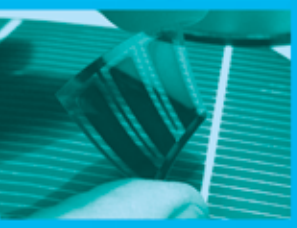
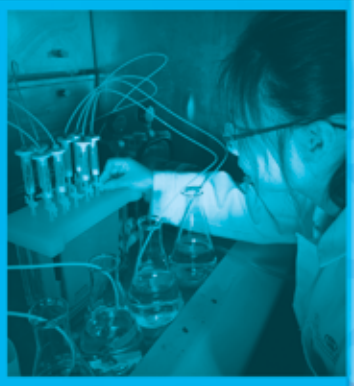




Diminishing Funding and Rising Expectations: Trends and Challenges for Public Research Universities



A COMPANION TO **SCIENCE** AND **ENGINEERING INDICATORS** 2012

NATIONAL SCIENCE BOARD

NATIONAL SCIENCE FOUNDATION

NATIONAL SCIENCE BOARD

Dan E. Arvizu, *Chairman*, Director and Chief Executive, National Renewable Energy Laboratory (NREL), Golden, Colorado

Kelvin K. Droegemeier,[†] *Vice Chairman*, Vice President for Research, Regents' Professor of Meteorology and Weathernews Chair Emeritus, University of Oklahoma, Norman

Mark R. Abbott,[*] Dean and Professor, College of Earth, Ocean, and Atmospheric Sciences, Oregon State University, Corvallis

Bonnie L. Bassler, Howard Hughes Medical Institute Investigator and Squibb Professor of Molecular Biology, Princeton University, New Jersey

Camilla P. Benbow,[*] Patricia and Rodes Hart Dean of Education and Human Development, Peabody College, Vanderbilt University, Nashville, Tennessee

Arthur Bienenstock,[*] Professor Emeritus of Photon Science, Stanford University, California

Ray M. Bowen, President Emeritus, Texas A&M University, College Station and Visiting Distinguished Professor, Rice University, Houston, Texas

John T. Bruer,[*] President, The James S. McDonnell Foundation, Saint Louis, Missouri

France A. Córdova,[†] President Emeritus, Purdue University, West Lafayette, Indiana

Patricia D. Galloway,[*] Chief Executive Officer, Pegasus Global Holdings, Inc., Cle Elum, Washington

José-Marie Griffiths,[*] Vice President for Academic Affairs and University Professor, Bryant University, Smithfield, Rhode Island

Esin Gulari, Dean of Engineering and Science, Clemson University, South Carolina

Alan I. Leshner, Chief Executive Officer, American Association for the Advancement of Science, and Executive Publisher, *Science*, Washington, DC

W. Carl Lineberger, E.U. Condon Distinguished Professor of Chemistry and Fellow of JILA, University of Colorado, Boulder

G.P. "Bud" Peterson, President, Georgia Institute of Technology, Atlanta

Douglas D. Randall, Professor Emeritus and Thomas Jefferson Fellow and Director Emeritus, Interdisciplinary Plant Group, University of Missouri, Columbia

Arthur K. Reilly,[*] Retired Senior Director, Strategic Technology Policy, Cisco Systems, Inc., Ocean, New Jersey

Anneila I. Sargent, Benjamin M. Rosen Professor of Astronomy and Vice President for Student Affairs, California Institute of Technology, Pasadena

Diane L. Souvaine, Professor of Computer Science and Mathematics, Tufts University, Medford, Massachusetts

Arnold F. Stancell, Emeritus Professor and Turner Leadership Chair, School of Chemistry and Biomolecular Engineering, Georgia Institute of Technology, Atlanta

Claude M. Steele, Dean, School of Education, Stanford University, California

Thomas N. Taylor,[*] Roy A. Roberts Distinguished Professor, Department of Ecology and Evolutionary Biology, Curator of Paleobotany in the Natural History Museum and Biodiversity Research Center, The University of Kansas, Lawrence

Richard F. Thompson,[*] Keck Professor of Psychology and Biological Sciences, University of Southern California, Los Angeles

Robert J. Zimmer, President, University of Chicago, Illinois

Member *ex officio*: **Subra Suresh**, Director, National Science Foundation, Arlington, Virginia

Michael L. Van Woert, Executive Officer, National Science Board and National Science Board Office Director, Arlington, Virginia

Committee on Science and Engineering Indicators

Ray M. Bowen, *Chairman*[†]
José-Marie Griffiths, *Chairman, 2010-2012*[*†]

Bonnie L. Bassler
Camilla P. Benbow[*†]
Arthur Bienenstock[*]
John T. Bruer[*]
W. Carl Lineberger
G.P. "Bud" Peterson
Douglas D. Randall
Arthur K. Reilly[*†]
Claude M. Steele
Richard F. Thompson[*]
Robert J. Zimmer

Executive Secretaries

Robert K. Bell
Nirmala Kannankutty
Rolf F. Lehming

National Science Board Office

Lisa M. Nichols, *Staff Lead*
Matthew B. Wilson, *Liaison*

[*] Board consultant
[†] Member, *ad hoc* group on public research universities

National Science Board

July 18, 2012

Dear Colleague:

As part of our mandate from Congress, the National Science Board (Board) supervises the collection of a very broad set of policy-neutral, quantitative information about U.S. science, engineering, and technology, and publishes the data and trends biennially in our *Science and Engineering Indicators* (*Indicators*) report. The data in *Indicators* reveal some trends that raise important policy concerns that the Board then conveys to the President, Congress, and the public in the form of a "companion" policy statement to the *Indicators* report.

In the 2012 edition of *Indicators,* the Board reported a substantial decline over the last decade in per student state appropriations at the Nation's major public research universities. This companion report to *Indicators, Diminishing Funding and Rising Expectations: Trends and Challenges for Public Research Universities*, highlights the importance of these universities to state and national economies, rising public expectations for university education and research, and the challenges posed by recent trends in enrollment, revenue, and expenditures.

The Nation's public research universities play a vital role in preparing the next generation of innovators—educating and training a large number of science and engineering students at the undergraduate and graduate levels while maintaining relative affordability. They perform over half of all academic research and development, are contributors to state and local economies, and provide numerous public services. In the wake of increasing enrollment and costs and declining per student state appropriations, the Board is concerned with the continued ability of these institutions to provide affordable, quality education and training to a broad range of students, conduct the basic science and engineering research that leads to innovations, and perform their public service missions.

In future editions of *Indicators*, the Board intends to expand the treatment of higher education institutions while providing greater depth of analysis specific to public research universities. The 2014 edition of *Indicators* will include consistent, policy-neutral information that policy-makers can use in considering whether these universities can meet local, state, and national demand for the type of skilled S&E workers and transformative research necessary to fuel economic growth and to address societal challenges.

Dan E. Arvizu
Chairman

National Science Foundation

4201 Wilson Boulevard • Arlington, Virginia 22230 • (703) 292-7000 • www.nsf.gov/nsb • email: nationalsciencebrd@nsf.gov

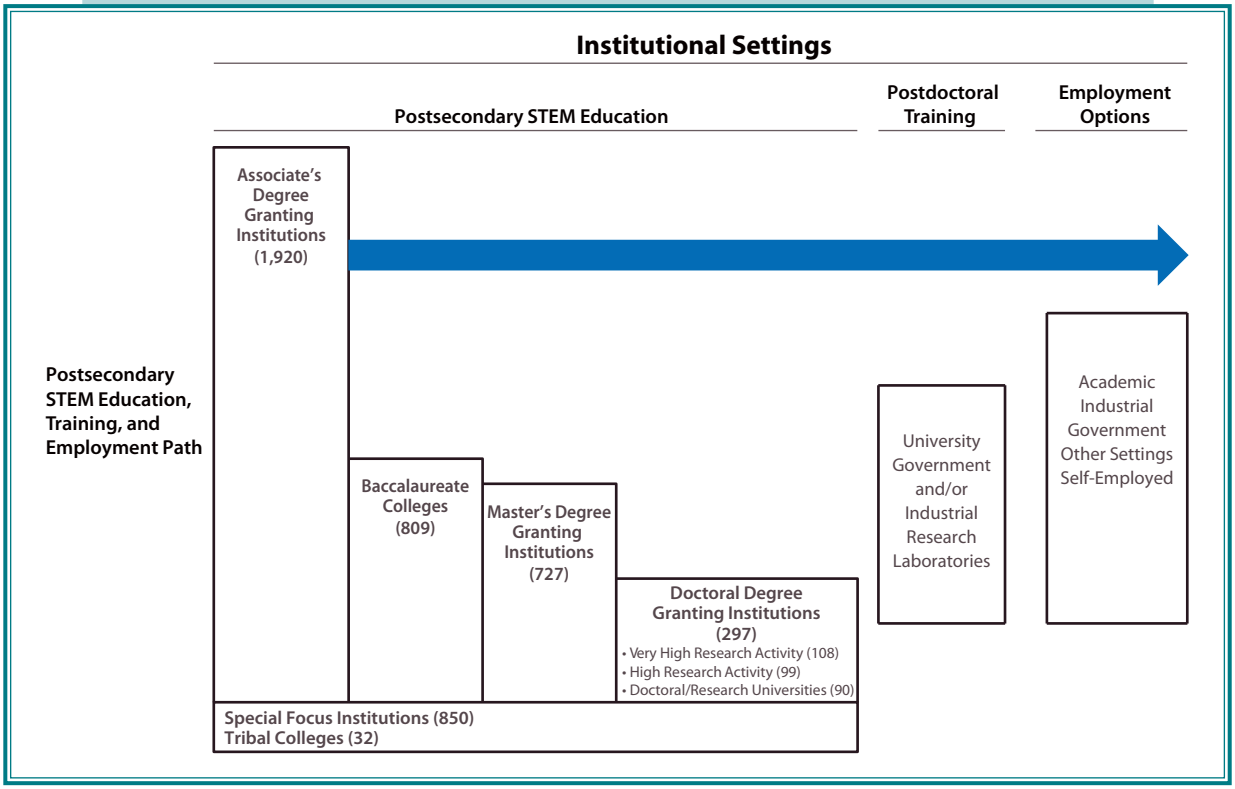
CONTENTS

INTRODUCTION

The higher education landscape in the U.S. comprises a diverse array of approximately 4,600 academic institutions (Figure 1), each with a variety of distinguishing characteristics, including mission, learning environments, types of degrees offered, and sector (public, private non-profit, private for-profit). Categorization schemes, such as the *Carnegie Classification of Institutions of Higher Education*, differentiate these institutions primarily by their highest degree conferred, level of degree production, and research activity. Although these institutions are categorized separately, each component part of the higher education system functions symbiotically to provide a continuous source of new knowledge and human capital.

Among these institutions are research universities. Research universities, both public and private alike, are the leading producers of science and engineering (S&E) bachelor's, master's, and doctoral degrees. They are contributors to economic development at the local, state, and national levels, performing over half of the Nation's total basic research in 2009, and they educate and train our Nation's next generation of scientists and engineers.

FIGURE 1: Postsecondary Science, Technology, Education, and Mathematics (STEM) Education, Training, and Employment Path



Note: The 809 baccalaureate colleges include 147 institutions granting both baccalaureate and associate's degrees.

Source: 2010 *Carnegie Classification of Institutions of Higher Education.*

The S&E talent and knowledge produced by academic research form crucial building blocks to innovation that improve the quality of life for our Nation's citizens, create jobs and in some cases even new industries, and are vital to maintaining U.S. global leadership in S&E.[1] The focus of this companion report to *Science and Engineering Indicators 2012* (*Indicators*) is public research universities, which are subject to greater financial and legislative pressure than private counterparts. Nevertheless, the health of the research university system and the overall higher education system relies on the strength of all of its component parts.

Public research universities are research intensive,[2] doctorate-granting institutions that receive a share of funding from state and local appropriations[3] and serve as a critical component of the overall higher education landscape. Though relatively small in number, these universities enroll a disproportionately large number of students at the undergraduate and graduate levels and maintain relatively low tuition when compared with equivalent private universities. They perform over half of academic research and development (R&D) and yield many potential gains for state and local economies, including the creation of hundreds of start-up companies annually. Public research universities also provide a number of services to their states, such as improving access to cutting-edge medical care and contributing to the protection of natural resources at the state and local level.

In the 2012 volume of *Indicators*, the National Science Board (Board) reported a substantial decline over the last decade in per student state appropriations at the Nation's 101 major public research universities[4] as appropriations failed to keep pace with inflation and substantial increases in enrollment. This decline in appropriations contributed to corresponding increases in tuition as universities sought to recoup lost revenue and limit declines in spending that would have otherwise affected the quality of education and training. The Board is concerned about the continued ability of these universities to provide affordable, quality education and training to a broad range of students, conduct the basic science and engineering research that leads to innovations, and perform their public service missions.

In the process of preparing this companion, the Board sought to identify information on public research universities, including data on enrollment, degrees granted, research and training, economic and service contributions, and revenue and expenditures. The Board found that these data were distributed among many sources with varied definitions of public research universities or were not disaggregated to allow for analyses specific to these universities, making it a challenge to create a clear picture of their current condition. The purpose of this companion is two-fold: (1) to highlight the importance of these universities to states and the Nation and describe the challenges posed by recent trends in student population growth and university revenue and costs, and (2) to preface the Board's intent to gather and synthesize trend data on higher education institutions, particularly public research universities, by presenting consistent and well-defined data in future editions of *Indicators* that will facilitate comparisons over time. The Board seeks to provide a factual basis for sound policy deliberations and support existing and future national initiatives.[5,6]

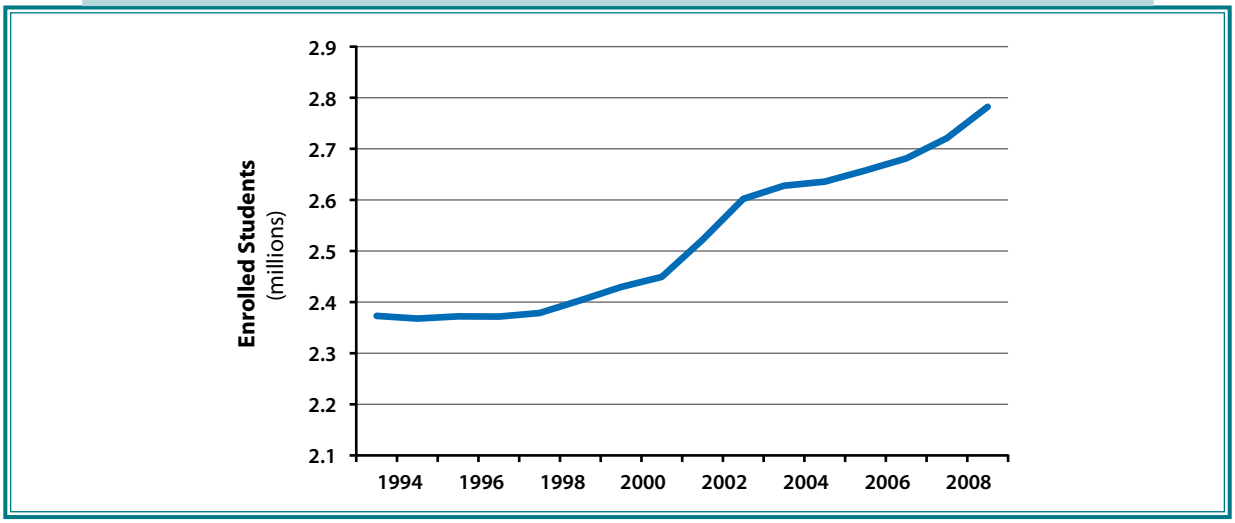
THE VALUE OF PUBLIC RESEARCH UNIVERSITIES

Education and Training

Enrollment at Public Research Universities

Enrollment in all U.S. institutions of higher education is on the rise. During the period from 1994 to 2009, enrollment in post-secondary institutions rose 43 percent. Undergraduate enrollment is projected to increase an additional 16 percent by 2019 as more individuals pursue a college education.[7] Among these institutions are the Nation's major public research universities,[8] where enrollment increased by 17 percent over the same period (Figure 2).[9] Increased enrollment in higher education is projected to come mainly from minority groups, particularly Hispanics.[10] Though enrollment has increased steadily over the last decade, the percentage of freshmen planning to study S&E remained relatively stable at 33 percent between 1972 and 2007. By 2010, this percentage increased gradually to 38 percent.[11]

FIGURE 2: Student Enrollment in Major Public Research Universities, 1994 to 2009



Note: Includes enrollment of all students at all degree levels at the Nation's 101 major public research universities.

Source: National Center for Science and Engineering Statistics (NCSES) special tabulations with data from the National Center for Education Statistics Integrated Postsecondary Education Data System.

Public research universities[12] enroll a large percentage of students including students from under-represented groups. These institutions represented less than 10 percent of all 4-year colleges and universities in the U.S. in 2009, but about 33 percent of first time, full-time undergraduate enrollment that year.[13] According to a report by the Association for Public and Land-Grant Universities (APLU), among the one million minority students enrolled at research universities, 80 percent attend public research universities.[14] Moreover, public 4-year institutions educate a larger proportion of students from lower socio-economic backgrounds than equivalent private institutions.[15]

While public research universities enroll a disproportionate number of students and have witnessed significant increases in enrollment, their share of enrollment has declined. According to data from the Delta Cost Project's *Trends in College Spending* report, the greatest growth in enrollment has occurred at

public 2-year and private for-profit institutions.[16] Two-year colleges also educate a disproportionate number of underrepresented minorities. For example, among the 81 percent of Hispanic students attending public institutions in 2008, 49 percent attended public 2-year colleges while only 13 percent attended public research universities.[17]

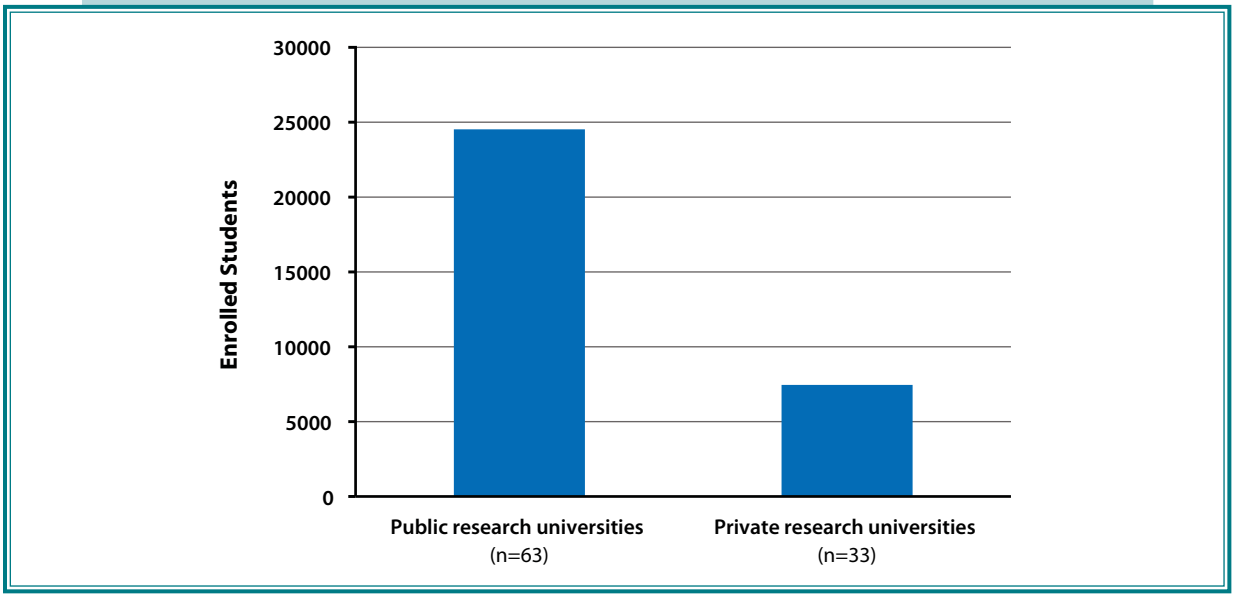
Educating and Training the Nation's Scientists and Engineers

Demand for higher education has grown as more fields require skilled workers, and employment and compensation for college-educated workers have exceeded that of workers without college degrees.[18,19,20] Recent data indicate that the gap in employment and compensation is even greater when college educated workers hold an S&E degree. The Bureau of Labor Statistics' *Current Population Survey* data for 1983 to 2010 indicate that the unemployment rate for all individuals in S&E occupations ranged from 1.3 percent to 4.3 percent, which contrasts favorably with unemployment rates for all U.S. workers (from 4.0 percent to 9.6 percent) and all workers with a bachelor's degree or higher (from 1.8 percent to 7.8 percent).[21] Moreover, labor data show that workers with S&E degrees earn more than those with comparable-level degrees in other fields, regardless of their occupations. For example, in 2012, half of workers in S&E occupations earned $75,820 or more–more than double the median earnings ($33,840) of the total U.S. workforce.[22]

Workforce growth in S&E occupations has exceeded the rate of growth for the general workforce over the last decade and this trend is projected to continue.[23] The Bureau of Labor Statistics projects that S&E occupations will grow by 20.6 percent between 2008 and 2018, while employment in all occupations is projected to grow 10.1 percent over the same time period.[24] These projections involve only the demand for strictly defined S&E occupations and do not include the wider range of jobs in which S&E degree holders often use their training.[25] A recent report from the President's Council of Advisors on Science and Technology (PCAST), *Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics,* calls for one million additional STEM graduates in the next decade.[26] As the leading producers of the Nation's scientists and engineers, public research universities will be vital to this effort. In 2009, public research universities awarded 34 percent of all baccalaureates and more than half of the doctoral degrees conferred by U.S. universities.[27]

Public research universities provide research and education opportunities to the largest proportion of students while maintaining lower tuition than their private counterparts. A review of enrollment data and tuition and fees at the Nation's top public and private research universities demonstrates the value of public universities (Figures 3 and 4).[28] Although the tuition prices at private non-profit institutions are greater, they are discounted through institutional aid, grant aid, tuition waivers and athletic scholarships awarded to students by the university. Tuition was discounted at a rate of 29 percent at private research universities and 18 percent at public research universities in 2009.[29] Tuition at private research universities is discounted principally for students demonstrating financial need, though many elite private institutions offer tuition-free education to students from families with incomes well above levels typically associated with financial need. [30,31]

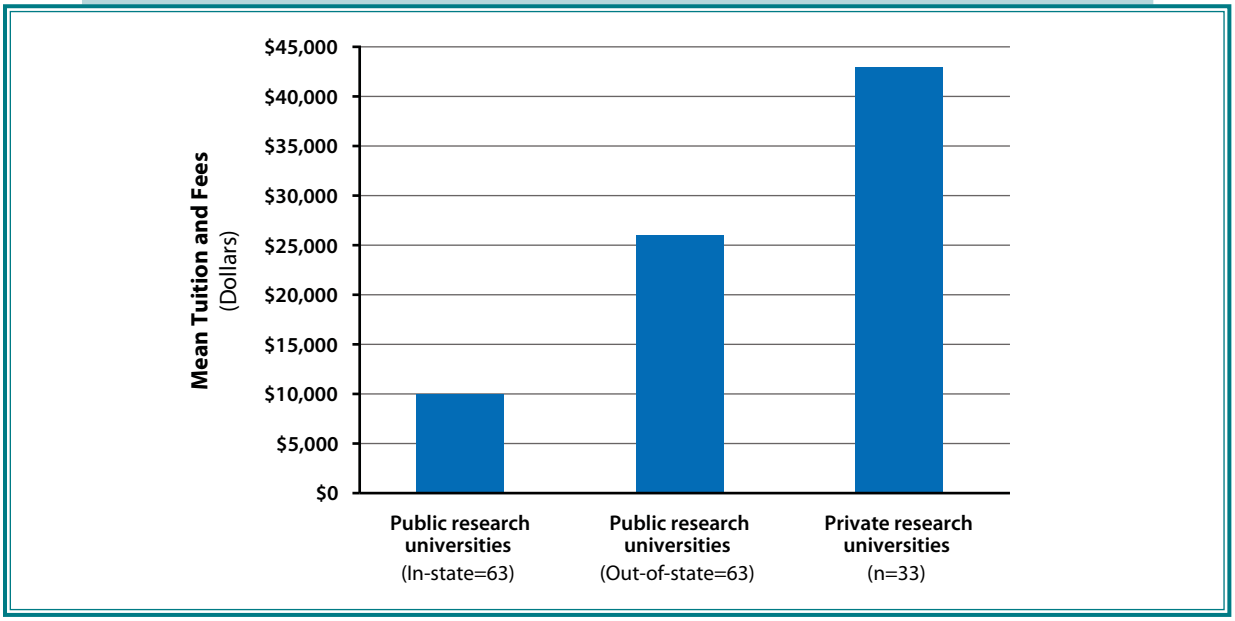
FIGURE 3: Average Undergraduate Enrollment at Public and Private Carnegie Very High Research Universities, Academic Year (AY) 2011-12



Note: Degree-seeking undergraduate enrollment number used for two public and one private university missing total undergraduate enrollment data.

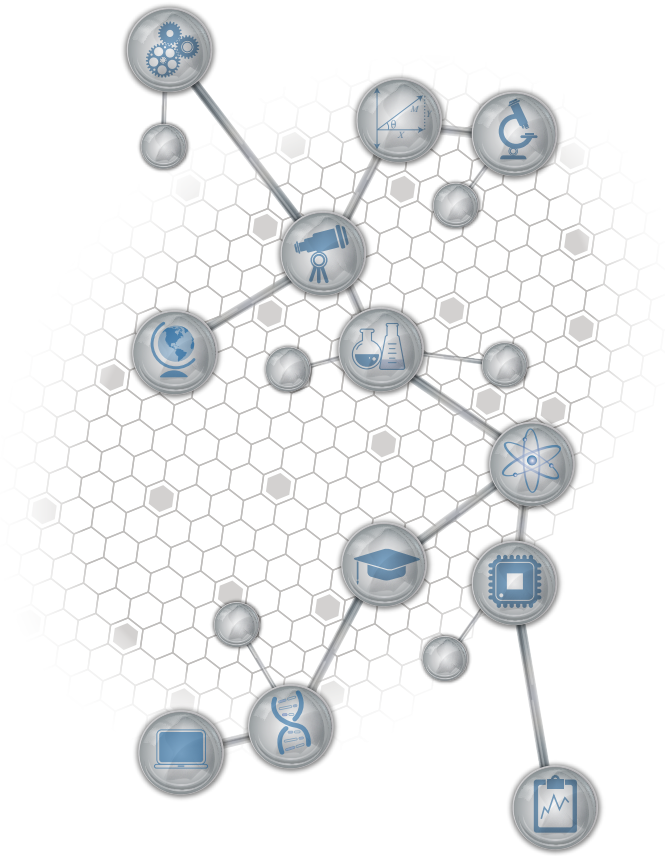
Source: Data provided by The College Board's "Big Future" search engine. Each university was manually searched and data were recorded by the Institute for Defense Analyses (IDA) Science and Technology Policy Institute (STPI).

FIGURE 4: Mean Fall 2012 Tuition and Fees Among Public and Private Carnegie Very High Research Universities



Note: Mean tuition and fees, fall 2012.

Source: The College Board's "Big Future" search engine. Each university was manually searched and data were recorded by STPI.



"Knowledge is the business of the research university: creating knowledge through research, preserving and renewing knowledge through scholarship, transmitting knowledge through teaching and learning, and distributing and applying knowledge in public service."

– Craig Calhoun, "Knowledge Matters: The Public Mission of the Research University"[32]

Academic R&D and Innovation

Public expectations for higher education have evolved as the economy has shifted from material- and labor-intensive products and processes to knowledge-intensive products and services.[33] In the book *Knowledge Matters: The Public Mission of the Research University*, Diane Rhoten and Walter Powell note that public research universities emerged in the United States in the nineteenth century as core social organizations designed to deliver higher education teaching and research as well as other public services, and this mission was further formalized in the twentieth century.[34] In the twenty-first century, the authors suggest that the public university is a contributor to and competitor in an increasingly intertwined global marketplace of knowledge production and innovation.[35] A primary way they make this contribution is through the education and training of our Nation's scientists and engineers and performing research that will generate new knowledge, a vital building block to innovation. In 2009, academic institutions performed 53 percent of the U.S. total basic research and 36 percent of all U.S. research.[36] Public research universities performed a significant share of this research. Of the $32.6 billion of academic spending on S&E R&D provided by the Federal Government public research universities received over 60 percent.[37] This research has yielded a number of potential gains for state and local economies. According to FY 2010 data from the Association of University Technology Managers, research at public universities led to 436 new start-up companies, 2,654 new technology licenses, 10,904 applications for new patents, and 2,625 patents.[38]

The reason I came here today is because this school…and this community represent the future of our economy. Right now, some of the most advanced manufacturing work in America is being done right here in upstate New York. Cutting-edge businesses from all over the world are deciding to build here and hire here. And you've got schools like this one that are training workers with the exact skills that those businesses are looking for.

— President Barack Obama, May 8, 2012, University at Albany–SUNY, College of Nanoscale Science and Engineering

STATE INVESTMENTS IN UNIVERSITY RESEARCH FOR ECONOMIC GROWTH: UNIVERSITY AT ALBANY–SUNY

In the late 1990s, New York State began a series of initiatives and investments to promote the greater Albany region as a high-tech competitor in the area of semiconductors, microelectronics, and nanotechnology. Since then the area has enjoyed a series of major research infrastructure investments anchored by the University at Albany (UAlbany)–State University of New York (SUNY). Taken together, these investments have made Albany an emerging innovation cluster in nanotechnology.

UAlbany-SUNY has been the anchor site for state and local investments totaling $4.2 billion to perform world-class research in advanced nanotechnology, all housed within its College of Nanoscale Science and Engineering (CNSE). The campus grew in 2002 when SEMATECH built a new plant at CNSE; this global consortium of leading nanoelectronics manufacturers later relocated its headquarters and other research and development operations to UAlbany's CNSE campus. In September 2011, New York Governor Andrew M. Cuomo announced a further investment of $400 million in the CNSE campus to facilitate the establishment of the Global 450 Consortium–a $4.4 billion collaboration among five leading international companies working to create the next generation of computer chip technology.[39]

CNSE today employs more than 2,700 workers on its campus, supporting approximately 250 professors and students.[40] Statewide, university and state officials estimate that the college generates roughly 13,000 jobs.[41]

The Global 450 Consortium investments are projected to create and retain approximately 6,900 jobs, including 2,500 additional high-technology positions.[42] In 2011, a report by the TechAmerica Foundation listed New York as the third fastest growing high-tech job market in the country.[43] Through its academic training programs, CNSE also is advancing the education of nanotechnology professionals for the region.

The large research investments at UAlbany are attracting additional Federal funding. CNSE has received more than $70 million in Federal funding awards over the past year from a variety of agencies. For example, the National Science Foundation (NSF) awarded a $600,000 grant to CNSE through their Partnerships for Innovation Program to support economic and workforce development through nanotechnology-enabled innovations in clean energy.

Government agencies that fund basic research are exploring new ways to facilitate the progression from university-based research concepts to marketable products. In July of 2011, NSF launched its Innovation Corps (I-Corps) effort to help develop S&E discoveries into useful technologies, products, and processes.[44] I-Corps is a public-private partnership that will connect NSF-funded scientific research with the technological, entrepreneurial, and business communities.[45] In addition to these Federal Government efforts, a number of universities have affiliated foundations, such as the University of Wisconsin's Alumni Research Foundation, that help to fund and promote technology transfer of university-based research to facilitate private sector job growth and economic development.[46]

The Public Mission

The mission of many public research universities includes service to their state. For instance, in the book *Knowledge Matters: The Public Mission of the Research University*, Michael Kennedy notes that in the University of Michigan's mission statement, the university is specifically charged to "serve the people of Michigan and the world through preeminence in creating, communicating, preserving and applying knowledge, art, and academic values, and in developing leaders and citizens who will challenge the present and enrich the future."[47] As illustrations of public good, apart from economic benefits, the author cites the Public Goods Council,[48] composed of museums, libraries, performance and other programs available to the larger public; the digitization of the university's library for worldwide access;[49] a program dedicated to helping seventh-grade girls master science and math;[50] and the cutting-edge healthcare provided by the university's hospital.[51] University hospitals also may provide greater service to residents in financial need. Although teaching hospitals (both public and private) represent just over 6 percent of all hospitals in the U.S. they account for over one-quarter of all Medicaid patients and 40 percent of all hospital charity care.[52]

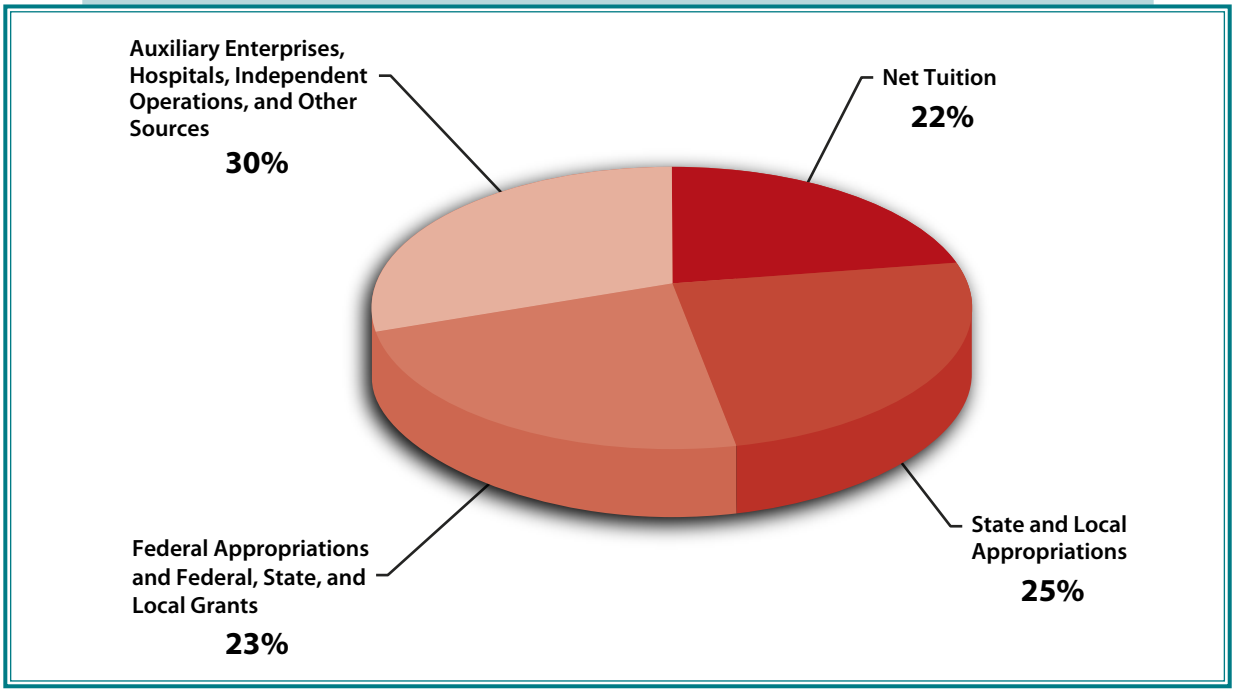
Public research universities–in particular "land-grant" institutions–also play an important role in the development and protection of biological and natural resources in states and localities. Land-grant institutions were established when President Lincoln signed the Morrill Act of 1862. The original legislative intent of the act and resulting land-grant institution system was to teach agricultural and mechanical arts; however, the contemporary outcome has been the development of institutions that have enabled millions of students to receive higher education in a wide variety of disciplines.[53]

A report from the U.S. Department of Agriculture's National Agricultural Statistical Service provides insights into the types of community outreach involving public research universities related to natural resources.[54] For example, an initiative at Rutgers University is documenting the market demand for particular types of crops and finding opportunities for east coast farmers to grow and cooperatively market them, creating a year-round supply of crops while retaining their value. In another example, the University of Maryland is leading the Mid-Atlantic Water Project, which has completed a new nutrient management handbook for the Chesapeake Bay Region. The handbook is a collaborative project of land-grant universities in Maryland, Virginia, Pennsylvania, Delaware, West Virginia, and the District of Columbia that focuses on tools, technologies, and management strategies to improve nutrient management in agriculture.

REVENUE SOURCES FOR PUBLIC RESEARCH UNIVERSITIES

Public research universities have traditionally received the greatest share of funding for institutional operations from state and local appropriations. Although state and local appropriations remain a principal source of revenue for operations, the share from tuition and fees has increased in the wake of declining state appropriations. Other sources of support include Federal funding, private gifts, investment returns, endowment income, and sometimes income from auxiliary enterprises (e.g., athletics, dormitories, bookstores, meal services, and hospitals) (Figure 5).

FIGURE 5: Average Revenues at Public Research Institutions, AY 2008-09



Note: Private gifts, investment returns, and endowment income were negative in AY 2008-09, a period of recession (declining to -$387 of the $35,736 in per student operating revenue), but otherwise have been positive, averaging $2,329 (2009 dollars) over the 5-year period from AY 2003-04 to AY 2007-08.

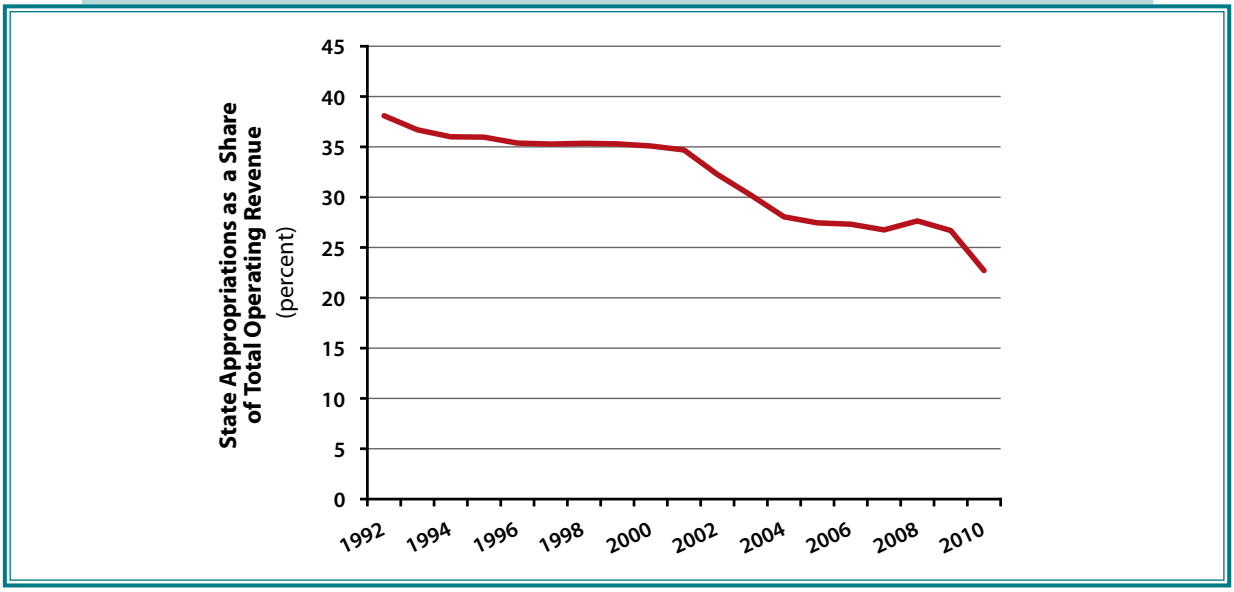
Source: Figure A1, Delta Cost Project, *Trends in College Spending.*

State Appropriations

Public research universities rely on state funding for a share of their operating revenues, most of which supports their education function. In the 2012 edition of *Indicators*, the Board examined data on state funding for 101 major public research universities that were either among the top recipients of academic R&D funding in the country or the leading recipients in their state.[55] During the period from 1992 to 2010, state appropriations as a percentage of public research universities' total revenue fell by 15 percentage points from 38 percent in 1992 to an average of 23 percent in 2010 (Figure 6).[56] During the period from 1992 to 2001 enrollment increased by only 2 percent, and state funding (constant 2005 dollars) increased 25 percent, or 23 percent per enrolled student (Table, p. 20-21). In contrast, over

the following decade, from 2002 to 2010, enrollment increased 13 percent, and state funding failed to keep pace. As a result, state funding per enrolled student[57] dropped 20 percent over this time period.[58] This decline in funding can impact these institutions' financial health and the quality of education provided.

FIGURE 6: State Appropriations as a Percentage of Public Research Universities Total Operating Revenue, 1992 to 2010



Note: These NCSES tabulations exclude Pennsylvania State University and Rutgers University because data for total revenues were unavailable.

Source: NCSES special tabulations using data from the National Center for Education Statistics Integrated Postsecondary Education Data System and the Illinois State University Center for the Study of Education Policy *Grapevine* data.

APPROPRIATIONS FOR HIGHER EDUCATION - A COMPARISON OF TWO STATE SYSTEMS

State funding (constant 2005 dollars) for higher education has varied widely, with forty-four states showing declines per enrolled student during the period from 2002 to 2010. An example of a state with declining appropriations is California, which has the largest projected budget shortfall for FY 2012 and has faced budget deficits over the last decade.[59] From 2002 to 2010 there was a 30 percent decline on average in funding per enrolled student (constant 2005 dollars) for California's major public research universities. In contrast, the four State Universities of New York received an average per student increase of 72 percent over the same time period (Table, p. 20-21). State appropriations have traditionally been high in California where funding increased in the 1990s and funding per enrolled student reached $16,120 in 2002 before declining to $11,228 in 2010. In New York, funding increases were much greater in the 2000s than in the 1990s. Appropriations per enrolled student in 2002 ($7,850) were about half that of California but increased to $13,495 in 2010. The overall decline in state revenue at most public research universities has led to concerns about the ability of these universities to effectively educate students and to act as innovation hubs for their respective states.

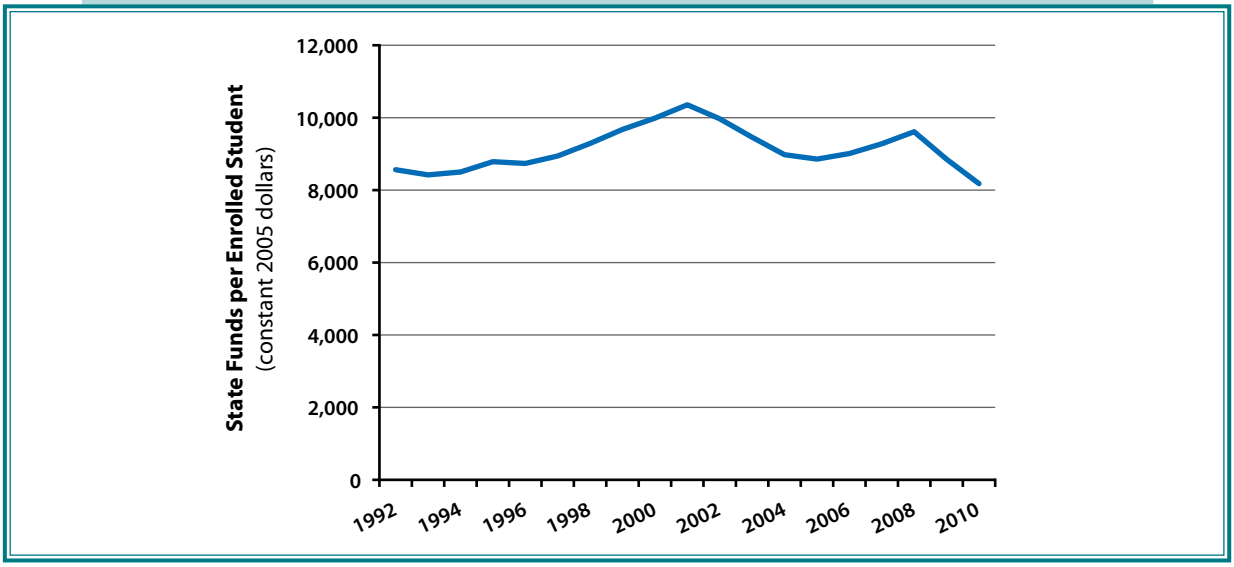
The state data provided here and in the Table represent a snapshot of per student funding over the period from 1992 to 2010 for the 101 major public research universities using available data from NCES IPEDS and the Illinois State University *Grapevine* data with enrollment accounting for part- and full-time undergraduate and graduate students. They do not account for longer-term trends and overall per student state funding and may not capture many of the complexities in per student funding or the funding decisions that university systems must make.

Trends in State Appropriations

Several factors are associated with the decline in per student state appropriations over the last decade. As mentioned earlier, college enrollment has increased consistently and this upward trend is expected to continue. At the same time, state appropriations have not kept pace. A report by the State Higher Education Executive Officers Association indicates that while the overall level of state support for higher education has increased over the last 25 years it has failed to keep pace with rising enrollment and inflation.[60] As a result, state appropriations per student (measured in constant dollars) declined to a 25-year low in 2011.[61]

Another factor driving this decline is economic recession. Unlike primary and secondary education, state and local funding for higher education is discretionary and has historically declined during periods of recession. Per student funding (constant 2005 dollars) had not fully recovered to 2001 peak levels when the most recent recession began in December of 2007 and has since declined to a record low (Figure 7).[62]

FIGURE 7: State Funds per Enrolled Student in Public Research Universities, 1992 to 2010



Note: Enrolled students includes all students at all degree levels.

Source: NCSES special tabulations using data from the National Center for Education Statistics Integrated Postsecondary Education Data System and the Illinois State University Center for the Study of Education Policy *Grapevine* data.

A final factor associated with the decline in per student state appropriations is the rising cost of non-higher-education-related state needs and mandated requirements. As the Nation recovers from economic recession, states may struggle to meet growing demands for higher education due to rising costs in Medicaid and other mandatory programs.[63] According to a recent report by the advocacy organization Dēmos, in FY 1990-91, 10.5 percent of states' general fund expenditures were allocated for the Medicaid program, while in 2010-11 the percentage rose to 17.4 percent.[64] During that same time period, discretionary funding for higher education declined from 14.1 to 11.5 percent.[65] Despite reported growth in state tax revenues following the last recession,[66] it is unclear whether states will restore per student funding to 2001 peak levels in the face of rising costs for mandatory programs and growing demand for college education.

Tuition and Fees

In recent years, public research universities have raised tuition and fees at rates that have exceeded inflation and rates of increase at private universities, in part due to declining state appropriations. Data from the Delta Cost Project's *Trends in College Spending* report indicate that net tuition revenue, defined as total revenue from tuition and fees including grant and loan aid, has risen continually at public research universities over the past decade. From 1999 to 2009, revenue from net tuition per full-time equivalent (FTE) student increased by 50 percent.[67]

While the cost of higher education has increased, the Federal Reserve reports that median family income has declined, from $49,600 in 2007 to $45,800 in 2010.[68,69] The total annual nominal charge, including standard in-state charges for tuition, required fees, and room and board, in 2010 for a full-time undergraduate student to attend a public 4-year institution[70] in their state of residence averaged over $15,000 nationally, an increase of 43 percent since 2000 (after adjusting for inflation).[71] In 2009, this would have consumed, on average, 39.7 percent of a state resident's disposable income, compared to 31.8 percent in 2000.[72]

Public research universities have, in addition to raising tuition and fees, looked for additional ways to offset reductions in state appropriations. In the 2011 *Inside Higher Ed Survey of College and University Admission Directors,* half of respondents from public doctoral universities reported increasing recruitment of affluent students and out-of-state students who pay a higher rate of tuition. Likewise, 42 percent of respondents indicated that they had increased the recruitment of international students.[73] Increasing the percentage of out-of-state and international students at public universities potentially could lead state policy-makers to further lower state appropriations to these institutions as the number of in-state students they educate declines. Alternatively, states may seek to limit out-of-state and international enrollment to maintain a high percentage of in-state enrollment. For example, California lawmakers have proposed restricting the enrollment of out-of-state and international students to 10 percent of undergraduate enrollment.[74]

Student Aid

Federal student aid has increased 164 percent since AY 2000-01 (inflation adjusted dollars). Total Federal aid from grants and loans for students attending all higher education institutions reached $169 billion in AY 2010-11, and undergraduate FTE students received an average of $12,455 in financial aid.[75]

Financial aid from states also has risen. The total amount of state financial aid from grants provided to undergraduates increased nationwide, rising from $4.5 billion (inflation adjusted dollars) in 2000 to $7.2 billion in 2008.[76] In recent years, a growing proportion of state grants to students have been awarded based on merit. According to a report from the Brookings Institution, many of the recent large-scale grant programs enacted by states are not need-based, though states are spending 1.6 times as much per student on need-based grant aid in AY 2010-11 (inflation adjusted dollars) as they spent in AY 1980-81.[77] Although only 9 percent of all state grant aid for undergraduates was awarded without regard to financial need in AY 1985-86, by AY 2009-10 it reached 28 percent.[78]

Tuition discounting–the reduction in published tuition and fees through institutional awards–has remained relatively stable in the public sector since AY 2000-01 according to a 2010 report by the College Board.[79] Prices net of institutional grants and tuition waivers averaged about 20 percent below the published tuition price at public 4-year institutions and 29 percent below the published tuition price

at public flagship institutions,[80] a rate similar to the rate at private 4-year institutions.[81] Institutional aid requires larger published tuition prices to compensate for diminished revenue resulting from university tuition discounts to a percentage of students. Several publications have proposed significant reductions in aid that is not based on financial need as a means to reduce published tuition prices.[82,83]

Student borrowing has grown in the wake of declining per student state appropriations and increased tuition and fees despite increases in state and Federal financial aid. Total education borrowing per FTE student, including Federal student and parent loans, increased by 57 percent in inflation adjusted dollars over the decade from AY 2000-01 to AY 2010-11 for undergraduate and graduate students combined and 56 percent for undergraduate students.[84] In AY 2009-10, students earning bachelor's degrees from public 4-year institutions graduated with an average of $22,000 in debt.[85] A recent report by the Federal Reserve indicates that the share of families with education-related debt has risen from 15.2 percent in 2007 to 19.2 percent in 2010.[86] The share of parent PLUS loans for education doubled from $5 billion in AY 2000-01 to $10 billion in AY 2010-11.[87]

Federal Funding for Academic Research and Training

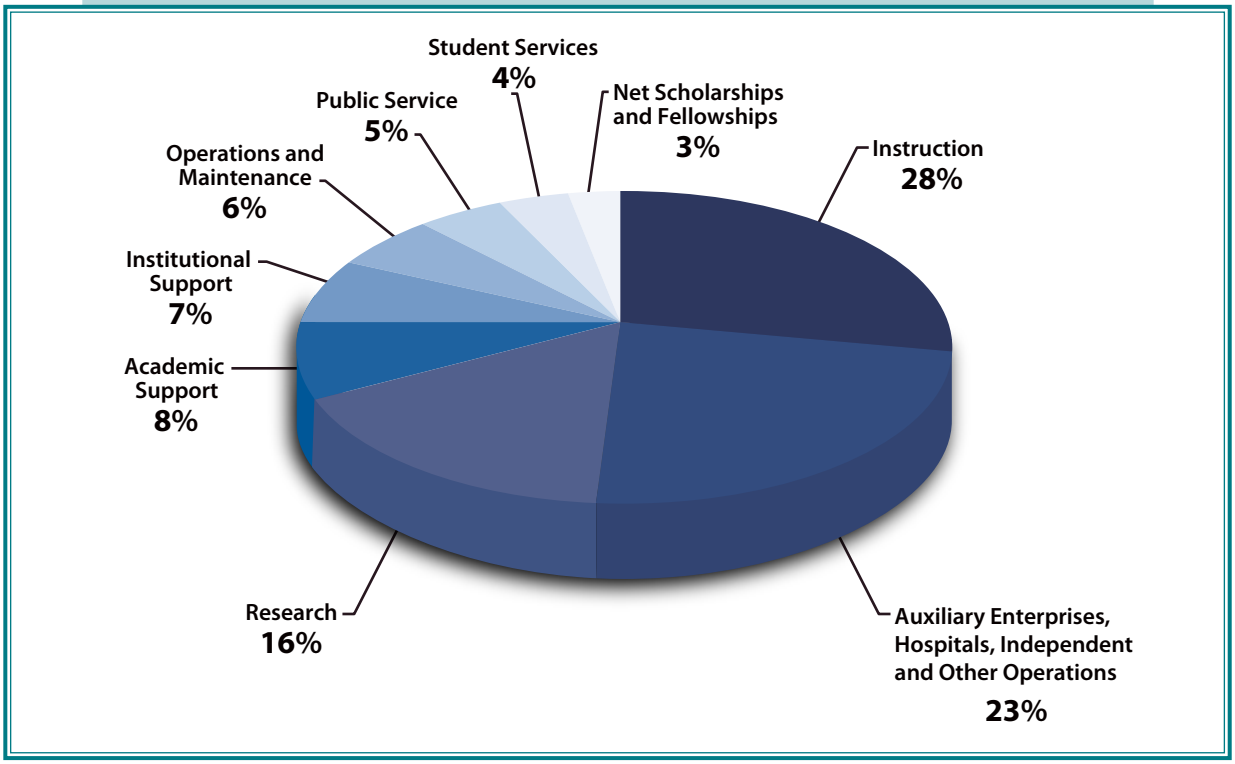
The Federal Government has been the primary source of funding for academic R&D for over half a century.[88] Federal funding for S&E R&D continued to increase at an average of 4.8 percent (constant 2005 dollars) from 2000 to 2009 when it provided 59 percent of academic spending on S&E R&D. However, it has been relatively flat over the 5-year period from 2004 to 2009, increasing by only 0.8 percent.[89] The Federal Government also provides funding for S&E workforce development. In 2009, the Federal Government funded 63 percent of S&E graduate students on traineeships, 49 percent of those with research assistantships, and 23 percent with fellowships.[90]

Compared to public research universities, private research universities receive a larger percentage of their total academic R&D from the Federal Government. Nevertheless, the top public research universities have remained competitive for Federal R&D funding. According to the NCSES *Survey of Research and Development Expenditures at Universities*, of the 25 universities with the greatest total academic R&D expenditures in 2009, 17 were public.[91] Though these universities have remained competitive in securing Federal research dollars, public research university presidents expressed concern about potential cuts in Federal funding for academic research in a recent survey by *Inside Higher Ed*.[92] In the current budget-constrained environment and with ongoing discussions regarding reducing national budget deficits, continued growth in Federal funding for academic R&D is uncertain.

EXPENDITURES BY PUBLIC RESEARCH UNIVERSITIES

The cost of higher education increasingly has become part of the national dialogue, in particular, the implications of increased university expenditures on the cost of education to students in the form of tuition, fees, and room and board. In addition to instruction and research, universities have a variety of other expenditures (Figure 8), including institutional and academic support, student services, scholarships, increased regulatory costs, auxiliary enterprises such as hospitals, and operating expenses.[93] According to the Delta Cost Project's *Trends in College Spending* report, spending increased in most categories[94] for public and private 2- and 4-year institutions during the period from 1999 to 2009.

FIGURE 8: Average Expenditures at Public Research Institutions, AY 2008-09



Note: Expenditures as a percentage of total education and general expenditures per FTE student (2009 dollars).

Source: Figure A1, Delta Cost Project, *Trends in College Spending.*

In the book, *Why Does College Cost So Much?*, the authors take a broad economic view in addressing this question and suggest that rising costs in higher education, like other service industries relying on highly educated labor, are due, in part, to labor costs. The authors suggest that technology and innovation also have led to rising costs. To prepare students for an increasingly advanced workforce, university campuses are equipped with the latest technology in classrooms, labs, and other campus facilities and the associated staff needed to service them.[95]

The National Research Council (NRC) report, *Research Universities and the Future of America*, recommends that research universities strive to contain cost escalation of all ongoing activities to the inflation rate or lower through improved efficiency and productivity, adoption of modern instructional methods such as cyber-learning, and greater collaboration among investigators and institutions, particularly in the acquisition and utilization of expensive research equipment and facilities.[96]

Instruction

Instructional spending represents the largest proportion of spending at public research universities.[97] Instructional spending includes faculty salaries and benefits, office supplies, administration of academic departments, and the proportion of faculty salaries going to departmental research and public service.[98] In the period from 1999 to 2009, instructional spending per FTE student increased from $9,086 to $9,986, or 9.9 percent, at public research universities compared with $16,251 to $20,232, or 24.5 percent, at private research universities.[99]

The Delta Cost Project's *Trends in College Spending* report indicates that overall compensation for faculty and non-instructional staff comprises between 60 and 70 percent of education and general spending–that is, total expenditures less auxiliary activities and hospitals–in all sectors of higher education institutions.[100] The gap in faculty wages and benefits between public and private institutions has widened with public institutions spending more on benefits at the expense of wage increases.[101] Between 2002 and 2008, benefit costs increased by an average of 5.2 percent per full-time employee per year at public research universities but only 1.6 percent at private research universities.[102] Benefit costs approached 25 percent of compensation at public institutions in 2009, up from 20 percent in 2000.[103] Full-time faculty salaries, which represent 40 to 60 percent of all faculty salaries, increased by only 0.2 percent annually on average at public research universities compared with 0.6 percent at private research universities during the period from 2002 to 2009.[104] Note that these rates of salary increases are on different bases. Salaries at private research universities are greater than those at public universities.

Research

Institutional funds from universities and colleges comprise the second largest source of funding for academic R&D, accounting for $11.2 billion of the $54.9 billion of academic spending on S&E R&D in 2009.[105] Since 1991, the overall share of university support for research has remained stable.[106] However, the actual costs to institutions during this period have increased three-fold in current dollars,[107] with compliance costs representing a large component. Institutional funds are directed toward institutionally financed research expenditures, including infrastructure, such as buildings, laboratories, field stations, facility renovation, cyberinfrastructure,[108] and unrecovered indirect costs and federally mandated cost sharing.[109] Research universities make these investments to support current and future academic S&E R&D both independently and in partnership with the Federal Government and others.

Institutional funds are partly used to cover unreimbursed costs of federally funded research resulting from Federal limitations on reimbursement for the indirect costs of research.[110] Federal funding for academic research includes both direct and indirect facilities and administrative (F&A) costs. The F&A rate is used to reimburse universities for expenses associated with funded research, but that are not easily identified with a specific project.[111] According to the NCSES *Higher Education R&D* (HERD) survey, unrecovered indirect costs of academic R&D reached $4.7 billion in FY 2010.[112]

In their 2012 report to Congress, the NRC Committee on Research Universities recommended the Federal Government and other research sponsors strive to support the full cost, direct and indirect, of research and other activities they procure.[113] The NRC also recommended that Federal and state policymakers and regulators identify and eliminate regulations that are redundant, ineffective, or inappropriately applied to higher education and harmonize regulations across Federal agencies.[114] This message was echoed by

vice-presidents and provosts of research universities during a Congressional hearing on the report[115] and in a recent report by the Research Universities Futures Consortium, which noted that these requirements divert faculty time from research.[116,117]

Student Services

Public and private research universities continue to increase the share of spending on student services, defined as non-instructional, student-related activities such as admissions, registrar services, career counseling, recruitment, financial aid administration, student organizations, and intramural athletics. Between 1999 and 2009, spending on student services increased by 19.4 percent at public research universities and 35.3 percent at private research universities.[118]

In the article, *American Higher Education in Transition*, Ronald Ehrenberg notes that the annual growth rates of student service expenditures are double the rates of instructional expenditures for every category of academic institution.[119] Although aspects of spending in this category are sometimes viewed as unnecessary, these services have been shown to positively influence first-year persistence and graduation rates at 4-year academic institutions that enroll a greater share of disadvantaged students.[120] Universities now provide an increasing number of services to students to improve retention and graduation rates and to allow students to transition successfully into the labor market. These services include assistance with job searches, career counseling, resume writing, and clubs and organizations, among others.

Academic and Institutional Support

Academic support expenditures are used for activities that support instruction, research, and public service, including libraries, museums and academic computing. Spending on academic support increased by 11 percent per FTE student at public research universities during the period from 1999 to 2009.[121] This rise in spending is due, in part, to the adoption of technology to enhance student learning and the growing cost of libraries.[122] For example, academic networking infrastructure is rapidly expanding in capability and coverage. In FY 2009, colleges and universities reported external network connections with greater bandwidth, faster internal network distribution speeds, more connections to high-speed networks, and greater on-campus wireless coverage.[123]

Institutional support is defined in the Delta Cost Project's *Trends in College Spending* report as general administrative services, executive management, legal and fiscal operations, public relations, and central operations for physical operations. Institutional support at public research universities increased on a per-student basis by 15 percent from 1999 to 2009. A potential reason for this growth is an increase in non-faculty staff. A recent report by the American Association of University Professors indicated that while student-to-faculty ratios have remained relatively stable, student-to-staff ratios changed from nine-to-one to six-to-one at public institutions and from seven-to-one to four-to-one at private institutions–a significant increase in the number of staff per student.[124] The report suggests that increased Federal and accreditor-mandated reporting requirements have contributed to this trend.[125] The increase in spending on institutional support and on non-faculty staff also may be attributed, in part, to an increase in Federally-funded research following the doubling of the National Institutes of Health budget during this same period.

Operations and Maintenance

In the wake of the recession from December 2007 to June 2009 and declining per student state appropriations, public research universities have deferred maintenance. Though spending on operations and maintenance per FTE student increased by 20 percent during the period from 1999 to 2009, between 2008 and 2009 spending in this category declined by 5 percent.[126] A 2009 survey by the APLU indicated that 63 percent of member (public) research universities planned to defer maintenance expenditures in the short-term.[127] Among institutions with a state appropriation decrease of greater than or equal to 10 percent, the percentage planning to defer maintenance rose to 88 percent.[128] Deferred spending on maintenance potentially could lead to greater spending in the long-term, lowering of an institution's credit rating, and higher interest rates on debt.[129]

CONCLUSIONS

The Board is concerned with the long-term fiscal health of the Nation's public research universities and their ability to maintain affordable, quality education for all students. These institutions have witnessed substantial growth in enrollment coupled with diminishing state funding per student over the course of the last decade. This trend, if it continues or if other sources of support are not identified, threatens their continued capacity to attract the best talent, to provide quality education and training for the next generation of scientists and engineers, and to compete with their private counterparts, and is likely to result in an ongoing increase in tuition and fees. An enduring commitment to strengthen these universities and maintain quality and affordability is imperative if our Nation is to increase the number of highly-skilled U.S. S&E graduates and compete in today's knowledge-driven global economy.

In future editions of *Science and Engineering Indicators*–the Board's biennial report on quantitative information about U.S. science, engineering, and technology–the Board intends to expand the treatment of higher education institutions while providing greater depth of analysis specific to public research universities. The 2014 edition of *Indicators* will include data on the major revenue and expenditure streams of public research universities and cost to students and families, providing consistent, policy-neutral information that policy-makers can use in considering whether these universities can meet local, state, and national demand for the type of skilled S&E workers and transformative research necessary to fuel economic growth and to address societal challenges.

The National Science Board offers the following observations:

1. Increased enrollment and declining state support have occurred in all sectors of the public higher education system. Public research universities educate and train the majority of our Nation's scientists and engineers. They are contributors to economic development at the local, state, and national levels and represent an essential component of the higher education landscape. A continued decline in state support will negatively impact the ability of these universities to provide quality education and training to a diverse student body and attract and retain the talent needed to maintain the scope and quality of their research efforts.

2. Increased enrollment in higher education is projected to come mainly from traditionally underrepresented minority groups. While enrollment at public research universities has continued to increase, a greater share of students, particularly minorities, are attending public 2-year or private for-profit institutions. Public research universities provide opportunities for undergraduate research training and access to researchers in the classroom that are typically unavailable at these institutions. These opportunities can positively impact students majoring in S&E disciplines at a critical time in their academic career. Greater emphasis should be placed on recruiting underrepresented groups to public research universities and facilitating the transfer and continued success of S&E majors from community colleges. The PCAST report, *Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics*, suggests pathways that provide authentic research experience for community college students and opportunities to develop relationships with faculty at 4-year institutions to ease the transition to these institutions.

3. Reductions in revenue of public research universities and gaps in salary between public and private research universities have the potential to lead to an outflow of talent at public research universities and reduced research capacity. These could result in greater concentration of talent and R&D in fewer geographical locations, and at fewer universities, with smaller and less diverse student bodies. This could have a substantial impact on economic and workforce development at the local, state, and national levels.

4. The Federal subsidized loan program continues to evolve. Any proposed changes to the program should be carefully examined to avoid unintended consequences to undergraduate and graduate education.

TABLE: Trends in Enrollment and State Funding for the Nation's 101 Major Public Research Universities

State	# of 101 major public research universities by state	% change in enrollment 1992-2001	Per student state funding 1992	Per student state funding 2001	% change in state funding 1992-2001	% change in per student state funding 1992-2001
ALABAMA	3	-6%	$8,592	$10,067	10%	17%
ALASKA	1	-7%	$15,371	$14,619	-11%	-5%
ARIZONA	2	1%	$7,686	$8,764	15%	14%
ARKANSAS	1	8%	$10,262	$12,077	28%	18%
CALIFORNIA	9	7%	$13,588	$15,920	26%	17%
COLORADO	2	0%	$5,744	$6,709	17%	17%
CONNECTICUT	1	-22%	$6,786	$10,140	17%	49%
DELAWARE	1	-9%	$4,657	$6,319	24%	36%
FLORIDA	5	26%	$8,423	$9,764	46%	16%
GEORGIA	3	6%	$9,007	$15,597	84%	73%
HAWAII	1	-11%	$16,571	$11,599	-37%	-30%
IDAHO	1	6%	$9,393	$10,752	22%	14%
ILLINOIS	3	-3%	$9,870	$11,581	14%	17%
INDIANA	2	4%	$6,957	$7,533	13%	8%
IOWA	2	1%	$9,012	$11,540	30%	28%
KANSAS	2	1%	$6,003	$7,166	21%	19%
KENTUCKY	2	-8%	$10,764	$13,445	15%	25%
LOUISIANA	1	17%	$9,625	$8,751	6%	-9%
MAINE	1	-20%	$6,774	$9,709	15%	43%
MARYLAND	2	-2%	$7,239	$11,841	59%	63%
MASSACHUSETTS	1	-1%	$6,709	$11,386	67%	70%
MICHIGAN	3	0%	$8,681	$10,228	18%	18%
MINNESOTA	1	-19%	$9,708	$14,974	24%	54%
MISSISSIPPI	2	10%	$6,362	$9,228	60%	45%
MISSOURI	1	-6%	$7,472	$10,701	35%	43%
MONTANA	1	15%	$7,159	$5,811	-6%	-19%
NEBRASKA	1	-10%	$8,268	$10,291	13%	24%
NEVADA	1	12%	$9,382	$11,624	39%	24%
NEW HAMPSHIRE	1	8%	$3,930	$4,574	25%	16%
NEW JERSEY	2	8%	$9,127	$9,951	18%	9%
NEW MEXICO	2	-2%	$7,599	$10,336	33%	36%
NEW YORK	4	-1%	$9,693	$11,964	23%	23%
NORTH CAROLINA	2	4%	$12,737	$17,271	41%	36%
NORTH DAKOTA	2	2%	$6,518	$7,046	10%	8%
OHIO	3	-13%	$6,308	$8,669	19%	37%
OKLAHOMA	2	5%	$7,855	$9,743	30%	24%
OREGON	2	2%	$7,077	$7,187	4%	2%
PENNSYLVANIA	3	-3%	$6,692	$8,177	19%	22%
RHODE ISLAND	1	-7%	$4,966	$6,691	26%	35%
SOUTH CAROLINA	2	-5%	$7,779	$10,960	34%	41%
SOUTH DAKOTA	1	0%	$5,286	$6,278	19%	19%
TENNESSEE	1	-1%	$13,636	$16,890	22%	24%
TEXAS	4	3%	$8,040	$7,867	0%	-2%
UTAH	2	8%	$6,634	$7,998	30%	21%
VERMONT	1	-9%	$3,592	$4,268	8%	19%
VIRGINIA	5	10%	$6,154	$8,052	43%	31%
WASHINGTON	2	9%	$10,922	$11,471	14%	5%
WEST VIRGINIA	1	-2%	$8,566	$10,728	23%	25%
WISCONSIN	1	-6%	$10,445	$11,664	6%	12%
WYOMING	1	-7%	$8,365	$10,142	13%	21%

Note: Enrollment and per student funding (constant 2005 dollars) by state from 1992 to 2001 and 2002 to 2010 at the 101 major public research universities.

State	% change in enrollment 2002-10	Total enrollment 2010	Per student state funding 2002	Per student state funding 2010	% change in state funding 2002-10	% change in per student state funding 2002-10	% change in appropriations of state tax funds for operating expenses of higher education/ state GDP 2000-10
ALABAMA	12%	49,157	$10,836	$9,679	0%	-11%	-10%
ALASKA	28%	9,137	$14,711	$16,220	41%	10%	0%
ARIZONA	31%	106,831	$8,207	$6,403	2%	-22%	-9%
ARKANSAS	26%	19,849	$11,455	$9,727	7%	-15%	-1%
CALIFORNIA	14%	253,013	$16,120	$11,228	-21%	-30%	-1%
COLORADO	6%	61,912	$6,617	$3,417	-45%	-48%	-16%
CONNECTICUT	26%	25,029	$10,247	$8,586	6%	-16%	0%
DELAWARE	1%	21,138	$6,231	$6,305	2%	1%	-7%
FLORIDA	20%	223,509	$8,458	$6,851	-3%	-19%	-8%
GEORGIA	16%	85,603	$13,344	$8,447	-26%	-37%	21%
HAWAII	17%	20,435	$12,244	$9,681	-8%	-21%	3%
IDAHO	-1%	11,957	$11,650	$8,903	-24%	-24%	-7%
ILLINOIS	6%	91,071	$12,020	$7,566	-33%	-37%	-7%
INDIANA	7%	83,399	$7,403	$6,070	-12%	-18%	-5%
IOWA	1%	56,932	$11,277	$8,550	-24%	-24%	-38%
KANSAS	10%	52,823	$7,044	$5,405	-16%	-23%	-14%
KENTUCKY	9%	47,311	$12,765	$10,630	-10%	-17%	-8%
LOUISIANA	-11%	28,643	$9,733	$10,049	-8%	3%	-3%
MAINE	11%	11,894	$9,721	$7,779	-11%	-20%	-8%
MARYLAND	10%	50,065	$12,600	$9,108	-20%	-28%	0%
MASSACHUSETTS	9%	27,016	$9,956	$7,280	-20%	-27%	-16%
MICHIGAN	6%	120,531	$9,914	$6,889	-26%	-31%	-14%
MINNESOTA	11%	51,659	$14,191	$10,811	-16%	-24%	-15%
MISSISSIPPI	17%	34,533	$8,243	$6,701	-5%	-19%	-37%
MISSOURI	32%	31,237	$10,200	$8,811	14%	-14%	-12%
MONTANA	6%	12,348	$5,766	$4,645	-15%	-20%	-14%
NEBRASKA	6%	24,100	$10,335	$9,340	-4%	-10%	-14%
NEVADA	18%	16,875	$11,304	$7,907	-16%	-28%	0%
NEW HAMPSHIRE	3%	15,253	$4,792	$4,309	-7%	-10%	1%
NEW JERSEY	4%	46,206	$15,697	$11,133	-26%	-29%	-2%
NEW MEXICO	17%	45,767	$10,636	$10,489	16%	-1%	2%
NEW YORK	12%	86,291	$7,850	$13,495	93%	72%	1%
NORTH CAROLINA	15%	62,735	$15,003	$15,049	15%	0%	10%
NORTH DAKOTA	23%	27,361	$6,427	$6,710	28%	4%	-16%
OHIO	14%	109,212	$7,908	$6,385	-8%	-19%	-13%
OKLAHOMA	4%	48,914	$8,448	$7,092	-13%	-16%	-12%
OREGON	20%	44,285	$6,371	$4,331	-19%	-32%	-20%
PENNSYLVANIA	13%	110,020	$8,599	$7,729	2%	-10%	-11%
RHODE ISLAND	15%	16,389	$6,920	$3,692	-39%	-47%	-12%
SOUTH CAROLINA	19%	47,593	$10,568	$6,565	-26%	-38%	-14%
SOUTH DAKOTA	34%	12,376	$6,080	$4,888	7%	-20%	-16%
TENNESSEE	15%	29,934	$16,640	$13,762	-5%	-17%	3%
TEXAS	8%	152,480	$8,200	$7,234	-4%	-12%	-2%
UTAH	-11%	44,896	$8,351	$7,931	-16%	-5%	-19%
VERMONT	33%	13,391	$4,653	$3,482	-1%	-25%	1%
VIRGINIA	19%	143,477	$7,553	$4,987	-21%	-34%	-20%
WASHINGTON	23%	72,044	$10,928	$7,921	-11%	-28%	-8%
WEST VIRGINIA	27%	28,898	$10,396	$7,231	-12%	-30%	-12%
WISCONSIN	2%	41,654	$10,275	$9,323	-8%	-9%	-13%
WYOMING	0%	12,427	$10,514	$16,986	62%	62%	-3%

Source: NCSES special tabulations using data from the National Center for Education Statistics Integrated Postsecondary Education Data System and the Illinois State University Center for the Study of Education Policy *Grapevine* data. The last column, change in state appropriations for operating expenses of higher education by gross domestic product (GDP), was calculated using data from *Indicators 2012*, Table 8-27.

TECHNICAL NOTES

This report cites data from the Delta Cost Project's *Trends in College Spending* report that defines public research universities using the widely utilized 2005 *Carnegie Classification of Institutions of Higher Education* and includes doctoral/research universities. Carnegie classifies research universities in three ways: those with "very high" research activity, those with "high" research activity, and "doctoral/research" universities that grant fewer doctorate degrees and do not conduct high levels of research. The 101 major public research universities highlighted in *Indicators 2012* and included in this companion in the section on state appropriations correspond primarily with the *Carnegie Classification* of research universities with very high research, with roughly a quarter of the universities classified as high research universities. The group of 101 universities does not include the category of doctoral/research universities. Academic R&D expenditures are concentrated in a relatively small number of institutions. In FY 2009, 711 institutions reported spending at least $150,000 on S&E R&D. Of these, the top-spending 20 institutions accounted for 30 percent of total academic R&D spending and the top 100 for 80 percent of this spending.[130]

Readers should be aware that other reports cited in this companion might define public research universities using varied criteria (e.g., 2010 *Carnegie Classification*). In instances where reports have used classifications other than the 2005 *Carnegie Classification* we have included an endnote with the definition used by that source.

RESOURCES

In preparation for this companion to *Indicators 2012*, the Board sought to create a bibliography of pertinent books and articles on higher education and a resource with links to related Web sites and periodic reports. Though not exhaustive, Annex 1 contains a bibliography of books, articles and reports on funding for higher education.[131] Annex 2 includes a list of higher education organizations that produce annual or periodic reports and databases on a range of topics related to higher education.[132] This resource includes the mission of the agencies, the topics of the reports, details on databases, and links to agency Web sites. A review of existing data has shed light on limitations and gaps that the Board may address in future editions of *Indicators*.

ENDNOTES

1 National Science Board. 2012. *Research and Development, Innovation, and the Science and Engineering Workforce: A Companion to Science and Engineering Indicators 2012*, Arlington, VA: National Science Foundation (NSB-12-03).

2 Defined by the 2005 *Carnegie Classification of Institutions of Higher Education* as research universities with "very-high" and "high" research activity and "doctoral/research universities."

3 Private universities may receive a very small amount of state and local appropriations but public universities have traditionally received a share of state and local appropriations as a principal source of revenue.

4 Major public research universities are defined as the 101 public research universities that were either among the top recipients of academic R&D funding in the late 2000 decade or the leading recipients in their state.

5 National Research Council. 2012. *Research Universities and the Future of America: Ten Breakthrough Actions Vital to Our Nation's Prosperity and Security.* Committee on Research Universities, Board on Higher Education and Workforce Policy and Global Affairs. Washington, DC: National Academies Press. Retrieved from: http://sites.nationalacademies.org/PGA/bhew/researchuniversities/index.htm

6 The NRC study on research universities was supported, in part, by a grant from the National Science Foundation (OIA-1048372). Other sources of support include the Alfred P. Sloan Foundation, the John T. and Catherine D. MacArthur Foundation, and the U.S. Department of Energy.

7 National Science Board. 2012. *Science and Engineering Indicators* (p. 2-16). Arlington, VA: National Science Foundation.

8 See endnote 4.

9 NCSES special tabulations using data from the National Center for Education Statistics Integrated Postsecondary Education Data System.

10 National Science Board. 2012. *Science and Engineering Indicators* (p. 2-16). Arlington, VA: National Science Foundation.

11 Ibid.

12 Public research universities are defined here as the 2005 *Carnegie Classification of Institutions of Higher Education* "Very High" or "High" research universities.

13 Calculations based on the "Bachelor Degrees" variable in the Delta Cost Project database. It is defined as "Total number of awards conferred (baccalaureate or equivalent degree, as determined by the Secretary, U.S. Department of Education) that normally require at least 4- but not more than 5-years of full-time equivalent college-level work."

14 McPherson, P., Gobstein, H.J. and Shulenburger, D. 2010. *Ensuring that Public Research Universities Remain Vital* (p. 6). Retrieved from: https://www.aplu.org/NetCommunity/Document.Doc?id=2819

15 Baum, S. and Payea, K. 2010. *Trends in Student Aid: 2011.* The College Board (p. 16, Figure 7). Retrieved from: http://trends.collegeboard.org/downloads/Student_Aid_2011.pdf In AY 2009-10, 30 percent of Pell grant recipients attended public 4-year institutions (research and non-research) and 13 percent private non-profit 4-year institutions, and 67 percent of the National Science & Mathematics Access to Retain Talent Grant recipients attended public 4-year institutions although 25 percent attended private non-profit institutions.

16 Desrochers, D.M. and Wellman, J.V. 2011. *Trends in College Spending 1999-2009* (p. 11, Figure 2). Delta Cost Project on Postsecondary Education Costs, Productivity, and Accountability. Retrieved from: http://www.deltacostproject.org/resources/pdf/Trends2011_Final_090711.pdf

17 Aud, S., Fox, M.A. and Kewal-Ramani, A. 2010. *Status and Trends in the Education of Racial and Ethnic Minorities* (p. vi, 127). National Center for Education Statistics. Retrieved from: http://www.air.org/files/AIR-NCESracial_stats__trends1.pdf

18 Carnevale, A.P., Smith, N., and Strohl, J. 2010. *Help Wanted: Projections of Jobs and Education Requirements through 2018*. Georgetown University Center on Education and the Workforce. Retrieved from: http://www9.georgetown.edu/grad/gppi/hpi/cew/pdfs/HelpWanted.FullReport.pdf

19 National Science Board. 2012. *Science and Engineering Indicators* (p. 3-12). Arlington, VA: National Science Foundation.

20 Ibid., (p. 3-5).

21 Ibid., (p. 3-29).

22 Ibid., (p. 3-32).

23 Ibid.

24 Ibid., (p. 3-12, Table 3-A, Appendix Table 3-1).

25 Ibid.

26 Executive Office of the President. President's Council of Advisors on Science and Technology. 2012. *Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics* (p. 2). Retrieved from: http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-engage-to-excel-final_feb.pdf

27 Calculations based on the "Doctor Degrees" variable in the Delta Cost Project database. It is defined as "The total number of doctoral degrees conferred."

28 Data provided by College Board's "Big Future" search engine. Analysis included public and private research universities classified as very high research universities using 2005 *Carnegie Classifications of Institutions of Higher Education*. Each university was manually searched and data were recorded by STPI. Data accessed on July 11, 2012. Retrieved from: https://bigfuture.collegeboard.org/

29 Desrochers, D.M. and Wellman, J.V. 2011. *Trends in College Spending 1999-2009* (p. 19). Delta Project on Postsecondary Education Costs, Productivity, and Accountability. Retrieved from: http://www.deltacostproject.org/resources/pdf/Trends2011_Final_090711.pdf

30 Baum, S. and Ma, J. 2010. *Tuition Discounting: Institutional Aid Patterns at Public and Private Colleges and Universities.* College Board Advocacy and Policy Center. Retrieved from: http://www.collegeboard.com/prod_downloads/trends/tuition-discounting-brief.pdf

31 Archibald, R.B. and Feldman, D.H. 2011. *Why Does College Cost So Much?* (p. 167). Oxford University Press.

32 Calhoun, Craig. 2011. "The Public Mission of the Research University" (Chapter 1, p. 28). *Knowledge Matters: The Public Mission of the Research University*. New York. Columbia University Press.

33 Duderstadt, J.J. 2008. *Aligning American Higher Education with a 21st-Century Public Agenda* (p. 5). Retrieved from: http://www.aplu.org/document.doc?id=1970

34 Rhoten, Diana R. and Powell, Walter W. 2011. "Public Research Universities: From Land Grant to Federal Grant to Patent Grant Institutions" (Chapter 10, p. 319-320). *Knowledge Matters: The Public Mission of the Research University*. New York. Columbia University Press.

35 Ibid.

36 National Science Board. 2012. *Science and Engineering Indicators* (p. 5-4). Arlington, VA: National Science Foundation.

37 National Science Board. 2012. *Science and Engineering Indicators* (p. 5-9). Arlington, VA: National Science Foundation. Data on the public share of Federally-financed R&D expenditures is based on NCSES informal calculations using data from WebCASPAR. In 2009, public research universities performed 62 percent of all Federally-funded research.

38 STPI calculations based on data provided by the Association of University Technology Managers Statistics Access for Tech Transfer 6.1 database.

39 New York Governor's Office. September 27, 2011. *Governor Cuomo Announces $4.4 Billion Investment by International Technology Group Led by Intel and IBM to Develop Next Generation Computer Chip Technology in New York*. Press release. Albany, NY. Retrieved from: http://www.governor.ny.gov/press/092711chiptechnologyinvestment

40 CBS News. May 3, 2012. Nanotech creating Rust Belt jobs for everyone. Albany, NY. Retrieved from: http://www.cbsnews.com/8301-201_162-57427639/nanotech-creating-rust-belt-jobs-for-everyone

41 Ibid.

42 New York Governor's Office. September 27, 2011. *Governor Cuomo Announces $4.4 Billion Investment by International Technology Group Led by Intel and IBM to Develop Next Generation Computer Chip Technology in New York*. Press release. Albany, NY. Retrieved from: http://www.governor.ny.gov/press/092711chiptechnologyinvestment

43 TechAmerica Foundation. October 5, 2011. *New York Remains 3rd largest Cyberstate by Tech Employment*. Washington, DC. Retrieved from: http://www.techamericafoundation.org/cyberstates2011-new-york

44 National Science Foundation fact sheet on I-Corps. Retrieved from: http://www.nsf.gov/news/newsmedia/i-corps/factsheet.pdf

45 Ibid.

46 Wisconsin Alumni Research Foundation. Retrieved from: http://www.warf.org/

47 Kennedy, Michael, D. 2011. "Cultural Formations of the Public University: Globalization, Diversity, and the State at the University of Michigan" (Chapter 15, p. 466). *Knowledge Matters: The Public Mission of the Research University*. New York. Columbia University Press.

48 Ibid., (p. 467).

49 Ibid., (p. 471).

50 Ibid., (p. 471).

51 Ibid., (p. 469).

52 American Association of Medical Colleges. February 15, 2012. *Memorandum to M. Tavenner, DHHS, Centers for Medicare & Medicaid Services.* Retrieved from: https://www.aamc.org/download/273860/data/aamccommentletteronmedicaiddshuninsureddefinition.pdf

53 The Cooperative State Research, Education and Extension Service, U.S. Department of Agriculture, University of Florida-IFAS, North Carolina A&T State University, and National Association of State Universities and Land-Grant Colleges Web pages. Retrieved from: http://wateroutreach.uwex.edu/education/documents/DirectoryNWQCoordinators.pdf

54 U.S. Department of Agriculture, Research, Education, and Economics, National Agricultural Statistics Service, Office of Small Farms Coordination Small Farms Success Stories: USDA Small Farms and Beginning Farmers and Ranchers Coordinators' Collections, 2006 – 2008. Retrieved from: http://www.csrees.usda.gov/nea/ag_systems/pdfs/small_farm_success_stories.pdf

55 Data are from annual surveys of the National Center for Education Statistics (NCES), supplemented with data from Illinois State University's Center for the Study of Education Policy.

56 These NCSES special tabulations exclude Pennsylvania State University and Rutgers University because data for total revenues were unavailable.

57 All enrolled students, part- and full-time

58 National Science Board. 2012. *Science and Engineering Indicators* (p. 2-12). Arlington, VA: National Science Foundation.

59 2011-2012 California Governors' Budget, May revision. Retrieved from: http://www.growinwatsonville.com/FullBudgetSummary-1.pdf

60 State Higher Education Executive Officers. 2012. *State Higher Education Finance FY 2011* (p. 7). Retrieved from: http://www.sheeo.org/finance/shef/SHEF_FY11.pdf

61 Ibid.

62 Ibid., (p. 11).

63 Kane, T.J. and Orszag P.R. 2003. *Funding Restrictions at Public Universities: Effects of Policy Implications* (p. 14). Retrieved from: http://www.brookings.edu/views/papers/orszag/20030910.pdf

64 Quinteros, J. 2012. *The Great Cost Shift: How Higher Education Cuts Undermine the Future Middle Class* (p. 18). Dēmos. Retrieved from: http://www.demos.org/sites/default/files/publications/thegreatcostshift_0.pdf

65 Ibid.

66 Dadayan, L. 2012. *Tax Revenues Surpass Previous Peak But Growth Softens Once Again* (p. 1). The Nelson A. Rockefeller Institute. Retrieved from: http://www.rockinst.org/pdf/government_finance/state_revenue_report/2012-04-19-SRR_87.pdf

67 Desrochers, D.M. and Wellman, J.V. 2011. *Trends in College Spending 1999-2009* (p. 48). Delta Project on Postsecondary Education Costs, Productivity, and Accountability. Retrieved from: http://www.deltacostproject.org/resources/pdf/Trends2011_Final_090711.pdf

68 Board of Governors of the Federal Reserve System. June 2012. *Changes in U.S. Family Finances from 2007 to 2010: Evidence from the Survey of Consumer Finances*. Federal Reserve Bulletin, 98 (2). Retrieved from: http://www.federalreserve.gov/pubs/bulletin/2012/PDF/scf12.pdf

69 Appelbaum, B. June 11, 2012. Family Net Worth Drops to Level of Early '90s, Fed says. *The New York Times*. Retrieved from: http://www.nytimes.com/2012/06/12/business/economy/family-net-worth-drops-to-level-of-early-90s-fed-says.html

70 Though specific data for public research universities are not available, the data for all 4-year publics may be instructive.

71 National Science Board. 2012. *Science and Engineering Indicators* (p. 8-60). Arlington, VA: National Science Foundation.

72 Ibid., (p. 8-62).

73 Jaschik, S. and Lederman, D. 2011. *The 2011 Inside Higher Ed Survey of College and University Admission Directors* (p. 7). Retrieved from: http://www.insidehighered.com/sites/default/server_files/files/9-20finaladmissionsreport.pdf

74 Inside Higher Ed. May 25, 2012. *Berkeley Chancellor Opposes Out-of-State Limit.* Retrieved from: http://www.insidehighered.com/quicktakes/2012/05/25/berkeley-chancellor-opposes-out-state-limit

75 Baum, S. and Payea, K. 2010. *Trends in Student Aid: 2011* (p. 10, 20). The College Board. Retrieved from: http://trends.collegeboard.org/downloads/Student_Aid_2011.pdf

76 National Science Board. 2012. *Science and Engineering Indicators* (p. 8-66). Arlington, VA: National Science Foundation. Deflated values provided by NCSES.

77 Brookings Institution State Grant Aid Study Group. 2012. *Beyond Need and Merit: Strengthening State Grant Programs* (p. 6). Brown Center on Education Policy at Brookings. Retrieved from: http://www.brookings.edu/~/media/research/files/reports/2012/5/08%20grants%20chingos%20whitehurst/0508_state_grant_chingos_whitehurst.pdf

78 Baum, S. and Payea, K. 2010. *Trends in Student Aid: 2011* (p. 10, 20). The College Board. Retrieved from: http://trends.collegeboard.org/downloads/Student_Aid_2011.pdf

79 Baum, S. and Ma, J. 2010. *Tuition Discounting: Institutional Aid Patterns at Public and Private Colleges and Universities* (p. 1). College Board Advocacy and Policy Center. Retrieved from: http://www.collegeboard.com/prod_downloads/trends/tuition-discounting-brief.pdf

80 The College Board defines "flagship universities" in the following way: "Flagship institutions are the best-known institutions in the state, were generally the first to be established, and are frequently the largest and most selective, as well as the most research-intensive public universities." A list of flagship universities can be found here (Appendix Table A2): http://advocacy.collegeboard.org/sites/default/files/10b_1976_TuitionDiscountReport_Int_WEB_100910.pdf

81 Ibid., (p. 5, 6).

82 Ibid.

83 Archibald, R.B. and Feldman, D.H. 2011. *Why Does College Cost So Much?* (p. 170). Oxford University Press.

84 Baum, S. and Payea, K. 2010. *Trends in Student Aid: 2011* (p. 4, 20). The College Board. Retrieved from: http://trends.collegeboard.org/downloads/Student_Aid_2011.pdf

85 Ibid., (p. 9).

86 Board of Governors of the Federal Reserve System. June 2012. *Changes in U.S. Family Finances from 2007 to 2010: Evidence from the Survey of Consumer Finances* (p. 70). Federal Reserve Bulletin, 98(2). Retrieved from: http://www.federalreserve.gov/pubs/bulletin/2012/PDF/scf12.pdf

87 Baum, S. and Payea, K. 2010. *Trends in Student Aid: 2011* (Figure 4 data). The College Board. Retrieved from: http://trends.collegeboard.org/downloads/Student_Aid_2011.pdf

88 National Science Board. 2012. *Science and Engineering Indicators* (p. 5-7). Arlington, VA: National Science Foundation.

89 Ibid., (p. 5-9).

90 Ibid., (Chapter 2 highlights).

91 Ibid., (Appendix Table 5-10).

92 Green, K.C., Jaschik, S. and Lederman, D. 2012. *The 2012 Inside Higher Ed Survey of College and University Presidents* (p. 6). Retrieved from: http://www.insidehighered.com/news/survey/concerns-about-sports-backing-obama-survey-presidents

93 The data in this section were drawn from the Delta Cost Projects *Trends in College Spending* report for 1999-2009 unless otherwise noted. Dollar figures are reported in constant 2009 dollars. The Delta Cost Project adjusts data from the annual Integrated Post-Secondary Education System (IPEDS) surveys to allow for comparisons between public and private institutions and trends over time.

94 Spending categories include instruction, research, student services, public service, academic support, institutional support, and operations and maintenance. Spending increased for all public and private sectors in all areas with the following exceptions: at public 2-year institutions spending on instruction, public service, and academic support declined, spending on research and public service declined at private master's institutions, and in the private bachelor's sector spending on public service declined.

95 Archibald, R.B. and Feldman, D.H. 2011. *Why Does College Cost So Much?* New York: Oxford University Press.

96 Committee on Research Universities, Board on Higher Education and Workforce Policy and Global Affairs. 2012. *Research Universities and the Future of America: Ten Breakthrough Actions Vital to Our Nation's Prosperity and Security* (p. 12), National Research Council of the National Academies.

97 Desrochers, D.M. and Wellman, J.V. 2011. *Trends in College Spending 1999-2009* (p. 22). Delta Project on Postsecondary Education Costs, Productivity, and Accountability. Retrieved from: http://www.deltacostproject.org/resources/pdf/Trends2011_Final_090711.pdf

98 The Delta Cost Project includes departmental or non-sponsored research as part of instructional spending and notes that it is a mission-related instructional cost in research institutions (p. 21).

99 Desrochers, D.M. and Wellman, J.V. 2011. *Trends in College Spending 1999-2009* (p. 22-23). Delta Project on Postsecondary Education Costs, Productivity, and Accountability. Retrieved from: http://www.deltacostproject.org/resources/pdf/Trends2011_Final_090711.pdf

100 Ibid., (p. 26).

101 Ibid.

102 Ibid., (p. 27).

103 Ibid.

104 Ibid.

105 National Science Board. 2012. *Science and Engineering Indicators* (p. 5-10, Appendix Table 5-2). Arlington, VA: National Science Foundation.

106 Ibid., (p. 5-4).

107 Ibid., (Appendix Table 5-2).

108 Including networking, high performance computers, research data systems, and workstations.

109 National Science Board. 2012. *Science and Engineering Indicators* (Appendix Table 5-2). Arlington, VA: National Science Foundation.

110 Ehrenberg, Ronald G. 2012. American Higher Education in Transition. *Journal of Economic Perspectives*; 26(1). p. 206.

111 Council on Government Relations. March 2008. *Finances of Research Universities* (p. 10). Retrieved from: http://www.cogr.edu/viewDoc.cfm?DocID=151534

112 National Center for Science and Engineering Statistics Higher Education R&D Survey Retrieved from: https://webcaspar.nsf.gov/Help/dataMapHelpDisplay.jsp?subHeader=DataSourceBySubject&type=DS&abbr=RDEXP&noHeader=1&JS=No

113 Committee on Research Universities, Board on Higher Education and Workforce Policy and Global Affairs. 2012. *Research Universities and the Future of America: Ten Breakthrough Actions Vital to Our Nation's Prosperity and Security* (p. 15). National Research Council of the National Academies.

114 Ibid., (p. 7).

115 Committee on Science, Space, and Technology Subcommittee on Research and Science Education hearing. Retrieved from: http://science.house.gov/hearing/subcommittee-research-and-science-educatoin-hearing-role-research-universities-securing

116 The Research Universities Futures Consortium. June 2012. *The Current Health and Future Well-Being of the American Research University*. Retrieved from: http://www.researchuniversitiesfutures.org/RIM_Report_Research%20Future%27s%20Consortium%20.pdf

117 Rockwell, Sara. 2009. The FDP Faculty Burden Survey. *Research Management Review*; 16(2). p. 29-44. Retrieved from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2887040/ A report on faculty burden by the Federal Demonstration Partnership, an association of federal agencies, academic research institutions, and research policy organizations that work to streamline the administration of federally sponsored research, found that on average, faculty spent over 42 percent of the time allocated to their federally-sponsored research projects on administration activities related to those projects, instead of actual research activities.

118 Desrochers, D.M. and Wellman, J.V. 2011. *Trends in College Spending 1999-2009* (p. 22, 23). Delta Project on Postsecondary Education Costs, Productivity, and Accountability. Retrieved from: http://www.deltacostproject.org/resources/pdf/Trends2011_Final_090711.pdf

119 Ehrenberg, Ronald G. 2012. American Higher Education in Transition. *Journal of Economic Perspectives*; 26(1). p. 205.

120 Ehrenberg, Ronald G. and Webber, Douglas A. 2010. Student Services Expenditures Matter? *Change*; 42. p. 26-39.

121 Desrochers, D.M. and Wellman, J.V. 2011. *Trends in College Spending 1999-2009* (p. 21, 22). Delta Cost Project on Postsecondary Education Costs, Productivity, and Accountability. Retrieved from: http://www.deltacostproject.org/resources/pdf/Trends2011_Final_090711.pdf

122 Ehrenberg, Ronald G. 2012. American Higher Education in Transition. *Journal of Economic Perspectives*; 26(1). p. 206.

123 National Science Board. 2012. *Science and Engineering Indicators* (p. 5-18). Arlington, VA: National Science Foundation.

124 Thornton, S. and Curtis, J.W. 2012. *A Very Slow Recovery: The Annual Report on the Economic Status of the Profession 2011-12* (p. 10). American Association of University Professors. Retrieved from: http://www.aaup.org/NR/rdonlyres/5C8E1EE3-D041-40EE-A235-060B2E9BE1D1/0/zreport.pdf

125 Ibid., (p. 9).

126 Desrochers, D.M. and Wellman, J.V. 2011. *Trends in College Spending 1999-2009* (p. 21, 22). Delta Cost Project on Postsecondary Education Costs, Productivity, and Accountability. Retrieved from: http://www.deltacostproject.org/resources/pdf/Trends2011_Final_090711.pdf

127 Keller, C.M. 2009. *Coping Strategies of Public Universities During the Economic Recession of 2009* (p. 14). The Association of Public and Land-Grant Universities. Retrieved from: http://www.aplu.org/document.doc?id=1998

128 Ibid., (p. 18).

129 Carlson, S. 2011. Business Officers Discuss Deferred Maintenance as a Financial Threat. *The Chronicle of Higher Education*. Retrieved from: http://chronicle.com/blogs/buildings/business-officers-discuss-deferred-maintenance-as-a-financial-threat/29900

130 National Science Board. 2012. *Science and Engineering Indicators* (p. 5-14, Figure 5-9). Arlington, VA: National Science Foundation.

131 The bibliography that accompanies this report (Annex 1) can be found on the NSB Web site: http://www.nsf.gov/nsb/

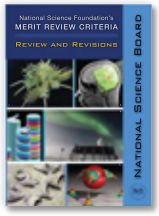
132 The list of higher education organizations (Annex 2) that accompanies this report can be found on the NSB Web site: http://www.nsf.gov/nsb/

NATIONAL SCIENCE BOARD RECENT PUBLICATIONS

Science and Engineering Indicators 2012
(NSB-12-01)

Research & Development, Innovation, and the Science and Engineering Workforce: A Companion to Science and Engineering Indicators 2012
(NSB-12-03)

Digital Research Data Sharing and Management
(NSB-11-79)



National Science Foundation's Merit Review Criteria: Review and Revisions
(NSB-11-86)

Recommended Citation:

National Science Board. 2012. *Diminishing Funding and Rising Expectations: Trends and Challenges for Public Research Universities, A Companion to Science and Engineering Indicators 2012*, Arlington, VA: National Science Foundation (NSB-12-45).

The cover design and interior layout were created by Jennifer R. Keating, Design and Publishing Section, Information Dissemination Branch, NSF.

Cover images (left to right): 1. Consoli, John, Brain Cap with Neural Interface Software. University of Maryland. **2.** Levere, Douglas, Electrical Engineering Lab. University at Buffalo. **3.** Nebesny, Ken. Research-sized Organic Thin-film Photovoltaic Solar Cell. University of Arizona. **4.** Department of Physics and Astronomy. Data Analysis Methods for Gravitational Wave Searches. University of Texas-Brownsville. **5.** Scripps Institution of Oceanography. Researchers Look for Ocean-based Antibiotic Sources. University of California-San Diego. **6.** UNR Department of Anthropology. Great Basin Paleoindian Research Unit. University of Nevada, Reno. **7.** Leary, Stan. Research at the College of Agriculture Griffin Campus. University of Georgia. **8.** U.S. Army RDECOM. Michigan Robotics Team Honored at International Competition. University of Michigan. **9.** Freire, Juliana. Using VisTrails for Complex Data Sets. University of Utah. **10.** Rutgers CTS. Development of Commercial Grass Seed from the Center for Turfgrass Science. Rutgers University. **11.** Garvey, Kathy. Bee breeder-geneticist Susan Cobey at the Harry H. Laidlaw Jr. Honey Bee Research Facility. University of California-Davis. **Interior Images: 12.** Keating, Jennifer R. (p. 6) Molecule with Scientific Icons IDB/NSF. **13.** Wade, Matt H. (p. 7) University at Albany–SUNY, College of Nanoscale Science and Engineering Building. Wikipedia/CC-BY-SA-3.0. **14.** Suny.edu. (p. 11) Seal of the State University of New York. State Universities of New York. **15.** Universityofcalifornia.edu. (p. 11) Seal of the State University of California. State Universities of California.

The complete *Science and Engineering Indicators 2012* report, *Science and Engineering Indicators Digest 2012*, Appendix Tables, this companion report, *Diminishing Funding and Rising Expectations: Trends and Challenges for Public Research Universities*, and related resources can be obtained online at www.nsf.gov/nsb. To obtain printed copies, use NSF's online publication request form, http://www.nsf.gov/publications/orderpub.jsp, or call (703) 292-7827.


NATIONAL SCIENCE FOUNDATION
NSB
National Science Board
Est. 1950

NSB-12-45