the two sectors—was the sharp split that occurred on many university campuses when students and many faculty engaged in heated protests against U.S. involvement in the war in Vietnam, from 1964 through about 1975. These protests often took the form of direct challenges to the legitimacy of industry presence on campus, even extending to near-violent student demonstrations protesting the recruiting activities of firms engaged in defense work during that time.

The U.S. "competitiveness crisis" of the 1980s, which actually began to emerge in the late 1970s, caused a resurgence of interest in building new and stronger ties between academia and industry. Certain prominent industrial leaders such as William Norris, Chairman of Control Data Corporation, an important producer of supercomputers, and Erich Bloch, who had headed the 360 mainframe computer project at IBM, pointed out the virtues of collaborative research in helping industry overcome its challenges from Japan and Germany, and universities were quickly seen as an important element in building such consortia. Norris was instrumental in establishment in 1982 of the Microelectronics and Computer Technology Corporation (MCC), whose members were leading firms in the computing industry.[27] Bloch was a leader in setting up the Semiconductor Research Corporation, also in 1982, through which a consortium of companies funded research on computing and information technology at universities.[28]

It was quite significant, then, when Erich Bloch was appointed as Director of the National Science Foundation (NSF) by President Reagan in 1984. Bloch was not an academic; in fact, he did not even hold an earned doctorate, yet he was appointed director of the flagship U.S. government agency principally concerned with funding basic research in academia in a broad range of fields. He lost no time in putting his stamp on the agency, and by 1986 he had established, with the advice of the National Academy of Engineering and the oversight of Congress, a program of Engineering Research Centers in which NSF would provide generous long-term funding to universities to do research on topics of interest to industry. In order to

[27] MCC was founded in 1982 and ended its work in 2000. See: http://en.wikipedia.org/wiki/Microelectronics_and_Computer_Technology_Corporation

[28] Current activities of SRC are described at http://www.src.org/

qualify to receive NSF funding, the university applicant had to demonstrate that it had attracted substantial financial and in-kind support from industrial firms. This program, which continues today, has supported more than forty ERCs.

Success with the ERC program led other agencies to set up similar arrangements, including NASA, the Department of Energy and the Department of Defense. NSF also supports the Industry-University Cooperative Research Centers Program on less generous but more demanding terms than the ERCs.[29] Today, it is safe to say that programs and centers that feature both cooperation between universities and industry and industrial financial support are a ubiquitous feature of the U.S. research university system.

The individual states have also made extensive use of incentives for industry cooperation with universities in research. States, which are usually more likely to support industry directly than is the federal government, have often made funds available to firms for research and technology commercialization on the proviso that the funds actually be spent in the state's universities. Other state programs have funded universities directly but require that the projects have support from local business and industry as well. State funds for individual programs and awards are typically smaller than the ones available from the federal government, but they are also more likely to be provided with some certainty to leading researchers and companies in the state. On the other hand, the state programs tend to have relatively short lives (often ending when a new state governor is elected or when the state faces a financial crunch). The State Science and Technology Institute is an excellent source of up-to-date information on individual state programs.[30]

In short, both federal agencies and state governments in the United States are active in funding and otherwise promoting university-industry cooperation for the purpose of helping industry and the overall economy.

More than program financing has been involved in incentivizing industry-university research cooperation. The National Cooperative Research Act of 1984 passed by Congress provides certain procedural protections against potential challenges to cooperative research under the U.S. antitrust laws, for example. The Small Business Innovation Research Act and its related Small Business Innovation Research Program (SBIR) has been an important mechanism for providing seed funding to help small businesses bring innovations to market. SBIR is often used by university faculty as the first step in financing a new company based on their research.

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[29] A companion program at NSF for Science and Technology Centers was created after the scientific community reacted negatively against the ERC program, but it has never had the same expectation of industry participation as has the ERC program.

[30] See: http://www.ssti.org/

University Governance and the Economic Development Role

The structures and mechanisms of university shared governance discussed earlier have by-and-large been able to accommodate the growth in the economic development role of the university. Here we discuss briefly how university governance has influenced and been influenced by engagement in economic development. We look at governance as both an enabler and an inhibitor of a more active engagement.

Governance as an Enabler of an Economic Development Role

The primary role of the faculty in making change in the university has worked to the advantage of the proponents of a stronger role in economic development. Essentially, each faculty member is free, within very broad bounds, to select the topics of his or her research and other academic activities and to seek financial support for that research from sources of his or her choice. This has meant that faculty have been free to respond to the incentives coming from industry or government to become more closely tied to industry. So long as other faculty obligations are met, including teaching, and so long as university policies are complied with, there are few barriers to closer ties. And, as noted above, there is often strong administration support for building such ties.

At the same time, administrations who would like to see their institutions more closely committed to economic development activities can be frustrated if the faculty do not display real interest in moving in that direction. Generally, administrators do not "assign" faculty to their tasks; instead, the work of the faculty is heavily inner-directed and cooperative with peers, and faculty do not take well to be being told that they must take responsibility for new roles.

Another factor that has enabled the growth of university engagement in economic development is the well-established system of externally-funded research and other projects via so-called "sponsored programs." Most if not all research universities have well established policies, procedures and staffs for the administration and financial management of externally funded projects. Projects supported by industry go through the same system as projects funded by government (with few exceptions). Junior faculty have just as much flexibility as do established ones to pursue new opportunities in such areas as economic development.[31]

[31] A note of caution must be entered here. Junior faculty are those who have not yet been awarded tenure or promoted to advanced rank. Because the promotion and tenure decisions in U.S. universities are largely made by senior faculty peers, junior faculty have to be sure that their work will be judged meritorious by their senior colleagues. The primary criteria for promotion and tenure are demonstrating high quality in teaching and research. Activities that detract from those outcomes may not be viewed favorably by senior faculty who are committed to traditional views of the roles of the university.

Governance as an Inhibitor of an Economic Development Role

Economic development and cooperation with industry do not always fit smoothly into traditional conceptions of the role of the university. In some cases, this results in outright opposition to such engagement by some faculty members. In most cases, institutions have had to review and revise various operating policies so that they do not unduly inhibit economic development work.

In addition to the traditional university roles of teaching and research, there is a tradition of the university as an institution whose members have a responsibility to be informed about, and critical of, the established order in society. Faculty are encouraged, under this tradition, not just to teach what is known and to engage in the unfettered search for new knowledge. In addition, they are encouraged to study and to speak out on controversial matters of public importance. It is no accident, for example, that U.S. universities have occasionally been hot beds of protest and complaint, whether it is about the War in Vietnam, the invasion of Iraq, the environmental movement, support for civil rights actions, protection of rights of privacy in the Internet age, and so on. Certainly some of that critique has gone to the heart of the capitalist system that undergirds the U.S. economy. If not that far, many in academia have found fault with a myriad specific actions taken by private companies in the pursuit of profit. Those on the faculty who are committed to the strongly critical role of the university tend to rise in opposition to any engagement of the institution with established interests, especially private industry. Taking government funds, too, can be viewed with suspicion as compromising of the faculty's freedom to speak out when they believe government is off track.

One way institutions have sought to address the problems of overly-close ties to industry has been to focus on financial conflicts of interest that can arise when faculty take money from industry that may appear to have the potential to influence the research that they do, their publications and even their teaching. Institutions now have policies, reinforced by expectations from the federal funding agencies and from the professional associations, that either prohibit certain forms of financial conflict or require them to be managed in open and transparent ways. It should be noted, however, that managing or prohibiting financial conflicts of interest is not the same as ensuring the ability and credibility of the institution as a societal critic. It is a tribute to the integrity of the system of research universities and their faculties that more internal conflicts on these matters do not arise routinely.

One of the leading values held by universities and their faculties is the primacy of scholarly publication as the vehicle through which the results of research and scholarship are transmitted to others. For this reason, most institutions require that all research that is done

lead to publishable and published results.[32] And, most institutions refuse to accept external grants and contracts for projects if they come with expectations that publications will be limited or controlled by the funding agent or company. Typically, institutions will agree to allow sponsors to review draft publications for a limited period of time (30 to 90 days is typical) but only to ensure that intellectual property revealed in the publication has been adequately protected. For some potential sponsors, this requirement can be a roadblock to providing funding for a research project that is expected to have high economic value.

Generally, institutions have been able to accommodate the demands imposed on governance by engagement in economic development, but there have been costs to doing so. Administrative staffs responsible for project administration have grown in size and cost. Internal debates about the wisdom or propriety of certain projects have sometimes been bitter and costly. Yet, on the whole universities have embraced the new role of active engagement in economic development.

[32] University policies requiring open publication of research results when private funds are involved are reinforced by Federal policy that removes the "basic research exemption" from the U.S. export control laws if the research is supported by private funds and its results are considered proprietary. This can be more than a minor issue for universities, since the export control laws can affect the participation of students from certain other countries in university research. See: Robert Hardy, "Presentation on Deemed Export Controls," Council on Governmental Relations, November 10, 2004. On line at: http://cogr.edu/viewDoc.cfm?DocID=151610

4. GLOBALIZATION OF THE RESEARCH UNIVERSITY

Research universities, along with much of the rest of higher education in the United States, have become global institutions, serving not only the regions in which they are housed but much of the world as well. In this chapter, we discuss the on-going process of globalization, with specific focus on globalization of the research function. Within that frame of reference, we discuss the role of foreign business and industry in supporting research in U.S. universities, and we close this chapter with a particular focus on how U.S. research universities market themselves to overseas private interests.

The Emergence of the Global University

Globalization of the U.S. research university has many aspects, including, but not limited to, recruitment of foreign nationals as students, researchers and faculty; dispatching domestic students to other countries for "study abroad" programs; engaging in collaborative research with researchers at institutions abroad; incorporation of studies of foreign cultures and languages into the curriculum; engagement of faculty in international consulting, including for foreign governments; setting up research and policy centers devoted to studies and research on key international issues; and setting up subsidiary campuses in other countries. One of the more interesting recent developments is the emergence of partnerships between U.S. and overseas universities to offer joint or dual degrees, in which, for example, a student might study in a U.S. university for two years and then move to a foreign institution for two more (or vice versa) and then receive a degree awarded jointly by the two institutions.

More important than any one such activity is that a university has become "globalized" when it begins to conceive of itself as an institution serving the needs, not only of its host state or country, but of the entire world or major parts of it as well.

From a policy perspective, the globalized university can be a major positive force. For example, academic institutions and their faculties have played important roles in U.S. foreign policy for years. One way this has happened is that U.S. faculty members may be able to engage in fruitful collaboration and dialogue with counterparts in other nations with which official exchanges may be difficult or impossible.[33] Academic institutions also are a ready

[33] Even in the darkest days of the Cold War between America and its allies and the Soviet Union and its allies, some U.S. faculty members were encouraged to seek ways to do joint research projects with their counterparts behind

source of experts who can advise governments (or industry) or even accept appointments to high positions in the federal government where their special knowledge and skills may be uniquely useful.

International engagement by universities and their faculties is not new. Following traditions established in academia in Europe, American scholars traveled to Europe well before the 20th century to study for specialized or advanced degrees or to do research with leading European faculty members. The same thing happened with Asian institutions, although because of language and cultural barriers, such travel was less common there. As the United States took on its new role after World War II as the leading superpower in the West, there was an urgent need for people who were deeply knowledgeable about other countries and regions and who could speak the local languages well. This led to the founding of so-called "area studies" programs at many universities, devoted, for example, to the Middle East, Latin America, or south Asia.

American scholars have also long been engaged in studies in and of other countries, both of their contemporary cultures and of their histories. Some kinds of research can only be done in other countries because that is where the research materials are located. Some projects are so large that only international teams can take them on, and some objects of study do not respect national boundaries at all and require international cooperation and collaboration for effective study. Both global air pollution and ocean fisheries studies fit this latter category.

In addition, of course, American universities have recruited large numbers of international students and faculty. For example, in 2007 foreign students received 24 percent of all American science and engineering master's degrees and 33 percent of all science and engineering doctoral degrees granted that year.[34] Many of these international students come from China and India, two countries that are now economic competitors as well as economic partners. As recently as 2003, large numbers of foreign American-trained Ph.D. recipients stayed in the United States, in part because U.S. immigration law allowed it and in part because of economic and academic opportunities. More recently, though, a smaller percentage of these students are staying in America, perhaps reflecting new opportunities in their home countries.[35]

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the Iron Curtain. This was a way not only to remain abreast of Soviet advances in key areas of research but also to build personal linkages through which messages might be sent or received from parties in the U.S.S.R. More recently, science exchanges between certain American academic scholars and those in Libya were encouraged for much the same reasons.

[34] National Science Board, *Science and Engineering Indicators* – 2010, page 2-5.

[35] National Science Board, *Science and Engineering Indicators* – 2010, page 2-5. Here are relevant statistics, from the same page of *Indicators – 2010*: "More than 90% of 2004-2007 U.S. S&E [science and engineering] doctorate recipients from China and 89% of those from India reported plans to stay in the United States, and 59% and 62%,

Globalization of Academic Research

A more recent development of special interest to this report is the rapid growth of research collaborations between overseas entities and U.S. universities and their faculties. This growth is not unique to the United States, but can be seen among many countries of the world.[36] Figure 1 from Science and Engineering Indicators-2010 illustrates this growth as reflected in the proportions of all research publications from various countries that are internationally co-authored. These collaborations are highly diverse. They range from a very small project carried out by a U.S. professor and a graduate student temporarily in the United States for doctoral studies, to large-scale multinational collaborations epitomized by the hundreds of investigators who work together at CERN, the European Organization for Nuclear Research.

The nature and incentives for such collaboration are well known and have been commented on extensively, including in the previous section. Our interest here is in how such collaborations in the United States are financed, and especially in the role of non-U.S. firms in supporting research in U.S. universities.

Financing International Research Collaboration in U.S. Universities

Because most research in the sciences and engineering in U.S. universities is supported on the project grant and contract system discussed above, faculty members who wish to cooperate with overseas partners typically must raise external funding to do so. The total amount of money that is available in any year for the explicit purpose of supporting international cooperative projects is relatively small. On the other hand, the amount of international cooperation is large and is growing rapidly. What seems to be happening is that more and more academic researchers are finding ways to use funds provided for domestic projects to incorporate informal contributions from counterparts in other countries.[37]

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respectively, reported accepting firm offers of employment or postdoctoral research in the United States. Between 2000-03 and 2004-07, the percentage reporting definite plans to stay in the United States decreased among U.S. S&E doctorate recipients from all of the top five countries/economies of origin (China, India, South Korea, Taiwan, and Canada). However, for all but Taiwan, increases in the number of doctorate recipients more than offset declines in the percentages staying."

[36] See: Wagner, Caroline S., The New Invisible College: Science for Development, Brookings Institution Press, 2008. Using bibliometric methods, Wagner documents the increasing importance of international networks of co-authorship in science among both developed and developing nations.

[37] This is something of a conjecture, as the apparent contradiction between limited funding and growth in cooperation has yet to be adequately explained by science policy researchers.

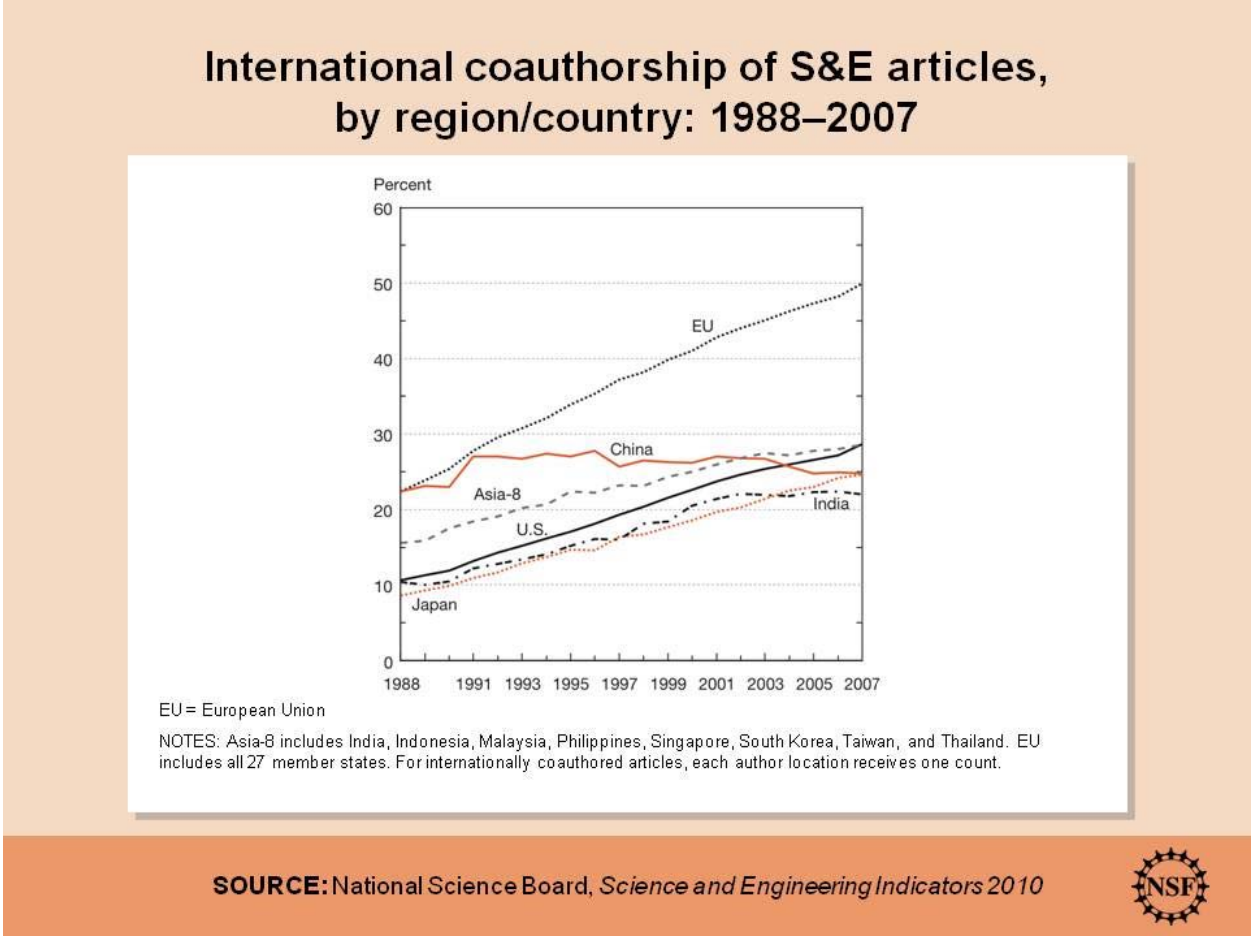

Figure 1

In a recent report to NEDO,TPI investigated the policies and practices of various countries with regard to whether their R&D funding programs would support investigators from other countries.[38] While we found and reported on diverse practices in the U.S., U.K., E.U., Finland and other countries (or associations of countries as in the E.U. case), the general thrust was that countries tend, not surprisingly, to focus their resources on their own institutions and researchers. At the same time, some programs in some countries welcome foreign researchers who offer the highest quality projects for funding. For example, the E.U. Framework 7 Program supports hundreds of cooperating researchers from other countries, including some several hundred from the United States. The U.S. Defense Advanced Research Projects Agency, DARPA, funds foreign investigators if they offer the strongest possibility of making key advances of interest to the agency, as does TEKES in Finland under certain conditions. As a general rule, but not always, countries are more likely to welcome proposals from researchers from other

[38] Heaton, George R., Jr., Christopher T. Hill, Patrick Windham and David W. Cheney, "National Preferences in Publicly-Supported R&D Programs," report to NEDO by Technology Policy International, March 2010.

countries into their applied research and development programs than into their programs that support basic and academic research.[39]

Foreign Company Support of Research in U.S. Universities

For several decades, private companies have provided around 6 percent of the external funding in support of research at U.S. universities, as shown in Figure 2. For 2009, NSF reports that academic institutions spent approximately $3.2 billion in industry-originated funds on R&D.[40] Most of these funds flow into the natural sciences, engineering and biomedical fields, reflecting the potential of research in those fields to have relatively direct application to industrial needs and opportunities. Industry funds are provided in the form of both grants for general support of research in a field and contracts in support of research of more direct interest to the sponsor. With few exceptions, universities require that industry supported projects be conducted in an open manner like that for publicly supported projects. Publication limitations are not accepted and results must be publishable.[41] Intellectual property licensing agreements typically give some sort of preferential treatment to the sponsoring company, such as the "right of first refusal" to enter into an exclusive license to exploit any inventions resulting from the research, but the university also usually requires that it retain title to any resulting inventions. Universities typically impose the same indirect costs on industrial funding that are applied to government research grants and contracts.[42]

In keeping with the increased globalization of business and industry, as well as of academia, U.S. universities have increasingly sought and obtained financial support for research from overseas businesses.[43] Unfortunately, in its collection of data on academic R&D expenditures in the United States, NSF does not ask institutions to break down the source of

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[39] Ibid.

[40] U.S. National Science Foundation, "Universities Report $55 Billion in Science and Engineering R&D Spending for FY 2009; Redesigned Survey to Launch in 2010," Table 1, NSF 10-329, September 2010. http://www.nsf.gov/statistics/infbrief/nsf10329/.

[41] Universities may agree to allow for a publication delay of 30 to 90 days to allow an industrial sponsor to review proposed publications, usually only to ensure that any potential intellectual property has been properly protected prior to publication.

[42] The requirements and conditions discussed here apply to circumstances in which a company makes a grant or enters into a research contract with a university. It should be noted that there are cases in which a private, non-profit charitable foundation associated with a company gives a grant to a university in support of research. These sorts of grants typically do not incorporate intellectual property agreements and usually do not include any contribution to meeting indirect costs of the research. The trend over the past few decades has been for companies to shift their support of research from foundation grants to direct company grants and contracts, reflecting the fact that companies are now more interested in "paying for" research of direct interest to their business performance than in fulfilling any charitable obligation they might feel themselves under. Their charitable giving today is more likely to be in support of the education role of universities or to take the form of scholarship assistance to needy students than to be in support of research.

[43] It is important to recognize that determining the "home country" of a global company is an increasingly ambiguous matter.

industrial R&D support between domestic and foreign companies, so we do not have access to a current or continuing data series on this aspect of academic R&D support.[44]

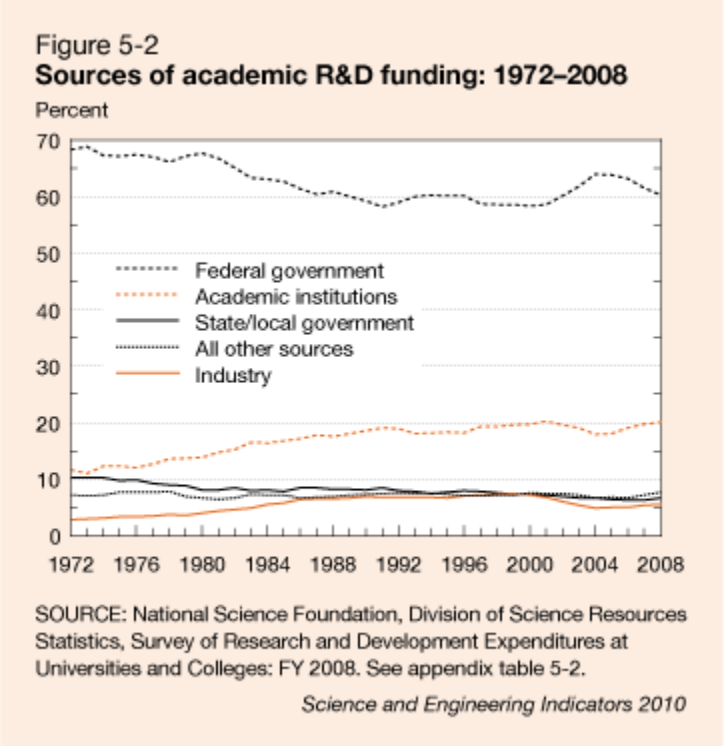

Figure 2

The most recent systematic survey of foreign company support of research in U.S. universities was done by the U.S. General Accounting Office (now the Government Accountability Office) in 1988.[45] In 1996, the National Academy of Engineering did a study of foreign participation in U.S. R&D that included a limited survey of leading universities regarding their support by foreign companies.[46]

The GAO study found that foreign firms supported about one-third of one percent of U.S. academic R&D in 1986. In 1996, ten years later, the NAE report estimated that there had

[44] In its 2010 survey of R&D expenditures by institutions of higher education, NSF has asked for the first time that institutions report the fraction of their total R&D expenditures that is supported by funds from "foreign sources." Unfortunately for our purposes, these data will not be available until late summer 2010. Private communication from John Jankowski, Director, R&D Statistics Program, National Center for Science and Engineering Statistics, National Science Foundation, June 8, 2011.

[45] United States General Accounting Office, "R&D Funding: Foreign Sponsorship of U.S. University Research," Report RCED-88-89BR, 48 pages, March 1988. http://archive.gao.gov/d34t11/135368.pdf

[46] Proctor P. Reid and Alan Schriesheim, editors, Prospering in a Global Economy—Foreign Participation in U.S. Research and Development: Asset or Liability?, National Academy of Engineering, 204 pages, 1996. Available on line at http://www.nap.edu/catalog.php?record_id=4922

been little change in this percentage. Thus, at least through the middle-1990s, foreign company support of academic research was actually quite limited in scope and amount. Not surprisingly, the foreign funds were heavily focused on top-ranking research institutions, such as Harvard, MIT, the University of Washington, Johns Hopkins, and the University of Wisconsin. Texas A&M University, although not quite so highly ranked, was a major recipient of foreign funds in 1986, owing to its major research program in petroleum exploration that was of interest to many countries.

It is the judgment of TPI, based on the generally increasing global engagement of U.S. universities that the proportion of funding for R&D that comes from foreign sources and especially from foreign firms could have increased somewhat in the quarter century since GAO collected data for 1986. However, we have no way to attach a quantitative estimate to our judgment or even to know whether such funding has increased. This is a topic for which the old cliché', "more research is needed," is certainly appropriate.

Marketing U.S. University R&D to Foreign Firms

A key question for consideration is, "How do U.S. universities market themselves to foreign companies?" In other words, what do U.S. universities do to attract foreign company support of their R&D programs?

Of course, research linkages between U.S. universities and foreign companies have both supply and demand aspects. U.S. universities can supply top people, flexible administrative arrangements, and openness to other cultures. U.S. universities tend to "demand" substantial funding to conduct research with company support and they usually impose rules and limitations on that support which can inhibit the interest of companies in supporting them. Foreign companies can "demand" high quality research performance by universities, and can supply funds to universities that might not be available from other sources.

In considering actions by U.S. universities to attract foreign company research support, the overall context must first be kept in mind; namely, that U.S. universities have been widely believed to be among the best in the world, dominating various rankings of universities across the globe by quality. Thus, companies, regardless of location, that are seeking to support research in academia will naturally turn to the United States in many instances simply because we are perceived to have the very best people, in large numbers, in top institutions. Furthermore, as noted in the introduction to this report, the U.S. system of external funding of academic research via grants and contracts sets up an environment in which the institutions and their faculty members are well positioned to accept external funds, including from foreign sources, and to shape their research programs in response to sponsor interests. The attractiveness of the United States as a place in which to sponsor academic research is

reinforced by the fact that very large numbers of students have obtained advanced degrees from U.S. institutions, including doctoral degrees. When these doctoral graduates return to their home countries, they retain the contacts and linkages they had to professors in the United States. Since so much of research collaboration and research support is based on confidence in individuals and their abilities to "deliver" on promises made in research proposals, these "returnee" students can turn to their former American mentors when they need to fund a research project in academia. Likewise, the returnees are important "targets" of marketing programs when faculty members are recruiting private firms to help support their research.

U.S. universities are not just passive recipients of foreign industrial interest, however. They also engage in determined efforts to raise research support from foreign companies. Individual faculty members present their research papers and projects at professional, scientific and other meetings, where they are likely to be heard by, and to build linkages to, technical staff members from foreign companies. These linkages may lead to individual consulting agreements and/or contracts with the faculty member's university. U.S. universities aggressively market their graduate and professional degree programs to students overseas via paper marketing, foreign recruitment trips, and, increasingly the Web. Marketing for students spills over into marketing research programs and skills. University administrators (department chairs, deans, provosts, research officers, presidents, etc) make frequent visits to overseas institutions and companies in efforts to interest them in supporting the research of their faculty and graduate students. The Web, of course, has become the focus of marketing and outreach for many universities, research groups, and individual faculty members. Almost every substantial academic research program or center maintains a web presence through which they implicitly seek the interests of potential funders at home and overseas.

Considerable attention has been paid to "industrial liaison programs" of universities as tools for marketing their faculties to companies, both domestic and foreign. As noted in the NAE report cited above, "Industrial liaison programs (ILPs) charge membership fees to companies in return for providing them with general access to the results of university research, to researchers, and to laboratories in specified fields[47]." According to the NAE report, in 1992 GAO did a survey of research universities in which they determined that 30 of 35 leading universities surveyed had one or more industrial liaison programs. Further, according to NAE, most ILPs do not differentiate between domestic and foreign firms as members, although a few charge higher fees to foreign firms. Today, ILPs have become commonplace at research universities. Some, like the one that has been in place at MIT since 1948, are very wide-reaching, covering essentially all disciplines and fields within the institution. Others, such

[47] Reid and Schriesheim, *op. cit*., p. 107.

as the industrial affiliates programs of the various NSF-sponsored engineering research centers, apply only to the faculty who are active in a particular line of research.

To illustrate how ILPs work, consider the ILP at MIT, which has been an established feature of MIT for more than 60 years.[48] At present, more than 180 companies pay annual dues as members of ILP. They receive a variety of benefits from the program, including reduced costs for conference attendance, research reports, and books published by MIT Press. The MIT ILP staff routinely arranges meetings with faculty at no charge to members, and assists in arranging consulting engagements between faculty members and companies that are in ILP. Much of what ILP does is facilitate industrial interactions with the highly complex, multi-faceted organization that is MIT.

Another way in which universities market their capabilities in research to the private sector, both domestic and foreign, is through publication of newsletters featuring articles about research projects and accomplishments at their institutions. Some are much more than newsletters; in fact, many have the look, feel, and editorial quality of major commercial magazines. They are distributed at no charge to a wide array of persons and organizations interested in the work of the university, including industrial sponsors and advisors, donors, local business and industry, political leaders, opinion leaders, libraries, schools, and many others.

One of the great challenges universities face is making themselves transparent to potentially interested outside parties who would like to locate expertise in the institution. Large research universities typically have one thousand or more faculty with as many separate areas of expertise. To outsiders, such as technical staff members of companies, universities can be overwhelmingly complicated, confusing, and unresponsive. To overcome this problem, universities have adopted a number of strategies, including creating the ILPs discussed above. They also attempt to create searchable data bases of faculty expertise that are open to the public, generally through the web. They also encourage faculty to post their curriculum vitae, including full publication lists and research interests, on the public Web so that they will appear in the results of Web searches. Most universities post their faculty and staff directories on the Web, including individual email addresses and, often, telephone numbers. All this is done in part to help market the university and its faculty to the world.

In summary, we find that U.S. universities are actively engaged in marketing themselves and their capabilities through a variety of mechanisms. While most university web sites only appear in English, that is not a major barrier to their engagement by the world's scientific and technical community for which English is usually at least a second language. Marketing activities of the sort reviewed here are not inexpensive. They require dedicated professional

[48] For details on ILP at MIT, see: http://ilp.mit.edu/

staff to design programs, collect information, update web sites, organize activities, and write, edit and publish magazines and other materials. Nonetheless, in the United States today, marketing of this sort is routine for all research universities.

5. TENSIONS AMONG UNIVERSITY ROLES IN THE UNITED STATES

Introduction

Earlier chapters of this report have discussed the desire of American research universities for additional sources of money and political support. This chapter discusses some of the tensions and problems that have arisen as a result of these new university roles. In particular, tensions exist between traditional university roles of education, research for the overall community, and service to the local region and state and newer roles of helping specific companies and helping international as well as local interests. U.S. universities now need to balance these multiple roles, and different universities balance them in different ways.

This chapter briefly examines the following six types of tensions and conflicts. Not all of these conflicts exist at all American research universities, but university presidents and other administrators often must deal with them and find some balance between competing objectives.

- Managing professors: the long-existing tension between teaching and research.
- Managing professors: the tension between professors starting companies and otherwise engaging in external entrepreneurship and the amount of time they devote to their students and academic research.
- University research projects: helping individual companies versus maintaining the university's objectivity and credibility.
- University technology transfer offices: local economic development versus non-local activities.
- University contributions to overall economic development: the desire for political support versus the risk over-promising what universities can contribute to economic growth.
- Globalization of the university versus supporting economic and social development at home.

Six Types of Tension that Now Exist in U.S. Research Universities

Teaching Versus Research

This tension between education and research has existed for a long time in American universities. At the most basic level, it is widely recognized that teaching and research can be complementary activities—faculty who are excited by research tend to make interesting teachers, and the process of teaching can help faculty identify areas where the current knowledge base is weak. Professors who conduct cutting-edge research often make excellent mentors for PhD students. On the other hand, many senior professors prefer research over teaching and negotiate contracts that allow them to teach only a few courses. As a result, junior faculty, adjunct faculty, and graduate students sometimes teach many of a university's undergraduate courses.

When professors work closely with companies, additional complications can arise. First, if a professor accepts research money from a corporation, then that company may try to keep the research confidential or ask the professor to protect proprietary information that the company shares with him or her. This makes sense from the company's point of view, but it can cause problems for students. For example, if a graduate student participates in company-funded research, is that student restricted from publishing a PhD thesis because of confidentiality requirements? In general, U.S. universities require that students be allowed to publish their research results.

Second, if a professor helps start a company, the professor could push his or her graduate students to work on PhD projects that help the company but not necessarily the students. Here, too, many U.S. universities have rules regarding this potential conflict of interest.

External Entrepreneurship Versus University Duties

Most U.S. research universities allow their professors to spend 20 percent of their time on outside activities, such as consulting and starting companies. However, what happens if a professor is tempted to spend more than 20 percent time on a new company? Or, again, to push his students to work on projects that are particularly helpful to the company? To deal with such issues, U.S. universities have established policies to deal with both conflicts of interest (such as the need to protect students) and conflicts of commitment (to make sure that professors continue to perform their university duties).

Americans have also grappled with a related issue: when professors start companies or extensively work with companies, does that work make them better researchers and teachers or worse? In an important 1996 paper, Professors Lynn Zucker and Michael Darby of the

University of California, Los Angeles, make an important point: top biology scientists who work with biotechnology companies are actually more scientifically productive academic researchers than colleagues who do not work with firms – meaning that company involvement helps them with their academic research. Zucker and Darby believe that the superior funding and equipment at companies help these researchers: "Commercial involvement of the very best scientists provides them greatly increased resources and is associated with increased scientific productivity as measured by citations."[49]

Doing Research for Companies Versus Maintaining a University's Credibility and Reputation for Objectivity

Does a university risk hurting its reputation when it and its professors accept money from corporations? The American experience suggests at least two possible problems.

First, while American universities have long accepted research contracts from industry, large contracts from controversial companies raise questions. For example, a large debate occurred at the University of California, Berkeley, in the late 1990s when the Swiss drug company Novartis proposed a large agricultural biotechnology agreement with the university. The proposed deal—eventually accepted—was controversial with many at Berkeley, even though the university itself had sought such a contract in order to raise more research money for the campus' Department of Plant and Microbial Biology. The proposal was to give Novartis first right to negotiate licenses on all intellectual property from the department, raising questions about whether a private company would control valuable research paid for not only by the company itself but also government agencies. Moreover, would the resulting products be in the public interest? Novartis was a biotechnology company, and critics wondered if farmers could easily afford the resulting products. This issue was particularly sensitive at Berkeley, a public land-grant institution created in part to help California agriculture. And some critics wondered if Berkeley's overall reputation would suffer if people perceived that its professors now in effect worked for private interests. In the end, Berkeley accepted the proposed contract, but with conditions and monitoring.[50] The Berkley-Novartis program ended in November 2003.

A related kind of controversy can arise when a university professor directly accepts money from corporations, either for research or for giving speeches. In the United States, this type of controversy has particularly arisen in medical schools and hospitals, and particularly

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[49] Lynne G. Zucker and Michael R. Darby, "Star scientists and institutional transformation: Patterns of invention and innovation in the formation of the biotechnology industry," Proceedings of the National Academy of Sciences USA, Vol. 93, November 1996, page 12715.

[50] For details on the UC Berkeley-Novartis contract, see William Rodarmor, "Dangerous Liaison," *California Monthly,* December 1998.

when medical professors accept large fees from drug companies. Some university administrators worry that the reputation of their schools will be harmed if the public believes that payments from companies influence what medical professors says about health issues. And universities have rules about these types of payments from companies. For example, in May 2011 Stanford University disciplined five faculty members "for giving paid promotional speeches for drug companies, a direct violation of school policy."[51]

Technology Transfer Policies

The previous sections have discussed potential tensions or conflicts regarding university research projects. However, similar tensions and conflicts can also develop in university technology transfer programs, including both technology licensing offices and industrial liaison or partnership programs, where universities give companies special access to research findings and graduate students.

Three types of conflicts are particularly important.

First is the conflict between getting money from foreign companies versus making sure that technology developed with U.S. taxpayer funds helps the U.S. economy. One notable example of a controversy arising from this conflict developed in 1990, when MIT agreed to teach Japanese scientists how to replicate the famed MIT Media Lab in return for $10 million.[52] A second controversy, also involving MIT, occurred a few years later, when MIT's Industrial Liaison Program was criticized for establishing partnerships with Japanese firms. Given that Japanese companies were competing with American companies in high-technology businesses, some members of the U.S. Congress strongly criticized MIT for, in their view, attempting to sell American technology to Japanese competitors.[53] In future years, it is possible that similar controversies will arise over deals between U.S. universities and China or India.

A second, related conflict occurs when university administrations choose whether the principal job of technology transfer offices is to make money or help local entrepreneurs. The conflict arises because often, although not always, large companies in distant locations can offer more money for licensing university inventions than can local entrepreneurs (including the university's own professors). Large firms may also typically offer financial returns to the university more quickly than entrepreneurial firms can, and may thus offer more attractive

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[51] Lisa M. Krieger, "Stanford medical faculty members disciplined by school," San Jose Mercury News, May 19, 2011, http://www.mercurynews.com/health/ci_18100255?source=pkg.

[52] Gina Kolata, "M.I.T. Deal With Japan Stirs Fear on Competition," The New York Times, December 19, 1990, http://www.nytimes.com/1990/12/19/us/mit-deal-with-japan-stirs-fear-on-competition.html?scp=1&sq=MIT%20and%20Japan&st=cse,

[53] MIT's president at the time, Paul Gray, offered a rebuttal to his critics in an article published in 2003: Paul E. Gray, "Advantageous Liaisons," Issues in Science and Technology, Summer 2003, http://www.issues.org/19.4/updated/gray.html.

deals to technology transfer offices in search of immediate pay-off to satisfy an administration interested in making money now. Some universities have decided that the goal is not to get the most possible money but rather to help local people. One example is the University of California, San Diego. UCSD is one of America's top research universities, and it could license its technologies to the companies that would pay the highest royalties. But the campus made an explicit decision ten years ago that helping the local economy is the top priority, even if that policy leads to less revenue. UCSD therefore prefers to license to its own professors or to other local entrepreneurs, in order to help the local economy. [54]

The third issue is a larger one: how should universities handle the tension between the free dissemination of publicly-funded research versus the ability to make money and help companies through patenting new knowledge and licensing those patents? In short, how much should universities use the Bayh-Dole Act?

This is not a simple issue. On the one hand, universities traditionally have helped the U.S. economy by disseminating new knowledge, and some analysts worry that the emphasis on patenting and licensing new inventions hurts the U.S. economy by restricting the free flow of new knowledge. On the other hand, patents can be very helpful to start-up companies, particularly in the biomedical field. David Mowery of UC Berkeley, Richard Nelson of Columbia University, and two colleagues have criticized university efforts to patent and license every invention, arguing that this policy hurts information dissemination and also usually makes little money for universities, except in the biomedical field. So an aggressive Bayh-Dole policy (outside of the biomedical area) may not in fact help either the universities or the economy, they argue. If this is true—and they have some impressive evidence—each U.S. university must decide how often to patent and license new inventions and discoveries.[55]

Helping Local Economic Development Versus Over-promising What Universities Can Contribute

Another, large tension is between the desire of U.S. universities to gain funding and political support by helping economic development (in the U.S. as well as overseas) versus promising too much. Both universities and political leaders want to argue, and they want to believe, that the universities can help local communities and entire nations create new industries and jobs. Public universities, in particular, want to argue that they are helping their states create jobs. But when do university promises become unrealistic?

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[54] The UCSD approach leaves untested whether it is appropriate for institutions that receive research funds from the federal (national) government to give preference to the exploitation of research results by local entrepreneurs. Arguably, this approach works to the disadvantage of the nation as a whole, even as it helps local interests.

[55] David Mowery, Richard Nelson, Bhaven Sampat, and Arvids Ziedonis, Ivory Tower and Industrial Innovation: U.S. University-Industry Technology Transfer Before and After the Bayh-Dole Act, Stanford: Stanford University Press, 2004.

On the one hand, there is no doubt that some universities have, under particular circumstances, significantly helped create new industries and jobs. Stanford and Berkeley are well known for their roles in Silicon Valley, as is MIT in Boston. And there is solid evidence that world-class scientists and engineers can help create companies. The previously mentioned article by Zucker and Darby finds not only that "star" biologists who worked with biotechnology companies are productive academic researchers. It also finds that they have significantly helped start these new biotechnology companies. "We have seen for biotechnology—and possibly other science-driven breakthrough technologies—that the very best scientists play a key role in the formation of new and the transformation of existing industries…."[56]

Moreover, a second, more recent paper by Zucker and Darby looks at "star scientists" in all areas of science and technology and finds that U.S. regions and other countries that have these top researchers also have top companies. In short, it is the presence of the researchers themselves that is important in a region—not so much having access to their scientific papers or patents. People are important.[57]

On the other hand, not all regions of the United States have star scientists and engineers in their universities. So it is not certain that these other universities can in fact do much to make their local industries international leaders. They certainly can train good students and help mentor local entrepreneurs. But are both university presidents and local political leaders expecting too much of their universities—particularly if the local regions lack other key ingredients for dynamic companies, such as venture capital and experienced business leaders?

Expectations may be too high, as shown in two recent examples from the State of New York. In the first case, Mayor Michael Bloomberg of New York City—himself a very successful entrepreneur—has created an initiative to build a new applied sciences school in New York, in the hope of creating new jobs. The mayor has asked for proposals from universities both within New York City and outside of it on how to create such an applied sciences university, and the City may offer a $100 million or more in capital for the project. But the Mayor's proposal has proven to be very controversial.[58]

The second recent proposal in New York State comes from the city of Buffalo, a former industrial leader that is now economically depressed. Local leaders want to invest heavily in the University of Buffalo to create a larger and more successful local economy. The project could

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[56] Zucker and Darby, *op cit.*

[57] Lynne G. Zucker and Michael R. Darby, "Movement of Start Scientists and Engineers and High-Tech Firm Entry," National Bureau of Economic Research, Working Paper 12172, April 2006, http://www.nber.org/papers/w12172.

[58] Javier C. Hernandez, "Bloomberg's Big Push for an Applied Sciences School," The New York Times, April 26, 2011.

cost up to $5 billion. But to help pay for the project, local leaders want to increase the tuition payments that students at the University of Buffalo pay. In turn, that proposal has alarmed some Democratic Party legislators in the state capital. They argue that increasing tuition will hurt poor students. In Buffalo, there is a tension between helping students and raising money for the university's economic development projects.[59]

New York City, Buffalo, and other cities that want their universities to help their economies face two key questions. First, can these proposals really work? In particular, can they attract top professors and students, and are other key economic factors—such as venture capital—present in these areas? And, second, what are the trade-offs—that is, what must be given up in order to fund these projects? Higher tuition for poor students is one possible cost. Both university presidents and local political leaders must decide how much universities really can help local economies and at what costs.

Globalization of the university versus supporting economic and social development at home

Globalization of the university brings a host of tensions into how the university operates, where it puts it emphases, and how it allocates its resources. In one sense, universities are creatures of their host countries and cultures, with an expectation that, in return for financial support, academic freedom, and the umbrella of a nationally-based board and community; the university will focus its energies on meeting the needs of its host.

To the extent that the host country or state understands that its interests are being well-served by the globalization of the university, there need be no real conflict between its domestic and international roles. For example, as local economies have attempted to reach out to other nations for markets and to attract branch plants of foreign firms, the political and economic leadership of that community may applaud the efforts of the local university to engage with those same nations. Families may appreciate the opportunities that a global university may offer to their college-attending children to experience other cultures and to study or do research abroad. If, however, the university is perceived as acting globally in a way that is not thought to be in the interests of the local community in which it is located, tensions can arise between the university's local/state/national roles and its global role.

Tensions between domestic economic development and foreign engagement can arise in at least two ways: in the training of students, particularly doctoral students, and in conducting economically-valuable research.

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[59] Thomas Kaplan, "In Buffalo, Visions, Perhaps Illusions, of a University-Fueled Revitalization," The New York Times, May 8, 2011.

As mentioned earlier in this report, in 2007 one-third of all doctorate recipients came from other countries, and it appears than increasing proportions of them are returning home rather than staying in the United States. Is this a problem? The available evidence is not clear. On the one hand, some U.S.-trained scientists and engineers may return home to work for companies that compete with American firms and workers. On the other hand, some of these American-trained scientists and engineers may work for American-based companies in their home countries or may work for firms that supply components and expertise to American firms. More analysis of these issues is needed. However, TPI is not aware of any current political controversy stemming from the fact that U.S. research universities train large numbers of foreign scientists and engineers. [60]

As other nations become wealthier, it is not surprising that American universities seek research funding from foreign companies and governments, particularly in Asia. However, since most research at U.S. universities is still funded by American taxpayers and companies, one possible criticism of projects with international clients is that the universities are "selling" knowledge and expertise paid for by Americans. Moreover, given promises to help with local and national economic development in the United States, are these foreign contracts a betrayal of promises made by the universities?

TPI is not aware of any major controversy so far of this type, but we expect that such a controversy could develop in the near future. For example, the University of California, Berkeley, is now negotiating a large research contract with the Government of Singapore. The focus is on energy-efficiency technologies for large buildings. UC professors argue that the U.S. as well as Singapore will benefit if the project develops new techniques to save energy and money. This may be true. But, if observers believe that Berkeley, a public university, is helping Singapore gain an economic advantage in the construction industry, then strong criticism will result. It appears that American universities have not developed clear policies for deciding when a proposed research contract with a foreign entity is appropriate or not.

Concluding Observations on Tensions Among 21st Century University Roles

Universities seek to raise money and to build political support, and promising to help their local communities and even foreign countries to build their economies and create jobs is one way to do that. However, these efforts can conflict with other university goals, such as education and research. In particular, in a global economy universities should be careful about

[60] Controversies did arise in the last decade over a related issue: the large number of foreign engineers and computer programmers (most trained in their home countries) allowed into the United States under temporary work visas (so-called H-1B visas). Some critics objected that these foreign-born workers took jobs that otherwise would have gone to Americans.

promising to help their local regions while also seeking money from foreign entities and sharing technology with those entities. Such actions could lead to controversy and criticism.

6. CONCLUSIONS

This report began by asking several key questions about the roles of U.S. universities in economic development and in globalization:

- What exactly are U.S. research universities doing in these two areas, and why are they doing it? American universities vary a great deal, but many have embraced economic development and globalization. Why?

- How are they able to be "entrepreneurial" and expand their activities in these two areas? After all, universities around the world appear to be decentralized and slow to change. For example, what organizational and management features—what this report calls "governance structures"—and what other factors allow American universities to attract large amounts of corporate money?

- What are the advantages, disadvantages, and management problems associated with these expanded activities of economic development and globalization? For example, does the goal of helping local economic development conflict with the goal of raising money from international companies and helping them? And while recruiting large numbers of international students from China, India, and other countries adds to the quality of the student body, does it hurt the U.S. economy by, in effect, training people who will compete economically with American companies and workers?

- Do major American research universities offer any "lessons" to other universities, both in the United States and in other countries that may want to expand their economic development and globalization activities?

What relevant conclusions and possible policy lessons can one draw from the analysis in this report?

First, many U.S. research universities have indeed become more active in economic development and also more global in their educational and research activities. Universities and their professors seek at least three things: money, prestige, and political support. Beginning around 1980, a variety of factors allowed American universities to become more active in both economic development and globalization and rewarded them for becoming more active.

In the economic realm, the transition to a "knowledge economy" made university training and university research more important economically. Both professors and business executives began to realize that university research could be useful not only to existing companies but also to help new start-up companies. The move of industry towards an "open innovation" business model added to the attractiveness of university research. And the Bayh-Dole patent law of 1980 helped this process, by allowing American universities to own and license inventions developed with federal research funds. The success of high-tech regions such as Silicon Valley, Boston, San Diego, and Austin, and the apparent role of research universities in these regions, increased the public visibility of universities' economic contributions, gave universities new prestige and political support, helped to recruit both faculty and students interested in starting companies, and eventually led some political leaders to expect that research universities can help revitalize many regional economies.

Two points about this development are important. One is that different research universities play different roles. Publicly-supported land-grant universities continue, as they long have, to play a vital role in providing applied research and technical services to a wide range of existing industries. Often, it is the "second" university in a state that plays this long-standing and vitally important economic role—for example, Texas A&M University or the University of California at Davis or Clemson University in South Carolina. The "first-rank"public universities and the top private universities are, or aspire to be, world-class institutions doing cutting-edge basic research. However, changes in world economics and technology have made these basic-research institutions increasingly economically important, as their professors and students turn their knowledge of cutting-edge technologies into new high-tech companies. Stanford, the University of California at San Francisco (a biomedical research institution), the University of California at San Diego, and the University of Texas are examples. MIT, the University of Illinois, the University of Wisconsin, and the University of Michigan are example of schools that play both the traditional role of helping existing industries and the new role of providing world-class researchers and technologies that can create high-tech start-ups.

The other key point is that these U.S. research universities succeed because they are part of an overall national innovation system that allows and rewards entrepreneurship. Generous federal research funding and a competitive grants process help ensure that top U.S. universities have high-quality research programs and world-class research facilities. In the new era of "open innovation" many American companies want to take advantage of this high-quality academic research and knowledgeable professors and students. Some regions of the United States have "supporting institutions" such as venture capital firms and specialized law firms that help entrepreneurs (both from universities and from outside them) to easily start new companies. Other federal policies also help: Bayh-Dole, the Small Business Innovation Research (SBIR) program, tax laws favorable to entrepreneurs, and immigration laws that allow the U.S.

to attract bright and ambitious people. One important policy lesson follows from this point: if another country were to adopt simply one or two parts of this overall national innovation system, success might not follow.

The second main question is how American research universities are able to be so "entrepreneurial," in the sense of adopting new roles, seeking new funding, and making new contributions. The apparent paradox is how institutions with relatively weak presidents and many different actors can nonetheless change and do new things. This report suggests that the answer lies in the governance structure of U.S. research universities and the larger economic environment in which they operate. While many groups must agree to fundamental changes in an American university—the administration, the faculty, boards of trustees, sometimes state legislatures, and a variety of funders—American universities in fact have considerable autonomy and also give their faculty members great freedom to seek new funding and engage in new activities. Generous outside funding, from both government and private donors, and competitive awards processes are important supporting factors. Because professors can compete for and obtain new outside funding, their success does not usually come at the cost of existing programs in the university. This gives university administrators a major reason to allow their professors to be "entrepreneurial."

These expanded activities in economic development and globalization provide certain advantages, disadvantages, and management issues—both for individual universities and for the United States as a whole. The economic development activities clearly have generated great direct and indirect benefits for the country: helping to create new companies and new jobs, helping existing companies modernize, and providing the skilled people that the overall economy needs to thrive. Being more global in both education and research has helped U.S. students better understand the world, helped train international students (some of whom stay after graduation and help the U.S. economy), and brought additional research funding into U.S. schools.

There are also some clear disadvantages to the American system, including the high costs students must pay, the fact that some professors are more interested in research than teaching, and growing inequalities within universities between those departments that can raise large amounts of outside funding and those that cannot. At the moment, other disadvantages seem more theoretical than actual, but U.S. political leaders may someday object to universities "selling" taxpayer-supported research to foreign companies or training foreign students who will compete with American workers. Universities, of course, have an incentive to claim that foreign students and foreign research money do not harm U.S. interests, but they may not be impartial judges of this question. Ultimately, U.S. citizens, the federal government, and the state governments that support public universities will need to decide whether

universities that receive large amounts of federal money are providing good benefits for the United States.

Universities have found that newly expanded economic activities and increased globalization do create certain internal management problems. For example, as discussed earlier universities must make sure that professors do not neglect their teaching and research responsibilities when they start companies and that their students are protected from inappropriate pressures to do work for those companies. Universities must also ensure that corporate research projects do not compromise research integrity, open publication, or academia's reputation for objectivity and integrity. One lesson is that university administrators must pay careful attention to these issues in order to avoid problems and embarrassments.

These conclusions and possible lessons suggest that the American model of the research university can indeed produce major benefits for a country. But the model has disadvantages as well as advantages. And it only works if the other parts of a country's national innovation system are present and supportive.