ILLINOIS INNOVATION INDEX

2019 R&D INDEX

ILLINOIS' R&D LANDSCAPE & PATH FORWARD

Argonne National Laboratory

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ILLINOIS SCIENCE & TECHNOLOGY COALITION

WHY R&D MATTERS

Research and development (R&D) is the lifeblood of innovation. Universities, businesses, and government all use R&D to create new technologies and services that create jobs and drive economic growth.

University research has been a core mission of Illinois' leading universities since their founding. Research at universities in the state has led to the creation of technologies such as the LED, graphical web browser, MRI, modern nuclear energy, cloud computing, countless modern medicines and cancer treatments, and many, many more. The past decade has seen Illinois' universities place an increased emphasis on commercializing discoveries made through university research. This emphasis has led Illinois' universities to become hubs of economic development through the creation and commercialization of new technologies.

For businesses, R&D is vital to competitiveness as companies look to grow their share of increasingly globalized markets. R&D fuels companies to improve existing products; discover and develop new products; or create more efficient processes. Business R&D growth is integral to Illinois' economy, allowing companies in the state to remain ahead of the technology curve and create strong jobs.

Lastly, research conducted at federally financed R&D centers (FFRDCs) keeps the country on the leading edge of discovery and innovation. Illinois' two national labs, Argonne and Fermi, have a long history of discovery in key areas like advanced materials, defense, energy, supercomputing, and many more. Illinois' federal labs are also working to make their facilities and technologies accessible to businesses through user facilities, technology transfer, and incubator programs—driving economic impact.

Together, R&D activity at universities, businesses, and federal labs propel Illinois' innovation ecosystem and economy forward.

KEY FINDINGS

- Illinois' total R&D activity reached **$17.5 billion** in 2016, an increase of nearly **$1 billion** over 2015. From 2015 to 2016, Illinois' growth in total R&D activity exceeded the national average, growing by **6 percent**, compared with **4.1 percent** nationally.
- The uptick in Illinois' total R&D activity can largely be attributed to the growth of business R&D in both the **food** and **IT industries**, which collectively grew by more than **$700 million** from 2015 to 2016.

- Following a period of relative stagnation, business R&D jumped by more than **$1 billion** in 2016, reaching **$13.7 billion**. Illinois' single-year business R&D growth outpaced the national average from 2015 to 2016, growing by **8 percent**, compared with **5.3 percent** nationally.
- Illinois' business R&D landscape is heavily concentrated in **pharmaceuticals** and **machinery**. **More than half** of all business R&D activity in the state is conducted in these two fields, compared with just over **20 percent** nationally.
- Anchored by established Fortune 500 companies and growing newcomers, Illinois is also a national business R&D leader in both **food** and **finance & insurance**. The state **ranks 2nd** in food R&D, and **3rd** in finance & insurance R&D, respectively.
- Compared with the national average, business R&D in Illinois is **more concentrated** in large companies (more than 10,000 employees). Businesses with fewer than 1,000 employees make up a **smaller share** of business R&D, compared with the national average.
- Illinois' top patent producing companies are **Caterpillar**, **IBM**, **Motorola Mobility**, and **State Farm**. Other notable Illinois-headquartered companies among the top patent producers include **Allstate**, **Cleversafe (IBM)**, **AbbVie**, **Boeing**, **Molex**, **John Deere**, and **Illinois Tool Works (ITW)**.
- Illinois' two federally funded R&D centers (FFRDCs), Argonne and Fermilab, conduct more than **$1 billion** in R&D activity annually. Thanks to its robust user facilities, Argonne receives more R&D funding from businesses than any other federal lab in the country.
- To promote the growth of R&D and innovation in Illinois, the state should look to grow **university-industry R&D collaborations**. Currently, the state **ranks 8th** for both university R&D funded by businesses, and patents co-assigned to both a university and company. Illinois also **ranks 13th** in publications co-authored by at least one university and industry researcher.
- R&D activity at Illinois' universities reached **$2.5 billion** in 2017, up from around **$2.4 billion** in 2016. This level of university R&D activity eclipses the state's previous high-water mark, set in 2013.
- Both federal and state funding for university research in Illinois has fallen over the past five years. To compensate for this decrease in funding, universities in the state have grown the share of funding received from **non-traditional sources**. These sources include **institutional funds**, **funding from businesses**, and **other sources**.
- Compared with the national average, Illinois' university R&D is more concentrated in **medical** and **computer fields**. Together, these disciplines make up nearly **60 percent** of university R&D in the state.
- In 2017, Illinois universities produced **13,817 academic articles** in science and engineering fields—**6th most** among states nationally. Universities in Illinois were also issued **394 patents** in 2018, **8th most** among states nationally.

CONTENTS

TOTAL R&D

Illinois' R&D Activity Climbs in 2016 4

BUSINESS R&D

R&D Among Illinois Companies Gathers Steam 6

Growth Mixed Among Illinois' Key Business Industries 8

Illinois' R&D Concentrated in Large Businesses 10

Illinois' Largest Patent Producing Businesses 11

FEDERAL LABS

Federal Labs Assist Business Innovation 12

UNIVERSITY-INDUSTRY COLLABORATION

The Importance of Growing University-Industry R&D Collaborations 13

UNIVERSITY R&D

University Research Grows to Record-Level 14

Universities Fill Funding Gaps from Non-Traditional Sources 15

Medicine, Computer Science Lead R&D Disciplines 17

Illinois a Leader in University R&D Output 19

LOOKING FORWARD

Illinois' Path Forward 19

TOTAL R&D

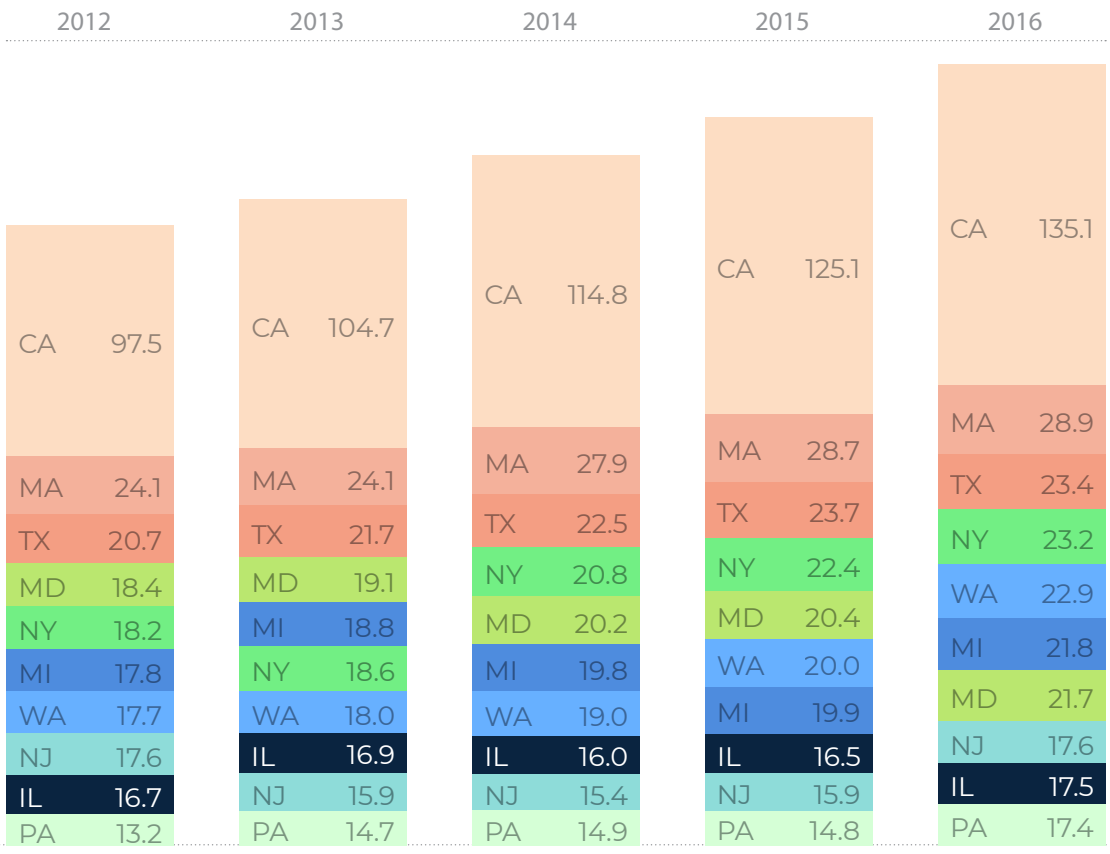
ILLINOIS' R&D ACTIVITY CLIMBS IN 2016

Total R&D activity in Illinois rose to $17.5 billion in 2016, up from $16.5 billion in 2015. From 2015 to 2016, Illinois' growth in total R&D activity exceeded the national average, growing by 6 percent, compared with 4.1 percent growth nationally. The increase in Illinois' R&D activity in 2016 follows a period of relative stagnation in the state. From 2011 to 2015, Illinois' total R&D activity grew by just 0.8 percent annually, compared with 3.7 percent annual growth nationally.

Despite the uptick in activity in 2016, Illinois fell from 8th to 9th among states for total R&D due to strong growth among peer states. Illinois also lags behind the national average in R&D intensity, a measure of R&D activity as a share of GDP. Illinois spends 2.2 percent of its GDP on R&D, compared with 2.8 percent nationally. The state ranks 22nd nationally for the share of GDP spent on R&D.

Total R&D Activity by State

Source: National Science Foundation, National Center for Science and Engineering Statistics (NCSES)

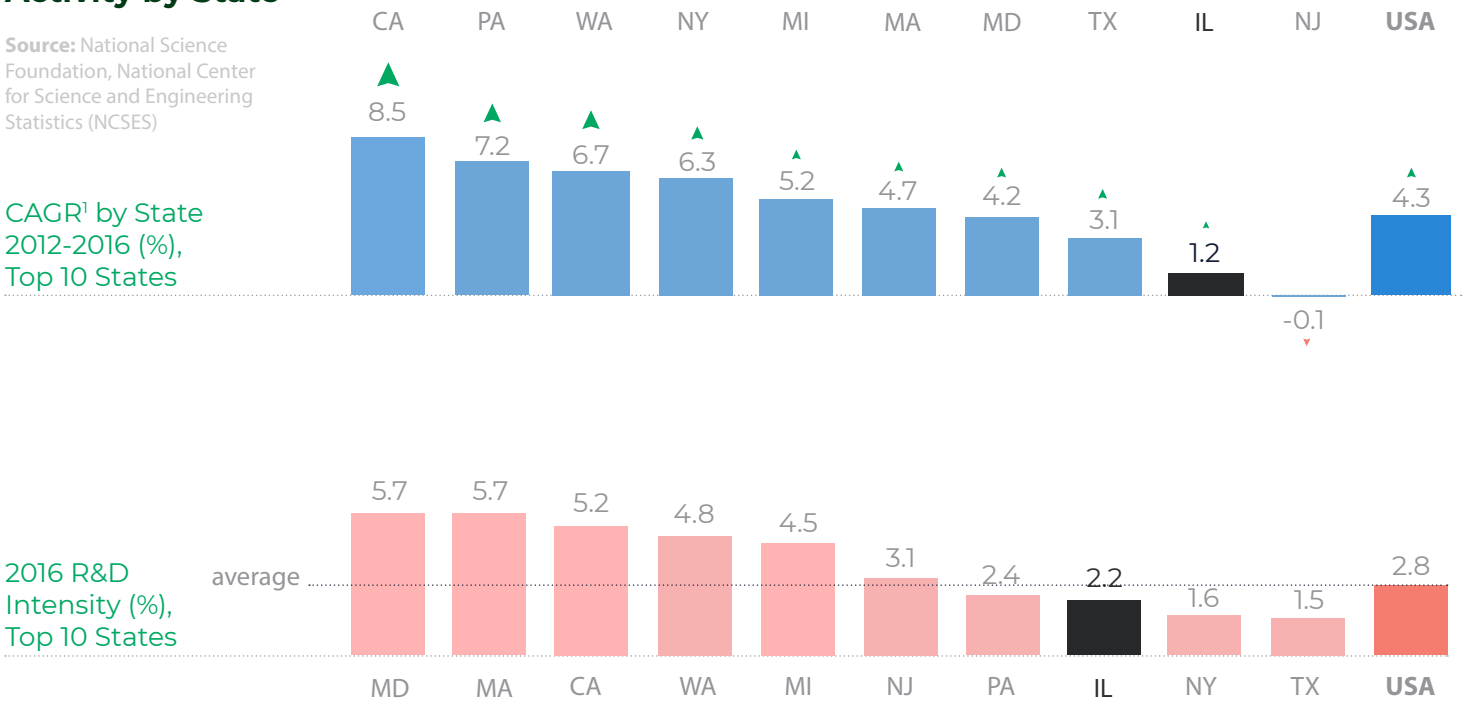


Top 10 States 2012-2016 ($ billion)

USA Total	2012	2013	2014	2015	2016
	435.3	456.1	477.7	495.2	515.3

Total R&D Activity by State

Source: National Science Foundation, National Center for Science and Engineering Statistics (NCSES)



As is the case in most states, Illinois R&D activity is performed primarily by businesses and universities. In Illinois, these two groups performed 16.1 billion in R&D activity, 92.2 percent of the state's total activity in 2016. Illinois' two national labs, Argonne and Fermilab, also conduct more than $1 billion in R&D activity each year. Federal agencies, non-profit organizations, and the State of Illinois conduct less than 2 percent of Illinois' total R&D activity (around $300 million).

[1] "CAGR" refers to compound annual growth rate, a measure of year-on-year growth over a specified time period.

Northwestern

Northwestern Opens State of the Art Biomedical Research Center

In June, Northwestern University's Feinberg School of Medicine opened the Louis A. Simpson and Kimberly K. Querrey Biomedical Research Center on its Chicago academic medical campus. The new research center is the largest new building solely dedicated to biomedical research at any American medical school. The new center will further Northwestern's growth as a national leader in biomedical research. The university is the single largest recipient of research funding from the National Institutes of Health in Illinois. The new 12-story building adds more than 625,000 square feet of research and laboratory space. The building is designed for a future expansion that can more than double its size vertically, with up to 16 new floors in the second phase of construction.

BUSINESS R&D

R&D AMONG ILLINOIS COMPANIES GATHERS STEAM

R&D conducted by Illinois businesses grow by more than $1 billion between 2015 and 2016, reaching $13.7 billion. Illinois' business R&D growth outpaced the national trend from 2015 to 2016, with 8 percent growth in the state, compared with 5.3 percent growth nationally. The uptick in business R&D is encouraging for the state, as it follows a period of relative stagnation. From 2011 to 2015, Illinois' business R&D growth lagged behind the national trend, growing at an annual rate of just 1.4 percent, compared with 4.9 percent annual growth nationally.

Business R&D by State

Source: National Science Foundation, Business R&D and Innovation Survey (BRDIS)

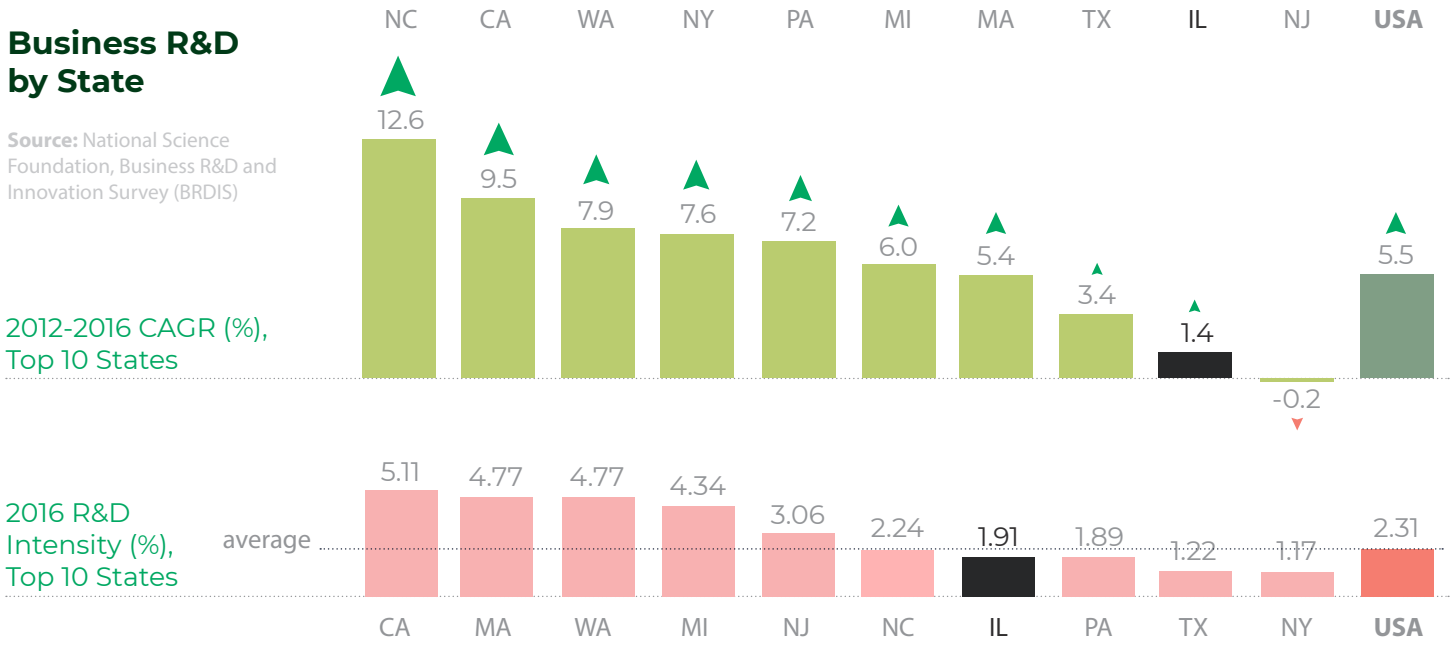
Top 10 States 2012-2016 ($ billion)

USA Total ($ billion)	2012	2013	2014	2015	2016
	302.3	322.5	340.7	355.8	374.7

Illinois ranks 8th among states for business R&D. However, the state lags behind the national average for business R&D intensity—a measure of R&D activity as a percentage of business output. In 2016, 1.9 percent of business output in Illinois was spent on R&D, compared with 2.3 percent nationally. Though business R&D intensity grew slightly in 2016—up from 1.8 percent in 2015—the state has struggled to match leading states like California, Massachusetts, Michigan, and Washington, each with business R&D intensities above 4 percent.

Business R&D by State

Source: National Science Foundation, Business R&D and Innovation Survey (BRDIS)



City Tech Partnering with Companies to Take on Urban Challenges

City Tech Collaborative (City Tech) fosters cross-sector collaboration to create scalable, technology-enabled products, capabilities, and solutions to solve problems that are too big for a single sector or organization to solve alone. Two challenges City Tech is currently tackling are urban heat and mobility. To understand the impact of urban heat reduction efforts, City Tech, Microsoft, Esri, d3i Systems, and the City of Chicago are partnering on the Urban Heat Response Solution. The pilot will make NASA environmental data accessible to urban planners via ESRI's ArcGIS mapping and analytics platform hosted in Microsoft's Azure cloud. With this new capability, governments and civic officials will be able to better evaluate the need for and impact of urban green spaces and other efforts to reduce urban heat. City Tech also launched the Advanced Mobility Initiative to help cities take a more proactive role in transportation planning in the face of urban mobility's rapidly evolving landscape. Along with founding partners Bosch, HERE Technologies, and Microsoft, City Tech will integrate policy and technology innovations to create a prioritized and actionable mobility roadmap. The efforts from this plan will create a more seamless and frictionless transportation system with increased accessibility and reach for its residents.

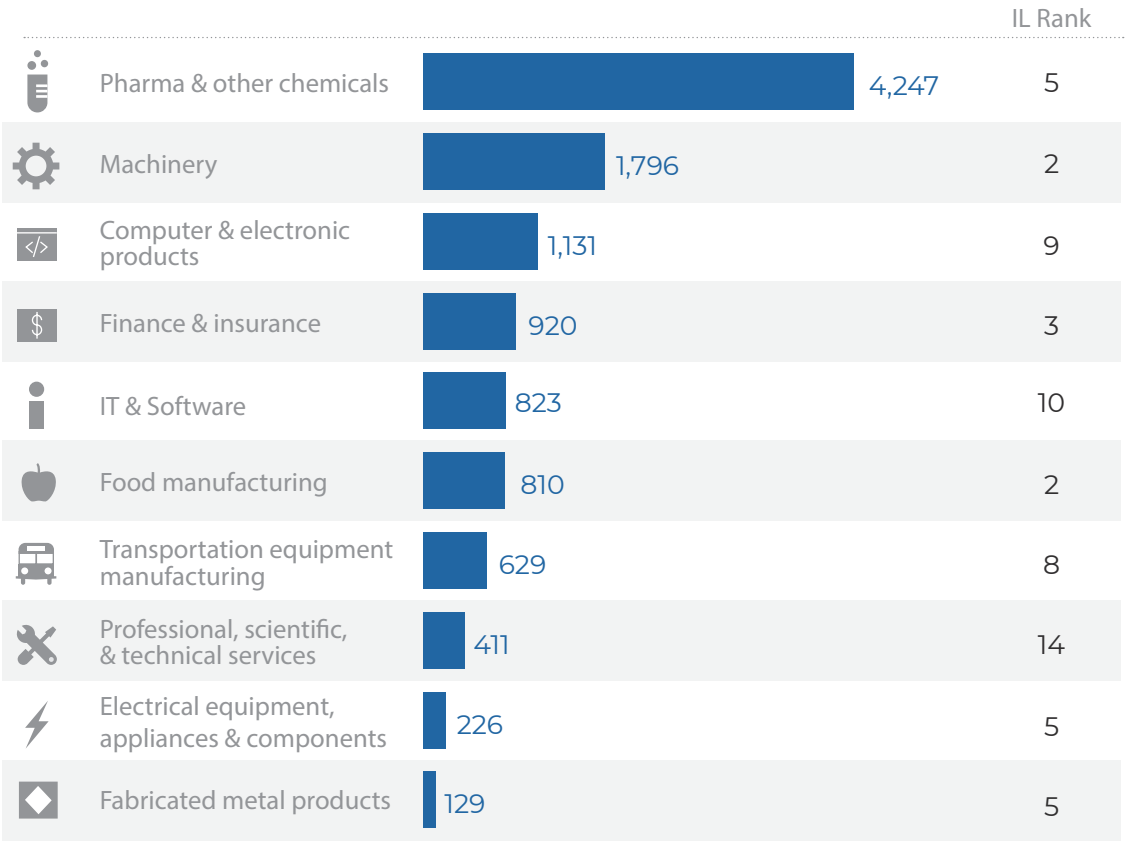
GROWTH MIXED AMONG ILLINOIS' KEY BUSINESS INDUSTRIES

More than half of Illinois' business R&D is conducted in pharmaceuticals & other chemicals (35.9 percent) and machinery (15.2 percent). Compared to the national average, Illinois' business R&D activity is far more concentrated in these industries. Pharmaceuticals & other chemicals and machinery make up just over 20 percent of business R&D activity nationally. Illinois is also a leader in food R&D, ranking second nationally. Food industry R&D activity in Illinois has grown by 350 percent over the past five years.

Conversely, Illinois business R&D landscape is significantly less concentrated in computer & electronics and IT. Nationally, these industries make up 43.6 percent of business R&D activity, but account for just 16.5 percent of activity in Illinois. Compared with the national average, Illinois conducts a smaller share of R&D in transportation and professional, scientific, and technical services.

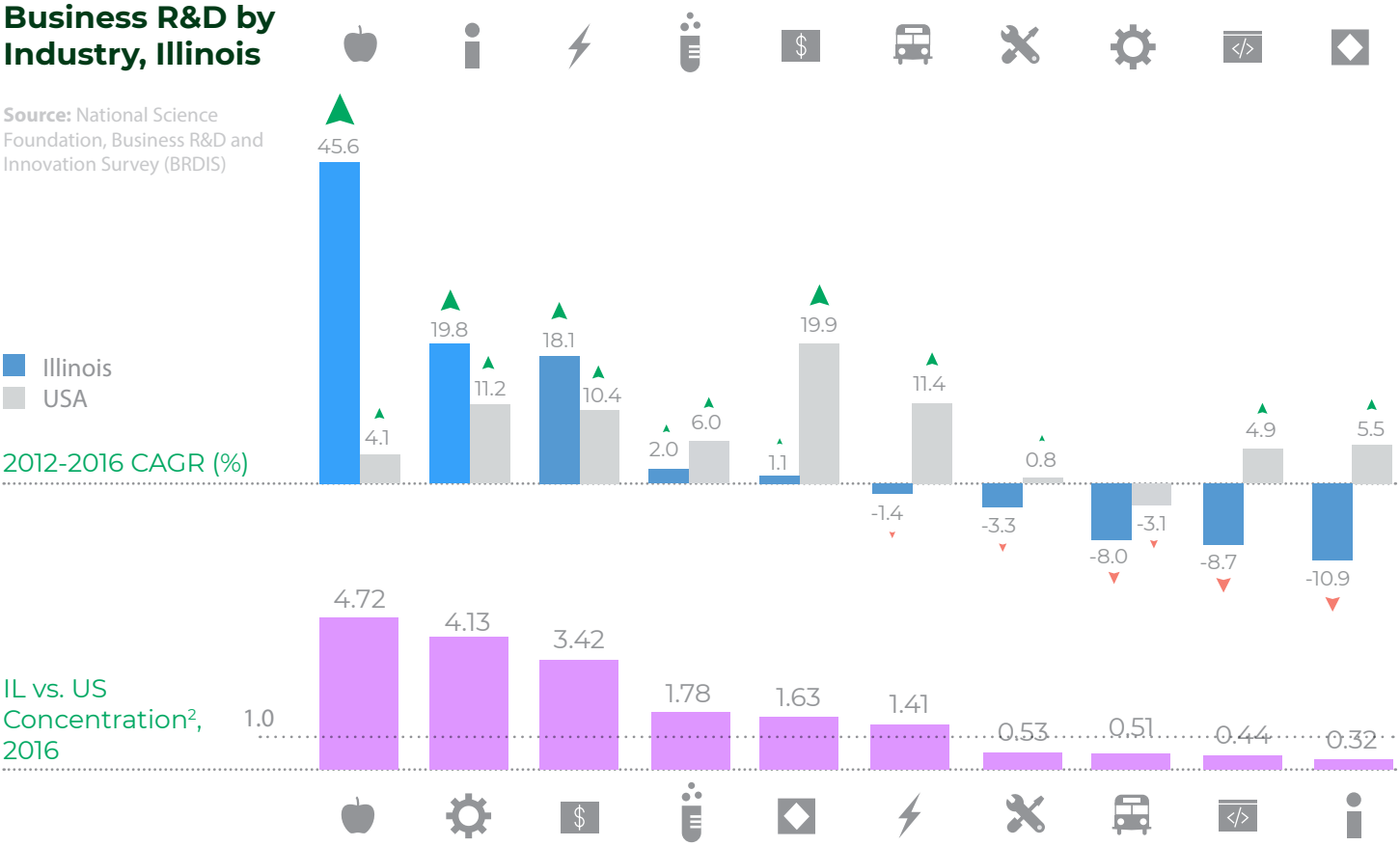
Business R&D by Industry, Illinois, 2016 ($ million)

Source: National Science Foundation, Business R&D and Innovation Survey (BRDIS)



Illinois' concentration of R&D in pharmaceuticals and other chemicals (the state ranks 5th nationally) is driven by industry leaders like Abbott, AbbVie, Astellas and Baxter, as well as growing companies like Lundbeck and Horizon. Contrary to the narrative that Illinois' pharmaceutical R&D is leaving the state, activity grew by 2 percent annually from 2012 to 2016. However, this growth is slower than the national trend, which saw 6 percent annual growth from 2012 to 2016.

Business R&D by Industry, Illinois



The state's strength in machinery R&D (2nd nationally) can be attributed to national industry pillars like Caterpillar, Illinois Tool Works (ITW), and John Deere. More than 15 percent of national R&D in machinery is conducted in Illinois. Despite the high volume of activity, R&D in the industry has decreased, both nationally and in Illinois. Machinery R&D decreased by 8 percent annually between 2012 and 2016, compared with a 3.1 percent decrease nationally.

Home to two of the largest insurance providers in the country, State Farm and Allstate, Illinois' insurance industry is a major economic driver for the state. As the finance hub of the Midwest, Illinois is also home to regional or national headquarters of many of the largest financial firms in the nation. As a result of this industry concentration, more than 10 percent of national R&D in finance and insurance is conducted in Illinois (3rd most among states). However, R&D in finance and insurance grew by a modest 1.1 percent in Illinois from 2012 to 2016, compared with 19.9 percent annual growth nationally.

Illinois' most significant R&D growth has by far been in food, where the state has become a national hub for innovation. R&D activity in food grew by a staggering 350 percent, from $180 million in 2012, to $810 million in 2016. Growth in food R&D has seen the state raise from 6th nationally in 2012, to 2nd in 2016. In total, more than one-sixth of national food R&D is conducted in Illinois. This raise can be attributed to significant R&D investment across Illinois' large community of

[2] Here, "concentration" refers to the share of R&D conducted in each industry, relative to the national average.

food companies, including the state's Fortune 500 companies ADM, Kraft Heinz, Mondelez International, McDonald's, US Foods, Conagra, TreeHouse Foods, and Ingredion. In addition, well known brands and companies headquartered outside the state—such as Sara Lee and Tyson Foods—have invested heavily in R&D in Illinois. The state is also home to a vibrant food startup ecosystem, which has seen the launch and growth of companies like Farmer's Fridge, Fooda, GrubHub, Home Chef, RXBAR, and many more.

THE UNIVERSITY OF CHICAGO

Argonne NATIONAL LABORATORY Fermilab

ILLINOIS Northwestern

Chicago Quantum Exchange Brings in New Partners

The Chicago Quantum Exchange (CQE) is an intellectual hub for the advancement of academic and industrial efforts in the science and engineering of quantum information. CQE is anchored by the University of Chicago, Argonne National Laboratory, Fermi National Accelerator Laboratory, and the University of Illinois at Urbana-Champaign, and includes the University of Wisconsin-Madison and Northwestern University. Launched in 2017, CQE is based at the University of Chicago's Pritzker School of Molecular Engineering and is focused on developing new ways of understanding and exploiting the laws of quantum mechanics, which govern nature at its smallest scales. Research at the Exchange aims to develop radically new types of devices, materials, and computing techniques. In July 2019, QCE announced new corporate partnerships with Boeing, Applied Materials, Inc., ColdQuanta, Inc., HRL Laboratories LLC and Quantum Opus LLC. With strong collaboration between in-state universities, federal labs, and companies, CQE is establishing Illinois as a national hub for discovery in quantum.

ILLINOIS' R&D CONCENTRATED IN LARGE BUSINESSES

Compared with the national average, R&D activity in Illinois is more concentrated in large businesses. In 2016, 63 percent of all R&D activity in Illinois is conducted by companies with more than 10,000 employees, compared with 54 percent nationally. R&D activity in Illinois is less concentrated in smaller businesses. In 2016, companies with fewer than 1,000 employees conducted 15.3 percent of R&D activity in Illinois, compared with 17.9 percent nationally.

The concentration of R&D in large businesses fits Illinois' business community makeup—the state has the fourth-most Fortune 500 companies nationally. However, the imbalanced growth in activity by company size highlights the need to further support R&D within smaller businesses. Between 2012 and 2016, R&D activity in Illinois companies with fewer than 1,000 employees grew by

just 0.6 percent annually, compared with 3.4 percent annual growth nationally. To assist smaller companies, Illinois should look to enact an SBIR matching program[3], which would further the incentive for small companies to develop new technologies through R&D.

[3] Illinois' most recently proposed SBIR matching program would provide grants of up to 50% of the amount of a federal Phase I award, and encourage grantees to pursue Phase II awards.

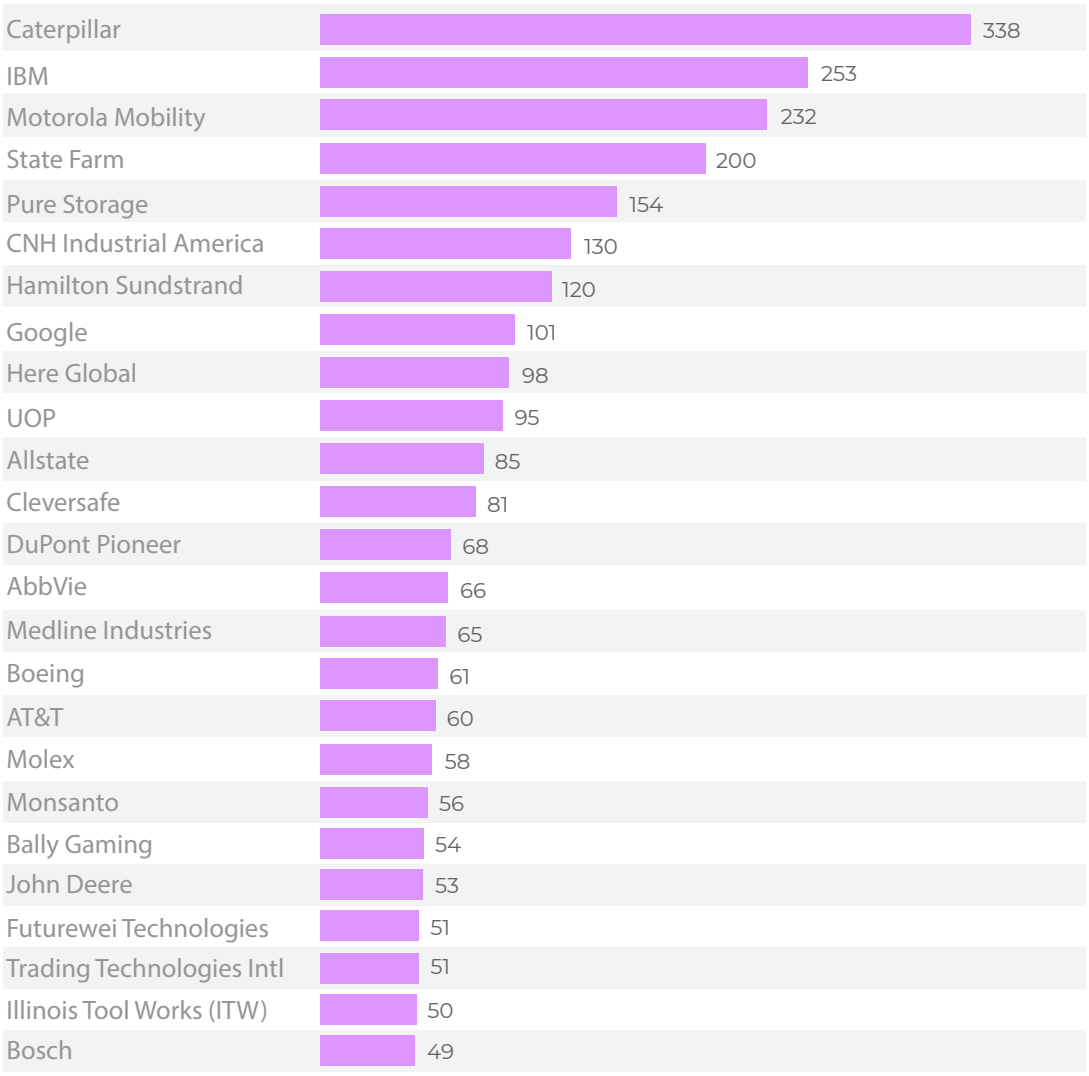
ILLINOIS' LARGEST PATENT PRODUCING BUSINESSES

Patents are a tangible output of business R&D activity, representing the creation of a new technology, process, or service. Illinois ranks 7th in patents issued to businesses, with 6,788 patents issued in 2018. Patents awarded to businesses in the state have fallen by 1.3 percent annually since 2014, compared with 2.2 percent growth nationally. As of 2017, Illinois was issued 19.6 patents per 1,000 individuals employed in science and engineering occupations, compared with 21.8 nationally.[4]

[4] National Science Board, Science and Engineering Indicators 2018: Patents Awarded per 1,000 Individuals in Science and Engineering Occupations

Top 25 Companies by Patents, Illinois, 2018

Source: US Patent and Trademark Office, Wellspring Scout Data Platform



Illinois businesses producing the most patents in 2018 include Caterpillar, IBM, Motorola, and State Farm. Other notable Illinois-headquartered companies among the top 25 patent-producers include Allstate, Cleversafe (IBM), AbbVie, Boeing, Molex, John Deere, and Illinois Tool Works (ITW).

FEDERAL LABS

FEDERAL LABS ASSIST BUSINESS INNOVATION

Illinois' federally funded R&D centers (FFRDCs), Argonne Argonne National Laboratory and Fermi National Accelerator Laboratory, conduct more than $1 billion annually in R&D activity. In 2017, Argonne conducted $724 million in R&D activity, while Fermilab conducted $321 million—each a slight decrease compared with 2016 levels. Since 2013, R&D activity at Argonne has remained relatively flat (0.5 percent annual growth), while Fermilab has seen a decline in activity (3.9 percent annual decrease).

As is the case for all federal labs, both Argonne and Fermilab receive the vast majority of their funding from the federal government. However, compared with the average for FFRDCs nationally, Argonne receives a higher share of funding from businesses (3.8 percent vs. 1 percent). The amount of R&D funding Argonne receives from business has nearly doubled since 2013, reaching $27.4 million in 2017. Argonne receives more R&D funding from businesses than any other federal lab in the country. The amount of funding from business is largely due to the growth of Argonne's user facilities, which allow businesses, universities, and other organizations to utilize lab facilities and equipment for research.

Argonne NATIONAL LABORATORY

Argonne User Facilities Attracting Business Collaboration

Argonne National Laboratory conducts research spanning from basic science to engineering solutions, changing the world for the better. Argonne is home to four world-class U.S. Department of Energy (DOE) Science User Facilities: The Argonne Leadership Computing facility (ALCF); Advanced Photon Source (APS); Center for Nanoscale Materials (CNM); and Argonne Tandem Linac Accelerator System (ATLAS). Argonne also operates a fifth, the Atmospheric Radiation Measurement (ARM) Southern Great Plains atmospheric observatory, in

Lamont, OK. Each year, these facilities are relied on by thousands of researchers for breakthroughs in fields ranging from construction and aeronautics to pharmaceuticals. Last year's economic impact of these five facilities was $116 million in contracts awarded to entities located within Illinois.

THE IMPORTANCE OF GROWING UNIVERSITY-INDUSTRY R&D COLLABORATIONS

Collaboration between universities and members of industry can be a valuable tool for increasing innovation output, while also leading to business attraction, high-skilled job growth, and talent retention. For universities, these collaborations provide vital R&D funding, insight into industry trends, and the potential development of new intellectual property (IP). For industry, these collaborations allow companies to gain an innovation advantage by working with renowned university researchers and accessing unique research facilities.

Though university-industry collaborations can be difficult to measure, a number of indicators show Illinois has room to grow these efforts. By funding, Illinois ranks 8th for university R&D funded by businesses. From 2013 to 2017, companies spent $663 million on collaborative research with Illinois universities, just 3.2 percent of such activity conducted nationwide. The state ranks 8th nationally (tied with North Carolina) in patents co-assigned to both a university and company, with 273 such patents from 2014 to 2018. Illinois ranks 13th in publications co-authored by at least one university and industry researcher.

University-industry collaboration indicators, Illinois state ranking

Sources: National Science Foundation, National Center for Science and Engineering Statistics (NCSES) ; US Patent and Trademark Office, Wellspring Scout Data Platform

Collaborative R&D funding, 2013-2017

Co-assigned patents, 2014-2018

Co-authored publications, 2014-2018

To promote the growth of university-industry collaborations, Illinois should join several of its peer states by incentivizing the growth of such partnerships. Examples include university-industry collaboration networks that match companies with university researchers, often providing matching grants to support R&D collaborations. These programs have been shown to effectively grow R&D efforts while creating positive economic impacts.

UNIVERSITY R&D

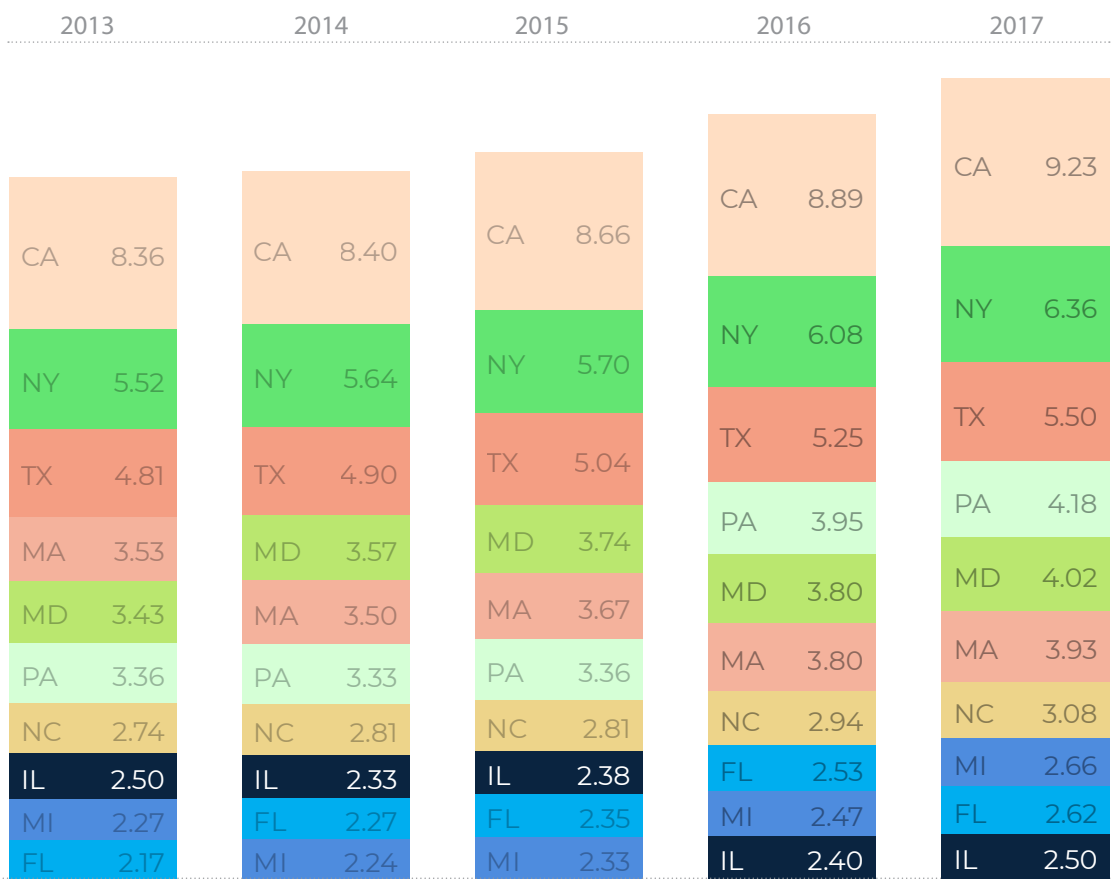
UNIVERSITY RESEARCH GROWS TO RECORD-LEVEL

R&D activity at Illinois' universities reached $2.5 billion in 2017, up from around $2.4 billion in 2016. This activity eclipses the state's previous high-water mark, set in 2013 when the National Center for Supercomputing Applications (NCSA) Blue Waters project at the University of Illinois injected more than $100 million into the state. Since the start of the decade, university R&D in Illinois has grown by 2 percent annually, compared with 3.5 percent annual growth nationally.

Though university R&D has grown steadily since 2010, significant disparities exist between universities in the state. Since 2010, R&D at the state's two largest research universities—Northwestern University and the University of Illinois at Urbana-Champaign (UIUC)—has increased by 4.2 percent annually, while R&D at all other universities in the state has fallen by 0.4 percent annually. R&D activity at public universities other than UIUC has fallen by 1.2 percent annually since 2010.

University R&D Activity by State

Source: National Science Foundation, Higher Education Research and Development Survey (HERD)



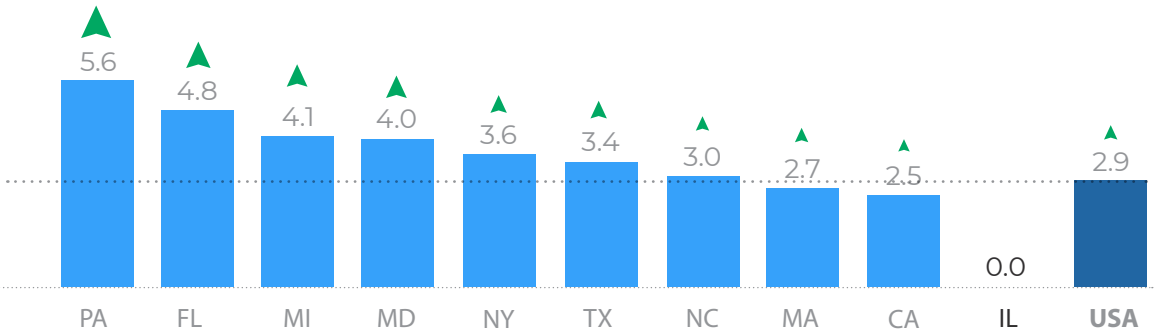
Top 10 States 2013-2017 ($ billion)

USA Total ($ billion)	2013	2014	2015	2016	2017
	67.0	67.2	68.6	71.8	75.2

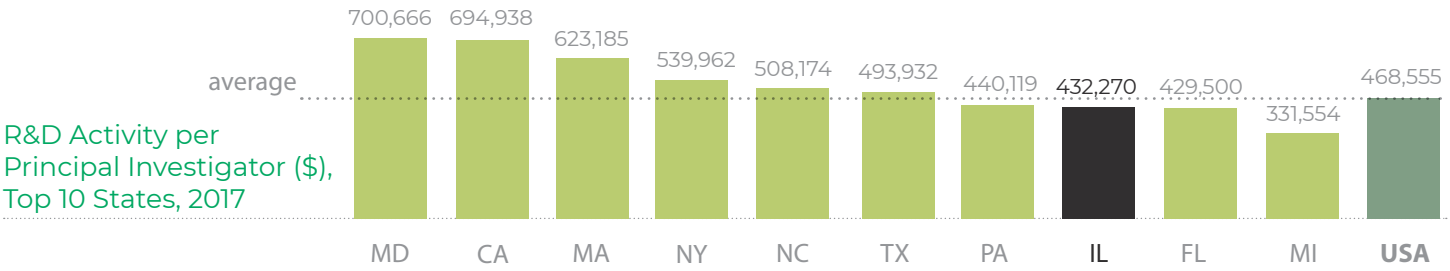
University R&D Activity by State

Source: National Science Foundation, Higher Education Research and Development Survey (HERD)

2013-2017 CAGR (%), Top 10 States



R&D Activity per Principal Investigator ($), Top 10 States, 2017



UNIVERSITIES FILL FUNDING GAPS FROM NON-TRADITIONAL SOURCES

Both in Illinois and nationally, universities receive more than half of their R&D funding from the federal government. However, Illinois is more reliant on the federal government for R&D funding than most states, with 58.6 percent of funding from the federal-level, compared with 53.5 percent of funding nationally. Conversely, Illinois receives very little university R&D funding from state or local government. In 2017, just 1.8 percent of R&D funding came from state or local government, compared with 5.6 percent nationally.

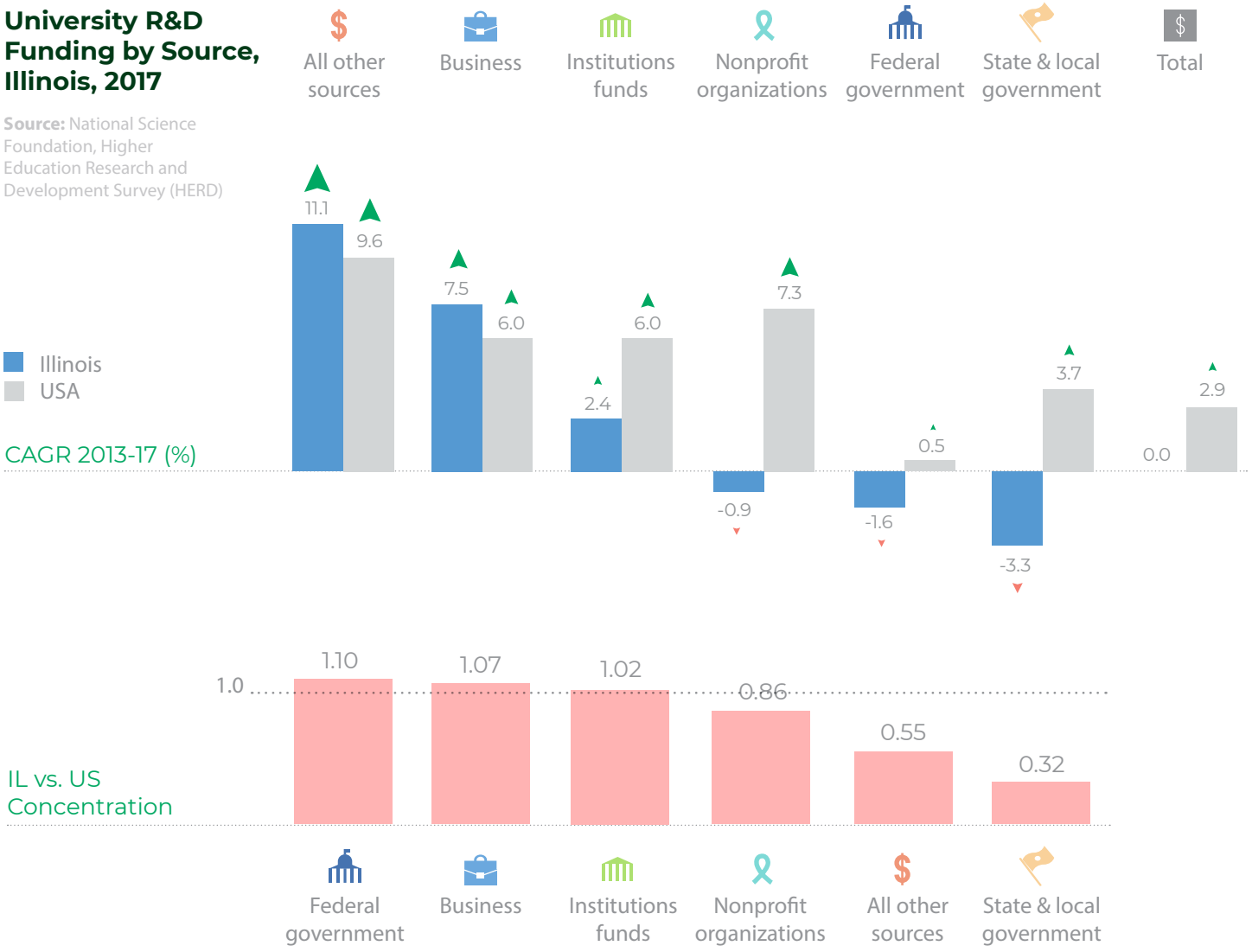
University R&D Funding by Source, Illinois, 2017 ($ million)

Source: National Science Foundation, Higher Education Research and Development Survey (HERD)

	% Share of total	Amount
Federal Government	58.6%	$1,468 M
Institution Funds	25.7%	$644 M
Business	6.3%	$158 M
Nonprofit Organizations	5.8%	$146 M
State & Local Government	1.8%	$45 M
All Other Sources	1.7%	$42 M
Total	100%	$2,503 M

University R&D Funding by Source, Illinois, 2017

Source: National Science Foundation, Higher Education Research and Development Survey (HERD)



For Illinois' universities, R&D funding from both federal and state governments has declined in recent years. Between 2013 and 2017, federal funding for R&D fell by 1.6 percent annually, while state funding fell by 3.3 percent annually. To fill gaps left by decreased government R&D funding, universities in the state have increasingly turned to non-traditional funding sources, including their own institutional funds, funding from businesses, and other sources.[5] Compared with the national average, R&D funding from businesses (7.5 percent annual growth) and other sources (11.1 percent growth) grew more quickly in Illinois from 2013 to 2017. R&D activity made possible by university institutional funds also increased by 2.4 percent annually between 2013 and 2017.

By federal agency, Illinois is among the national leaders in university R&D funding from several federal agencies. The state ranks 5th in funding from the National Science Foundation (NSF) and 6th in funding from the Department of Energy (DOE). Illinois also ranks 8th in funding from the Department of

[5] Other sources include funds from foreign governments, other universities, and gifts designated by donors for research.

Health and Human Services (DHHS, including the National Institutes of Health), receiving more than $850 million in R&D funding in 2017. More than half of all university R&D funding in Illinois (58.3 percent) comes from DHHS.

Illinois' leading research universities are also among the largest recipients of funding from several federal agencies. UIUC ranks 1st nationally in funding from the National Science Foundation (NSF), 6th in funding from the Department of Energy (DOE), and 20th in funding from the Department of Defense (DoD). Northwestern University ranks in the top 20 for funding from both the Department of Health and Human Services (19th) and DOE (20th).

UIC's West Loop Innovations Advancing New Therapeutics

In April, The University of Illinois at Chicago (UIC) and Deerfield Management—a healthcare investment firm—announced the establishment of West Loop Innovations to accelerate the commercialization of therapeutics developed by UIC researchers. West Loop will leverage up to $65 million from Deerfield Management to invest in UIC discoveries vetted through a joint steering committee and executed by a collaborative team of UIC researchers and Deerfield experts. The UIC-Deerfield partnership is also a major development for the new University of Illinois System-led Discovery Partners Institute (DPI). UIC faculty projects supported by Deerfield will advance the DPI's health and wellness efforts. Once constructed, these efforts may be pursued at the DPI-supported Drug Discovery and Innovation Pavilion on the UIC campus and at the permanent DPI headquarters to be built in Chicago, bringing together researchers, students and industry to pursue new, innovative therapeutics.

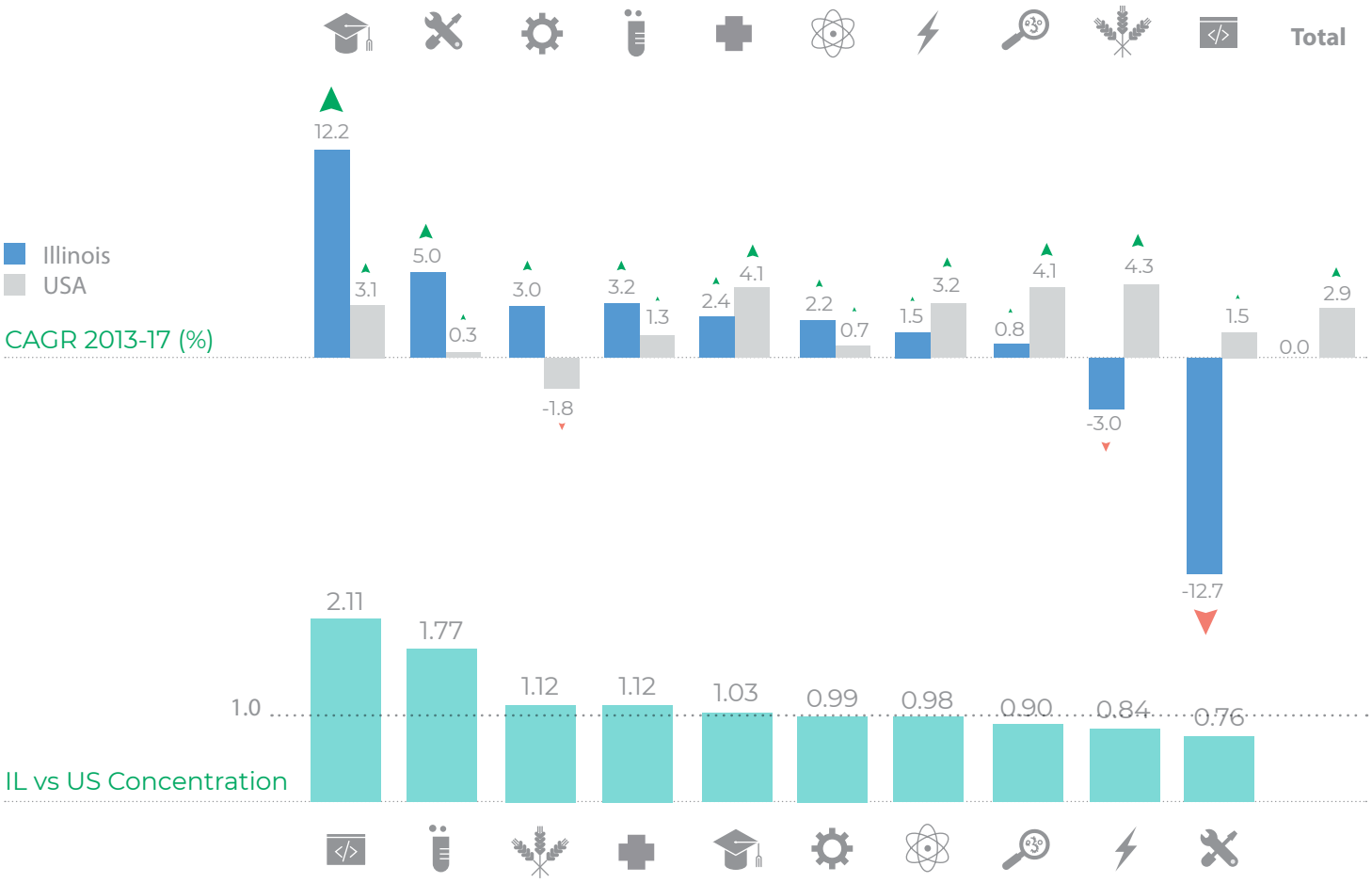
MEDICINE, COMPUTER SCIENCE LEAD R&D DISCIPLINES

Both in Illinois and nationally, medical disciplines (health, biological and biomedical sciences) make up more than half of all university R&D. In 2017, these disciplines make up 52.1 percent of all university R&D in Illinois, compared with 50.1 percent nationally. Compared with the national average, R&D in computer and information sciences also makes up a significantly larger share of Illinois' university R&D. In 2017, 6.1 percent of university R&D in the state was in computer and information science, compared with 2.9 percent nationally. Chemistry also accounts for a larger share of university R&D in Illinois—4.2 percent, compared with 2.4 percent nationally.

University R&D by Discipline, Illinois, 2017 ($ Million)

Source: National Science Foundation, Higher Education Research and Development Survey (HERD)

		IL Rank
Health	894.0	8
Biological & Biomedical	410.7	9
Computer & information sciences	153.8	5
Agriculture & natural resources	147.4	5
Chemistry	105.6	5
Electrical, electronic & communications enginering	76.3	10
Physics	70.6	9
Other engineering	53.4	11
Mechanical engineering	50.5	11
Education	47.3	11



Growth among the state's top university R&D disciplines is mixed. Activity in chemistry; physics; mechanical engineering; education; and other engineering disciplines all grew faster than the national average between 2013 and 2017. However, growth in medical disciplines; computer and information sciences[6]; agriculture and natural resources; and electrical, electronic, and communications engineering either decreased or lagged behind national growth rates.

[6] The significant decline of university R&D in computer and information sciences between 2013 and 2017 is primarily due to the funding of the NCSA Blue Waters supercomputer at UIUC, which peaked in 2013.

ILLINOIS A LEADER IN UNIVERSITY R&D OUTPUT

While expenditures measure the input into the university R&D process, academic articles, invention disclosures, patents, and other technology transfer metrics measure the innovation output of this activity. In 2017, Illinois universities produced 13,817 academic articles in science and engineering fields—6th most among states nationally. Researchers at Illinois' universities produced 5.8 articles per $1 million in R&D funding, compared with 4.5 nationally. The state ranks 4th nationally by this measure. Universities in Illinois were also issued 394 patents in 2018, 8th most among states nationally. Patents issued to universities in the state have grown by 2.2 percent annually since 2014, compared with 4.1 percent growth nationally.

ILLINOIS' PATH FORWARD

Though Illinois' R&D activity has struggled to match national growth rates for much of the past decade, recent business R&D growth of 8 percent (from 2015 to 2016), and university R&D growth of 4.2 percent (from 2016 to 2017), show that R&D activity is trending in the right direction. Though this news is encouraging, it's hardly time for leaders in the state to step back and admire their accomplishments. If Illinois is to push forward and become a truly top-tier state for innovation, it must build upon strengths and fill gaps in its R&D landscape.

Business R&D in the food industry is one such example. Illinois' diverse industry makeup has benefited the state, especially during sluggish economic periods, but the meteoric growth of R&D in the food sector represents an opportunity for the state to double-down on an area of strength. Growing by more than $600 million from 2012 to 2016, Illinois' R&D activity in food has risen from 6th to 2nd nationally. A coordinated economic development strategy around promotion, business attraction, and innovation cluster[7] development could establish Illinois as the nation's flagship state for food innovation.

[7] Innovation clusters bring together start-ups, small, medium and large-size businesses, and research organisations operating in a particular sector and region and are designed to stimulate innovative activity by promoting intensive interactions, sharing of facilities, and the exchange of knowledge and expertise.

To boost innovation and economic growth across sectors, state leaders should also focus on growing collaborative R&D initiatives between Illinois' universities and companies. Such collaborations leverage the unique strengths of each party to drive innovation. To grow these initiatives, the state should look to create a formal university-industry network, matchmaking companies with universities and providing matching grants that incentivize the creation of new R&D projects. Such networks in peer states have been shown to generate positive economic impact.

Finally, to put Illinois on a path toward increased innovation and economic growth, the State of Illinois should step up its direct support for R&D. As a share of state GDP, Illinois ranks last among states for the amount of R&D funding provided by state agencies.[8] This funding, which is typically passed on to universities, businesses, or nonprofit research organizations, can be a vital incentive for increased R&D activity. To increase this direct funding, the State should follow the best practices of many peer states and enact an SBIR matching program. Such a program would provide matching grants for federal SBIR and STTR awardees in Illinois, increasing the incentive to translate R&D into new products and services—especially among small and midsize businesses, which currently conduct a smaller share of R&D in the state, compared with the national average

The recent uptick of activity in Illinois' R&D landscape bodes well for the state's economy in coming years. However, recent momentum must be matched by intentional efforts to increase R&D activity through the promotion of key sectors, collaboration between universities and industry, and new direct state funding. Such efforts would push Illinois to become a truly top-tier state for innovation and grow the state's economy.

[8] NSF State Indicators, 2018: State Agency R&D Expenditures per $1 Million of Gross Domestic Product

ABOUT THE RESEARCH

The R&D issue of *Illinois Innovation Index* uses the most up-to-date data available to measure and benchmark the state's R&D activity across universities, business, and federal labs. Due to differing data collection and analysis timelines between data sources, the latest available data year is not consistent across this analysis. Data used in this issue of the *Index* include:

- **Business R&D and Innovation Survey (BRDIS)**: Latest available data year is 2016
- **Higher Education Research and Development Survey (HERD)**: Latest available data year is 2017
- **FFRDC Research and Development Survey**: Latest available data year is 2017
- **United States Patent and Trademark Office, via the Wellspring Scout Data Platform**: Latest available data year in 2018

Since data on business R&D activity (which accounts for the majority of all R&D conducted nationally) is delayed relative to university and FFRDC data, this *Index* analysis of total R&D uses 2016 as the latest available data year.

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ILLINOIS SCIENCE & TECHNOLOGY COALITION

The Illinois Science & Technology Coalition (ISTC) is a member-driven nonprofit that measures, connects, and enriches the Illinois innovation economy. Created by the State of Illinois 30 years ago, we make powerful links between the state's universities, industry, startups, and government to strengthen our economy and talent pipeline through data collection, policy advocacy, and programs.

INDEX STAFF & CONTRIBUTORS:

Roxanne Atienza
Interim President & CEO, ISTC

Matthew Bragg
Director of Data & Policy, ISTC

Ana Kova
Illustration & Infographics

Edith Portales
Program Intern, ISTC

INDEX DATA PARTNERS:

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