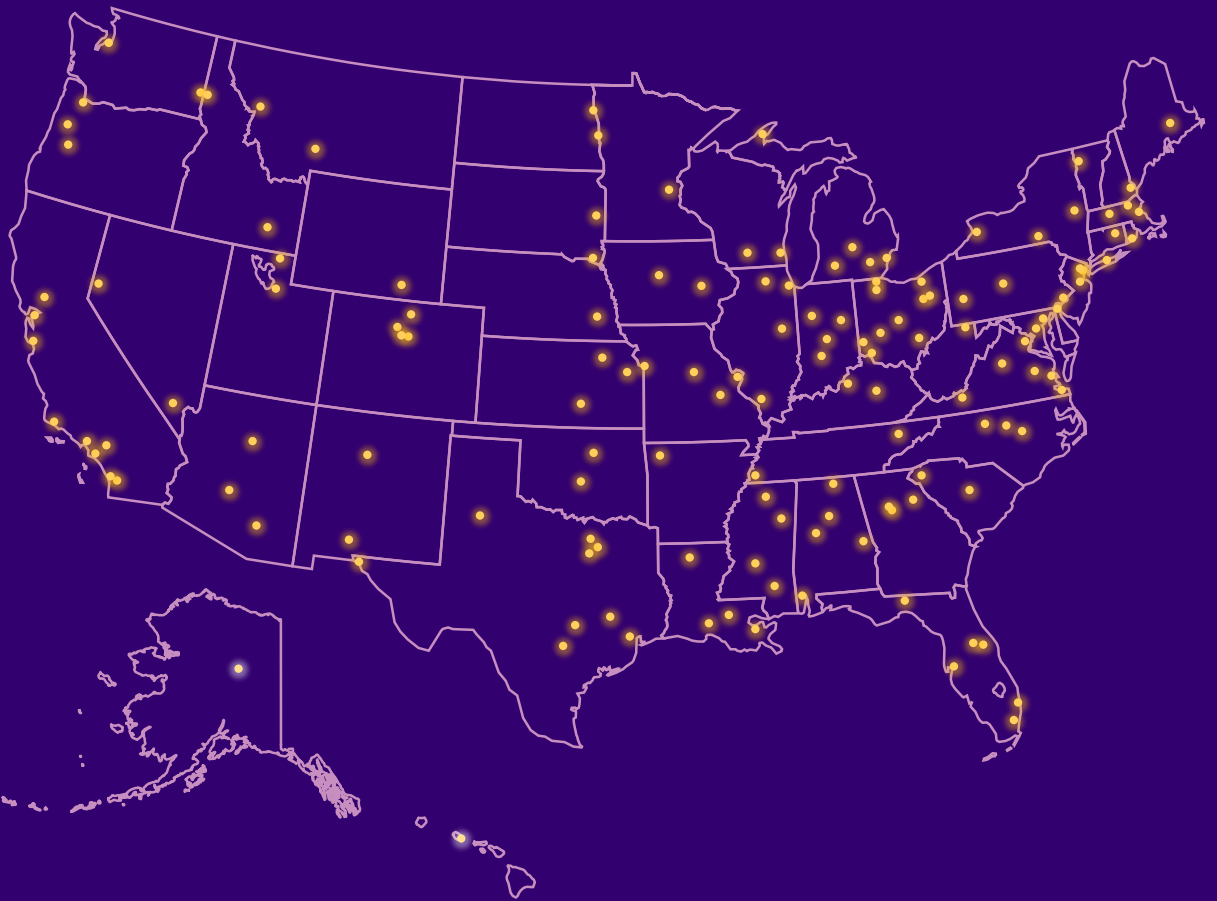


# Public Research Universities: Serving the Public Good



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*Cover:* The lights on the map represent the locations of Carnegie-classified Very High Research Activity and High Research Activity public universities in the United States as of January 2016.

# Public Research Universities: Serving the Public Good



## Introduction

**Public research universities support America’s technological innovation, its democratic vitality, and the promise of opportunity for the next generation.** Although they represent only 3 percent of the total number of institutions in the U.S. higher education system, their impact is profound. Public research universities transform the lives of the students and families they serve; and they improve the well-being of the entire nation—and much of the global community—through contributions to research, infrastructure, our knowledge base, and the economy.



The Lincoln Project defines **public research universities** as institutions of higher education that **receive a portion of their funding from state and local appropriations**, educate undergraduate and graduate students, are Carnegie-classified as Very High and High Research Activity universities, and are located in one of the fifty states.

Public research universities educate about 20 percent of all students nationwide; among the nation's research universities, they award 65 percent of all master's degrees and 68 percent of all research doctorate degrees. They enroll 3.8 million students, including almost 900,000 graduate students, annually.<sup>1</sup> Public research universities produce researchers, educators, entrepreneurs, civic leaders, and the basic research breakthroughs that drive innovation, grow our economy, and benefit the daily lives of all Americans.<sup>2</sup> Between 2012 and 2013 alone, research at public universities resulted in more than 13,322 patent applications, 522 start-up companies, and 3,094 intellectual property licenses.<sup>3</sup>

Public research universities also support the upward social mobility of large numbers of talented and ambitious young people from low socioeco-

nomic status backgrounds, many of whom are the first in their family to pursue postsecondary education. Public research universities provide a high-quality university education at reduced cost and act as pathways to higher-paying jobs than would otherwise be obtainable for most students. The sizable enrollment of undergraduate students from low-income families reflects the mission of public research universities to serve all facets of U.S. society; 31 percent of undergraduate students who attend public research universities receive Pell Grants, and the eight research universities with the highest shares of students who receive Pell Grants are all public.<sup>4</sup>

But there is growing concern about the future of these vital institutions. Over the last decade, and especially following the economic collapse of 2008, nearly every state in the nation has dramatically reduced its investment in higher education, with public research universities receiving the most severe cuts. Since 2008, public research universities have suffered a 26 percent drop in state investment.<sup>5</sup> Further, declining federal funds for research have added to the strain, despite the slight rebound afforded by the 2016 omnibus spending measure. The current funding model is broken and getting worse, putting at risk a critical component of the nation's postsecondary education system and research infrastructure.

The American Academy of Arts & Sciences has created the **Lincoln Project: Excellence and Access in Public Higher Education** to study the importance of public research universities, analyze economic trends affecting their operation, and recommend new strategies to sustain and strengthen these critical institutions. This publication, the fourth in a series of five Lincoln Project reports, examines the many ways in which public research universities contribute to their communities, states, regions, and the nation, and provides empirical evidence of their service to the public good.

## Section 1: Public Research Universities are Centers of Discovery

**Public research universities are responsible for conducting much of the nation's core research in science, medicine, engineering, and technology.** During and after World War II, the nation's federal research and development was performed primarily by national laboratories and industrial research laboratories, including those supported by Bell Telephone, Xerox, and Hewlett Packard. But many of these great industrial laboratories have since shut their doors, and American companies have formed partnerships with research universities to fill the gap.<sup>6</sup>

The discoveries made by researchers at public research universities have significantly advanced our shared knowledge and improved the health and lives of the public. In all, scientists at public research universities have been awarded fifty-three Nobel Prizes in Physics, Chemistry, and Physiology or Medicine, and fifteen Nobel Prizes in Economic Sciences.<sup>7</sup> Each public research university can claim breakthroughs made on its campus that have improved health, enhanced quality of life, and advanced new industries:

- Important antibiotics, including Streptomycin, were discovered at Rutgers University.<sup>8</sup>
- Life-saving safety devices, including retractable locking seatbelts, were created at the University of Minnesota.<sup>9</sup>
- The CRISPR gene editing system was coined by a researcher at University of California, Berkeley, receiving the 2015 Breakthrough of the Year Award from the editors of *Science*.<sup>10</sup>
- East Texas's blueberry industry and increased watermelon production resulted from agricultural research conducted at Texas A&M University's AgriLife Research center. The center's research has an estimated regional economic impact of more than \$1.2 billion.<sup>11</sup>
- The lithium-ion battery, a critical component of smartphones and tablets, was developed by faculty at the University of Texas at Austin.<sup>12</sup>

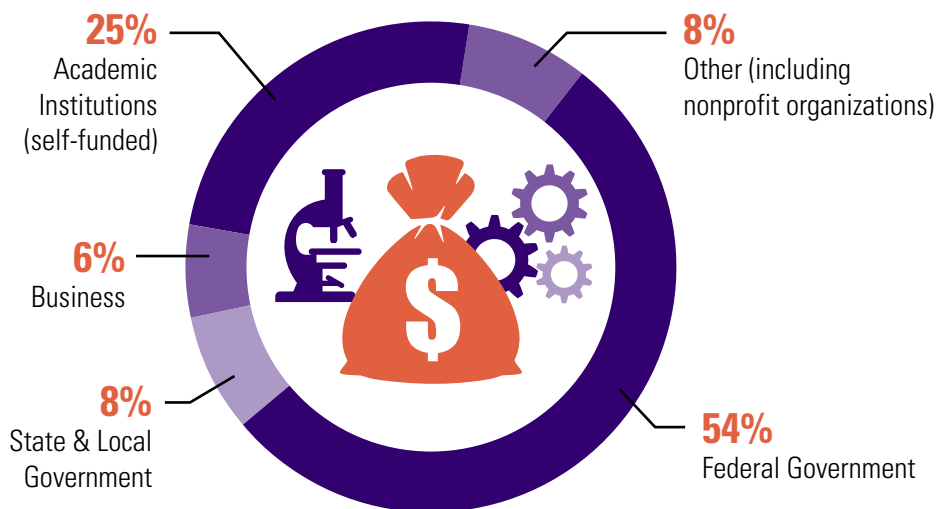
Of the **168 members** elected in 2015 to the National Academy of Inventors, **more than half (90) work at public research universities.**<sup>13</sup> These inventors have made significant contributions to our economy and daily life, **producing research breakthroughs** and creating successful start-up companies.



- Touch screens were developed at the University of Kentucky, and multi-scrolling capabilities originated at the University of Delaware.<sup>14</sup>
- Our social security system was developed using social science research conducted at the University of Wisconsin.<sup>15</sup>
- The advancement of modern industries based on information technology, nanotechnology, and biotechnology that drive our high-tech economy rely on basic research conducted at our public research universities.<sup>16</sup>

Reflecting their position in the nation's research enterprise, public research universities receive more than half of all government, industry, and foundation investment in basic and applied research. In 2014, the combined expenditures of public and private universities on research and development (R&D) totaled \$67.1 billion, of which \$63.7 billion was spent in science and engineering fields.<sup>17</sup> Public universities accounted for 66 percent (\$44.7 billion) of all university R&D expenditures, and public research universities classified as Very High Research Activity accounted for 46 percent (\$31.2 billion) of all R&D expenditures.<sup>18</sup>

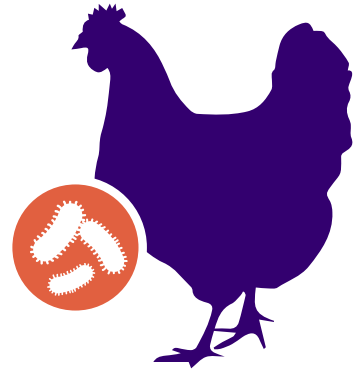
Figure 1: **Sources of Science and Engineering Research and Development Funding at Public Universities, FY2014**



Funding from Academic Institutions excludes research funds spent from multipurpose accounts. Distribution totals 101 percent due to rounding. **Source:** National Science Board, *Science and Engineering Indicators 2016* (Arlington, Va.: National Science Foundation, 2016), Appendix Table 5-3, "Sources of S&E R&D Funding for Public and Private Academic Institutions: Selected Years, FYs 1990-2014," <http://www.nsf.gov/statistics/2016/nsb20161/uploads/1/8/at05-03.pdf>.

## A Case Study: Federally Funded University-Based Research on Food Safety

There were approximately forty-eight million cases of food-borne illnesses in 2011, causing—according to conservative estimates—a \$14 billion burden on the U.S. economy. In response, the U.S. Department of Agriculture funded a pilot project headquartered at Georgia Tech University to investigate what food research is being done, where, by whom, and to what effect.<sup>19</sup> The resulting data sets show how research investments bring about new food safety measures, and the impact that these innovations have on policies governing safe growth, processing, and distribution of food. These connections also show the influence that research dollars have on other outcomes, including student job placement, publication of research articles, and number of patents filed.<sup>20</sup>



## Public Research Universities and the Grand Challenges

Inspired by the White House Office of Science and Technology Policy's 21st Century Grand Challenges program,<sup>21</sup> public research universities are investing in research programs to address our planet's most pressing problems.

- The **University of Indiana** is investing **\$300 million** in addressing challenges that are critical to its state but that can also have a global impact, including health equity, climate change and human well-being, sustainable water resources, environmental and human protection from chemicals, and precision medicine.<sup>22</sup>
- The **University of California** is investing **\$1 billion** over the next five years in a private fund dedicated to the development of large-scale carbon-free energy solutions.<sup>23</sup>
- The **University of Michigan** will spend **\$100 million** over the next five years on research and teaching related to data science and the power of big data for the good of society.<sup>24</sup>
- In 2013, **Texas A&M University** established an interdisciplinary Grand Challenges initiative that funds up to six faculty teams each year to tackle global issues facing the environment, food, human health, education, and the economy. **Each winning team receives \$150,000** for two years of research.<sup>25</sup>
- Many public research universities are utilizing their interdisciplinary centers and programs to gather perspectives from diverse disciplines, including the humanities, to find fresh approaches to these challenges. For example, the **University of California, Los Angeles Institute for Society and Genetics** is investigating how public participation transforms the nature of discovery and innovation by bringing together scientists with philosophers, anthropologists, law professors, ethnographers, and other social scientists and humanists engaged in issues in biotechnology, genetics, and genomics.<sup>26</sup>

## Section 2: Public Research Universities Drive Economic Development and Social Well-Being

**Public research universities are anchors of stability and growth in their regions.** As hubs of research and innovation and as cultural institutions—where concerts, plays, public lectures, and political debates take place—they are vital to economic development and the creative economy. Along with other **anchor institutions** that, once established, tend to remain in their location and support their immediate community, universities work with their counties to drive prosperity. Outside of government, public research universities are often the largest employer in their state.<sup>27</sup>

Midtown Detroit, for example, is being revitalized by its anchor institutions. Wayne State University, the Henry Ford Health System, and the Detroit Medical Center are working together to make Midtown a safe and vibrant place, while maximizing local hiring and investments. These anchor institutions employ thirty thousand local residents and enroll thirty-two thousand students. Each year they hire thirty-three hundred new employees and purchase \$1.7 billion in goods and services.<sup>28</sup>

Public research universities help meet a critical need for creative goods and services in local economies. One example is Houston, which has a thriving creative economy, estimated at \$20.53 billion in a 2012 report. This immense demand for artistic goods and services is met in large part by its anchor institutions. With programs in art theory, architecture, film, theater, dance, and industrial design, the University of Houston is a “training ground” for the creative economic sectors and vital to ensuring that businesses can better meet local demand without having to import talent, goods, and services.<sup>29</sup>



**Anchor institutions are** nonprofit institutions—such as **universities, hospitals, museums, performance centers, and libraries**—that take root in and serve a community through economic development, their missions, and the development of intellectual and human capital.

Public research universities drive **innovation districts**, in which anchor institutions and companies cluster and connect with start-ups, business incubators, and technology accelerators. These districts also integrate work with housing and recreation. Innovation districts containing public research universities are emerging in cities like Atlanta, Baltimore, Buffalo, Cleveland, Detroit, Houston, Philadelphia, Pittsburgh, St. Louis, and San Diego. Traditional exurban **science parks** such



as Research Triangle Park in Raleigh-Durham, with over two hundred companies and fifty thousand employees, are expanding into a more urbanized environment for their workers.<sup>30</sup> North Carolina State's Centennial Campus houses over 70 partner organizations alongside NC State research centers, their main library, walking trails, game fields, and an 18-hole golf course. This integrated campus facilitates constant interactions among companies, academic researchers, and nonprofit institutions, and has helped launch over 100 startup companies and bring over 400 new products to market.<sup>31</sup>

The University of Nebraska recently created the Nebraska Innovation Campus next to its main campus in Lincoln to promote knowledge transfer.<sup>32</sup> The University of Michigan joined a collaboration of the auto, technology, urban planning, and insurance industries and the local government in creating a thirty-two-acre facility on its north campus called Mcity. At Mcity, partnering organizations combine knowledge and resources to test connected and automated vehicles and transportation systems.<sup>33</sup>

Public research universities also create and operate **incubators** to serve the local community and stimulate its economy. TechTown, an incubator at Wayne State University in Detroit, served 1,026 companies from 2007 to 2014, raising more than \$107.26 million in startup capital and contributing 1,190 jobs to the local economy.<sup>34</sup> In a growing national trend, universities are also developing incubators to foster an entrepreneurial ecosystem on campus. The University of Massachusetts, Dartmouth launched its Center for Innovation and Entrepreneurship in 2001. This incubator has hosted 41 companies on campus, more than a dozen of which have since established their own corporate spaces, and has grown the Massachusetts economy by millions of dollars.<sup>35</sup>

The Institute for Research on Innovation and Science (IRIS), formed in January 2015 at the University of Michigan, is a national collaborative coordinating efforts around

## Fostering New Businesses and Entrepreneurship

Through knowledge and technology transfer, business incubation and support, community outreach, and the education of about four million students per year, public research universities play myriad roles that together return billions of dollars in revenues.<sup>36</sup>

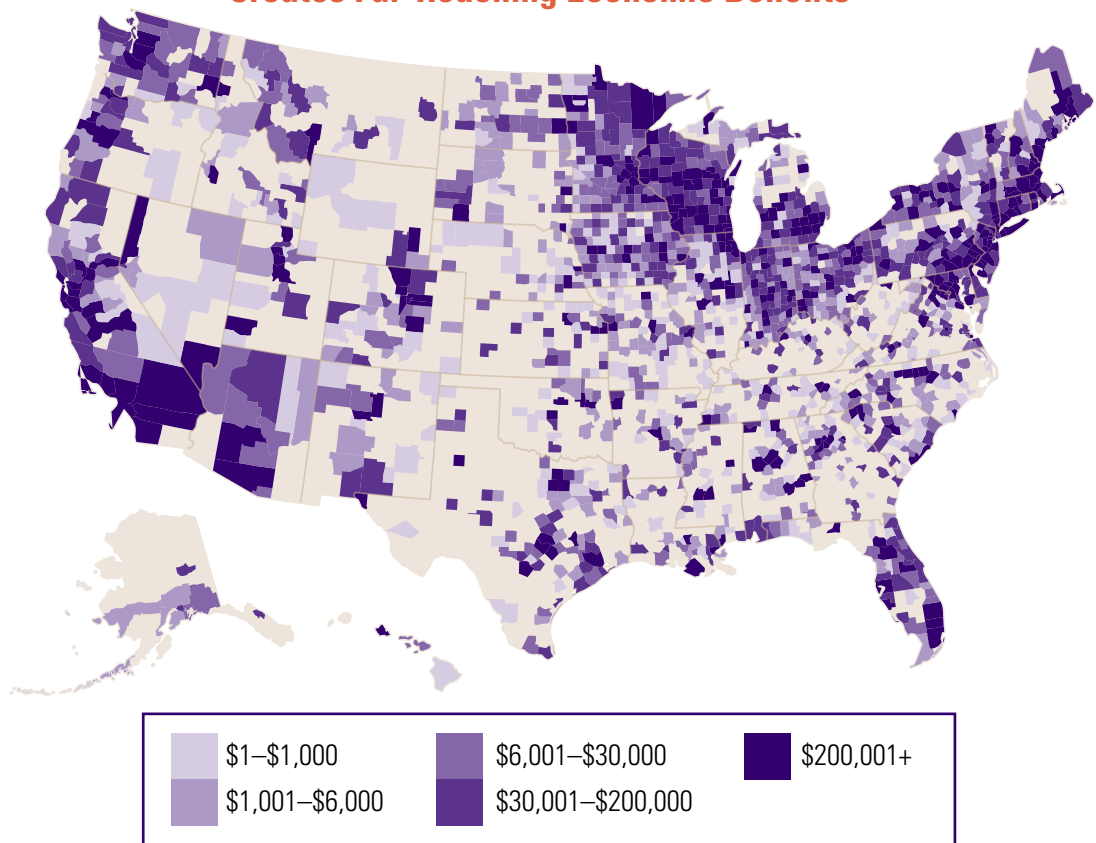
Public research universities from twenty-two states were named among the **Reuters Top 100 World's Most Innovative Universities in 2015** that "most reliably produce original research, create useful technology, and have the greatest economic impact."<sup>37</sup> Further, among the top fifty universities in the world at producing venture-capital backed entrepreneurs, twenty are public research universities.<sup>38</sup>

In 2014, the **University of Washington (UW)** received \$1.4 billion in total sponsored grants and contracts, including \$800 million in federal funding. Its Center for Commercialization launched 19 new start-ups, bringing its ten-year total to 103. UW research funding created about 25,960 jobs statewide, and the university generated \$12.5 billion in total economic impact in Washington State.<sup>39</sup>

Graduates of public research universities also go on to build companies in their university's state: alumni graduating from undergraduate programs at public research universities in the last five years have secured **\$28.6 billion in venture capital to create 3,458 companies.**<sup>40</sup>

the country to measure the impact of university investment. By linking federal award data to university transactions—including spending and payroll records and U.S. Census Bureau data—IRIS allows researchers to track and analyze information on knowledge transfer, economic impact, and job creation. IRIS’s work is already producing significant results, as illustrated in Figures 2 and 3.

Figure 2: **Public Research University Spending Creates Far-Reaching Economic Benefits**



The map shows county-level vendor and subcontractor spending for project research sponsored by eight public research university campuses: Ohio State University, Penn State, Purdue, University of Indiana, University of Iowa, University of Michigan, University of Minnesota, and University of Wisconsin. **Source:** IRIS (Institute for Research on Innovation and Science). IRIS PIs include James Evans, University of Chicago; Julia Lane, NYU; Barbara McFadden Allen, CIC (Committee on Institutional Cooperation); Jason Owen-Smith, University of Michigan; and Bruce Weinberg, Ohio State University. Visit <http://iris.isr.umich.edu/> for more information. See also Bruce A. Weinberg, Jason Owen-Smith, Rebecca F. Rosen, Lou Schwarz, Barbara McFadden Allen, Roy E. Weiss, and Julia Lane, “Science Funding and Short-Term Economic Activity,” *Science* 344 (6179) (2014): 41–43.

## Vendor Spending and On-Campus Employment

Public research university vendor spending from sponsored research projects is surprisingly widespread and illustrates the broad reach of these institutions as hubs of educational, research, and cultural activities. Between the third quarter of 2013 and the second quarter of 2014, the eight Midwestern universities represented in Figure 2 spent over \$1.76 billion on goods and services from vendors in 1,750 counties across the United States. These research projects also paid wages to 70,929 research employees during the same period. Slightly more than 16 percent of the people employed on these grants were faculty members. The remaining 84 percent were professional staff, postdoctoral researchers, and undergraduate and graduate students.<sup>41</sup>

## Employment and Earning Outcomes for Ph.D. Recipients

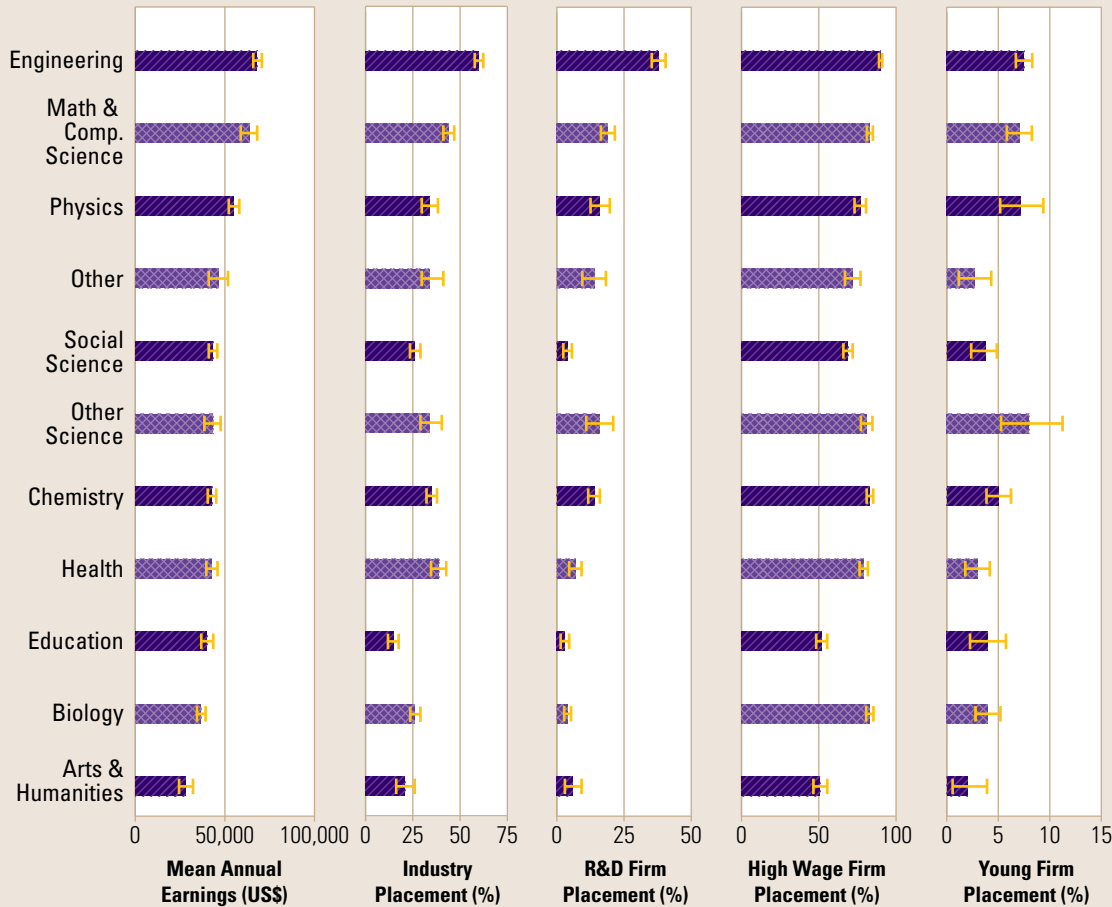
IRIS and U.S. Census Bureau data suggest that funding for academic research is positively linked to personal and national economic growth. Nearly 40 percent of new Ph.D.s from the eight public research universities studied by IRIS took jobs in industry. Many of those positions were at large and high-wage enterprises operating in high-tech and professional service industries that perform R&D and transmit knowledge from research to the marketplace. Engineers, physicists, and computer scientists were also likely to join young firms that directly facilitate economic growth.<sup>42</sup>

Table 1: **Postgraduation Employment of UMETRICS Doctoral Recipients who were Paid by Research Grants and Left the University between 2009 and 2011**

	Doctoral recipients placed in sector (%)				
	Industry		Academia	Government	All
	R&D firms	Non-R&D firms			
Placed within sector	17.0	21.7	57.1	4.1	100.0
National sample ( <i>M</i> )	10.8	75.0	10.7	3.5	100.0
Of those in sector, percent placed:					
Within 50 miles	10.1	23.5	8.9	18.2	12.7
Within state	16.6	36.0	18.0	25.8	22.0

Table reproduced with permission. Source: Nikolas Zolas, Nathan Goldschlag, Ron Jarmin, Paula Stephan, Jason Owen-Smith, Rebecca F. Rosen, Barbara McFadden Allen, Bruce A. Weinberg, and Julia I. Lane, "Wrapping It Up in a Person: Examining Employment and Earnings Outcomes for Ph.D. Recipients," *Science* 350 (6266) (2015): 1367.

Figure 3: **The Annual Earnings and Placement of Doctoral Recipients Supported by Grants Vary by Field**



Purple bars represent the mean for each variable, and yellow lines (error bars) indicate the standard error. Figure reproduced with permission. **Source:** Nikolas Zolas, Nathan Goldschlag, Ron Jarmin, Paula Stephan, Jason Owen-Smith, Rebecca F. Rosen, Barbara McFadden Allen, Bruce A. Weinberg, and Julia I. Lane, "Wrapping It Up in a Person: Examining Employment and Earnings Outcomes for Ph.D. Recipients," *Science* 350 (6266) (2015): 1369.

## Section 3: Public Research Universities Serve Their Communities

**Public research universities are centers of cultural learning; they house museums, theaters, and athletic centers that are open to the public.** These hubs enhance the quality of community life by serving as access points to arts, performance, and athletic events; offering recreational activities and educational outreach to K–12 schools; and engaging undergraduate and graduate students in internships and direct service. Public research universities also drive efforts to improve student achievement. Through the Albany Promise, a regional, cross-sector partnership, the University at Albany, SUNY has created a district-wide assessment for incoming kindergarteners, aligned in-school and after-school programs, and increased SAT participation among high school seniors by 29 percent (from 53 percent in AY2013 to 82 percent in AY2014).<sup>43</sup>

Housed at Rutgers University-Newark, the Newark City of Learning Collaborative (NCLC) works with area public higher education institutions, over 60 local organizations, major corporations, Newark Public Schools, and the City of Newark to raise the percentage of residents in Newark with a postsecondary degree from 17 to 25 percent by 2025. The NCLC collectively tracks citywide enrollment, retention, and completion while also strengthening college readiness programs; simplifies and aligns college pathways from high school to postsecondary institutions; and increases financial support and career development opportunities for young students and adult-learners alike.<sup>44</sup>

Professional schools at public research universities also foster community service and engagement. The Center for Rural Health and Social Service Development at Southern Illinois University's School of Medicine educates members of the community on important health topics. One of their programs works to fill education gaps in southern Illinois by hosting workshops, trainings, and conferences for rural health care and social service providers.<sup>46</sup> Similarly, the Public Interest Institute through the

The **4-H Tech Wizards program** developed by the **Oregon State University** Extension Service, mentors youth in **vital computer and technology skills**. The program has taken root in Georgia, Mississippi, and Texas.

And when a series of severe storms and tornadoes struck Mississippi in 2014, leaving many residents without access to computers, **4-Hers set up mobile computer stations** at local malls and churches, enabling residents to stay in touch with family members and sign up for insurance.<sup>45</sup>



University of Alabama’s School of Law actively seeks out opportunities for pro bono service and participates in Birmingham’s annual Project Homeless Connect.<sup>47</sup>

As concerns about resource scarcity continue to intensify, public research universities have made important advances in managing land and natural resources. The University of Arizona, Pima County and the city of Tucson recently opened the Water & Energy Sustainable Technology (WEST) Center, a public-private-academic partnership that helps communities manage water scarcity and develop new technologies necessary to improve water security.<sup>48</sup> In this way, the University of Arizona is able to bring its extensive research and intellectual capital to the businesses and public works programs that can transform them into action.

Many public research universities offer large extension programs—both traditional and urban—that offer degree-granting and nondegree educational opportunities through outreach and distance learning. Oklahoma State University is offering a Massive Open Online Course (MOOC) entitled “Farm to Fork: A Panoramic View of Agriculture,” which connects students with the agricultural practices and workers who provide the food they consume. Last spring, more than seventy Oklahoma State students enrolled in the online course for credit and more than seven hundred learners from within and outside the student community participated for free.<sup>49</sup>

Public research universities also play a special role with 4-H, the youth development program of the Cooperative Extension System of land-grant universities. Universities provide research-driven programming to help 4-Hers engage in hands-on learning activities in the areas of science, citizenship, and healthy living, and help 4-Hers respond directly to areas of need in their communities. With a network of six million youths, six hundred thousand volunteers, thirty-five hundred professionals, and more than twenty-five million alumni, the impact and reach of the organization is vast.<sup>50</sup>

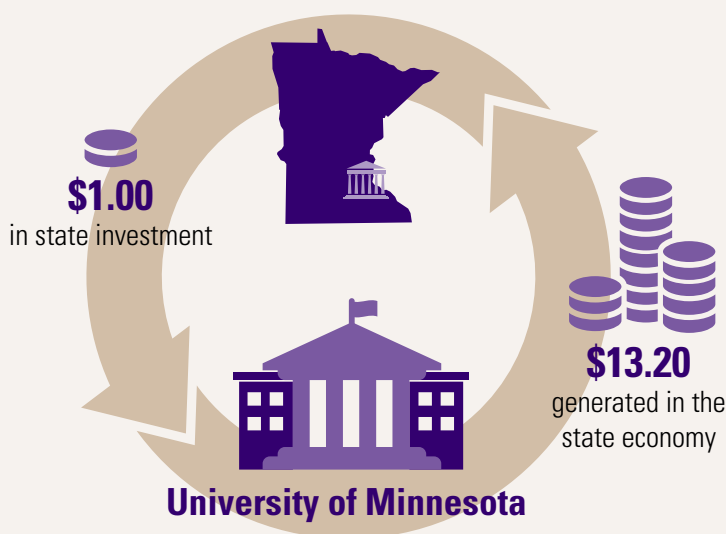
## Conclusion

Public research universities are dedicated to the public: that is their mission; it is the value that animates all of their activities. They serve their communities, states, region, and the nation through their commitment to excellence and access. They have contributed broadly to economic growth, innovation, upward socioeconomic mobility, civic engagement, and our vibrant democracy. The United States’ public research universities are unparalleled in the level of service provided to the nation through research, economic stimulus, and individual well-being.

In its fifth and final publication, the Lincoln Project will offer substantive policy recommendations for sustaining public research universities, calling on all funding partners—states, the federal government, philanthropies, business, and the public—to maintain and enhance their investment in these institutions.

## Appendix: Case Study—The University of Minnesota

Figure 4: **State Investment in the University of Minnesota has Provided Enormous Returns**



Data from FY2009–2010. Source: Tripp Umbach, *The Economic and Societal Impact of the University of Minnesota* (Pittsburgh: Tripp Umbach, 2011), 5, [http://impact.umn.edu/assets/pdf/Final\\_Report.pdf](http://impact.umn.edu/assets/pdf/Final_Report.pdf).

*“The last five decades reveal that college access is a strongly shared value among citizens and policymakers in Minnesota. In 1963, a legislative committee codified this value by creating the ‘35 mile rule,’ which demonstrated the state’s prioritization of access to higher education by establishing a college campus within 35 miles of every Minnesotan. As a result of the 35 mile rule, between 1963 and 1983 Minnesota developed more 2 year campuses per capita than nearly any state in the country. Many towns viewed a college campus as a community asset and encouraged development. Today a highly educated populace is the legacy of the 35 mile rule, evidenced by Minnesota’s ranking as the 8th best-educated state in the nation, with nearly 10 percent of Minnesotans holding advanced degrees and 63 percent with at least some college education.”<sup>51</sup>*

– College Funding in Context: Understanding the Difference in Higher Education Appropriations across the States

Among the state's public colleges and universities, the University of Minnesota serves the largest number of students (nearly seventy thousand each year).<sup>52</sup> According to the most recent analysis, for 2009–2010, the University of Minnesota generated \$8.6 billion in economic impact for the state,

**University of Minnesota** alumni have founded approximately ten thousand companies in the state, generating **\$100 billion in annual state revenues**. One-quarter of these alumni originated as out-of-state students.

measured as dollars generated within Minnesota due to the presence of the university, both as direct expenditures (\$4.1 billion) for goods and services by the university, its employees, students, and visitors; and indirect or induced spending (\$4.5 billion) circulating within the state and supporting local businesses.<sup>53</sup>

As of 2011, the University of Minnesota had eighty-seven extension county offices, fifteen regional extension offices, seven research and outreach centers, and thirty-five thousand volunteers to partner

with educator-researchers. Staying true to their mission as part of a land-grant university dedicated to serving its region, university staff (including medical staff), faculty, and students routinely provide free medical care, volunteer in local communities, and make donations to charitable organizations. Estimates value these benefits to the Minnesota community at \$204 million per year.<sup>54</sup>

The University of Minnesota is also a hub of research, featuring an Academic Health Center, a Center for Magnetic Resonance Research, a Stem Cell Institute, an Institute for Translational Genetics, and MnDRIVE, which has resulted in 120 state projects among 354 collaborative researchers across multiple sectors, examining robotics, sensors, and advanced manufacturing along with global food ventures, treatments for brain conditions, and energy conservation.<sup>55</sup> These centers and others span across diverse fields including mathematics, psychology, biology, and engineering.

Over 65 percent of University of Minnesota students who have graduated since 1980 continue to live in the state. Alumni have founded an estimated ten thousand companies in the state, with one-quarter of the companies' founders originating as out-of-state students. All together, companies founded by University of Minnesota alumni are estimated to generate \$100 billion in annual revenues and employ five hundred thousand state residents.<sup>56</sup>

In 1983, the Minnesota state legislature passed the Design for Shared Responsibility, or the Funding Policy Statute (135A.01), which mandated state support of two-thirds of instructional costs at public colleges and universities. But the protection afforded by that statute has eroded over time and public universities in Minnesota, as in other states, have faced significant reductions in state funding. Minnesota now ranks tenth among states experiencing the sharpest decline in educational appropriations per full-time equivalent (FTE) student over the past five years (down 32.8 percent from FY2008 to FY2013).<sup>57</sup> Meanwhile, FTE student enrollments have risen 7.4 percent during this same period, reaching 210,546 FTE students in FY2013.



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