Public Research Universities

From Land Grant to Federal Grant to Patent Grant Institutions

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According to the historian Thomas Bender, "No institution in the West, save the Roman Catholic church, has persisted longer. From small medieval beginnings [the university] has become diffused throughout the world, assuming everywhere principal responsibility for advanced teaching and, more often than not, research."[1] Despite the university's persistence as an institution, however, he argues that "the terms of the university's connection to society . . . have of course changed."

The American public research university is no exception to Bender's rule. Public universities emerged in the United States in the nineteenth century as a core social organization designed to deliver higher education teaching and research as well as other public services to individuals of the nation-state. Thanks to the growing demand for expanded educational opportunities and increased research outputs, this mission was further formalized in the twentieth century as the public research university became even more central to the American landscape. The global expansion of higher education is truly remarkable: there are more university students in Kazakhstan today (100,000) than there were in the entire world in 1900.[2] In the twenty-first century, however, the public university

is no longer only a provider—nor the only provider—of human capital and basic research to society; it is itself a contributor to and a competitor in the increasingly intertwined global marketplace of knowledge production and innovation.

We argue that while the American public research university has endured and prospered as an institution, its organizational missions of research, teaching, and service have been challenged in the wider society as calls for commercial engagement, broader impacts, and economic development have echoed throughout the country. Clearly, these new values and behaviors have implications for both public and private research universities, but we contend that they carry greater potential conflict and consequence for the latter. As tensions emerge between historical missions and contemporary demands, we find that the public research university's efforts to adapt an old set of activities to new a theory of action are inhibited by the very structural models and cultural myths that make it uniquely "public." At first glance, then, while the public university may appear chameleon-like, seemingly susceptible to and changing its colors in response to environmental shifts, we conclude that beneath the surface, the public research university may be more clam-like, dug in and resilient in the face of changing tides.

In this chapter, we provide a very brief history of the public research university and the development of its mission in the United States, examining the dominant myths and models that have guided public research university activities over time as a way to contextualize the present. We then interrogate the degree to which recent changes in the broader environment of higher education have led to a reorientation of assumptions about and enactments of what public research universities should do, for whom, and how. To do so, we explore key trends involving intellectual property, industry partnerships, and the professoriate. We conclude by discussing implications of the tensions between historical visions and current realities for the public university and the public interest. Although our focus is on American universities, public universities throughout the world have been exposed to similar environmental demands and may thus face somewhat similar organizational dilemmas.[3]

HISTORICAL MYTHS, MODELS, AND MISSIONS OF THE PUBLIC RESEARCH UNIVERSITY

An organization's mission is defined, and its activities directed, by the prevailing worldviews of its key members and constituents. These worldviews are based on

preexistent myths (assumptions) and models (actions) of the organization that are shaped and tempered by the wider environment. Changes in the environment can surface anomalies or provoke disorder in these myths and models, as well as disrupt or alter an organization's worldviews, mission, and activities.[4] In this section, we show how the public research university's organizational mission has expanded over time, shaped in large part by exogenous factors.

The Land Grant Institution

The American roots of the public research university can be traced back to the turn of the nineteenth century, with the founding of the University of Georgia (1785), North Carolina (1789), Vermont (1800), South Carolina (1801), and Virginia (1819) all in a relatively few decades. Shortly thereafter, the University of Michigan (1841) set the pace for the large midwestern universities. But the real signal of public commitment to university-based research came with the passage of the Morrill Act in 1862. With this legislation, the federal government donated public lands to a number of states and territories for the purpose of establishing at least one institution of higher learning in the areas of agriculture and mechanical arts, without excluding other scientific and classical studies.[5]

After the Civil War, sixty-seven land grant institutions were founded in this spirit, and the modern American public land grant university was born. With the Second Morrill Act (1890), the federal government extended this commitment to public higher education by providing additional financial endowments for all land grant institutions, except those that made distinctions by race in admissions. The land grants were also given responsibility for research and extension, primarily in the area of agriculture. In this regard, the Hatch Act of 1887 provided for permanent annual appropriations to each state to establish an agricultural experiment station, thus marking the advent of public universities' responsibilities to help generate research that both enhanced agricultural productivity and supported agricultural communities. With the passage of the Smith-Lever Act of 1914, federal funding also became available for the dissemination of such research for public use and service.

These laws did more than grant land to institutions of higher education. Collectively and with remarkably few strings attached, they established the first formal mechanisms for the public funding of institutions of higher education. Thus, although they are not responsible for creating the American public research university, they are largely responsible for distinguishing "public" from

"private" universities in the United States and making permanent the role of state and federal support to the former for teaching, research, and service.[6]

The public aspects of teaching and research, long viewed as coequal in the land grant model of the public university, proved to be prescient responses of the government to the needs of the rapidly developing agricultural and industrial sectors of the late nineteenth-century United States. By the early twentieth century, scientific research had become a major avenue of growth and expansion. Scholarly publication was emerging as a source of prestige for universities, and the production of scientific knowledge beyond subjects initially introduced by land grant policies represented a potent new opportunity for university research. By the 1930s and the arrival of the Great Depression, a number of major universities were convinced that sustained engagement with the nation's pressing issues could not be their concern alone but was perhaps something for which both government and industry should pay.

THE FEDERAL GRANT INSTITUTION

Before World War II, the federal government played a significant role in establishing teaching, research, and service activities in certain fields, particularly agriculture and mechanical arts. During the war, both public and private universities contributed vitally to scientific and technical research, most notably in the areas of engineering and the physical sciences related to national security. But land grant endowments and wartime investments were a long way from a coherent, statute-based federal science policy.

After the war, American higher education expanded rapidly. With returning veterans supported by federal funding through the G.I. bill, public universities became wellsprings of education. With the institutionalization of federal policies and agencies, public universities also became major founts of public research. As Gustavo E. Fischman, Sarah E. Igo, and Diana R. Rhoten discuss in chapter 2, this postwar period is often nostalgically considered the golden age of the university generally. The same can be said of academic science more specifically. Understanding this period's influence on the growth and norms of research helps explain the myths and models of the public research university's mission.

Motivated by the critical wartime advances in science and engineering achieved by the Office of Scientific Research and Development and justified by national defense and health needs, Washington came to favor a postwar science

policy that emphasized an active role for the federal government in cultivating and expanding scientific research, both basic and applied. The foundations of this strategy were outlined in Vannevar Bush's famous 1945 report, "Science—The Endless Frontier." Bush applauded the government's support of directly useful, applied research but argued that immediately applicable studies were not enough and that the nation needed to redefine its pursuit of scientific knowledge with an emphasis on continued basic research. To spur and support basic research, Bush specified the importance of a federal role in university-based science:

> There are areas of science in which the public interest is acute but which are likely to be cultivated inadequately if left without more support than will come from private sources. . . . [W]e are entering a period when science needs and deserves increased support from public funds. . . . As long as [colleges, universities, and research centers] are vigorous and healthy and their scientists are free to pursue the truth wherever it may lead, there will be a flow of new scientific knowledge to those who can apply it. . . . [B]asic research is essentially noncommercial in nature. It will not receive the attention it requires if left to industry.[7]

Though not entirely explicit about how academic science would ultimately be converted into technological advances and industrial applications, Bush's report was rooted in the belief that federally funded basic research and scientific training conducted by the universities would be the engine of economic progress and national development. The postwar era essentially defined the research university as a public entity and scientific knowledge as a fundamental public good, destined to enjoy government patronage. This logic fueled the creation of such federal units as the Office of Naval Research (1946), the National Institutes of Health (1944–1946), the Atomic Energy Commission (1946), and the National Science Foundation (1950).

With the emergence of the cold war and the Soviet Union's launching of *Sputnik*, federal support of higher education research continued to grow, as did the budgets of these newly formed agencies. Federal spending for research and development doubled in just four years, rising from $15.3 billion in 1953 to $31.1 billion in 1957 (in 2000 U.S. dollars).[8] These halcyon days of the federal grant institution bolstered the physical and biological sciences, health sciences, and engineering on public university campuses. As with other dimensions of higher education life, however, 1968 also proved to be a year of disruption, marking the first downturn in total federal spending for research and development since 1945.

THE PATENT GRANT INSTITUTION

If the 1950s and 1960s marked the era of public and federal support for higher education and research, the 1970s and 1980s witnessed its erosion. In the early 1970s, the widespread belief was that as a matter of necessity as well as opportunity, spending for public universities would continue to rise. Expectations for and expansions of higher education were multiplying exponentially, resulting in unprecedented increases in student enrollment, academic faculty, scholarly fields, research capacities, and campus resources, all of which translated into amplified costs and expenditures.[9]

Rather than a steady increase, however, the 1970s ushered in the onset of decades of decline and stagnation in per capita funding for research and education, particularly at the state and local levels, from which public universities, compared with private universities, receive a disproportionately greater share of their funding.[10] In the 1970s, on average, about 50 percent of public higher education budgets were state supported. By the twenty-first century, this average had dropped to roughly 30 percent and, in some cases, had fallen to as low as 10 percent. For example, at the University of Illinois, state funding shrank from 37 percent of the institution's budget in 1990 to 20 percent in 2004, and at the University of Virginia, the share of its operating budget coming from the state fell from about 28 percent in 1985 to 8 percent in 2004.[11] In the 2002, the University of North Carolina at Chapel Hill received 25 percent of its general funds budget from the state; the University of Missouri, 21 percent; Ohio State University, 18 percent; and the University of Michigan, 10 percent.[12] This downward turn in per capita funding for higher education was sparked by several factors, including an expanding student enrollment, a declining tax base, and a series of national recessions.

Somewhat ironically perhaps, policymakers at the time openly blamed the worsening economy on two factors, both of which they blamed on Vannevar Bush's linear model of innovation. The first factor was the failure to move ideas from the university lab into the market economy, and the second was the ease of access to U.S. research results by foreign firms.[13] To many scholars, this critique was, and still is, puzzling. How could ideas be both simultaneously accessible to foreign competitors and not sufficiently useful to domestic companies? In actuality, the buildup of basic research in academia was not the main motivating problem. Rather, policymakers were flummoxed primarily by the idea that American science was not matching the technological innovations of Japan and West Germany. Fueled by concerns of global economic competitiveness, U.S.

policymakers and industry captains demanded more economic bang for their American research buck, so federal research spending—particularly for basic research at universities—came under increasing scrutiny in Washington.

Shortly thereafter, as government interests shifted from sponsoring basic research justified by national concerns to promoting applied research targeting global competition, a series of new federal legislative initiatives emerged. The earliest and most commonly cited is the Bayh-Dole Act of 1980, which transferred the rights of ownership of federally funded inventions from the government to the recipient of the federal funds.[14] As a virtual equivalent of the transfer of land grant rights under the Morrill Act, the Bayh-Dole Act turned over intellectual property rights emanating from federally funded research to all universities. With a growing family of policies behind it—including the Stevenson-Wydler Technology Innovation Act of 1980, the Economic Recovery Tax Act of 1981, the Small Business Innovation Research Act of 1982, the National Cooperative Research Act of 1984, and judicial decisions granting expansive rights to intellectual property claims—Bayh-Dole sent a clear and concerted signal for universities to promote technology transfer and pursue property rights.

While prompted by economic concerns and facilitated by legal regimes, the incorporation of such commercial and entrepreneurial activities into the university also was accelerated by technological change and the rise of venture capital financing, particularly in the areas of biomedical and computer science.[15] Under these new conditions—which essentially underpin the global knowledge economy—universities moved away from older models of practice in which the university pushed publicly funded research out to industry toward newer models in which scientists collaborated with industry on publicly and privately supported research. In an array of technologically sophisticated sectors, from biotechnology to semiconductors, design and apparel, and telecommunications, a dense web of affiliations between universities and commercial firms were spawned.[16] To be sure, such relationships are not entirely new. The assumptions and actions surrounding them, however, are different in subtle but potentially significant ways, which can place such activities at odds with the historical myths and missions of the public research university.

University technology transfer has prompted an array of new metrics by which universities are evaluated. The generation of licensing income is one. For public universities, the number of spin-off companies is regarded as a contribution to local economic development. Likewise, some universities underscore patenting as a measure of their contribution to commercial science. These new metrics of accomplishment trigger novel forms of competition among universities and generate

new criteria by which universities are assessed.[17] State legislators are much more prone to ask public universities whether they are having an impact on job creation and employment growth in their communities. Indeed, some states tie funding to these goals and allocate resources to commercial engagement. Thus, the embrace of technology transfer has altered the way in which universities are regarded by various key constituencies, and the creation of measures of entrepreneurial accomplishment has led to more intensive efforts inside universities to manage and publicize such activities. Critics, ranging from those who allege the corporate capture of universities to others who contend that bureaucracy and public relations deter the actual transfer and application of knowledge, note that this new regime can conflict with long-standing goals of knowledge production and teaching.[18]

In sum, the missions of the American public research university have shifted over the last 150 years, imbuing the institution with multiple myths and endowing it with different models from one period to the next. As a land grant institution, the public research university was in many ways the "local servant" responsible for homesteading a new field of higher education, democratizing teaching and learning, conducting mission-oriented research, and rendering services directly to local communities and citizens. This nineteenth-century ideal of the public research university was captured in the "Wisconsin Idea," which, as expressed by the then president of the University of Wisconsin, states that the public university should "never be content until the beneficent influence of the university reaches every family in the state."[19]

As a federal grant institution, the public research university took on more of a "national scholar" persona. In this role, the public research university graduated from a set of loosely connected pioneering organizations to a federated system of professional organizations responsible for integrating research with teaching, supplying rigorous basic science for industrial innovation, and leveraging its well-resourced base to advance the country socially and economically. This view of the twentieth-century public research university was best encapsulated in the "Social Contract for Science," which embodied the expectation that in exchange for the government's investments, universities would produce public good research that served the nation's interests and solved its ills.[20] As a patent grant institution, the public research university assumed yet another identity, that of the "international salesman" responsible for taking knowledge products directly from laboratory to the market, reinvesting earnings to enhance prestige and reputation, and carrying the country forward into a globally competitive knowledge economy. Michael Crow, president of Arizona State University, best summarized this vision for the twenty-first-century public university:

"The modern university is the ideal environment for the creation and transfer of knowledge that drives national competitiveness in an increasingly global era."[21]

THE PUBLIC RESEARCH UNIVERSITY: CLAM OR CHAMELEON?

Although our broad sketch of the historical context of the U.S. public research university draws on a wide range of sources, the periods and shifts we have emphasized are generally agreed on by both scholars and commentators. Debate remains, however, over whether recent shifts in mission and the wider environment have translated into alterations and disruptions in the internal activities of public research universities. In this section, we take up these concerns, focusing specifically on activities closely associated with shifts to the "patent grant institution."

On the one hand are those who believe that the work of the university has not changed significantly, although they do not always necessarily agree on its starting point. For example, Clark Kerr, former president of the University of California, suggested that markets and market logic have always been a part of the academic landscape. Describing the tension between the acropolis, with its focus on values and mission, and the agora, the marketplace, Kerr commented:

> The cherished academic view that higher education started out on the acropolis and was desecrated by descent into the agora led by ungodly commercial interests and scheming public officials and venal academic leaders is just not true. If anything, higher education started in the agora, the market, at the bottom of the hill and ascended to the acropolis at the top of the hill. . . . Mostly it has lived in tension, at one and the same time at the bottom of the hill, at the top of the hill, and on the many pathways in between.[22]

Echoing the theme of engagement, Richard Nelson and Nathan Rosenberg argued that science in the United States has always had a more practical character than its European counterpart, and thus contact with industry and involvement with industrial applications has long been a distinguishing feature of the U.S. university.[23]

On the other hand are those who believe that the mission of the public research university has shifted, particularly over the last two decades, creating a sea change in the institution's norms and logics regarding the purpose of knowledge and practice of science. In this view, the once separate streams of public

(often academic and/or basic) and proprietary (often industrial and/or applied) science have breached the levies, thereby altering the landscape, particularly of the public research university.[24] Within this camp, there is some disagreement about the incredulity versus the inevitability of these changes. Some believe this intermingling has led universities to be dominated by market interests, thereby undermining its capacity to serve its public purposes and sometimes even its fundamental mission.[25] Others feel "given that reality, . . . the key to making the more modern university more publicly relevant lies in making it, ironically, even more market responsive—or, to use the term we have come to favor, more market-smart."[26]

Next we explore recent trends that characterize and challenge the "patent grant institution": intellectual property, industry partnerships, and the professoriate. We argue that the activities themselves are not entirely new to the public research university but that many of the emergent values and behaviors surrounding them are. We suggest that the current embrace of market mechanisms provokes discussions and conflicts that reveal the core tensions of the twenty-first-century public university. These debates and their resolutions suggest which worldviews are prioritized and which constituents are rewarded.

Intellectual Property

As we pointed out earlier, a number of today's public research universities were established by the Morrill Land Grant Act, with a specific mandate to conduct locally useful research in agriculture and the mechanic arts. Given the immediate economic potential of such mission-oriented research, land grant institutions were among the first universities to address the issue of ownership of government-funded research results.[27] The protection of intellectual property has been a regular activity at most public research universities since the late nineteenth and early twentieth century, whereas private research universities had more ambivalent, if nonexistent, patenting policies for much of the first half of the twentieth century. For example, as early as 1890, the University of Wisconsin sought and secured a patent for Stephen Babcock's test for butterfat. In 1912, Frederick Cottrell, a chemist at the University of California, at Berkeley, obtained a patent for developing an electrical method of recovering valuable materials from smokestack emissions. In 1923, Harry Steenbock, again at the University of Wisconsin, patented an irradiation process to enhance vitamin D in foodstuffs.[28] Moreover, while it is true that technology transfer offices (TTOs) diffused rapidly across universities and that patents began to mushroom in the post-Bayh-

Dole era of the knowledge economy, we should not forget that thirteen of the twenty universities that established such offices before 1980 were public.[29]

Even though patenting efforts are not altogether new, the dominant values and behaviors now attached to patenting and licensing seem to be. This has implications for both public and private universities, but arguably more so for the former. The historical land grant legacy carries with it the view that patenting for commercial intent and individual gain was inappropriate. The motivations for taking patents in earlier times were largely institutional and societal. Take the examples of Frederick Cottrell and Harry Steenbock. They used their first patents to establish the Research Corporation of America (RCA) and the Wisconsin Alumni Research Foundation (WARF), respectively, each with the purpose of managing and supporting their and other public-minded inventors' research. Not only did RCA and WARF protect the rights of products specifically designed to serve the interests of the public, but the organizations also plowed patenting incomes back into their universities to seed new research before World War II when federal monies were limited. In 1925, WARF took over managing Steenbock's patented irradiation technique to prevent its use by producers of oleomargarine (which does not naturally contain vitamin D) and thereby to protect his local state's dairy industry. WARF executed its first licensing agreement on this patent in 1927 with Quaker Oats, to fortify breakfast foods, and subsequently licensed the invention to various pharmaceutical companies while at the same time denying requests from manufacturers wishing to use the process for nonnutritional purposes. The revenues from Steenbock's patent provided the financial base for continued work on vitamin D for several decades.[30]

The contrast with the objectives of current patenting activities is considerable. Today, greater priority is often given to commercial "payoff" and individual incentives over institutional "payback" or public benefit.[31] This is particularly true in the area of biotechnology, for example, where the race for licensing dollars has driven patenting progressively "upstream" to embrace gene and protein sequences, despite the known threats this poses to slowing, restricting, or even eliminating the "downstream" development of new therapies or diagnostic products. Consider the story of the BRCA1 and BRCA2 genes. In 1994, with funding from the National Institutes of Health, a team led by Mark Skolnick at the University of Utah identified the first of these breast-cancer susceptibility genes and filed for a patent on portions of the BRCA1 gene, as well as on the probe to detect mutation in it. The patent was issued three years later to the university and to Myriad Genetics, a company founded by Skolnick in 1991. NIH was left off the patent, and the patent was licensed exclusively to Myriad, which insisted

on doing all U.S. testing for the presence of unknown mutation in this and the related BRCA2 gene. Those women who have a mutation in either gene are said to have as high as an 86 percent chance of getting cancer, and the cost for the complete two-gene analysis is now $2,975.[32] In addition to being cost prohibitive for many, exclusive control of the intellectual property (IP) precludes other companies from developing the test and creating competing, possibly superior, tests. Moreover, as a clinical consequence of this proprietary control, some women are undergoing mastectomies on the basis of false positive results.

On the face of it, the lure of potential profit as a rationale for patent-licensing activities is not surprising, given the explosive growth of science-based industries and the regressive state of public financing for public universities. Assessing the pursuit of potential profit as the primary goal for patent-licensing activities requires deeper consideration, however. Despite the uptick in patent-licensing activities at public universities, very few academic patents actually generate considerable revenue.[33] While university-licensing income rose from $123 million in 1991 to slightly more than $1 billion in 2002, only a handful of public universities have had blockbuster successes, most notably University of Florida, Florida State University, and Michigan State University.[34] Most public research universities either make a paltry sum or lose money when the costs of running an office are included. In fact, as Lori Turk-Bicakci and Steven Brint show, public universities are less likely to receive licensing income than are their private counterparts.[35] We believe this is due at least in part to the structural models and cultural myths that define research universities as "public" (in both source and service) and constrain them in ways distinct from that of their private counterparts.

David Mowery, Bhaven Sampat, and Arvids Ziedonis argue that public research universities can and do learn over time how to focus on high-value patents. But by virtue of their mission, public research universities must do more than generate revenue; they must also disseminate knowledge.[36] Sometimes these goals correspond, and other times they clash. Whereas generating revenue often requires restricted access to key research, disseminating knowledge generally entails open access to such research. Thus, embedding new commercial behaviors and values into the core assumptions of the public research university and becoming a successful patenting grant institution may introduce conflicts between past and present missions. How these conflicts are ultimately resolved can reveal much about the true state of organizational change. Donald Siegel, Leanne Atwater, and Albert Link discovered through site visits and interviews that universities, especially public ones, are quite sensitive to the charge that they are "giving away" university-based, taxpayer-funded technologies that sub-

sequently yield substantial profits for companies. As a result, many TTOs are adopting a hard line in licensing negotiations.[37] And, indeed, in some cases, state legislatures are demanding that universities strike "better" deals.

Nonetheless, some universities are turning to an emphasis on the social value of innovation. We see steps toward improving access to important technologies that serve underdeveloped nations or underrepresented groups. Some universities are still and again plowing back licensing income into valuable but decidedly noncommercial pursuits. Florida State's revenues, for example, have helped build a first-rate theater department, and the University of Iowa's income supports its noted writers' workshop. This does not mean that concern about the expansion of intellectual property claims on public university campuses is not warranted. To be sure, new values and behaviors with respect to patenting and licensing activities have been broadly introduced at public research universities, but the consequences of these activities are highly varied and, in some cases, reinforce traditional pursuits rather than enter new commercial territory.

INDUSTRIAL PARTNERSHIPS

Public universities have long had partnerships with industry. From their very beginning in the late nineteenth century, land grant universities have been expected to contribute to the economic vitality of their states by training students in the agricultural and mechanic arts to meet the needs of industry and technology.[38] By the turn of the twentieth century, university professors were already routinely working with industry in fields like chemistry and engineering, moving back and forth between the two sectors through either contract or consulting arrangements.[39] These cross-sector relationships accelerated with World War I as academic scientists in these and other fields like physics often temporarily vacated university labs to work with industry on military endeavors. Although they were facilitated by organizations like the National Research Council or philanthropic foundations like Rockefeller or Carnegie, these early university-industry relationships applied to individual-level assignments or connections.

Institutional-level agreements and arrangements with industry initially arrived at public university campuses after World War I and in the form of corporate-sponsored research. In 1920, Michigan was the first to establish a department of engineering with the purpose of coordinating major industrial projects, with Minnesota and Illinois following closely behind.[40] During World War II, federal agencies like the Department of Defense, the Atomic Energy Commission, and

even the National Aeronautics and Space Administration (NASA) supported a number of university-industry-government research projects on public university campuses.

After a lull in industry sponsorship and partnership during the 1960s and 1970s, industry investment and involvement both multiplied and diversified over the last few decades.[41] Although universities still receive a very small fraction of their research funding from industry (estimated at around 5 percent), industry investment in public university research increased fourteenfold to $1.16 billion between 1977 and 1997.[42] This compares with private schools, where industry investment increased only tenfold to $555 million.[43] Notably, by the turn of the twenty-first century, eight of the top ten industry-funded universities in the United States were public.[44] More interestingly, however, is how industry involvement with the twenty-first-century university has morphed, moving well beyond traditional relationships based on student training, academic consulting, or research services to new complicated marriages set forth in research parks, cooperatives, joint ventures, and strategic alliances. Thus, whereas twentieth-century university-industry partnerships involved corporations with extensive in-house corporate R&D labs that invited basic research inputs from universities, twenty-first-century partnerships are more likely to involve joint R&D between company and university scientists.

The idea of the science park first gained traction shortly after World War II with the founding of the Stanford Research Park in Palo Alto, California (1951), University Research Park in Norman, Oklahoma (1957), and Research Triangle Park in Raleigh-Durham-Chapel Hill, North Carolina (1959). Fifteen research parks were established before 1980, with the express purpose of creating jobs for university-trained youth. In a second wave of foundings, another 110 parks were created before the turn of the century. Unlike their predecessors, these later parks were dedicated to incubating new firms based on and for university-produced research.[45] Many of these newer parks are focused on the life sciences, such as the Virginia BioTechnology Park in Richmond (1992), the Colorado Bioscience Park Aurora (1999), and the University of Maryland BioPark at Baltimore (2003).

In addition to science parks, numerous industry-university cooperative research centers (IUCRC) and research joint ventures (RJV) began popping up across campuses in the 1980s. The primary purpose of both IUCRCs and RJVs is to engage in ongoing collaborative research and foster rapid technology transfer between universities and firms. In contrast to the older linear model of innovation in which university research essentially moved downstream to industry, these partnerships involved simultaneous inputs by academic and industry sci-

entists. The number of IUCRCs on university campuses increased by 154 percent during the 1980s and to more than a thousand by 2000.[46] IUCRCs cover a range of traditional engineering and manufacturing fields to newer areas in biotechnology, information technology, and green technology. University participation in RJVs has also risen steadily since the National Cooperative Research Act of 1984, with the share of all RJVs in the United States involving at least one university doubling from 8 percent (1984–1992) to 17 percent (1992–1999). The bulk of the university RJVs are in electronic and electrical equipment and industrial machinery (including computer manufacturing).

A more recent development in university-industry relationships is the widespread appearance of strategic corporate alliances (SCAs) in the 1990s. Unlike science parks, IUCRCs, or RJVs, these alliances do not create third-party organizations. Instead, in this partnership model, firms pay millions of dollars directly to university labs for research programs that align with their needs and interests. Notable examples include MIT's $30 million alliance with the biotech company Amgen to fund biology researchers; Stanford University's $225-million partnership with Exxon Mobil and others to create the Global Climate and Energy Project; and the University of California at Berkeley's $500-million contract with the energy giant British Petroleum (BP) for its new Energy Biosciences Institute. Generally speaking, the SCA model is used by high-technology firms to access cutting-edge basic science. Companies that are familiar with this form of partnering have multiple alliances with different faculties and universities. The universities, for their part, increasingly have an array of corporate alliance partners, although individual faculty rarely have multiple affiliations with corporate sponsors. Thus, from the faculty side, such connections are more likely to be monogamous, but from industry they are polygamous. While SCAs are typically designed to foster ongoing, open-ended relationships and replace the need for complex legal negotiations, the terms of these alliances vary significantly from case to case. For example, Amgen and MIT simply agreed that patents resulting from work specifically funded by Amgen would be jointly held. In contrast, the Berkeley-BP alliance specifies that nearly a third of the annual financing is designated for confidential research by BP, and it gives BP the rights to negotiate exclusive licenses on the "public" part of this alliance.[47]

Clearly, then, the nature of the public university's relationship to industry has been neither static nor universal; and the dominant values and behaviors surrounding these ties have evolved along with the development of different industries and the changing ideologies of the day. Beyond the education and training objectives of early arrangements, many of the nineteenth- and early twentieth-

century projects resembled an outsourcing arrangement in which industry contracted for university research but owned all property, responsibility, and liability for the outcome. In more recent collaborations, which involve joint technological development in third-party centers or a firm's strategic outsourcing of research interests and needs directly to a university, the outcome is often the result of mutual efforts and may yield jointly owned assets between industry and university.[48] The complexity of these new alliances has prompted debate over the publicness of research universities. On the one hand, these alliances bring much needed revenue to the public university, allowing them to carry out their historical missions by delivering better-resourced research programs. On the other hand, with such alliances, universities can run the risk of being captured by and beholden to a private corporate partner's research agenda, threatening the scientific integrity of the university and its ability to serve the public interest independently and without bias. Resolving this debate requires understanding the extent to which industry relationships are altering or disrupting core university actions and assumptions.

At the institutional level, Lawrence Cote and Mary Cote found that despite the increase in industry-university relations, land grant schools had a greater involvement in industry-sponsored contract research or technology extension activities than in science parks or spin-offs.[49] Similarly, in a more recent comparative study, Turk-Bicakci and Brint suggested that public research universities are less likely than private research universities to be highly active collaborators with industry.[50] At the individual level, in a survey of university and industry participants in RJVs, Yong Lee found that faculty gave priority to two things when discussing their motivations: obtaining funds for research assistance, lab equipment, and their own research agenda; and obtaining insights into their own research by being able to conduct field tests.[51] Faculty members viewed opportunities to place students, obtain patents, or start businesses as less important motivations.[52] Even though the empirical basis is limited, the results indicate that as with intellectual property activities, new values and behaviors of entrepreneurialism are influencing industry partnerships at public universities but that business goals and proprietary claims may not yet be fully institutionalized into the core actions and assumptions of the university and its faculty.

THE PROFESSORIATE

The historical missions of nineteenth-century land grants established a strong public purpose for public research universities, seeking to balance responsibili-

ties in its faculty for teaching, research, and extension as services to the community. While still seeking to maintain this three-way balance, the twentieth-century role of public university faculty emphasized national science over local service. This repriortization was evident with the mobilization of national wartime science, and these efforts took faculty off their campuses and away from their communities. After the war, faculty returned to their local institutions, but the "professionalization of scholarly allegiance" and the "institutionalization in higher education" caused professors to turn inward to their research and their scholarly invisible colleges and away from their local or national publics.[53]

As Christine Musselin describes in chapter 14, the onslaught of fiscal retrenchment and the response of new managerialism in the 1970s yielded another redefinition of scientific scholarship and a reconceptualization of academic life. Apart from dedicating significantly more time to research and less to service in their activities, faculty today have also taken up new roles and positions that their predecessors could have never imagined. Some faculty look more and more like entrepreneurs, juggling start-ups and consulting gigs with classrooms and lab work.[54] Others resemble contingent workers, piecing together postdocs, lectureships, and adjunct posts from one institution to the next.

The upshot of this period is a marked diversification in and stratification across career trajectories, research priorities, and fiscal opportunities for American faculty. To be sure, academia has always been competitive and status driven, with rewards and incentives motivating and accruing to the most successful scientists and scholars. As fame and fortune have gained greater currency in the new world of commercial and entrepreneurial returns, however, these new behaviors and values may be altering the twenty-first-century university's compensation, prioritization, and evaluation of faculty work on campuses everywhere, but with particular disadvantages for public universities.

The 1940 Statement of Principles of the American Association of University Professors (AAUP) noted that tenure is a means not only to academic freedom but also to "a sufficient degree of economic security to make the profession attractive to men and women of ability" by providing sufficient financial rewards to maintain commitment and loyalty (AAUP, 1940). Although 2006 faculty salaries outpaced inflation for the first time in a long time, the growing financial disparity between public and private institutions may well be straining the financial commitment and loyalty of public research university faculty. In the late 1970s, across all fields, the average full professor at a public university earned 91 percent of what her private university counterpart earned.[55] Today they earn only 78 percent; or, on average $30,000 less: $106,495 compared with $136,689 (AAUP salary survey,

2006–2007). Indeed, the average salary for *assistant* professors at private universities is more than the average for *associate* professors at publics. According to the results of a recent faculty survey, private university professors are also more satisfied than their public counterparts in the number of courses they teach, the number of students in classes, and the quality of students they advise.[56] Other evidence points to the negative effects of bureaucratic meddling, political constraints, and dwindling public support on faculty morale at public research universities.[57]

In addition to the growing differences in faculty benefits between public and private research universities, there also are yawning gaps in the salary and support offered to faculty whose skills are in demand by the private sector—computer and life sciences, as well as business, law, engineering—and their colleagues in the humanities and social sciences. By 2006, for example, full professors in engineering earned on average about $20,000 more than full professors in social sciences and almost $30,000 more than humanities faculty.[58] These disparities between what are sometimes called the "have" and the "have not" fields are even wider among new assistant professors. Start-up packages for new tenure-track faculty right out of graduate school can average about $300,000 or more in any of the physical or life sciences and engineering fields. By one account, the going annual rate today for sought-after theoreticians in physics is $400,000 to $600,000 at the level of assistant professor, including salary and research support. The price tag for top experimentalists, who have far more extensive laboratory needs, is $1.5 million to $2 million.[59] Whether in hot or traditional fields, private universities are able to offer more customized, lucrative packages than public universities can, which have to consider issues of equity and public scrutiny in ways that private universities do not. When we turn from recruiting to retention, we find private universities again at a considerable advantage.

The intersection of these trends has powerful ramifications for which faculty and fields research universities can and will pursue. Obviously, institutions with larger endowments are in a better position to offer and maintain these types of high salaries and cutting-edge facilities. In 2006, Harvard, Yale, and Stanford had the three largest endowments, which totaled $61 billion dollars, or 125 percent of combined endowments of the fifteen largest public universities. Harvard's endowment alone was $29 billion, more than twice that of the entire University of Texas system and almost five times that of the University of California or the University of Michigan.[60] Absent significant endowment funds, investments in faculty and university facilities must come from either the university budget or the state. The comparative endowment-driven spending power of the privates, combined with the limitations of public budgets and the complications of state

financing, which handicap even the finest public research universities, begins to reveal the disadvantages the latter might face when competing for faculty in the new academic marketplace.

As the total costs of hiring and retaining faculty in the sciences are rising across all research universities while the relative salaries, satisfaction, and scientific purchasing powers are falling at public research universities, these institutions are finding it more and more difficult to compete with private universities for "star" faculty in "leading" fields. The expanding incongruence between faculty costs and fiscal conditions at public research universities may have prompted comments such as the following from Harvard University President Drew Gilpin Faust: "One thing we all must worry about—I certainly do—is the federal support for scientific research. And are we all going to be chasing increasingly scarce dollars?" Not that Faust seems worried about Harvard or other top-tier research schools. "They're going to be—we hope, we trust, we assume—the survivors in this race," she says. As for the many lesser universities likely to lose market share, she adds, they would be wise "to really emphasize social science or humanities and have science endeavors that are not as ambitious" as those of Harvard and its peers.[61]

In response, the provosts of eleven public universities in the Midwest (the "Big 10" except for Northwestern University, which is private, plus the University of Illinois at Chicago) argued in an op-ed that "collectively, our institutions educate more than 380,000 students, produce 1 in every 8 American PhDs, and conduct more than $4.5 billion worth of research every year." The provosts also argued that

> what's imperiled goes beyond the public research universities themselves. The relative impoverishment of these schools threatens to upset the public-private balance that is at the core of America's status as the world leader in higher education and academic-based research. That balance underwrites our ability to meet global competition with social, scientific, and economic leadership.[62]

Clearly, the leaders of research universities in our nation's heartland are not willing to be relegated to the backseat by Harvard's president. Nevertheless, the fiscal challenges are very real.

Most of the academic literature views faculty actions and assumptions as inputs to, rather than outcomes of, the tension between historical visions and current realities.[63] We are interested in understanding the extent to which changes in the environmental values and behaviors surrounding the professoriate are altering or disrupting how public university faculty pursue and perform their work. Reflecting the need to legitimate the type of extreme spending decisions described earlier and

to demonstrate the broad research contributions of public research universities to global competition mentioned earlier, universities are increasingly deploying performance appraisal systems that rely on easy-to-count and easy-to-report bibliometrics and scientometrics, including publications, research dollars, patents, start-ups, spin-offs, and licensing revenues, to name but a few.[64] Simon Marginson and Imanol Ordorika discuss the rise of this audit and ranking paradigm within higher education chapter 3. In a recent study using a subset of these metrics, James Adams and J. Roger Clemmons found that the research productivity in private universities was roughly twice that of their public counterparts.[65] The disparities in research output between public and private institutions was further supported by new data from a company, Academic Analytics, that ranks research universities on the basis of per capita faculty productivity. Only one public university—the biomedical powerhouse University of California at San Francisco—is on Academic Analytics' list of top ten large research universities.[66]

While these calculations could suggest a reversal of fortune for public research universities, many of these metrics are rather superficial and account for activities that are more closely aligned with commercialism and entrepreneurialism than with historical missions of teaching, research, and service. Thus failure on these measures might suggest a reluctance by faculty at public universities to accept some of the "new" values and behaviors into their core actions and assumptions. While there has been a general and significant increase in the time that faculty dedicate to research at all universities since the 1970s, twenty-first-century faculty also report spending more time teaching.[67] In public institutions, however, by their very definition of the university, faculty still continue teach and perform service at greater rates than do their private university colleagues. These demands on their time inevitably detract from attention to activities that are captured by simple metrics. Thus, the very structural models and cultural myths that define institutions as "public" and differentiate them from their private counterparts, which many fear are at risk in the present climate, may in fact be the key factor in faculty's maintaining some resiliency in this new political economy of academic science.

BENDER'S RULE AND THE NET IMPLICATIONS FOR THE PUBLIC RESEARCH UNIVERSITY

In a 2004 lecture entitled "Building and Sustaining Excellence in the Public Research University: The American Model," Chancellor Richard Herman of University of Illinois at Urbana-Champaign observed that "universities are constantly re-

fashioning themselves."[68] As we have tried to show in this chapter, over time there have appeared many apparent alterations or disruptions in the way that public research universities do things. Most recently, such changes can be identified in the new concerns about intellectual property, alternative forms of industrial partnerships, and sharp changes in faculty compensation and composition. At first glance, the diffusion of activities in these three areas suggests that public research universities are running fast to adapt to the latest environmental trends and fads driving the evolution of the "patent grant institution." On closer examination, however, the adoption, or perhaps the lack thereof, of values and behaviors like commercialism and entrepreneurialism identified with being a "patent grant institution" suggests that public research universities lag behind private universities.

We do not see efforts to pursue investments in intellectual property or industrial partnerships or to privilege star faculty as new evidence of public research universities' trying to radically reengineer themselves. In fact, we have demonstrated that public research universities have long legacies of activity in each of these areas. Moreover, we do not interpret the halting steps of public research universities toward the "patent grant institution" to be primarily a matter of resources, even though their motivation might be explained this way. Rather, we believe the public research universities' ability to adapt as rapidly and as robustly as their private counterparts are doing to the demands of the twenty-first-century knowledge economy and ecology is inhibited by the very structural models and cultural myths that make this institution "public."

Whether the public research university's difficulty in morphing fully into a "patent grant institution" is qualitatively good or bad depends in part on where one sits. What concerns us are the net implications of being betwixt and between for the public research university and the publics it serves. For example, by establishing technology transfer offices and entertaining large-scale alliances with industry, public research universities signal to their constituents that they can be proprietary and commercial. In so doing, they may jeopardize their position as neutral and objective sites of public good science. Likewise, by offering unparalleled incentive packages to "star" faculty and making ever larger investments in property and facilities to stay on the vanguard of research and discovery, public universities indicate to legislators and Congress that they can survive in competition with private universities. But the very pretense of entrepreneurial viability could threaten their protected status as "public," which has earned these universities considerable material and symbolic support historically.

On the surface, it looks to many people that the public research university has broken the social compact that both assigned them responsibilities for the

democratization, prosperity, and progress of America and allowed them to prosper as a protected species on the landscape of American society. Beyond appearances, it seems to us that these institutions have not fully recoded their organizational genetics so to render themselves completely viable as a "patent grant institution" in this new knowledge ecology and economy. Stuck in evolutionary transition, public research universities risk losing their niche and alienating their advocates. Many analysts are of the mind that the public research universities' competitive advantage continues to rest on their ability to teach and train young scientists as much as, if not more than, their capacity to chase patents, start companies, or house star faculty in leading-edge fields. This should not undermine the research potential of the public research university but, rather, capitalize on its teaching and service aptitude. Nonetheless, it has to be troubling to public research universities in the Midwest and South to recognize that their leading graduates, who publish and patent after receipt of their PhDs, move to the West Coast to create or join technology start-up companies.[69]

Thus, while we find fears of public research universities transforming into privatized entities overstated, we are concerned about the net implications of public research universities trying to adopt superficially, but not adapt successfully, to the new, current environment. In the end, this situation may only further disadvantage the public institutions and accentuate a stratification order among public and private universities. In order to assess these implications and weigh our concerns, however, more focused scholarship is needed. A significant challenge in writing this chapter was the lack of current studies that compare and control for public versus private universities when looking at issues of intellectual property, industrial partnerships, or faculty compensation. More comparative research on public-private differences and similarities would offer insight into key policy questions: Would public research universities be better off pursuing a more expansive public role than trying to compete with wealthy privates? What would be the consequences for public education and research science? Most critically, in the current environment, can public research universities do more to protect the public interest by playing the game or by not playing the game?

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