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ANDERSON ECONOMIC GROUP

Empowering Michigan

Tenth Annual Economic Impact Report of Michigan's University Research Corridor

Commissioned by Michigan's University Research Corridor

Michigan State University
University of Michigan
Wayne State University

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Executive Summary

The University Research Corridor (URC) is an alliance of Michigan's three largest higher education institutions: Michigan State University, the University of Michigan, and Wayne State University. In 2007, the presidents of the URC universities hired Anderson Economic Group in the spirit of promoting statewide economic development and accountability to the citizens of the state of Michigan. Anderson Economic Group was asked to perform an independent analysis of the URC's economic impact and to benchmark its performance against peer universities across the nation. This mission has deepened as the URC has reported the results in each year since the first report. This report is the tenth in the series, which is publicly available at www.urcmich.org/reports. The URC has also commissioned several reports on its contribution to key economic sectors. For more on these reports see "Summary of Past URC Sector Reports" on page C-1.

In this report, we estimate the impact of the URC's activities on Michigan's economy, and compare its performance to peer university innovation clusters nationwide. Using data from the universities and public sources, we quantify the universities' degrees awarded, research and development expenditures, and technology transfer activities, and analyze how the URC impacts jobs and income for residents, and state tax revenue.

KEY BENCHMARKS

The URC universities' combined performance is summarized in Table 1. The remainder of this executive summary lays out these results in greater detail.

TABLE 1. Key Benchmarks of the URC

	2007 Report (FY 2006 benchmarks)[a]	2017 Report (FY 2015 benchmarks)	Change Since 2007 Benchmark
Operational Expenditures[b]	$6.5 billion	$8.8 billion	+ $2.3 billion
Fall Enrollment[c]	124,586	139,194	+14,608
Net Economic Impact	$12.8 billion	$16.5 billion	+$3.7 billion
Tax Revenue Impact on State of Michigan	$343 million	$500 million	+$157 million
Total R&D Expenditures	$1.369 billion	$2.150 billion	+$781 million
Innovation Power Composite Rank[d] (1-8)	--	2	--

Source: AEG analysis using base data from Bureau of Economic Analysis (BEA); U.S. Census Bureau; National Center for Education Statistics Integrated Postsecondary Education Data System (IPEDS); URC Universities; National Science Foundation (NSF)

a. The net economic and tax revenue impacts reported here use the updated methodology, and are not the same numbers reported in the 2007 benchmark report. Part of this year's increase is from the addition of construction spending. The rest of the values are the same as initially reported.

b. In previous years, we included depreciation in our analysis; our updated methodology uses construction expenditures. See "Methodology" on page A-1.

c. Headcount provided by URC universities.

d. The composite ranking provides a way to benchmark the URC's overall innovation activities to those of its peer clusters. It factors in the contribution that the university clusters make as a result of their research, talent, and technology transfer activities. We started calculating the composite ranking in 2013. No ranking is available for 2007.

SCALE OF THE URC

The URC universities are the largest research universities in Michigan. We summarize the size of the URC in 2015, including number of students, employees, alumni, and amount of operational expenditures in Table 2 below.

TABLE 2. Innovation, Talent and Operations of the URC in FY 2015

Category	Impact
Number of Enrolled Students	139,194
Known URC Alumni Living in Michigan	650,749
Wage and Salary Earnings of URC Alumni in Michigan	$36.6 billion
Number of Full-Time-Equivalent Employees	56,960
Operational Expenditures (e.g. supplies, payroll, equipment)	$8.8 billion
Construction Spending[a]	$1.1 billion

Source: AEG analysis using base data from IPEDS Finance, FY 2015; URC Universities

a. Beginning in 2013, we measured spending on construction, which includes expenditures on capital, land acquisitions, and equipment associated with capital additions. See "Methodology" on page A-1.

ECONOMIC IMPACT

While generating economic impact is not their main goal, the URC universities make a significant contribution to Michigan's economy in the course of educating students, undertaking research, and serving their communities. The main drivers of this economic impact are university expenditures on both payroll and non-payroll items (such as supplies and equipment), spending by URC students, and incremental earnings by alumni. Crucially, much of this spending is funded by revenue sources that bring new funds to the state. Such sources include research grants and students who would have attended an out-of-state school.

The total impact includes both direct and indirect impacts. In FY 2015, the URC contributed $16.5 billion to the state economy, as shown in Table 3 below.[1]

TABLE 3. Net Economic Impact of URC in Michigan, FY 2015 (in billions)

Impact Category	Net Economic Impact
Non-payroll Operating Expenditures	$3.6
Faculty & Staff Wages and Benefits	$5.5
URC Student Expenditures	$2.9
Incremental Alumni Earnings[a]	$4.5
TOTAL NET ECONOMIC IMPACT	**$16.5**

Source: AEG analysis using base data from URC Universities; BEA; AEG Estimates

a. We estimate that the $36.6 billion in wages and salaries earned by URC alumni in Michigan in 2015 resulted in $4.5 billion in new economic activity. See "URC Alumni in Michigan" on page 28.

1. The economic impact estimates published in the 2014, 2015, and 2016 reports have been revised since these reports were released. See "Revisions to Previously Published Economic Impact Estimates" on page A-15 for further discussion.

The URC spends money in every Michigan county, extending its economic presence to every part of the state. The economic and jobs impact of the URC reaches every region in Michigan, as shown in Table 4 below. See "Economic Impact of the URC in Michigan" on page 33 and Map 5, "Net Economic Impact of URC Universities' Operations and Employment by Region, FY 2015 (in millions)," on page 37 for further details.

TABLE 4. Net New Jobs of URC in Michigan, by Region, FY 2015

Economic Development Collaboratives	Net Economic Impact of URC Operations (millions)	Total Direct and Indirect Jobs Caused by URC (FTE)
Upper Peninsula Region	$51.4	86
Northwest Region	$143.8	162
Northeast Region	$47.8	88
West Michigan Region	$509.4	450
East Central Region	$196.9	185
East Michigan Region	$633.1	1,882
South Central Region	$3,346.3	11,901
Southwest Region	$197.8	243
Southeast Michigan Region	$5,097.9	37,832
Detroit Metro Region	$6,321.0	16,068
State of Michigan	**$16,545.4**	**68,896**

Note: May not add to total due to rounding.
Source: AEG analysis using base data from URC universities; BEA; AEG Estimates

NEW STATE TAX REVENUE DUE TO URC

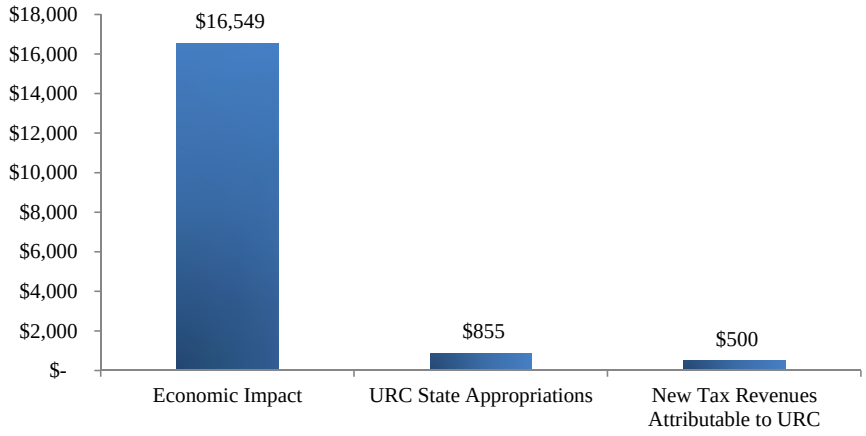
In 2015, we estimate that $3.2 billion in wages of URC employees and $5.4 billion of URC alumni earnings in Michigan were caused by the URC.[2] We attribute this share of alumni earnings to the URC because these universities helped graduates earn more than they would have otherwise. We estimate that the tax revenue the state received in 2015 because of these additional earnings was $500 million. This includes tax revenue the state receives from personal income, sales and use, property, and gasoline taxes. Our complete analysis can be found in "URC Contributions to State Tax Revenue" on page 38.

Comparison of Economic Impact with State Appropriations. While the main goal of these universities is not to generate economic impact and tax revenues for the state, it is noteworthy that the $16.5 billion in net economic impact is over 19 times the state's funding for URC universities.[3] Additionally, the State of Michigan receives $500 million in tax revenue from URC employees and alumni that it would

2. This figure is higher than the net economic impact because it is the untaxed amount and includes money that will be used on spending outside of Michigan. After factoring this in, we estimate the URC causes $3.9 billion of direct economic activity in Michigan due to alumni earnings.
3. Note that this is a comparison of the *total* impact vs. *total* appropriations; each additional dollar of appropriations would not necessarily generate a full $19 in economic impact.

otherwise not receive if the URC universities were not located in Michigan. Figure 1 below shows the fiscal impact of the URC, as well as state appropriations.[4]

FIGURE 1. Fiscal Impact of the URC in Michigan, 2015 (millions)



Source: AEG analysis using base data from AEG Estimates, Michigan House Fiscal Agency

INNOVATION AND TECHNOLOGY

Innovation and technology are exhibited at the universities through spending on research and development, as well as technology transfer, patents and licensing, and the cultivation of start-ups. The URC has an increasing role in training researchers and entrepreneurs, and facilitating new technology and business ideas; the contribution of URC schools, students, and alumni in terms of innovative technology, new business ideas, and fostering relationships with existing companies is a huge economic driver for Michigan, as well as across the globe.

More than 19% of URC alumni have founded or co-founded a business, adding an estimated 380,000 businesses to the economy by URC alumni worldwide; nearly half of these businesses were started in Michigan, and continue to contribute to the economy and spur further innovation throughout the state.[5]

R&D Spending

In 2015, the URC spent $2.15 billion on research and development, which exceeds 2013 levels after a slight decline in 2014. Overall, the URC ranks 5th among the eight clusters for total R&D in 2015.[6] Table 5 on page v highlights the growth in R&D expenditures for the URC, which have increased by more than 53% since

4. State appropriations are the State of Michigan 2014-2015 fiscal year appropriations.
5. The extent to which the URC universities, its students, and alumni, are engaged in innovative and entrepreneurial activities is discussed further in "Embracing Entrepreneurship: The URC's Growing Support for Entrepreneurs in Michigan and Throughout the World," Anderson Economic Group LLC, East Lansing, May 2013.
6. In 2013, we added Texas as an additional cluster to the benchmarking analysis. We also updated the Massachusetts cluster. See "Peer University Clusters" on page 3.

2007. This growth far surpassed the growth for all U.S. institutions, as well as the growth for the peer cluster average (33% and 45%, respectively).

TABLE 5. R&D Spending for URC and Peer Clusters, 2007-2015 (thousands)

	2007 R&D Spending	2014 R&D Spending	2015 R&D Spending	Growth, 2014-2015	Growth, 2007-2015
URC	**$1,405**	**$2,104**	**$2,150**	**2.2%**	**53.1%**
Northern California	$2,083	$2,788	$2,938	5.4%	41.1%
Southern California	$2,130	$2,703	$2,814	4.1%	32.1%
Illinois	$1,240	$1,657	$1,717	3.6%	38.5%
Massachusetts	$1,320	$2,209	$2,333	5.6%	76.8%
North Carolina	$1,591	$2,473	$2,472	0.0%	55.4%
Pennsylvania	$1,408	$1,921	$1,905	-0.8%	35.3%
Texas	$1,141	$1,581	$1,666	5.4%	46.0%
Peer Cluster Average	*$1,559*	*$2,190*	*$2,263*	*3.3%*	*45.2%*
All U.S. Universities	*$51,590*	*$67,304*	*$68,808*	*2.2%*	*33.4%*

Source: AEG analysis using base data from NSF HERD Survey

See “Research and Commercialization Benchmarks” on page 17 for additional details about R&D spending by the URC and its peer university innovation clusters.

Technology Transfer

An important result of successful university R&D is the transfer of technology to the private sector. University research and development expenditures often lead to the production and sale of new products and services in the private sector.

We highlight patent and licensing activity, as well as the number of cultivated start-ups in this report.

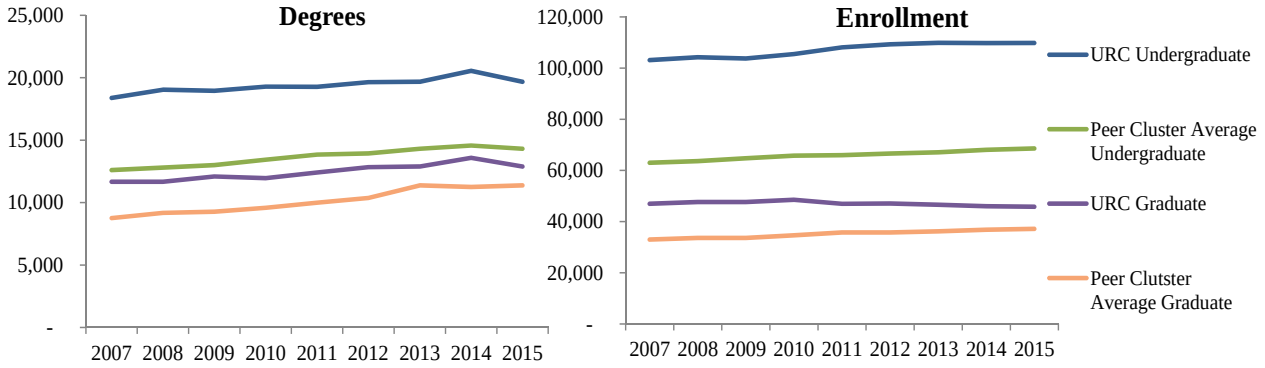
- **Patent and Licensing Activity:** In 2015, the URC surpassed its five-year averages for the number of patents issued, the number of licensing and options activity, as well as the number of invention disclosures for the fourth straight year.
- **Start-ups**: In 2015, URC supported 22 start-up companies, which exceeds not only the five-year average, but also the number of start-ups created in each of the four years prior.

We describe the number of patents granted, inventions disclosed, number of licenses or options entered into, and the number of new start-ups in “Technology Transfer” on page 21.

EDUCATING TALENT

In 2015, the URC educated more than 139,000 students[7] from across the state, the country, and the world, and awarded tens of thousands of degrees; these numbers have grown over time and have been higher than the peer cluster averages. Figure 2 below shows the growth in student enrollment and degrees since 2007. See "Student Enrollment" on page 9 and "Total Degrees Granted" on page 11.

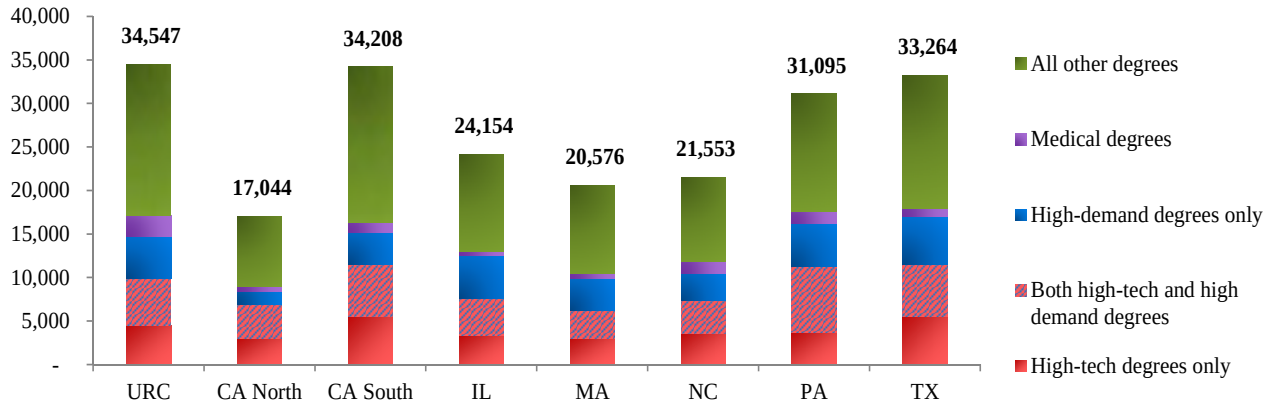
FIGURE 2. URC and Peer Cluster Degrees and Enrollment, 2007-2015



Source: AEG analysis using base data from IPEDS Completions and Enrollment, 2007-2015

We also show the number of students earning high-tech, high demand, or medical degrees in Figure 3 below. In 2015, the URC awarded the most degrees of any of its peer university innovation clusters, as well as the most medical degrees.

FIGURE 3. Degrees by Category, URC and Peer Clusters, 2015



Source: AEG analysis using base data from IPEDS Completions, 2015

7. This number represents the number of students as reported by the URC. Figure 2 on page vi uses 12-month enrollment numbers from IPEDS.

INNOVATION POWER RANKINGS

We compare the URC to peer clusters using the innovation power rankings, a composite ranking system to benchmark the URC and its peer innovation clusters on their overall innovation activity. We define innovation activity as performance on the following three components:

1. Research spending;
2. Technology transfer activity; and
3. Talent.

We rank each of these components separately, and combine them to determine the overall composite ranking for innovation activity. These rankings capture how each cluster contributes to their communities, as well as to industrial activity, as a result of their innovation activities. Overall, the URC ranks second of the clusters for its innovation activity. We summarize the rankings by component, as well as the composite rankings for each cluster, in Table 6 below.

TABLE 6. URC and Peer Cluster Rankings for Innovation Activity by Category

	Research Spending	Technology Transfer	Talent	Composite Ranking
URC	**5**	**7**	**1**	**2**
Northern California	1	2	8	**3**
Southern California	2	3	2	**1**
Illinois	7	6	5	**7**
Massachusetts	4	1	7	**5**
North Carolina	3	4	6	**4**
Pennsylvania	6	4	4	**6**
Texas	8	8	3	**7**

Source: AEG analysis using base data from NSF HERD 2015; University Technology Transfer Annual Reports; AUTM U.S. Licensing Activity Survey 2015; IPEDS 2015

See “Innovation Power Rankings” on page 25.

ABOUT ANDERSON ECONOMIC GROUP

Anderson Economic Group, LLC is a boutique research and consulting firm. Our team has conducted nationally-recognized economic and fiscal impact studies for private, public, and non-profit clients across the United States. We specialize in economics, public policy, business valuation, and industry analyses. We have offices in Chicago, Illinois; East Lansing, Michigan; New York, New York; and Istanbul, Turkey. For more information, please see “About the Authors” in Appendix D on page D-1 or visit www.AndersonEconomicGroup.com.

I. Introduction

WHAT IS MICHIGAN'S UNIVERSITY RESEARCH CORRIDOR?

Michigan's University Research Corridor (URC) is one of the nation's top academic research clusters and the leading engine for innovation in Michigan and the Great Lakes region. An alliance of Michigan State University, the University of Michigan, and Wayne State University, the URC universities are focused on increasing economic prosperity and connecting Michigan to the world. They do so by educating students, attracting talented workers to Michigan, supporting innovation, and encouraging the transfer of technology to the private sector. The URC universities have main campuses in East Lansing, Ann Arbor, Flint, Dearborn, and Detroit, and their reach extends to all areas of the state. Each URC university has research, teaching locations, and partner hospitals located throughout the state, as shown on Map 1 on page 4.

REPORT PURPOSE & METHODOLOGY

Michigan's University Research Corridor asked Anderson Economic Group (AEG) to undertake a comprehensive study that quantifies the economic impact of the URC's activities on the state of Michigan's economy. This report is the tenth in a series of annual reports intended to measure and benchmark the contributions of the URC universities to Michigan. The URC has also commissioned several reports on their contribution to specific economic sectors; for more on these reports, see "Summary of Past URC Sector Reports" on page C-1.

In 2013, we updated the methodology for several metrics in the benchmark series. While not all information in this report is directly comparable to reports in previous years, some of the metrics utilize the same methodology, and all of the reported metrics allow readers to track the URC's performance year-to-year and to understand URC operations.

In order to quantify the economic impact of the URC's activities, we asked ourselves the following questions:

1. What would be the loss to Michigan if the URC universities did not exist in the state?
2. What would be the loss to regions across the state if the URC universities were not here?

We then answered these questions in terms of the impact on jobs, earnings, tax revenue, and research. The following chapters of this report provide quantitative measures of how the URC is performing in these areas. For more details about the report's methodology please see Appendix A: "Methodology" on page A-1.

SOURCES OF ECONOMIC IMPACT

We define *net economic impact* as new economic activity that occurs in a defined geographic region directly or indirectly caused by the URC. We present two geographies of economic impact in "Economic Impact of the URC in Michigan" on page 33; the state of Michigan, as well as 10 economic regions in Michigan, as defined by the Michigan Economic Development Corporation (MEDC).[8] Our regional impact allocates the net economic impact on the state into regions based on where in Michigan the URC and its students spend their money, and where URC staff, faculty, and alumni reside in the state. See Map 5 on page 37 for more information on the regions.

Our economic impact estimates come from several sources of activity:

1. University operations and spending;
2. Talent; and
3. Research and innovation.

Operations and Spending

The URC universities bring large amounts of spending into Michigan, including operational expenditures that cause economic activity in every county in the state. These expenditures include salaries and wages for faculty and staff, public service expenditures, spending on goods and services, and many other categories of spending. Students that attend the universities pay for room and board; meals; books and supplies; and food, goods, entertainment and activities off campus.These expenditures also create economic activity across the state. See "Overview of URC Operations and Spending" on page 5.

Talent

The URC universities attract students to the state. Many of these students remain in the state after graduation, and many alumni become business owners and employees in Michigan. This attraction and retention of talent is important for the state's economy; alumni who remain in the state contribute to Michigan's direct employment and earnings in the state, and spur additional economic activity. Information about the URC's current students can be found in "Education and Talent Benchmarks" on page 9. The impact of URC alumni on the state's economy is discussed in "URC Alumni in Michigan" on page 28.

8. In March of 2011, Governor Snyder emphasized the importance of communities working together to promote their regional advantages. He asked the MEDC to develop strategies to engage in regional collaboration among economic and community development organizations. Together with local economic development partners, the MEDC defined 10 geographies to align economic development efforts. In 2013, the MEDC and Governor Snyder slightly changed the regions.

Research and Innovation

Each of the URC universities engages in significant research and innovation activities each year. Categories of research and innovation include:

- Research and development (R&D) spending;
- Patents and licensing activity; and
- Start-ups and other entrepreneurial activity.

The majority of the URC universities' R&D activities are funded by the federal government, which brings new economic activity into the state. Patents and licensing activity bring in money to the universities and the state, and attract further investment into new technologies. Start-ups that receive external funding also bring new economic activity to Michigan, and the successful start-ups that remain in the state may continue to do so for years. See "Research and Commercialization Benchmarks" on page 17 for details about the URC's research and innovation activity.

PEER UNIVERSITY CLUSTERS

In each of our annual reports, we compare the URC to peer university clusters in other states. We compare Michigan's URC with some of the best universities (public and private) in each of these states, as shown in Table 7 below, on a number of education and research metrics. We also include a composite ranking to benchmark the URC and peer clusters for overall performance on innovation activity. This ranking is discussed in "Innovation Power Rankings" on page 25.

TABLE 7. Comparison Peer University Clusters

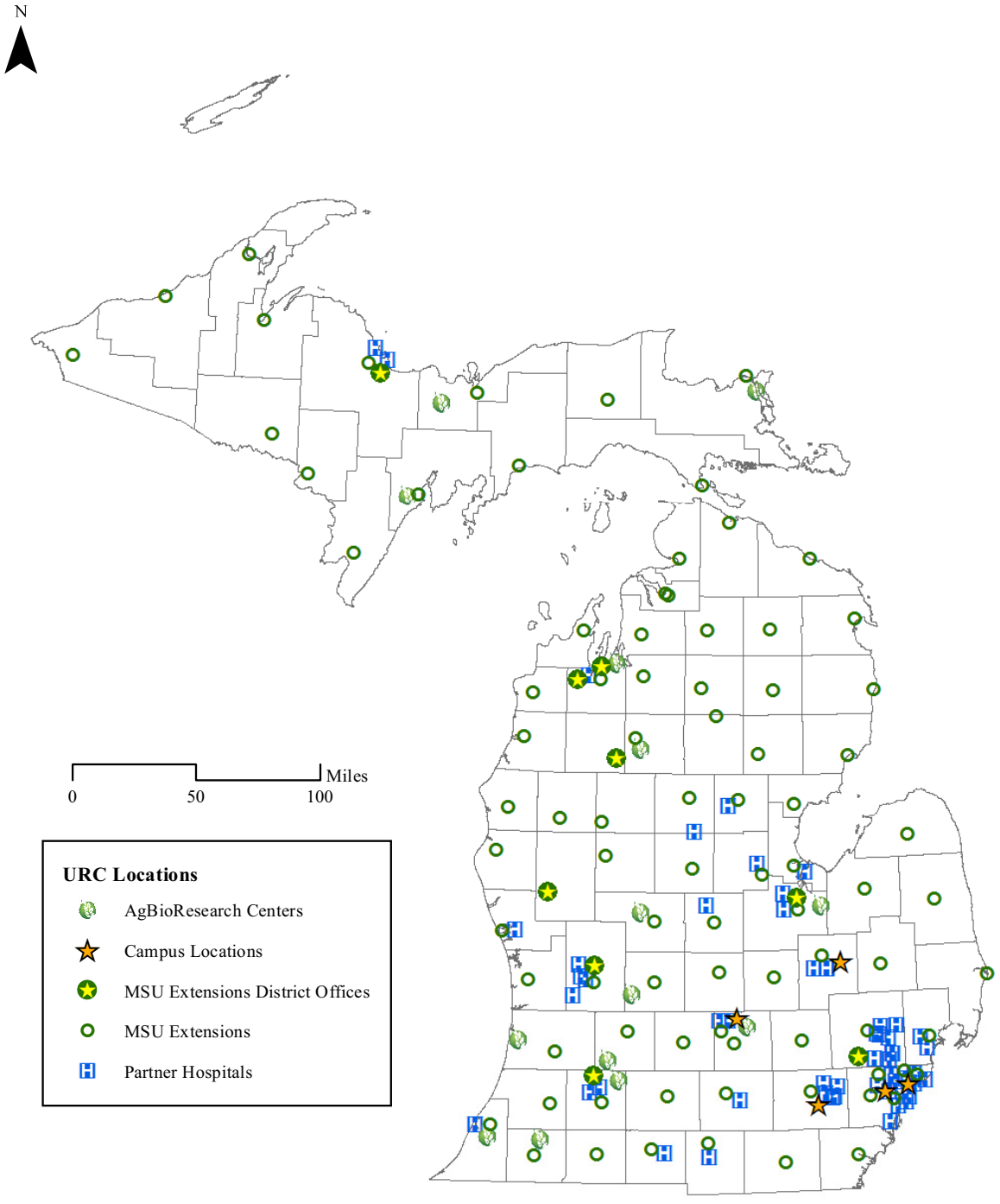
Michigan's URC	Michigan State University	University of Michigan (all campuses)	Wayne State University
Northern California	University of California, San Francisco	University of California, Berkeley	Stanford University
Southern California	University of California, Los Angeles	University of California, San Diego	University of Southern California
Illinois	University of Chicago	University of Illinois at Urbana-Champaign	Northwestern University
Massachusetts	Harvard University	Massachusetts Institute of Technology (MIT)	Boston University[a]
North Carolina	Duke University	University of North Carolina (Chapel Hill)	North Carolina State University
Pennsylvania	Pennsylvania State University (all campuses)	University of Pittsburgh (all campuses)	Carnegie Mellon University
Texas[b]	University of Texas (Austin)	Texas A&M University (College Station, and Commerce)	Rice University

Source: Anderson Economic Group, LLC

a. In previous reports we included Tufts in the Massachusetts cluster. Starting in 2013 Boston University has replaced Tufts University in the Massachusetts cluster.

b. University of Texas, Texas A&M, and Rice comprise an additional, new cluster starting in 2013.

Map 1. URC Presence in Michigan, 2016



Note: While this map reflects the URC's presence in Michigan as of 2016, it is representative of the URC's presence in 2015, the year of operations we're studying in this report.
Source: AEG map using base data from URC Universities

II. Overview of URC Operations and Spending

In this section, we discuss the operations and spending of the URC universities, which impact jobs and income throughout Michigan. We start with a summary of the expenditures by URC universities in Michigan in 2015. We then provide a summary of student spending, which also impacts economic activity in the state. These expenditures will be used to estimate the URC's net economic impact on the state, which is detailed in "Economic Impact of the URC in Michigan" on page 33.

URC EXPENDITURES IN FY 2015

The URC makes significant contributions to Michigan's economy through its direct spending on goods and services in the state. URC institutions spent almost $8.8 billion on operations in FY 2015 and employed 56,960 full-time-equivalent faculty and staff throughout Michigan.[9] Almost a quarter (22%) of expenditures were for student instruction, while 13% of expenditures were for university research, as shown in Table 8 below.[10] See "R&D Expenditures" on page A-4 for more information.

TABLE 8. Operational Expenditures by the URC, FY 2015[a]

	Expenditures (in millions)	% of Total
Instruction	$1,941	22%
Research	$1,182	13%
Public Services, Academic Support, Student Services, and Institutional Support	$1,505	17%
Athletics[b]	$234	3%
Operation and Maintenance of Plants, Auxiliary Enterprises, and Other Expenses	$804	9%
University of Michigan Hospital	$3,127	36%
Total Operational Expenditures	**$8,793**	**100%**
Construction Spending[c]	$1,115	

Source: AEG analysis using base data from IPEDS, URC Universities, NCAA

a. Since 2013, we have accounted for spending on capital using actual construction expenditures. Previously, we included depreciation in operational expenditures instead.

b. Athletics spending includes spending on salaries and wages, operating (game-day) expenses, recruiting expenses, and unallocated expenses.

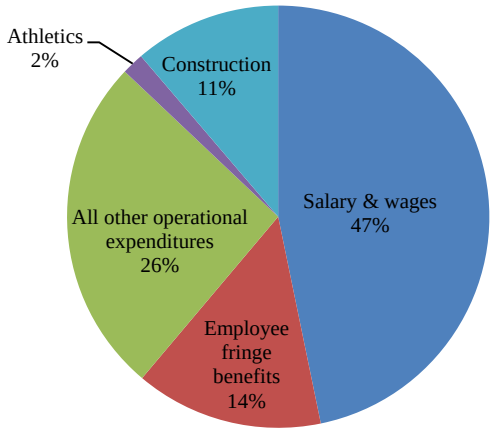
c. Construction spending is not included in operational expenditures.

9. Faculty and staff counts reflect full-time-equivalent (FTE) positions in Fall 2015, and include the U-M Hospital doctors and staff. FY 2015 data for U-M and MSU is from July 1, 2014 to June 30, 2015 and WSU's is from October 1, 2014 to September 30, 2015.

10. The data reported to the National Center for Education Statistics Integrated Postsecondary Education Data System (IPEDS) for research expenditures differ from the R&D expenditures reported to the National Science Foundation (NSF). IPEDS requests the data on any expense that is specific to R&D only. NSF collects data on any expense that is budgeted toward R&D.

We also examined URC expenditures by function, as shown in Figure 4 below. When including construction costs in addition to operating costs, nearly half of all expenditures paid for the salaries and wages of university faculty and staff. Fringe benefits made up 14% of expenditures. Athletics salaries and expenditures were 2% of spending. A quarter of all spending paid for supplies, equipment, maintenance of plant, and any other expenditure not included in the previous categories.

FIGURE 4. URC Expenditures by Function, FY 2015[11]



Source: AEG analysis using base data from URC Universities; NCAA

STUDENT SPENDING IN FY 2015

The URC brings in students from every county in Michigan, every state in the U.S., and more than 100 countries across the globe. These students spend money on and off campus, contributing significantly to the regional and state economies. Students spend money not only on tuition, but also on the following categories that we include in our economic impact estimates:

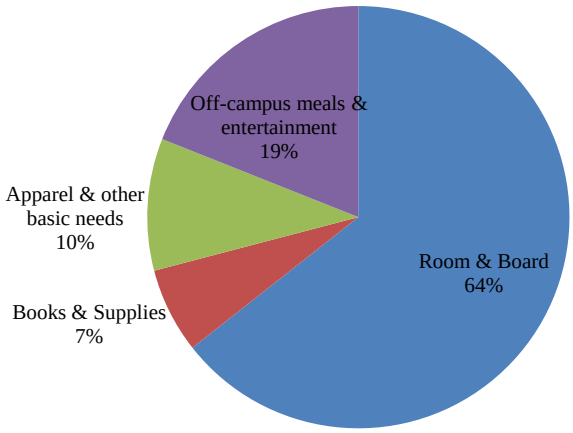
1. Room and board both on and off-campus;
2. Books and supplies;
3. Apparel and other basic needs; and
4. Off-campus meals and entertainment.

We estimate that in 2015, URC students spent over $2 billion on these categories of expenditures. The largest share of student spending was on room and board, at more than 64% of total spending. Figure 5 on page 7 shows the shares of student spending in the four different categories of analysis. See “Methodology” on page A-1 for details on how we estimated student spending.

11. Construction spending is not considered part of operational expenditures.

A large portion of this student spending stays in the state of Michigan and contributes to its economy; this portion is estimated in “Economic Impact of the URC in Michigan” on page 33.

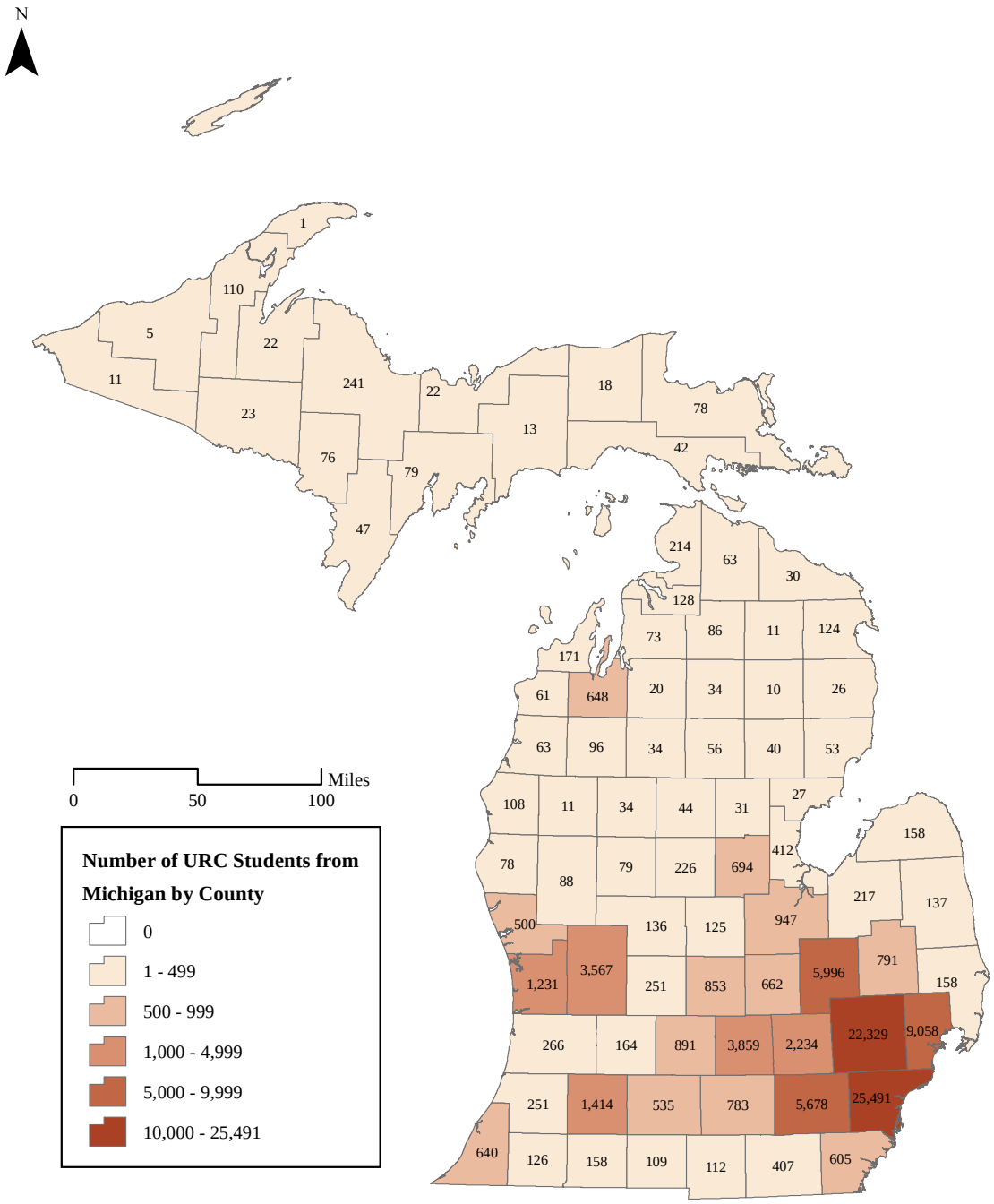
FIGURE 5. URC Student Expenditures, FY 2015



Source: AEG analysis using base data from URC Universities, BLS Consumer Expenditure Survey 2015, College InSight

There are students from every county in Michigan who contribute to this spending, as shown in Map 2, “URC Students by County, 2015” on page 8. The number of students enrolled in the URC is discussed in the following section, “Student Enrollment” on page 9.

Map 2. URC Students by County, 2015



Source: AEG analysis using base data from URC Universities

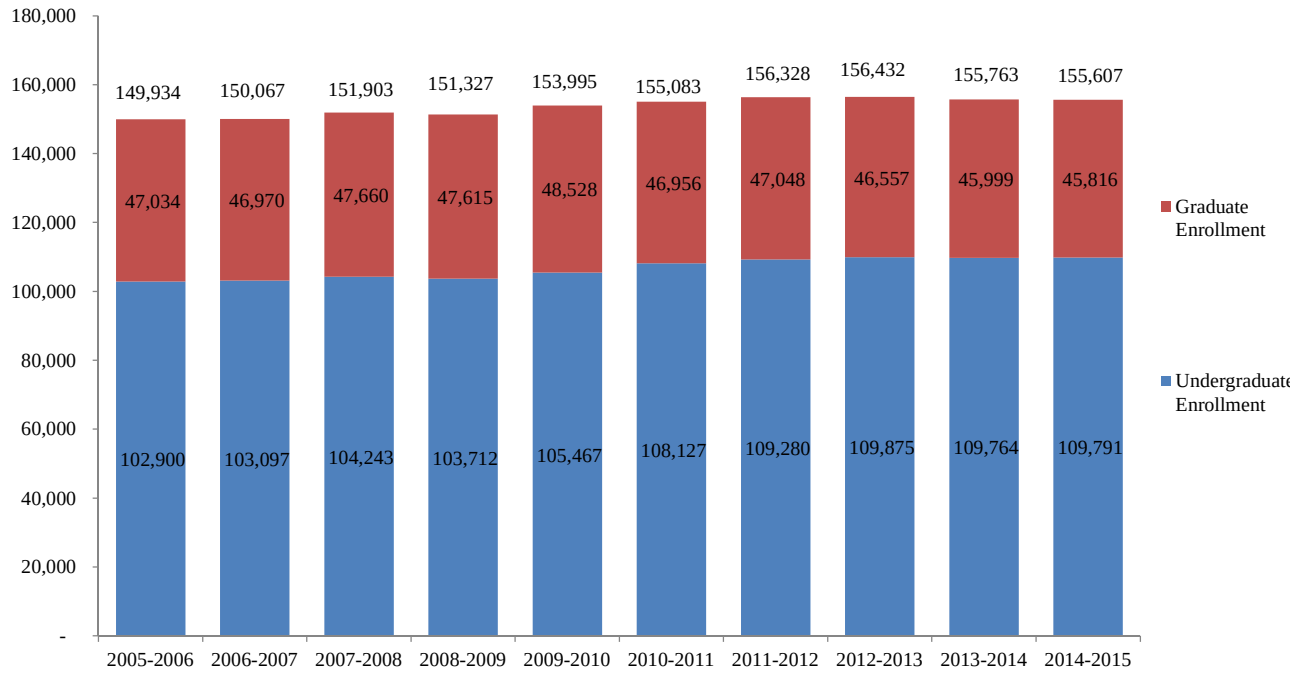
III. Education and Talent Benchmarks

Each year, we compare the URC to peer innovation clusters on metrics related to education, talent, research, and innovation. In this section, we highlight the URC universities and compare them to seven peer clusters on education metrics including student enrollment and the degrees awarded at each cluster.

STUDENT ENROLLMENT

Student enrollment at the URC has risen by 3.8% since 2005-2006, from just under 150,000 to nearly 156,000.[12] Figure 6 below shows enrollment by level from 2006 to 2015.

FIGURE 6. Student Enrollment at the URC, 2006-2015



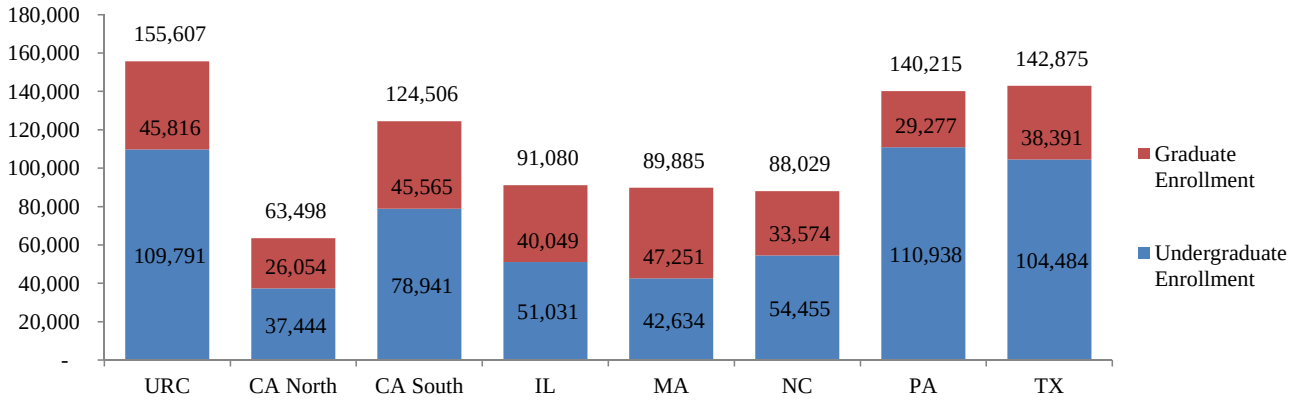
Note: Enrollment numbers are from the most recently available historical IPEDS data for "12-month Enrollment." Past reports used "Estimated Fall Enrollment." IPEDS has discontinued collecting "Estimated Fall Enrollment."

Source: AEG analysis using base data from IPEDS Enrollment, 2005-2006 to 2014-2015 12-month enrollment

12. The enrollment number of 155,607 is reported by IPEDS, and differs from the number of degree-seeking students reported in "Executive Summary" on page i. We use the IPEDS number in this section for accurate benchmarking against other peer clusters. In addition, previous reports used "Estimated Fall Enrollment" data from IPEDS. IPEDS has discontinued this variable. As a result, starting this year we switch to "12-Month Enrollment." Fall enrollment takes a snapshot of those enrolled on a particular day in the fall. The 12-month enrollment figure counts any individual enrolled between July 1 and June 31 of the following year, including every unique individual that enrolls over the time period. As a result, the 12-month enrollment can be more variable since it includes those who enroll for classes during the summer only and may not be degree-seeking students at the university. Variability in that enrollment can mask trends in degree-seeking enrollment.

As shown in Figure 7 below, the URC has the largest enrollment of any cluster in this analysis, as it has since 2006. Table B-1 on page B-1 details the historical attendance for each of the clusters by level of student.

FIGURE 7. Student Enrollment for the URC and Peer Clusters, 2015

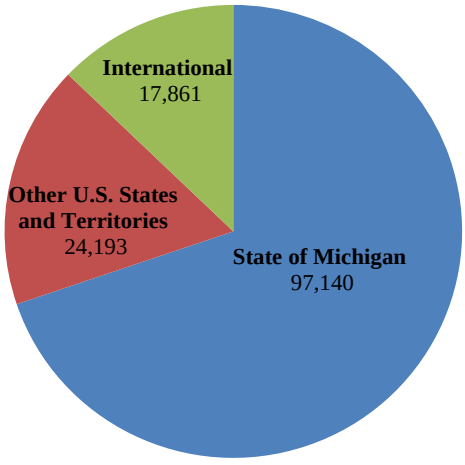


Source: AEG analysis using base data from IPEDS Enrollment, 2014-2015 12-month enrollment

Origin of URC Students

As shown in Map 2, on page 8, the URC has students from across the state of Michigan. Students also come from across the country and the world to attend URC universities. In fall 2015, 70% of enrolled URC students were from Michigan. An additional 17% were from other U.S. states and territories, and the remaining 13% were international students. Figure 8 below shows the breakdown of the origins for enrolled students in fall 2015.

FIGURE 8. Origin of URC Students, Fall 2015

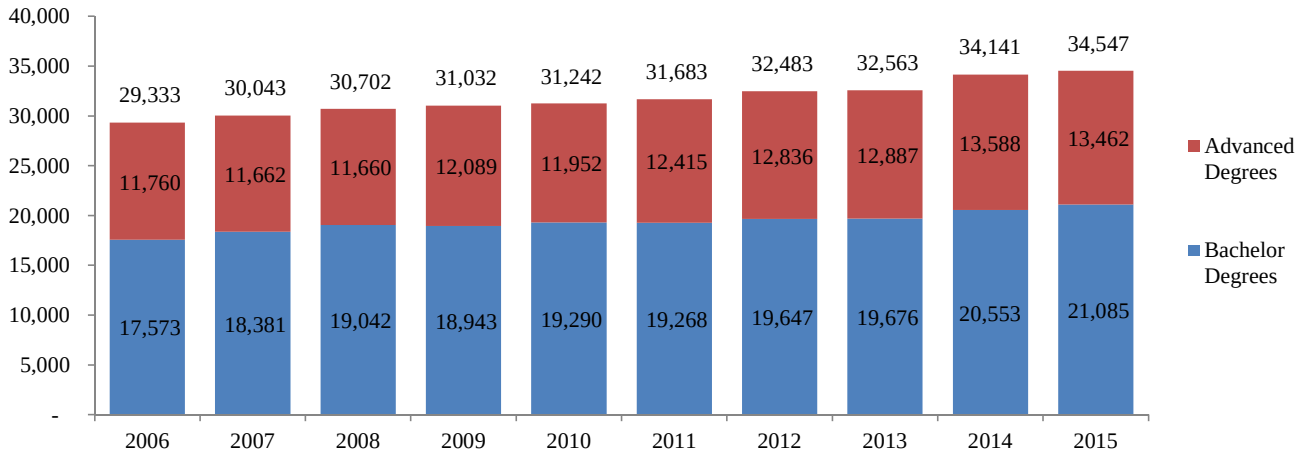


Source: AEG analysis using base data from URC Universities

TOTAL DEGREES GRANTED

The number of total degrees awarded by the URC has been on the rise. Since 2006, the number of degrees conferred has increased by nearly 18%, up from just greater than 29,000 to over 34,000. Figure 9 below shows the history of degrees granted by type, showing that the URC has consistently increased completions for each year since 2006.

FIGURE 9. Completions by Level of Degree for the URC, 2006-2015

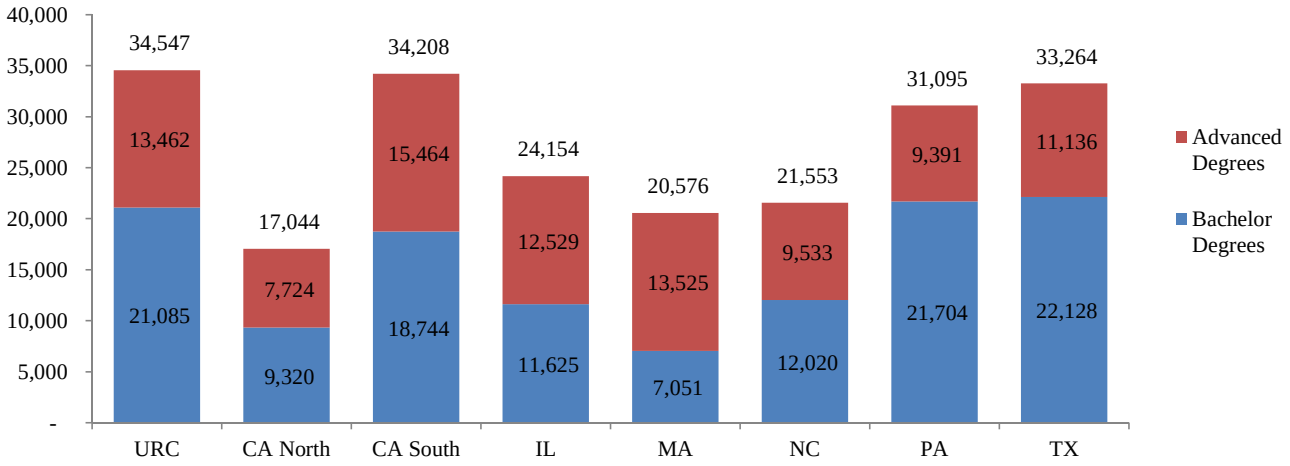


Source: AEG analysis using base data from IPEDS Completions, 2006-2015

In 2015, the URC ranked first in total number of degrees (undergraduate and graduate) conferred. As shown in Figure 10 on page 12, the URC issued more than 21,000 bachelor degrees and more than 13,000 advanced degrees. Table B-2 on page B-1 details the number of degrees conferred for each cluster between 2006 and 2015.

The number of degrees awarded at the URC universities has increased by nearly 18% since 2006.

FIGURE 10. Completions by Level of Degree for the URC and Peer Clusters, 2015



Source: AEG analysis using base data from IPEDS Completions, 2015

DEGREES BY PROGRAM

The URC offers degrees in nearly every subject categorized by the U.S. Department of Education.

We benchmark the number of degrees granted by the URC and the peer university clusters by the following subject areas:

- *Physical Science, Agriculture, and Natural Resources*
- *Business, Management, and Law*
- *Engineering, Mathematics, and Computer Science*
- *Liberal Arts*
- *Medicine and Biological Science*
- *Other*

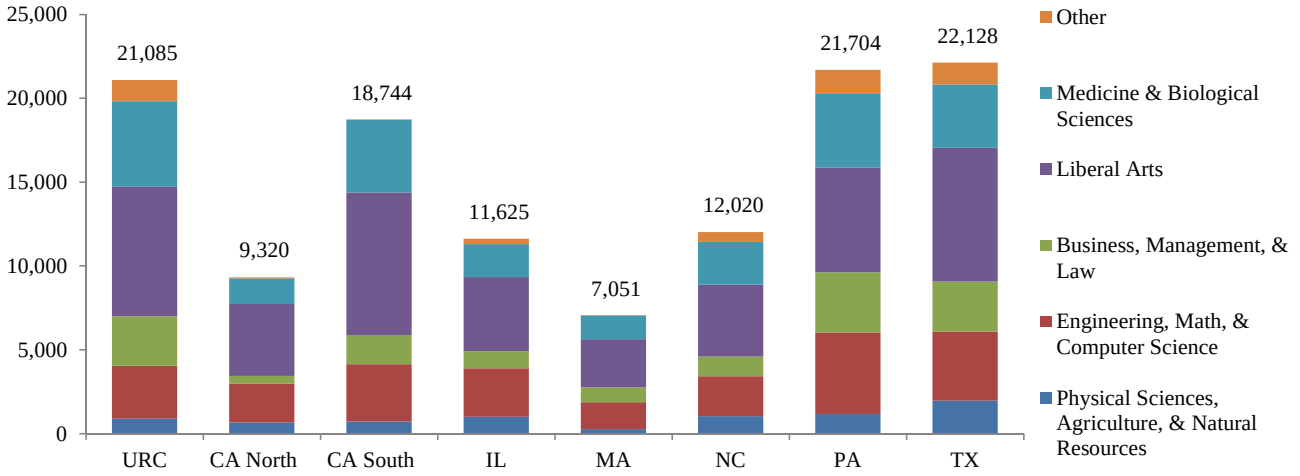
See "Academic Program Definitions" on page A-2 for the composition of each program area.

In 2015, the URC awarded the highest number of advanced degrees in the Medicine and Biological Science fields of any peer university innovation cluster.

Undergraduate Degrees Conferred

The URC conferred the third largest number of bachelor degrees overall in 2015, behind the Texas cluster and the Pennsylvania cluster, as shown in Figure 11 on page 13. For a detailed list of bachelor degrees conferred by field of study, see Table B-3 on page B-2.

FIGURE 11. Undergraduate Degrees Conferred by Area for the URC and Peer Clusters, 2015

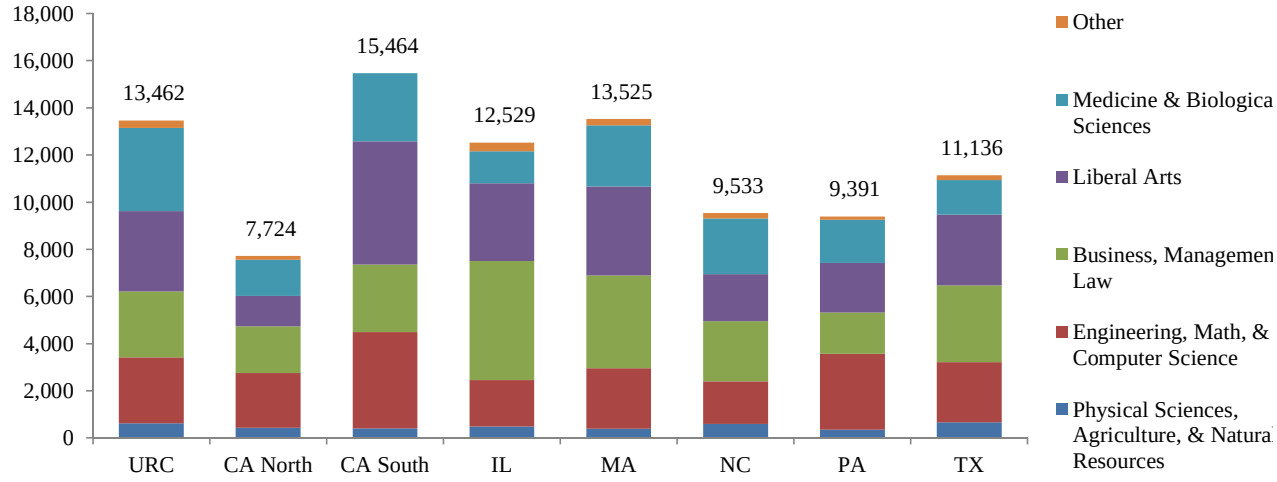


Source: AEG analysis using base data from IPEDS Completions, 2015

Graduate Degrees Conferred

In 2015, the URC awarded the highest number of advanced degrees in *Medicine and Biological Science* fields, and the third-highest amount of advanced degrees overall. See Figure 12 below. Table B-4 on page B-2 lists the amount of advanced degrees conferred by field of study.

FIGURE 12. Graduate Degrees Conferred by Area for the URC and Peer Clusters, 2015



Source: AEG analysis using base data from IPEDS Completions, 2015

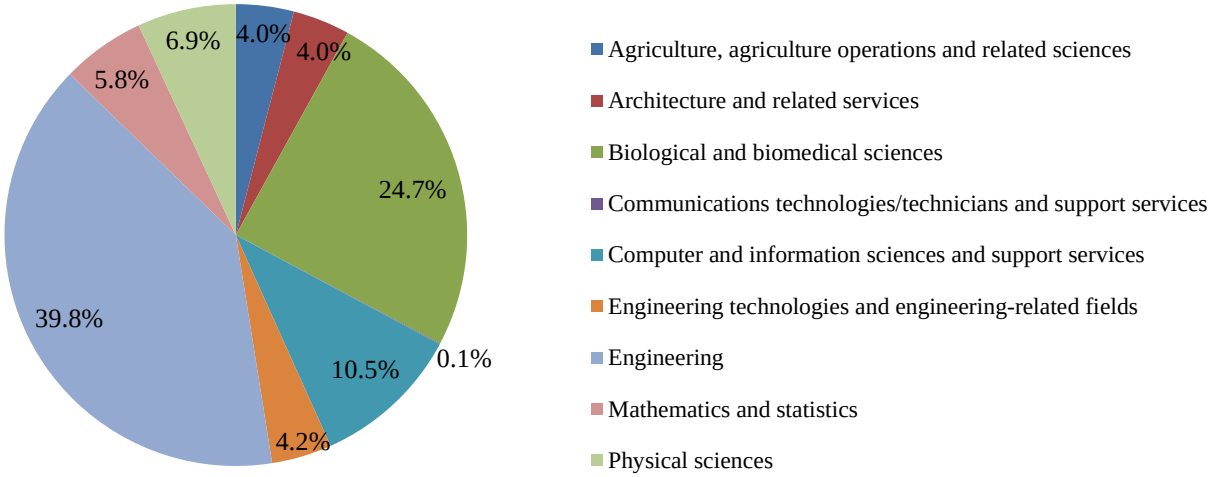
HIGH-TECH AND HIGH-DEMAND DEGREES

In this section, we identify the number of degrees awarded by cluster that prepare students for jobs in high-tech industries or that are in high demand by employers. See "High-Tech, High-Demand, and Medical Degrees" on page A-2 for further description of our methodology.

Benchmarking High-Tech Degrees

The URC awarded 9,887 high-tech degrees in 2015. As shown in Figure 13 below, the largest share of these degrees was awarded in engineering, with the second largest share being awarded in biological and biomedical sciences. A breakdown of high-tech degrees by cluster category can be found in Table B-5 on page B-3.

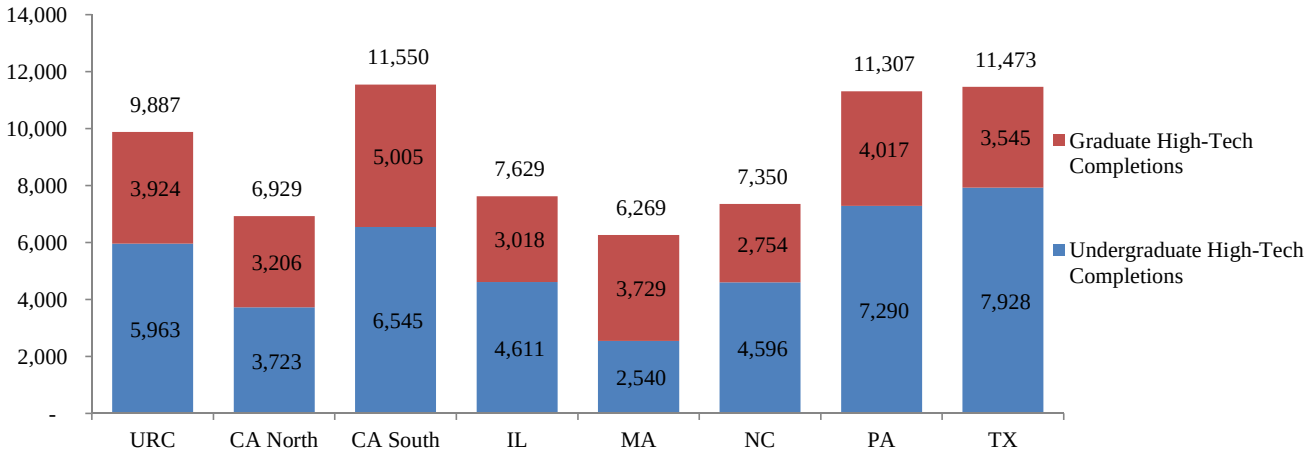
FIGURE 13. Completion of Undergraduate and Graduate High-Tech Degrees by Field of Study, 2015



Source: AEG analysis using base data from IPEDS Completions, 2015

As shown in Figure 14 on page 15, the URC awarded the fourth-highest number of undergraduate high-tech degrees, and the third-highest number of advanced high-tech degrees in the 2015 academic year.

FIGURE 14. Completion of High-Tech Degrees for the URC and Peer Clusters, 2015

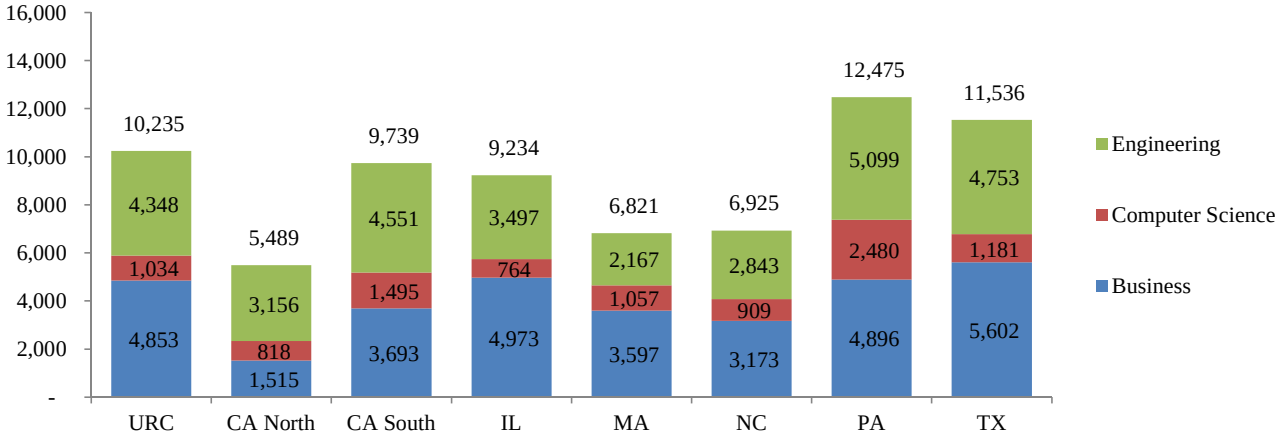


Source: AEG analysis using base data from IPEDS Completions, 2015

Benchmarking High-Demand Degrees

High-demand degrees include those in computer science, engineering, and business. Figure 15 below shows the total number of high-demand degrees conferred by academic area for the URC and each peer cluster. The URC conferred the third-highest number of high-demand degrees overall in 2015.

FIGURE 15. Completion of High-Demand Degrees for the URC and Peer Clusters, 2015



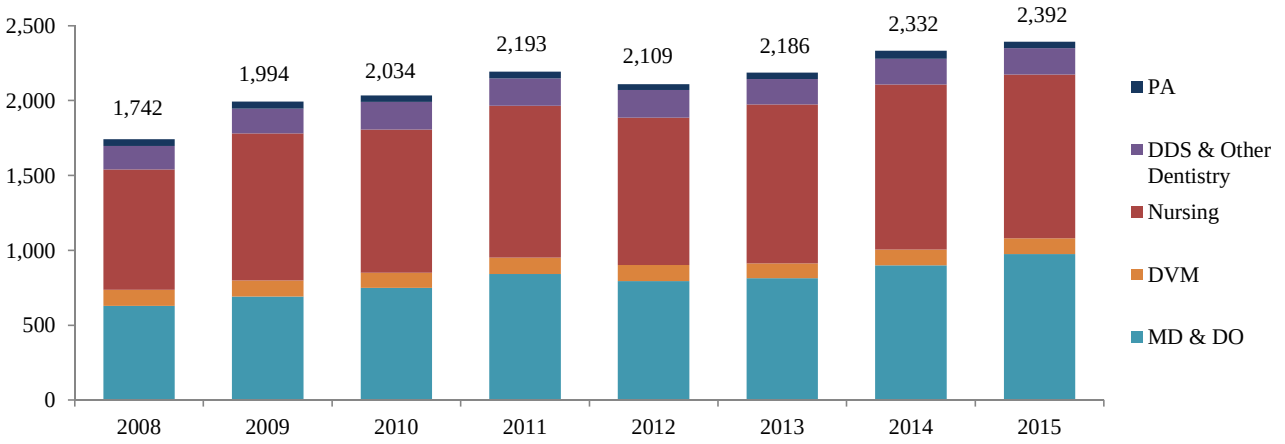
Source: AEG analysis using base data from IPEDS Completions, 2015

Medical Education

The URC universities offer allopathic (MD) and osteopathic (DO) medical schools, along with schools of dentistry (DDS and other dentistry), veterinary medicine (DVM), and physician assistant (PA) programs. Figure 16 on page 16 shows medi-

cal graduates for the URC, which increased by 37% between 2008 and 2015. The number of graduates receiving DO degrees increased by 115%, the largest increase over that period. For a list of degrees included in these categories, see "Benchmarking Metrics" on page A-1.

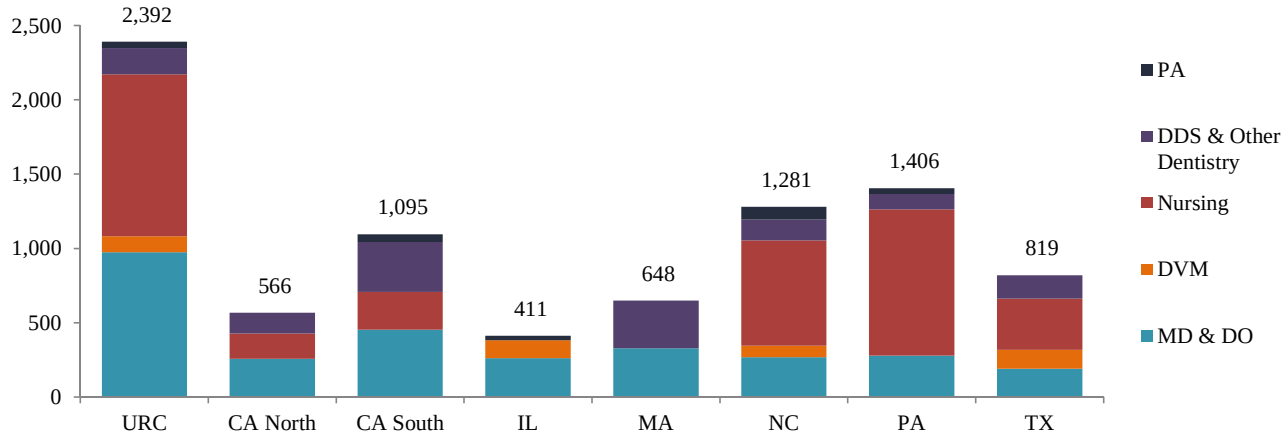
FIGURE 16. URC Medical Graduates by Field of Study, 2008-2015



Source: AEG analysis using base data from IPEDS Completions, 2008-2015

As shown in Figure 17 below, the URC had the most medical graduates in 2015, far more than any other peer cluster. The URC is the only cluster among the peers that offers a DO program, and it was also the leader in the number of MD and nursing graduates in 2015. See Table B-7 on page B-4.

FIGURE 17. Medical Graduates by Field of Study for the URC and Peer Clusters, 2015



Source: AEG analysis using base data from IPEDS Completions, 2015

IV. Research and Commercialization Benchmarks

In the previous sections, we discussed the scope of the operations of the URC and highlighted how the URC universities educate students in all fields of study. The URC also plays a role in advancing economic prosperity by engaging in research and commercialization activity.

URC universities contribute to the economy and to technological innovation in notable ways. Universities across the country spend billions of dollars on research and development activities of faculty, staff, and students; this investment often leads to new inventions or start-up companies. Universities provide assistance for these developments through programs within technology transfer offices. The support of tech transfer offices leads to transferring the technology from the university setting into the private sector, introducing the ideas to a larger audience, resulting in greater economic activity.

Nearly every university in the defined peer clusters is classified as an institution engaging in very high research activity.[13] This section highlights the URC's research and innovation, and benchmarks the URC against its peers in academic R&D expenditures, as well as technology transfer activity.[14]

ACADEMIC R&D EXPENDITURES

In FY 2015, academic institutions in the U.S. spent nearly $69 billion on research and development.[15] Using the most recent data available from the National Science Foundation (NSF), we show the sources for R&D expenditures for each university cluster in Table B-8 on page B-4. Total R&D expenditures by the eight university clusters totaled nearly $18 billion in 2015, making up about 26% of R&D expenditures by all U.S. universities. In 2015, the URC had the fifth-largest R&D expenditures of the eight university clusters at $2.15 billion.

13. "Very high research activity" is a classification designated by the Carnegie Foundation for the Advancement of Teaching, assigned to doctorate-granting institutions with the highest level of research activity. Carnegie classifications have been the leading framework for recognizing and describing institutional diversity in U.S. higher education for the past four decades. The exceptions are UCSF, which is classified as a medical school and medical center, and some of Pennsylvania State University and the University of Pittsburgh campuses.
14. For a more in-depth discussion about research and commercialization at the URC universities, please see "Embracing Entrepreneurship: The URC's Growing Support for Entrepreneurs in Michigan and Throughout the World," Anderson Economic Group LLC, East Lansing, May 2013.
15. NSF National Center for Science and Engineering Statistics, Higher Education Research and Development (HERD) Survey, FY 2015.

The URC accounted for 94% of federally-funded R&D expenditures at higher education institutions in Michigan.

Higher education institutions in Michigan spent $1.1 billion in R&D from federally-financed sources.[16] Ninety-four percent of the federally-funded R&D in Michigan was conducted at the URC. The majority of university funding for R&D comes from the federal government, as shown in Table 9 below. While the URC received 52% of its funding in 2015 from the federal government, the URC received less federal funding as a percentage of total funding when compared to its peers, except for the Texas Cluster (44%).

The URC relies on institution funds (which come from the universities themselves rather than outside entities) for a significantly higher proportion of its R&D spending than the other seven comparison clusters, as well as the average U.S. university. In 2015, the URC universities relied on their own funds for 37% of total R&D expenditures. While this percentage is greater than those of the peer clusters, other clusters have been increasing their institution support for research, which somewhat offsets decreases in federal support.

TABLE 9. Source of Funding for URC and Peer Clusters, 2015

	Federal Government	State & Local Government	Institution	Industry[a]	Non-Profits	All Other Sources
URC	**52%**	**2%**	**37%**	**4%**	**4%**	**2%**
Northern California	53%	4%	18%	8%	12%	6%
Southern California	54%	3%	18%	6%	10%	9%
Illinois	60%	2%	23%	5%	8%	1%
Massachusetts	55%	0%	20%	9%	10%	5%
North Carolina	54%	5%	20%	13%	6%	1%
Pennsylvania	66%	3%	17%	4%	5%	4%
Texas	44%	13%	27%	9%	5%	2%
All U.S. Universities	*55%*	*6%*	*24%*	*6%*	*6%*	*3%*

Source: AEG analysis using base data from NSF HERD Survey, 2015

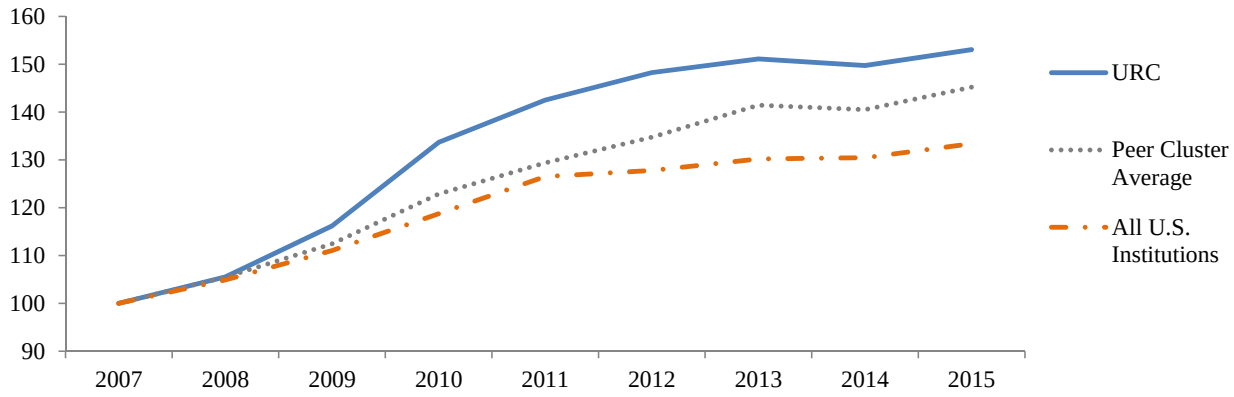
a. This category is labeled "business" in the NSF survey, but we have kept the category label "industry," as we have in prior reports.

16. This data comes from the NSF HERD survey and includes respondents that only filled out the short-form survey. As a result this number includes both public and private colleges and universities receiving federal research funding.

From 2007 to 2015, the URC increased R&D expenditures by 53%.

From 2014 to 2015, total R&D spending at the URC increased by 2.2%, placing the URC sixth out of the eight clusters in terms of one-year growth. The growth in R&D spending at the URC was in line with the average growth for institutions across the U.S. As seen in Figure 18 below, the URC increased its R&D spending by 53.1% since 2007, which is the third-highest out of its peer clusters during that time, behind only Massachusetts (76.8%) and North Carolina (55.4%). Figure 18 below compares the growth in URC R&D spending against the average spending of its peers between 2007 and 2015. See Table B-9 on page B-5 for detailed spending.

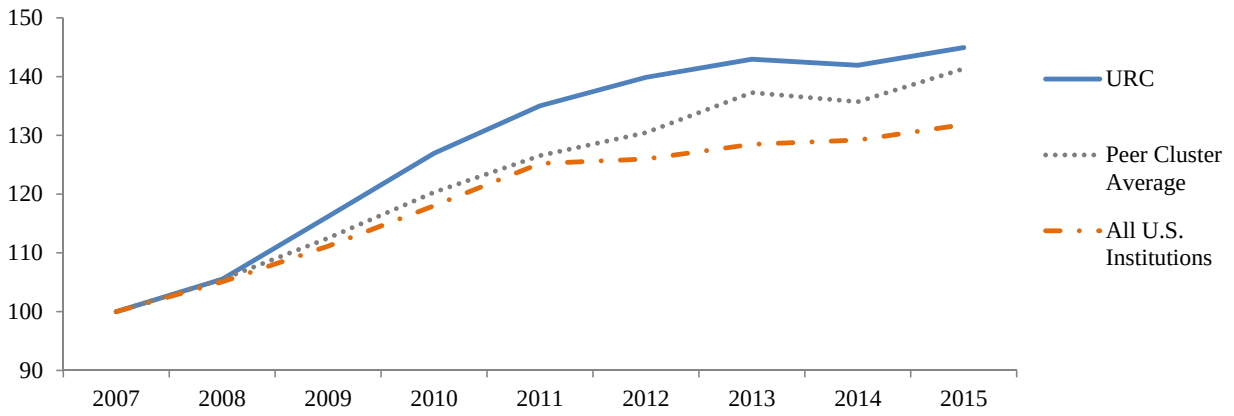
FIGURE 18. Growth in R&D Spending, 2007-2015 (2007 value=100)



Source: AEG analysis using base data from NSF HERD Survey

Between 2014 and 2015, the URC increased science and engineering (S&E) R&D expenditures by 2.1%. This growth was in line with institutions across the U.S., but lagged behind the peer cluster average. Since 2007, the URC increased its S&E R&D by 44.9%, which is the fourth-highest of the clusters. In addition, this growth was greater than the increase for the peer cluster average as well as all U.S. institutions. Figure 19 on page 20 shows the growth in R&D spending on S&E for the URC, and the average of its peers. See Table B-10 on page B-5 for the detailed spending amounts for the past two years.

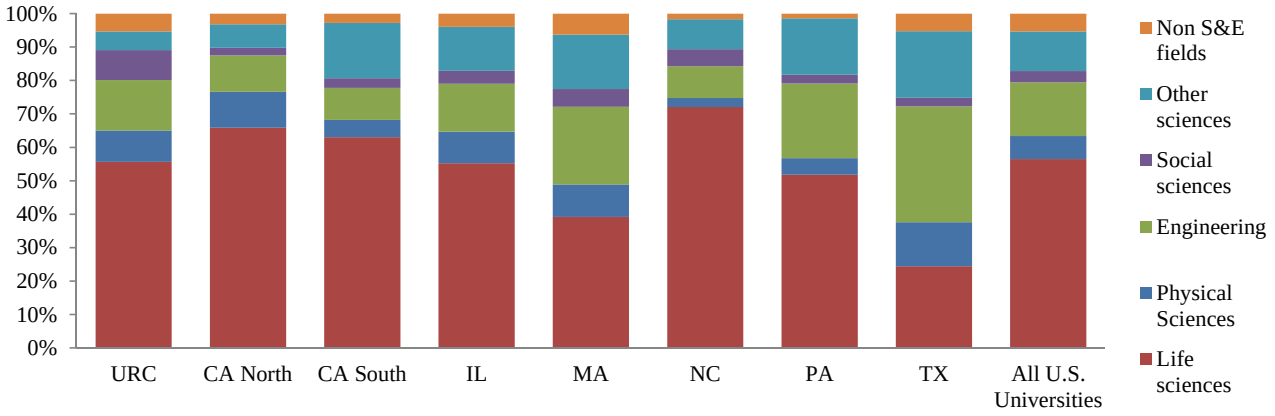
FIGURE 19. Growth in R&D Spending on Science and Engineering, 2007-2015 (2007 value=100)



Source: AEG analysis using base data from NSF HERD Survey

Research priorities vary across the university clusters, resulting in variation in which fields receive higher amounts of R&D funding. By and large, universities focus the greatest amount of their spending on S&E fields, as shown in Figure 20 below. Table B-11 on page B-6 details spending amounts by field.

FIGURE 20. R&D Expenditures by Field, 2015



Source: AEG analysis using base data from NSF HERD Survey, 2015

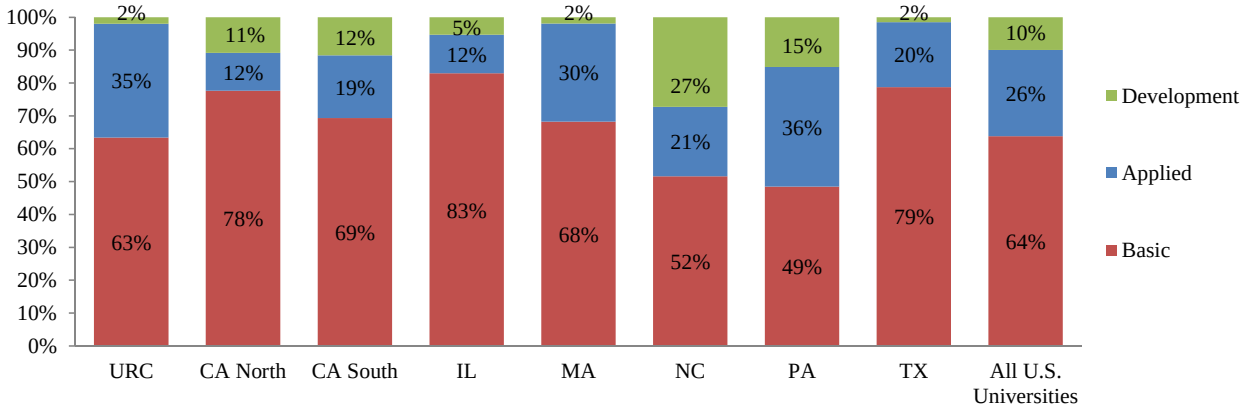
In 2015, the North Carolina and the Northern California clusters spent the largest shares on life sciences, while the Texas and Massachusetts clusters both spent significantly lower shares than the national average on life sciences. The Texas, Pennsylvania, and Massachusetts clusters spent higher percentages on engineering while the North Carolina cluster spent a lower percentage than the U.S. average. The URC is mostly consistent with U.S. university averages for spending shares, but within the other sciences category spends a significantly lower share on environmental sciences and a higher share on social sciences.

Expenditures by Research Type

There are three general categories of academic research: basic, applied, and development. The NSF defines *basic research* as research undertaken primarily to acquire knowledge without any particular application or use in mind, and *applied research* as research conducted to meet a specific, recognized need. *Development* is the systematic use of research towards the production of useful materials, devices, systems, or methods, including the design and development of prototypes and processes.

In Figure 21 below, we show the percentage of R&D funds going toward basic research, applied research, and development. The URC spends the second-highest amount of their funding on applied research (35%), behind only the Pennsylvania cluster (36%).

FIGURE 21. Share of R&D Expenditures Spent on Basic, Applied, And Development Research by URC and Peer Clusters, 2015



Source: AEG analysis using base data from NSF HERD Survey, 2015

TECHNOLOGY TRANSFER

An important function of successful university R&D is its transfer of technology to the private sector, which amplifies the impact of the basic and applied research performed by university researchers. University R&D expenditures support the research activity of students, faculty, and staff at the university. Technology transfer (or technology commercialization) offices at universities support moving these developments made in the university setting to the private sector. Tech transfer allows technology innovation and improvements to reach a larger audience. Invention disclosures, patent applications, licensing, and entrepreneurial support are some of the available resources.

While the number of patent applications and invention disclosures in a single year may provide a rough indication of success of the research and development at a university, it will not necessarily show the effectiveness of reaching the private sector. The statistics on other services provided by tech transfer offices, such as patents

granted, number of licenses, royalty revenue, and the number of new start-ups, provide a more holistic depiction of how innovative efforts of the universities have impacted the private sector. In Table 10 below, we show each of these metrics for the URC, and we benchmark the URC's performance against peer clusters.

Patents and Licensing

Patent and licensing activity includes invention disclosures, patents issued, licensing and options agreements, and licensing revenue. In 2015, the URC surpassed its five-year averages for all four measures for patent and licensing activity. In particular, the URC's licensing revenues in 2015 were about two and a half times the size of the five-year average. The URC exceeded its five-year average for this measure for the first time since 2010 and the five-year averages for all other measures for the fourth straight year. The URC ranks in the lower half for the 2011-2015 average annual technology transfer activities of the peer university clusters, fourth in average annual number of patent grants, sixth in invention disclosures, fifth in licenses and options issued, and sixth in licensing revenue, as shown below in Table 10.

TABLE 10. Average Annual Patent and Licensing Activity for URC and Peer Clusters, 2011-2015

	Invention Disclosures	*Rank (1-8)*	**U.S. Patent Grants**	*Rank (1-8)*	**Licenses/ Options**	*Rank (1-8)*	**Licensing Revenue (in millions)**	*Rank (1-8)*
URC	**588**	***6***	**183**	***4***	**180**	***5***	**$33.7**	***6***
Northern California	866	*3*	285	*2*	181	*4*	$142.9	*2*
Southern California	968	*2*	254	*3*	127	*6*	$59.9	*4*
Illinois	490	*8*	174	*5*	113	*7*	$185.9	*1*
Massachusetts	1,193	*1*	361	*1*	194	*3*	$97.8	*3*
North Carolina	611	*5*	127[a]	*8*	268	*2*	$39.4	*5*
Pennsylvania	677	*4*	127[a]	*7*	280	*1*	$22.6	*8*
Texas	512	*7*	133	*6*	99	*8*	$32.2	*7*

Source: AEG analysis using base data from universities' websites and technology transfer offices; Association of Technology Managers (AUTM) Surveys
See "Methodology" on page A-1 for detailed sources by cluster.

a. Numbers differ by amount smaller than rounding threshold.

One measure of R&D expenditure success is the amount of licensing revenue generated by each dollar spent in the S&E fields. Since licensing revenue can have large year-to-year variations, we compared the average revenue to the S&E R&D expenditures over a five-year period (2011-2015). Table 11 on page 23 shows that the URC has performed better than the North Carolina and Pennsylvania clusters in terms of revenues earned per S&E R&D dollar spent.

TABLE 11. Average Annual Licensing Revenue as a Percentage of S&E R&D Expenditures at URC and Peer Clusters, 2011-2015

	Average Licensing Revenue 2011-2015 (in millions)	Average S&E R&D Expenditures 2011-2015 (in millions)	Revenues per Expenditures	*Rank of Licensing Revenue as a Percent of Expenditures (1-8)*
URC	**$33.7**	**$1,980**	**1.7%[a]**	***6***
Northern California	$142.9	$2,644	5.4%	*2*
Southern California	$59.9	$2,626	2.3%	*4*
Illinois	$185.9	$1,622	11.5%	*1*
Massachusetts	$97.8	$1,971	5.0%	*3*
North Carolina	$39.4	$2,325	1.7%[a]	*7*
Pennsylvania	$22.6	$1,900	1.2%	*8*
Texas	$32.2	$1,450	2.2%	*5*

Source: AEG analysis using base data from universities' websites and technology transfer offices; Association of Technology Managers (AUTM) Surveys, NSF HERD Survey, 2015
See "Methodology" on page A-1 for detailed sources by cluster

a. Numbers differ by amount smaller than rounding threshold.

Start-ups

The number of start-ups is one indicator of the R&D process. Over the past several years, the URC has developed and expanded incubators, services to assist with entity formation, as well as grant programs for different stages of business development. These services, along with the relationships the URC has fostered with local communities and businesses, contribute to the success of start-ups at the URC universities for students, alumni, and the community.[17] The URC's reach spans farther than only those start-ups, which use URC-licensed technology. Although it is impossible to completely capture all the new companies assisted in some way by the URC, we have some data on the number we can directly attribute to the URC.

In 2015, the URC produced 22 start-ups, above its five-year annual average. Since 2002, the URC has cultivated 210 start-up companies, 79 of which have formed within the past five years. The URC has been actively involved in fostering and encouraging entrepreneurial activities, including the cultivation of start-ups.

Table 12 on page 24 shows the number of start-ups for the URC and peer clusters from 2011 through 2015. The URC ranks seventh among its peers based on both the

17. For a detailed discussion of the resources the URC offers to start-ups and other entrepreneurial endeavors, see "Embracing Entrepreneurship: The URC's Growing Support for Entrepreneurs in Michigan and Throughout the World," Anderson Economic Group LLC, East Lansing, May 2013.

number of start-ups cultivated in 2015 and five-year averages. On average, 16 new companies are started each year with licensed technology from a URC university.

TABLE 12. Number of Start-ups Cultivated at University Clusters, 2011-2015

	2011	2012	2013	2014	2015	Average, 2011-15	*Rank (1-8)*
URC	**18**	**14**	**10**	**15**	**22**	**16**	***7***
Northern California	16	34	25	42	51	34	*3*
Southern California	38	32	38	48	55	42	*1*
Illinois[a]	24	20	20	20	28	22	*6*
Massachusetts[b]	37	30	29	38	45	36	*2*
North Carolina	18	19	31	26	28	24	*5*
Pennsylvania	17	24	42	25	30	28	*4*
Texas	16	6	8	18	19	13	*8*

Source: AEG analysis using base data from universities' websites and technology transfer offices; Association of Technology Managers (AUTM) Surveys.
See "Methodology" on page A-1 for detailed sources by cluster

a. The five-year average (2006-2010) for the University of Chicago's start-ups was used as the 2011 number because it was unavailable.

b. The five-year average (2010-2014) for the Boston University's start-ups was used as the 2015 number because it was unavailable.

V. Innovation Power Rankings

In the previous sections, we compared the URC to seven peer innovation clusters on students, degrees, research, and technology transfer activity. In this section, we introduce a composite ranking of the innovation activity for the URC and each of its peer innovation clusters. This composite ranking incorporates the performance of each cluster on many of the metrics discussed earlier in the report, and provides a way to benchmark the URC's overall innovation activity to that of its peer clusters. It is a way to capture the contribution that the university clusters make as a result of their research, talent, and technology transfer activities.

COMPONENTS OF INNOVATION COMPOSITE RANKING

The purpose of the composite ranking is to capture the URC and each peer innovation cluster's measurable contributions to innovation from its efforts in the following categories:

- Research spending;
- Technology transfer activity; and
- Talent.

Research Spending

Each peer university cluster engages in a high-level of research activity, with nearly every school classified as a very high-level research university. We include research as a component of the composite rankings to assess the performances of research activity among the peer clusters.

We combine total research spending and research spending in S&E fields to determine the research ranking. We include research spending as a measure of innovation because it captures the gross research activity at the universities. We do not adjust research spending activity to measure spending per student, spending per research faculty, or any other ratio. Therefore, this particular component approximates the sheer volume of research at universities. This research provides a basis for many of the start-up companies and new technologies for the universities, which is measured in the technology transfer activity component of the composite ranking.

Furthermore, while we do not measure economic impact for the URC's peer clusters, research spending gives an indication of how universities contribute to economic activity in their communities.[18] See "Research and Commercialization Benchmarks" on page 17 for a discussion of research activity at the URC and its peer clusters.

Technology Transfer Activity

As discussed in "Technology Transfer" on page 21, technology transfer and commercialization is an important aspect of a university's contribution to industry. By

18. A lot of research spending at the universities comes from external funding that would not otherwise occur in the universities' respective communities. Therefore, there is additional economic activity associated with high research activity since schools can hire more staff and faculty, and spend more money to conduct research.

ranking each cluster on technology transfer activity, we capture how its research and technology efforts are utilized in the private and also in the public sectors. We rank each university cluster on the five-year averages for the following metrics:

- Licensing revenue;
- Start-up companies;
- Patent grants issued;
- Technology licenses issued; and
- Invention disclosures.

The combination of these measures provides an overview of the success of technology efforts in each cluster.

Talent

In "Education and Talent Benchmarks" on page 9, we benchmark the URC and its peer clusters on a number of education and talent benchmarks, including enrollment, the degrees awarded, and the degrees awarded by field of study. For the talent component of the composite ranking, we rank each university cluster on the total number of degrees awarded, as well as the number of high-technology degrees awarded.

We included a talent metric in the composite ranking to capture the number of graduates each university cluster contributes to the workforce each year. The number of degrees awarded approximates a university's contribution to an educated and productive workforce. High-technology degrees reflect graduates that may work in fields in which technology and innovation are key components of the industry. "High-Tech, High-Demand, and Medical Degrees" on page A-2 provides a list of which fields of study are included in high-technology degrees.

See Appendix A: "Methodology" on page A-1 for more details on how we measured the metrics in each component of the composite ranking.

RANKINGS BY CATEGORY

As mentioned above, we rank each cluster on research spending, technology transfer activities, and talent. We use the metrics from "Education and Talent Benchmarks" and "Research and Commercialization Benchmarks" in order to determine each rank. As shown in Table 13 on page 27, the URC ranks fifth in research, seventh in technology transfer, and first in talent.

We combine these rankings by weighting each cluster's performance in each category to determine the overall ranking for innovation activity. Research spending and talent each account for 40% of the overall ranking, and technology transfer activity accounts for 20%.

Overall, the URC ranks second when compared to its peer innovation clusters on measures of innovation. See "Methodology" on page A-1 for details on how we determined rankings by category, as well as the composite ranking for innovation.

A more detailed display of the URC and peer cluster rankings by metric can be found in Table A-1 on page A-7.

TABLE 13. Innovation Power Rankings for URC and Peer Clusters, 2015

	Research Spending	Technology Transfer	Talent	Composite Ranking
URC	**5**	**7**	**1**	**2**
Northern California	1	2	8	**3**
Southern California	2	3	2	**1**
Illinois	7	6	5	**7**
Massachusetts	4	1	7	**5**
North Carolina	3	4	6	**4**
Pennsylvania	6	4	4	**6**
Texas	8	8	3	**7**

Source: AEG analysis using base data from NSF HERD Survey 2015;University Technology Transfer Annual Reports; AUTM U.S. Licensing Activity Survey 2015; and IPEDS 2015

VI. URC Alumni in Michigan

An important way the URC institutions contribute to Michigan's economy is by educating and training the state's future workforce. Attending and graduating from a URC university increases the earning power for alumni, and many of these alumni live and work in Michigan. This section discusses the number of alumni in the state and the earnings in Michigan attributable to these alumni. These estimations are used as part of the economic impact analysis in the following section.

NUMBER OF URC ALUMNI

As of summer 2016, the URC had more than 1.2 million alumni worldwide. The nearly 651,000 URC alumni living in Michigan account for 9.5% of the state's population over the age of 24.[19] URC universities have alumni in every county in Michigan (see Map 3, "URC Alumni by ZIP Code, 2016,") and every state in the U.S. (see Map 4, "URC Alumni by State, 2016,"). URC alumni also live in more than 200 countries across the world.

ALUMNI EARNINGS

Alumni of URC universities contribute to the state's economy, as university graduates with bachelors and graduate degrees produce and earn more than the average worker. We estimated that URC alumni earnings for 2015 were $37 billion, after accounting for wages of URC alumni and the alum's year of graduation.[20] See "Impact of Alumni Earnings" on page A-13 for more information. This accounts for almost 17% of all wage and salary income in the state. While much of these earnings cannot be said to have been *caused* by the URC universities, this figure shows the scale of the URC's role in preparing and educating Michigan's workforce.[21]

Table 14 on page 29 shows our estimates of how URC alumni earnings are distributed across Michigan's 10 regions based on the current location of alumni. Since alumni are located all across the state, each region in Michigan benefits from alumni earnings. The South Central, Southeast, and Detroit Metro regions have a larger share of URC alumni earnings than their respective shares of state population. The West Michigan region, which includes the Grand Rapids area, is notable for having a significantly lower share of URC alumni earnings than state population. Not coincidentally, the West Michigan region is the most populous region not to contain a URC university. While URC alumni are located across the state, they make up the largest percentage of population in the South Central (12.0%), Southeast (11.7%), and Detroit Metro (9.2%) regions. Meanwhile, URC alumni are only 1.9% of the population of the Upper Peninsula Region.

19. According to the U.S. Census Bureau, Michigan had 6,820,461 residents over the age of 24 years on July 1, 2015.

20. While 650,749 URC alumni live in Michigan, we had valid information on the graduation year for only 620,688 alumni, which is an important input to the alumni earnings analysis.

21. Wage and salary income data for Michigan taken from the U.S. Bureau of Economic Analysis "Personal Income and Employment by Major Employment."

TABLE 14. Share of 2015 URC Alumni Earnings in Michigan by Economic Development Collaborative Region

Region number	Regions - Economic Development Collaboratives	Number of URC Alumni[a] Total	Number of URC Alumni[a] % of Total	Share of URC Alumni Earnings (in millions)[b] Total	Share of URC Alumni Earnings (in millions)[b] % of Total	*2015 Population* % of Total MI Population
1	Upper Peninsula Region	5,816	0.9%	329.8	0.9%	*3.1%*
2	Northwest Region	17,915	2.8%	1,017.6	2.8%	*3.1%*
3	Northeast Region	5,924	0.9%	333.8	0.9%	*2.0%*
4	West Michigan Region	50,243	7.7%	2,850.0	7.8%	*15.8%*
5	East Central Region	16,285	2.5%	924.4	2.5%	*5.7%*
6	East Michigan Region	46,498	7.1%	2,706.5	7.4%	*8.6%*
7	South Central Region	56,786	8.7%	3,159.9	8.6%	*4.8%*
8	Southwest Region	20,886	3.2%	1,188.0	3.2%	*7.9%*
9	Southeast Region	76,068	11.7%	4,456.4	12.2%	*10.1%*
10	Detroit Metro Region	354,143	54.4%	19,616.0	53.6%	*39.0%*
		650,564	100.0%	$36,582.5	100.0%	*100.0%*

Note: Sum of regions may not equal the total due to rounding.

Source: AEG analysis using base data from URC university alumni offices, BLS, U.S. Census Bureau

a. While 650,749 URC alumni live in Michigan, we had valid ZIP codes of residence for only 650,564 alumni.

b. While 650,749 URC alumni live in Michigan, we had valid information for the year of graduation, which allowed us to estimate the alumni ages and earnings, for 620,688 alumni.

In addition to the gross earnings of URC alumni, we estimate the incremental earnings to URC graduates that are a result of their education at a URC university. The main components considered in estimating the additional earnings of URC graduates are: projections of the earnings of URC graduates and substitution of earnings that would have occurred even if the individual had not attended a URC university.

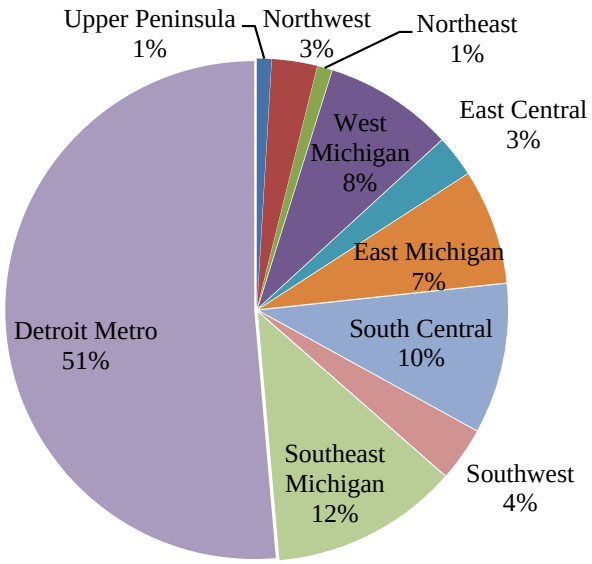
We estimate that URC alumni living in Michigan in 2015 earned $5.5 billion more due to the URC.[22] We show each region's share of alumni incremental earnings in the state in Figure 22 on page 30. The Detroit Metro, Southeast, and South Central regions lead the state in share of incremental URC alumni earnings, with other populous regions such as the West Michigan and East Mich-

URC alumni in Michigan earned $5.5 billion more due to the URC.

22. Using this methodology assumes that most of the current earnings of URC alumni living in Michigan are earnings they would have had earned even without the URC. These additional earnings contribute to the URC's economic impact, which we discuss in the following section.

igan regions also benefitting from hundreds of millions of additional earnings. See Map 5 on page 37 for the economic impact by region, which includes alumni earnings.

FIGURE 22. Share of Incremental Alumni Earnings in Michigan by Region, FY2015

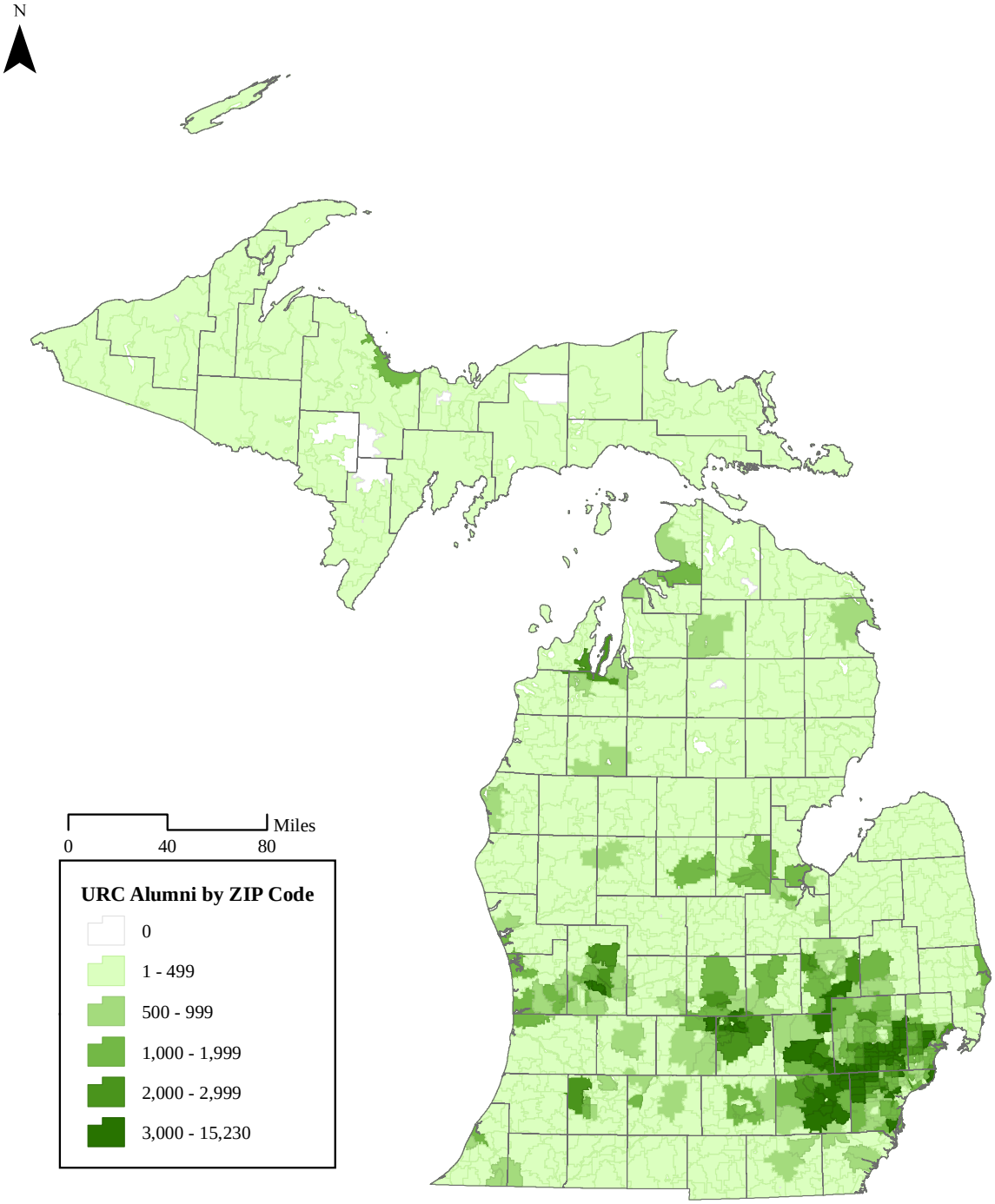


Source: AEG analysis using base data from URC university alumni offices; BLS; U.S. Census Bureau

Once we account for savings, taxes on these earnings, and expenditures outside Michigan, we estimate that alumni spent $3.9 billion in Michigan last year. We estimate the economic impact of these additional earnings in the following section. Table A-9 on page A-20 shows how additional URC alumni earnings attributable to the URC are distributed across Michigan's 10 regions.

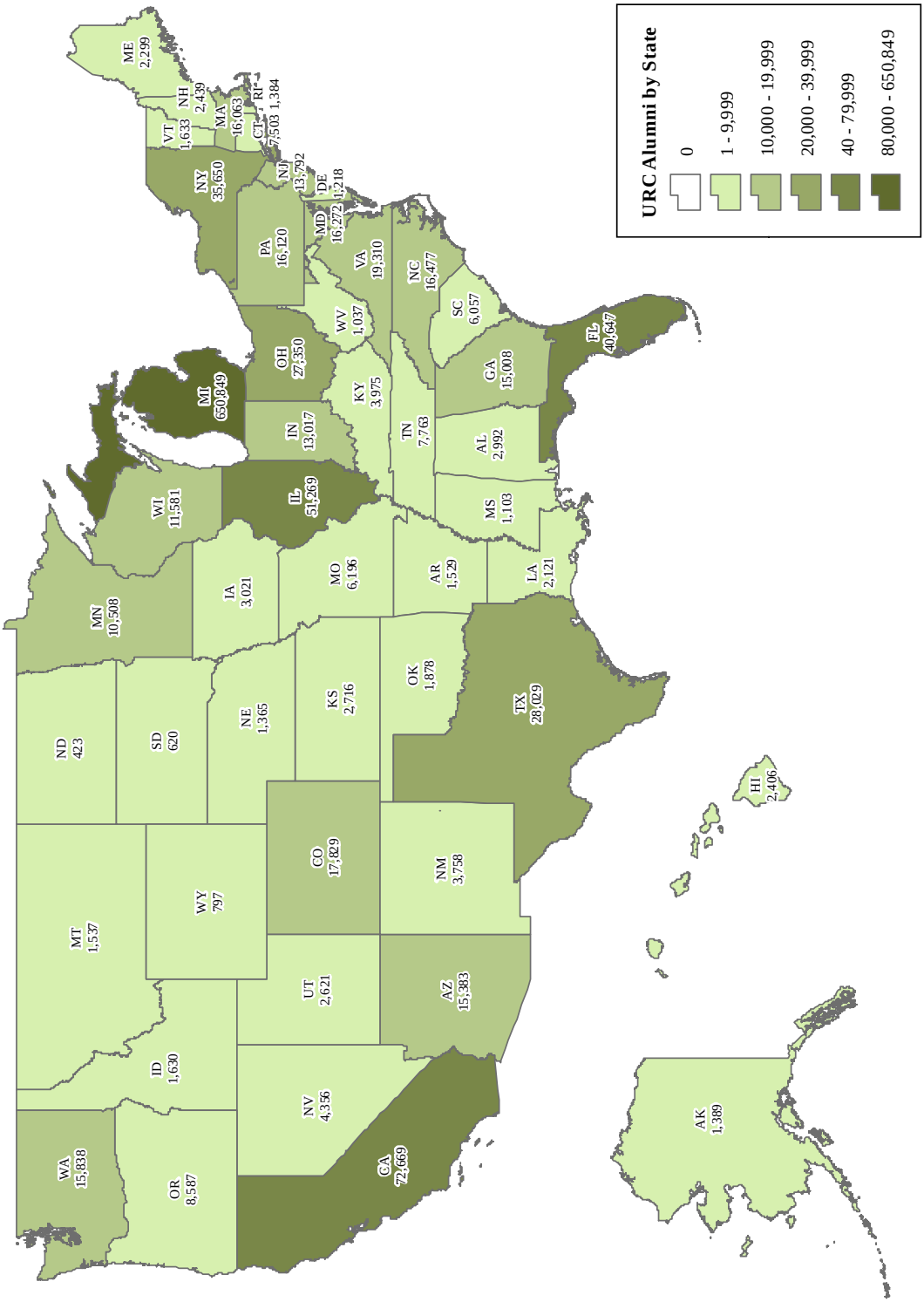
URC alumni spent $3.9 billion in Michigan in 2015.

Map 3. URC Alumni by ZIP Code, 2016



Note: Data include alumni with known ZIP codes.
Source: AEG map using base data from URC Universities

Map 4. URC Alumni by State, 2016



Source: AEG map using base data from URC Universities

VII. Economic Impact of the URC in Michigan

In the previous sections, we discussed the spending of the URC and its students, the extent of R&D spending and activity, as well as alumni earnings in Michigan. These components of the URC operations reach all regions and create an economic impact in the state of Michigan that would not exist without the URC universities. Not only are the URC universities world-class education institutions, but their contributions to the Michigan economy are significant. In order to quantify the economic impact of the URC universities, we answer the following questions:

1. What would the loss be to Michigan if the URC universities did not exist in the state?
2. What would be the loss to regions across the state if the URC universities were not here?

In this section, we discuss the impact that the URC universities have on output and jobs throughout the state of Michigan. We begin with the definition of "economic impact" that we use to assess the state-level impacts, and summarize the results of the total statewide economic impact. We then summarize the statewide impact by region, estimating the economic impact and jobs for 10 separate regions in the state. The net economic impact of the URC includes the impacts of the following components:

- URC operations (payroll and non-payroll);
- Student expenditures; and
- Alumni earnings.

DEFINITION OF ECONOMIC IMPACT

We define the *net economic impact* of the URC as the *new* activity that occurs in a region directly and indirectly caused by the URC. Economic activity from URC operations, student expenditures, and URC alumni have direct impacts, as well as indirect impacts, generating more economic activity in Michigan as it recirculates throughout the state. Further details about our methodology for estimating the URC's economic impact are in "Estimating Net Economic Impact" on page A-8.

We present two measures of economic impact in this section:

- *New Economic Output*
  This is the total value of all economic activity generated by the URC's operational expenditures in Michigan. This measure includes all new expenditures by the URC in Michigan after taking into account the amount that is considered net new, plus indirectly-generated activity by both firms and households in the state.
- *New Jobs*
  The URC directly employs almost 57,000 people and indirectly generates more jobs in Michigan due to the multiplier effect of employee spending in the state.

SOURCES OF ECONOMIC IMPACT

We describe the components of the URC's economic impact on Michigan and its 10 regions below. Further detail by category of expenditures can be found in "Estimating Net Economic Impact" on page A-8.

Nonpayroll Operating Expenditures

The spending shown in Table 8, "Operational Expenditures by the URC, FY 2015," on page 5 includes expenditures on supplies, equipment, maintenance of university buildings, services, athletics, U-M's hospital services, as well as the salaries of professors, researchers, doctors, and administrative staff.[23] We estimate that in FY 2015, the URC's nonpayroll expenditures brought $1.1 billion in direct net new spending to businesses in Michigan, as shown on Table 15 on page 35.

We estimate the total economic impact of nonpayroll expenditures (including indirect activity) is $2.3 billion. Spending on construction results in an additional $1.3 billion in total new economic activity, $629 million of which is direct net new spending in the state.

Payroll Expenditures for Faculty and Staff

The URC universities spent $6.1 billion on salary, wages, and fringe benefits for their employees in FY 2015, and we estimate that $4.2 billion was net new directly in Michigan. "Estimating Net Economic Impact" on page A-8 details our calculations for this estimate. The Southeast Michigan and Detroit Metro Regions comprised the largest proportion of this spending, representing 54% and 21% of expenditures, respectively. This is unsurprising, as staff and faculty live in these regions, which are near to the URC universities and heavily populated. We estimate the total net economic impact of faculty and staff earnings in Michigan is $5.5 billion (including indirectly-generated output).

Student Spending in Michigan

The URC universities have students from every county in Michigan, every state in the U.S., and more than 100 countries. Some of these students would not have remained in or come to the state of Michigan for a college degree if it were not for the URC universities. We count expenditures by these students as new economic activity. We estimate that new student direct expenditures in Michigan due to the URC were $1.7 billion in FY 2015. Of these expenditures, the South Central and Southeast Regions account for the greatest proportions, with 33% and 38%, respectively. We primarily allocated student expenditures to the region with the university that they attended in 2015. See "Regional Economic Impact" on page A-15. We estimate the indirect impact from these expenditures was $1.2 billion for a total economic impact of $2.9 billion on the state.

23. Starting in 2013, we estimate the economic impact of athletics as its own category of spending. In previous years, spending on athletics was included in operations spending.

Alumni Incremental Earnings

As discussed in "URC Alumni in Michigan" on page 28, the URC has nearly 651,000 living alumni in Michigan, who earned $37 billion in 2015.[24] After considering earnings that would otherwise have occurred in the state (e.g., if URC graduates had attended other Michigan universities instead of a URC university), these earnings contribute $5.4 billion in net new earnings to the state's economy, bringing in new economic activity year after year. We estimate that the direct expenditures caused by these earnings (after considering savings and out of state spending) is $3.9 billion, and the indirect economic impact is $0.90 billion, bringing the total impact to $4.5 billion. The greatest impact occurs in Detroit Metro region, accounting for 51% of the state's economic impact.

TOTAL NET ECONOMIC IMPACT IN MICHIGAN

In FY 2015, we estimate that the value of the economic activity that the universities generated in the state, benefiting households and businesses, was $16.5 billion.[25] See the components of the total net economic impact of the URC for the state below in Table 15. This net economic impact figure does not include any economic activity that would have occurred in Michigan even without the URC. See Map 5 on page 37 for the economic impact by region, which aggregates to the total economic impact in the state.

In 2015, the URC universities generated an additional $16.5 billion in economic activity in Michigan, and 68,896 direct and indirect jobs.

TABLE 15. Net Economic Impact of URC in Michigan, FY 2015 (in billions)

Impact Category	Direct Impact	Indirect Impact	Net Economic Impact
Non-payroll Operating Expenditures for Instruction, Research, and U-M Hospital	$1.10	$1.16	$2.26
Spending on Construction	$0.63	$0.71	$1.34
Faculty & Staff Wages and Benefits	$4.23	$1.30	$5.53
URC Student Expenditures	$1.73	$1.15	$2.88
Incremental Alumni Earnings	$3.89	$0.64	$4.53
TOTAL ECONOMIC IMPACT	**$11.58**	**$4.97**	**$16.55**

Note: Numbers may not sum to total due to rounding.

Source: AEG analysis using base data from URC Universities; BEA RIMS II 2013 Multipliers; IPEDS; U.S. Census Bureau, AEG Estimates

24. While 650,749 URC alumni live in Michigan, we had valid information for the graduation year for only 620,688 alumni, which is an important input to the alumni earnings analysis. We use this figure to provide a conservative estimate for economic impact.

25. The economic impact estimates published in the 2014, 2015, and 2016 reports have been revised since these reports were released. See "Revisions to Previously Published Economic Impact Estimates" on page A-15 for further discussion.

Jobs Impact of URC Operations

We estimate that 68,896 jobs in Michigan in 2015 were directly or indirectly caused by the URC's operations in Michigan. This jobs figure includes 11,892 faculty members and 45,068 staff directly employed by the URC universities and hospitals. It also includes indirectly-generated jobs in other industries in the state due to expenditures by the URC universities and their faculty, staff, and students.

ECONOMIC IMPACT BY MICHIGAN REGION

In addition to estimating the URC's net economic impact on the state of Michigan, we present its impact for the 10 economic regions in Michigan as defined by the MEDC, the significance of which is detailed on page 2. These regions and their estimated economic impacts are shown in Map 5 on page 37.

As mentioned in the section above, each region in Michigan is impacted by the URC, although this impact varies by region. We estimated the net economic and jobs impact for each of 10 Michigan regions. In general, the Detroit Metro, Southeast, and South Central Regions had the greatest additional economic activity from the URC, which are the regions in which the universities are located. This is also true for the jobs created by the URC universities' activities, as shown below in Table 16.

See "Regional Economic Impact" on page A-15 for our estimations for regional economic impact.

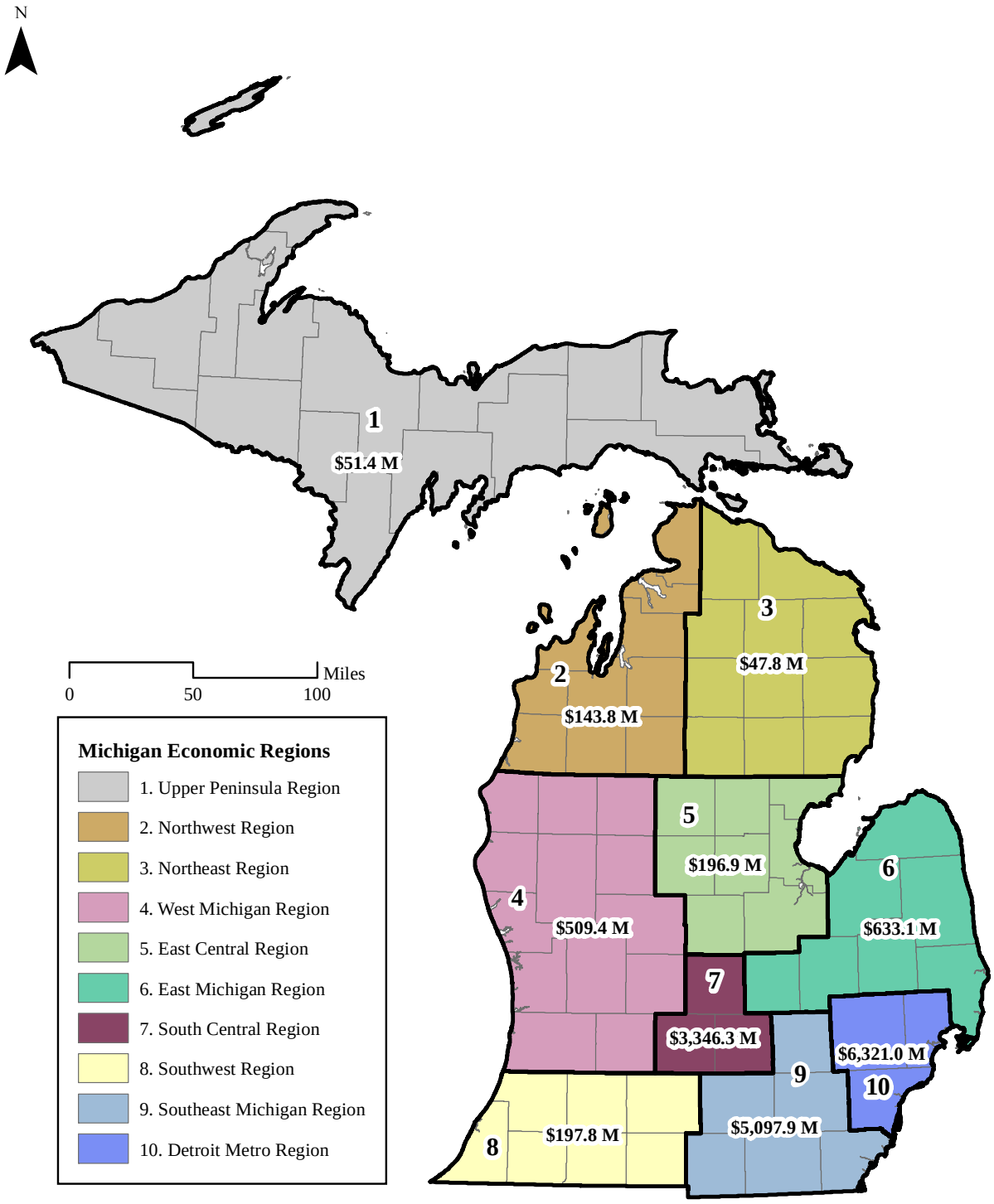
TABLE 16. Net Economic Impact of URC Operations and Employment Created by Region, FY 2015

Region number	Economic Development Collaboratives	Net Economic Impact of URC Operations (in millions)	Total Direct and Indirect Jobs Caused by URC
1	Upper Peninsula Region	$51.4	86
2	Northwest Region	$143.8	162
3	Northeast Region	$47.8	88
4	West Michigan Region	$509.4	450
5	East Central Region	$196.9	185
6	East Michigan Region	$633.1	1,882
7	South Central Region (MSU)	$3,346.3	11,901
8	Southwest Region	$197.8	243
9	Southeast Michigan Region (U of M)	$5,097.9	37,832
10	Detroit Metro Region (WSU)	$6,321.0	16,068
	State of Michigan	**$16,545.4**	**68,896**

Note: Numbers for each region do not add to state totals due to rounding.

Source: AEG analysis using base data from URC Universities; BEA RIMS II 2013 Multipliers; IPEDS; U.S. Census Bureau, AEG Estimates

Map 5. Net Economic Impact of URC Universities' Operations and Employment by Region, FY 2015 (in millions)



Source: AEG map using base data from URC Universities

VIII. URC Contributions to State Tax Revenue

This section provides an estimate of tax revenue the State of Michigan receives because of the URC's presence in Michigan. We estimate new tax revenue by first calculating the new wage and salary income that URC employees and alumni receive because of the URC. Then, we estimate the additional tax revenue to the state for several important state-level taxes: income, sales, property, and transportation taxes.

ADDITIONAL INCOME IN MICHIGAN DUE TO THE URC

We estimate that $3.2 billion in wages of URC employees in Michigan were *caused by* the URC in 2015. This figure accounts for the fact that at least some URC employees might earn wages in Michigan in the absence of the URC. We also estimate that URC alumni living in Michigan in 2015 earned $5.5 billion more due to the URC, as shown in "Alumni Incremental Earnings" on page 35.

TOTAL ADDITIONAL STATE TAX REVENUES IN 2015

Of the additional income in Michigan, $3.2 billion is from URC employees and $5.5 billion is from URC alumni. We estimate the additional taxes to the State of Michigan due to the URC universities by multiplying this income by the effective tax rates as described in "Methodology" on page A-1. Table 17 below shows the results of this analysis: $499.8 million in additional tax revenue to the State of Michigan paid by URC graduates and employees in FY 2015.

TABLE 17. Additional Tax Revenue to State of Michigan Due to URC, FY 2015 (millions)

Tax	Total Additional Paid
Personal Income	$239.0
Sales and Use Tax	$199.4
Property Tax	$40.0
Gasoline Tax	$21.4
Total Additional Tax Revenue	**$499.8**

Source: AEG analysis using base data from 2015 Consumer Expenditure Survey, Michigan House Fiscal Agency

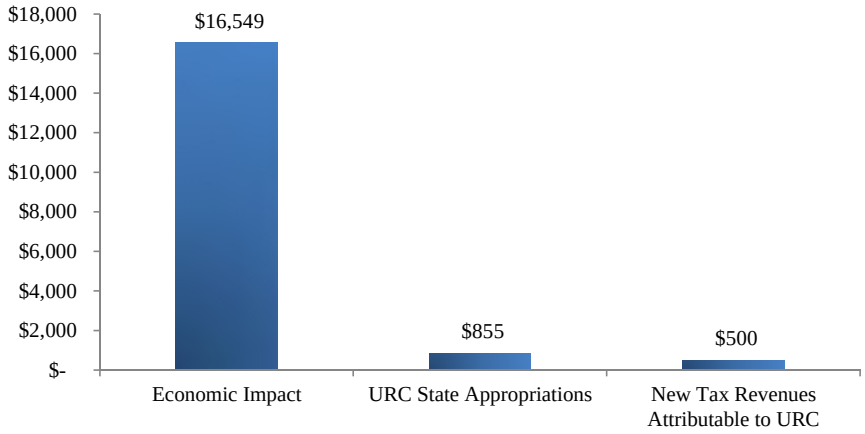
COMPARISON WITH ECONOMIC IMPACT AND URC APPROPRIATIONS

Clearly the main goal of the URC universities is not generating economic impact and tax revenue for the state. Nevertheless, since the state government provides funding for these universities, it is natural to compare the URC's net economic impact on the state to the state's appropriations for universities.

In 2015, the URC generated an additional $500 million in tax revenues for the State of Michigan.

As shown in Figure 23 below, the $16.5 billion in net economic impact is over 19 times[26] greater than the state's funding for the URC universities in FY 2015 of $855 million.[27] In addition, the State of Michigan received an estimated $500 million in tax revenue from URC employees and alumni that it would otherwise not have received if the URC did not exist in Michigan.

FIGURE 23. URC Net Economic Impact vs. State Appropriations (millions), 2015



Source: AEG analysis using base data from AEG Estimates, Michigan House Fiscal Agency

26. Note that this is a comparison of the *total* impact vs. *total* appropriations; each additional dollar of appropriations would not necessarily generate a full $19 in economic impact. Analysis of the economic impact of a marginal change in state appropriations is beyond the scope of this report.

27. The FY 2014-2015 state appropriations figure includes state funding for both the URC universities and MSU extension services. Previous reports in this series reported state appropriations for the universities but excluded MSU extension services.

Appendix A. Methodology

This appendix describes the following:

- How data sources were used to create the maps included in this report;
- The methods used to benchmark the URC against its peer clusters in terms of education and research metrics; and
- The methodology AEG used to complete our economic impact analysis.

The methodology used this year is consistent with the methodology used last year, except that we used updated multipliers in this year's analysis. We discuss this change further in "Updated Multipliers" on page A-8.

DATA AND ANALYSIS FOR MAPS

All of the maps in this report were created using Geographic Information Software (GIS). Using data provided by the URC universities, we created Maps 1 through 4. When data were incomplete or imperfect in terms of geographies, we used professional judgement and GIS to make estimations.

Map 2, "URC Students by County, 2015," on page 8 is based on data from the URC that details student enrollment by Michigan county for the cohorts entering the universities in Fall 2015. We took the number of URC students by county from the universities and calculated the share of students per county based on the total given to us.

Map 3, "URC Alumni by ZIP Code, 2016," on page 31 was created using zip code data from the URC alumni offices. Using this data, we estimated the number of alumni per county, which we used in our regional incremental alumni earnings analysis. This is discussed further in "Incremental Alumni Earnings in 2015 Caused by URC" on page A-13.

Map 5, "Net Economic Impact of URC Universities' Operations and Employment by Region, FY 2015 (in millions)," on page 37 is based on the economic collaborative regions created by the MEDC. We display our economic impact estimates of output and employment for those regions in "Economic Impact by Michigan Region" on page 36.

BENCHMARKING METRICS

Below we include definitions of degree categories created by AEG and describe any changes to methodology compared to previous years' reports.

Total Degree Completions

The completions data contained in "Total Degrees Granted" on page 11 may not perfectly match the numbers in our previous reports. While we continued to use completion data from the Integrated Postsecondary Education Data System (IPEDS) for this analysis, we no longer include second majors. Including both first and second majors over-represented degrees awarded as it double-counts students who may have two majors, but only one degree.

Academic Program Definitions

The academic program areas used in "Degrees by Program" on page 12 are based on the National Center for Education Statistics' Classification of Instructional Programs (CIP) codes that they use in their Integrated Postsecondary Education Data System (IPEDS). The composition of each program area is as follows:

The *Physical Science, Agriculture, and Natural Resources* academic program area includes the following fields of study: agriculture, agriculture operations, and related sciences; natural resources and conservation; and physical sciences.

The *Business, Management, and Law* academic program area includes the following fields of study: legal professions and studies; and business, management, marketing, and related support services.

The *Engineering, Mathematics, and Computer Science* academic program area includes the following fields of study: architecture and related services; computer and information sciences and support services; engineering; and mathematics and statistics.

The *Liberal Arts* academic program area includes the following fields of study: area, ethnic, cultural, and gender studies; communication, journalism, and related programs; education; foreign languages, literatures, and linguistics; family and consumer sciences/human sciences; English language and literature/letters; liberal arts and sciences; general studies and humanities; library science; multi/interdisciplinary studies; philosophy and religious studies; theology and religious vocations; public administration and social service professions; social sciences; visual and performing arts; and history.

The *Medicine and Biological Science* academic program area includes the following fields of study: biological and biomedical sciences; psychology; and health professions and related clinical sciences.

The *Other* academic program area includes the following fields of study: personal and culinary services; parks, recreation, leisure, and fitness studies; security and protective services; construction trades; mechanic and repair technologies/technicians; precision production; transportation and materials moving; undesignated fields of study; communications technologies/technicians and support services; engineering technologies/technicians; military technologies; and science technologies/technicians.

High-Tech, High-Demand, and Medical Degrees

In the following section, we define these categories of degrees and provide a basic reasoning for how they were created.

High-Tech Degree Definition. AEG's definition of high-tech degrees is one that we use regularly to assess Michigan's high-tech industry in Southeast Michigan.[28] As with the academic definitions, we used the CIP codes in IPEDS to pull degrees that fit our definition of high-tech. These degrees include:

- agriculture, agriculture operations, and related sciences (we include only 10% of this field of study as most agriculture is not high-tech)
- architecture and related services
- biological and biomedical sciences
- communications technologies/technicians and support services
- computer and information sciences and support services
- engineering technologies/technicians
- engineering
- mathematics and statistics
- physical sciences

High-Demand Degree Definition. The three fields of study with the highest demand among employers are business, computer science and engineering, according to a survey done by the National Association of Colleges and Employers. Their 2017 *Job Outlook Report* surveyed approximately 169 employers from a variety of sectors and found that computer science, engineering, accounting, finance, and business administration were in the most demand by employers.

For the purposes of this analysis we combined the three business related majors (accounting, finance, and business administration) into one category due to substantial overlap between these degrees at the undergraduate level in many universities. Our data source (IPEDS) does not distinguish clearly between them.

Additionally, for engineering degrees awarded, we included "engineering" and "engineering technologies/technicians," because the IPEDS database presents highly related concentrations under each and they likely signal similar skill sets in the entry-level job market.

Medical Degrees. For this analysis, we used the following IPEDS categories to represent the medical field:

- Medicine Doctor's degree - professional practice
- Osteopathic Medicine/Osteopathy Doctor's degree - professional practice
- Veterinary Medicine Doctor's degree - professional practice
- Registered Nursing, Nursing Administration, Nursing Research, and Clinical Nursing (Bachelor's, Master's, and Doctor's degrees)
- Dentistry Doctor's degree - professional practice

28. Anderson Economic Group, *Driving Southeast Michigan Forward*, prepared for Automation Alley (November 2008).

- Advanced/Graduate Dentistry and Oral Sciences (Master's and Doctor's degrees)
- Dental Support Services and Allied Professions (Bachelor's and Master's degrees)
- Physician Assistant (Master's degree)

R&D Expenditures

The data reported to IPEDS for research expenditures are lower than the research expenditures reported to the National Science Foundation because they include different things. Research expenditures reported to IPEDS only include direct research costs. Indirect costs, while included in NSF reporting, are counted in other spending categories when reported to IPEDS.

The science and engineering (S&E) fields used in "Academic R&D Expenditures" on page 17 are based on the NSF's survey of higher education institutions. The composition of each S&E field is as follows:

- Environmental sciences includes atmospheric and earth sciences, oceanography, and other miscellaneous sciences.
- Life sciences includes agricultural, biological, medical, and other miscellaneous life sciences.
- Physical sciences includes astronomy, chemistry, physics, and other miscellaneous physical sciences.
- Social sciences includes economics, political sciences, sociology, and other miscellaneous social sciences.
- Engineering includes aeronautical, biomedical, bioengineering, chemical, civil, electrical, mechanical, metallurgical, and other engineering fields.

Technology Transfer Information

For information on invention disclosures, patent grants, licenses and options, and licensing revenue, we relied on data provided by the URC universities, universities in each peer cluster, as well as the Association of University Technology Managers (AUTM) Surveys. For each cluster, we obtained the data from the following detailed sources:

- *URC*: Michigan State University, the University of Michigan, and Wayne State University information was obtained from the URC.
- *Northern California*: The University of California provided statistics for all their campuses through their Office of Technology and its Annual Reports for 2005-2015. Stanford University provided all statistics for 2005-2013 through their website and Office of Technology Licensing. Stanford's 2014 and 2015 data was obtained through the AUTM survey.
- *Southern California*: The University of California provided statistics for all their campuses through their Office of Technology and the office's Annual Reports for 2005-2015. USC data for 2006 and 2013-2015 was collected from the AUTM survey and through USC's Stevens Institute for 2007-2012.

- *Illinois*: Northwestern University provided all statistics for 2006-2009 through their website. Northwestern data for 2010, 2014, and 2015 was collected from the AUTM survey. Northwestern data for 2011 was collected from the Innovation and New Ventures Office, and data for 2012 and 2013 was found on page 61 of their annual report entitled "Northwestern University Research: Creating New Knowledge, Annual Report 2012." University of Chicago provided all statistics through their Office of Technology & Intellectual Property for 2005-2012 and the AUTM survey for 2013 through 2015. University of Illinois, Urbana-Champaign provided all statistics through their Office of Technology Management website.
- *Massachusetts*: MIT reported 2004-2015 data on their website via downloadable reports; however, licensing revenue and patent numbers were obtained and/or verified through AUTM, as patent data was not made available and licensing revenue numbers were unreadable in said reports. Boston University data for 2005-2015 was obtained through AUTM. Harvard data was collected from the 2006 and 2014 AUTM survey and through Harvard's Office of Technology Development for 2007-2013 and 2015.
- *North Carolina*: Data for UNC-Chapel Hill was collected from their Office of Technology Development for 2002-2014 and from the AUTM survey for 2015. Data for Duke University was provided by AUTM in 2006, 2014, and 2015 and through their Office of Licensing & Ventures for 2007-2013. North Carolina State University data were collected from their Office of Technology Transfer.
- *Pennsylvania*: Pennsylvania cluster data from 2002-2013 was obtained from the University of Pittsburgh's Office of Technology Management, Penn State's Intellectual Property office, Carnegie Mellon's Center for Technology Transfer and Enterprise Creation, and the 2006 AUTM surveys. The 2014 and 2015 data for all were collected from the AUTM survey.
- *Texas*: Data for Texas A&M was provided by their Technology Commercialization office for 2002-2013 and by AUTM for 2014 and 2015. Data for The University of Texas at Austin from 2005-2015 was provided by their Office of Technology Commercialization, while data from 2002-2004 was provided by AUTM (with the exception of number of licenses/options, which had no data reported for the aforementioned years). Rice University also had no license/option numbers to report (via AUTM) for 2002-2004, however, the rest of the university data from 2002-2006 was reported to and obtained from AUTM. Rice University data for 2007-2013 was from their Office of Technology Transfer and the data for 2014 and 2015 was from the AUTM survey.

INNOVATION POWER RANKINGS

In 2013, we included a new element: a composite ranking, which rates the URC's performance relative to its peer clusters for research spending, talent, and technology transfer activity. We ranked the URC on each of those three components separately, and then combined the rankings for an overall, composite ranking.

Research

For the research component, the clusters are ranked on total research spending, as well as spending on science and engineering R&D. We weighted these ranks at 80% and 20%, respectively, to determine the ranking for research.

Talent

The talent component is based on the total number of degrees awarded, as well as the number of high-technology degrees awarded. High-tech degrees are listed in "High-Tech Degree Definition" on page A-3. We weighted these ranks at 80% and 20%, respectively, to determine the overall ranking for talent.

Technology Transfer

The technology transfer and commercialization rankings are composed of each cluster's ranks for the five-year averages (2011-2015) of the following five measures:

- Licensing revenue
- Start-up companies
- Patent grants issued
- Technology licenses issued
- Invention disclosures

Licensing revenues and start-ups provide the strongest direct measures of how valuable university R&D efforts are to the private sector. Therefore, we weighted rankings for licensing revenues and start-up companies as a half of the total technology transfer ranking, and the other three measures are equally weighted to make up the other half of the overall ranking.

Overall Composite Ranking

Once we determine the overall rankings for research, talent, and technology transfer activity, we use a weighted average to combine them into a single composite ranking for each cluster. We weight talent and research at 40% each, and weight tech transfer and commercialization at 20% of the final ranking. What metrics to include and how to weight them involves some subjective judgement. Our goal is to combine the metrics for which we have high-quality data (those included in this report) into the best possible overall measure of a cluster's contribution to innovation.

We weight research and talent more heavily than technology transfer for two reasons. First, for most universities, research and educating students are more closely related to the institution's core mission than technology transfer, even though the latter is important and becoming increasingly emphasized. Second, while we believe the technology transfer metrics we use are the best available, they do not capture the universities' impacts on technology and practices outside of the universities as well as the talent and research metrics in their respective areas. University R&D reaches practical application outside the universities through a variety of channels, including formal technology transfer, research partnerships, and the education of students who may take what they have learned in the lab with them to the outside world. Table A-1 below displays the detailed rankings by metric for the URC and peer clusters.

TABLE A-1. 2015 Innovation Power Rankings for URC and Peer Clusters, Detailed

Cluster		Research Spending Rank (40% of Composite)	Technology Transfer (20% of Composite)	Talent (40% of Composite)	Composite Ranking
URC	**Category Rank:**	**5**	**7**	**1**	**2**
	Subcategory Ranks:	***Total R&D (80%): 5*** ***Total R&D in S&E (20%): 5***	***Licensing Revenue (25%): 6*** ***Start-up Companies (25%): 7*** ***Patent Grants Issued (17%): 4*** ***Tech. Licenses Issued (17%): 5*** ***Invention Disclosures (17%): 6***	***#. Degrees (80%): 1*** ***#. High-tech Degrees (20%): 4***	
Northern Cal.	Category Rank:	1	2	8	**3**
	Subcategory Ranks:	***Total R&D (80%): 1*** ***Total R&D in S&E (20%): 1***	***Licensing Revenue (25%): 2*** ***Start-up Companies (25%): 3*** ***Patent Grants Issued (17%): 2*** ***Tech. Licenses Issued (17%): 4*** ***Invention Disclosures (17%): 3***	***#. Degrees (80%): 8*** ***#. High-tech Degrees (20%): 7***	
Southern Cal.	Category Rank:	2	3	2	**1**
	Subcategory Ranks:	***Total R&D (80%): 2*** ***Total R&D in S&E (20%): 2***	***Licensing Revenue (25%): 4*** ***Start-up Companies (25%): 1*** ***Patent Grants Issued (17%): 3*** ***Tech. Licenses Issued (17%): 6*** ***Invention Disclosures (17%): 2***	***#.Degrees (80%): 2*** ***#.High-tech Degrees (20%): 2***	
Illinois	Category Rank:	7	6	5	**7**
	Subcategory Ranks:	***Total R&D (80%): 7*** ***Total R&D in S&E (20%): 7***	***Licensing Revenue (25%): 1*** ***Start-up Companies (25%): 6*** ***Patent Grants Issued (17%): 5*** ***Tech. Licenses Issued (17%): 7*** ***Invention Disclosures (17%): 8***	***#.Degrees (80%): 5*** ***# High-tech Degrees (20%): 5***	
Mass.	Category Rank:	4	1	7	**5**
	Subcategory Ranks:	***Total R&D (80%): 4*** ***Total R&D in S&E (20%): 4***	***Licensing Revenue (25%): 3*** ***Start-up Companies (25%): 2*** ***Patent Grants Issued (17%): 1*** ***Tech. Licenses Issued (17%): 3*** ***Invention Disclosures (17%): 1***	***#.Degrees (80%): 7*** ***# High-tech Degrees (20%): 8***	
N. Carolina	Category Rank:	3	4	6	**4**
	Subcategory Ranks:	***Total R&D (80%): 3*** ***Total R&D in S&E (20%): 3***	***Licensing Revenue (25%): 5*** ***Start-up Companies (25%): 5*** ***Patent Grants Issued (17%): 8*** ***Tech. Licenses Issued (17%): 2*** ***Invention Disclosures (17%): 5***	***#. Degrees (80%): 6*** ***#. High-tech Degrees (20%): 6***	
Penn.	Category Rank:	6	4	4	**6**
	Subcategory Ranks:	***Total R&D (80%): 6*** ***Total R&D in S&E (20%): 6***	***Licensing Revenue (25%): 8*** ***Start-up Companies (25%): 4*** ***Patent Grants Issued (17%): 7*** ***Tech. Licenses Issued (17%): 1*** ***Invention Disclosures (17%): 4***	***#. Degrees (80%): 4*** ***#. High-tech Degrees (20%): 1***	
Texas	Category Rank:	8	8	3	**7**
	Subcategory Ranks:	***Total R&D (80%): 8*** ***Total R&D in S&E (20%): 8***	***Licensing Revenue (25%): 7*** ***Start-up Companies (25%): 8*** ***Patent Grants Issued (17%): 6*** ***Tech. Licenses Issued (17%): 8*** ***Invention Disclosures (17%): 7***	***#. Degrees (80%): 3*** ***#. High-tech Degrees (20%): 3***	

Source: AEG analysis using base data from NSF HERD Survey 2015;University Technology Transfer Annual Reports; AUTM U.S. Licensing Activity Survey 2015; and IPEDS 2015

ESTIMATING NET ECONOMIC IMPACT

We define *net economic impact* as the new economic activity that occurs in a defined geographic region directly or indirectly caused by the URC. To quantify the economic impact of URC universities' operational expenditures, we asked, in effect, "What would be the loss to the state if the three University Research Corridor universities closed their doors?"

A direct impact stems from initial spending, while indirect and induced impacts stem from the recirculation of dollars within the defined geographic region. URC expenditures are at the foundation of the URC's impact on the state economy, but the full impact goes further than simply summarizing spending, for two reasons.

First, an economic impact analysis should count only net new spending, which accounts for spending that would have occurred in the state even without the URC universities, as well as spending that is crowded out by URC spending. For example, we exclude expenditures by students who would have otherwise attended another college and spent money in the state. We also exclude all expenditures by URC universities that go to firms outside Michigan.

Second, as the URC makes these expenditures, the money is then re-spent throughout the Michigan economy, creating a "multiplier" effect. These indirect effects are also a significant contributor to Michigan's economy, and are thus included in the total net economic impact.

For each of the following categories, we estimate the *direct impact*, which accounts for what is net new spending, and *indirect impacts*, which take the multiplier effect into account to incorporate the additional economic activity caused by the URC. We calculated the *indirect* economic impact of URC's expenditures by multiplying the direct expenditures by final demand output multipliers based on those released by the U.S. Department of Commerce's Regional 2013 Multipliers (RIMS II).

Updated Multipliers

The U.S. Bureau of Economic Analysis releases regional input-output multipliers for regions across the U.S. These multipliers are updated annually using regional data in order to provide the estimates for the economic impact in any given region. In previous reports, we used multipliers that were based on 2003 regional information (FY 2006-2008), 2006 regional information (FY 2009-2011), and 2010 regional information (FY 2012-2014). For this year's report, we updated the multipliers using 2013 data, which is the most recent year available.

Table A-2 on page A-9 displays how we assigned multipliers to different classes of URC spending, and the industry multipliers we used to estimate economic impact. As shown in the table, the 2013 multipliers are generally lower than the 2010 multipliers, indicating that less money is exchanged between industries in Michigan than in prior years.

TABLE A-2. Industrial Classification of URC and Student Expenditures, FY 2012-2014 and FY 2015

	Industry Classification		Final-demand Multiplier (Output) for Michigan	
Spending Category	**FY 2012-2014**	**FY 2015**	**2010**	**2013**
URC Spending				
Salaries and Wages	Households	Households	1.232	1.165
Employee Benefits	Insurance Carriers*	Insurance Carriers*	2.029	1.779
Instruction & Academic Support	Educational Services	Educational Services	2.028	2.034
Research	Scientific research and development services	Scientific research and development services	2.155	2.177
Public Service, Student Services, Institutional Support, Auxiliary Expenses, and Other Expenses and Deductions	Colleges*	Colleges*	2.158	2.010
Operation & Maintenance	Facilities support services*	Facilities support services*	2.083	1.983
Hospital Services	Hospitals*	Hospitals*	2.139	2.081
Athletics	Spectator sports *	Spectator sports *	2.221	2.031
Construction	Construction	Construction	2.168	2.128
Student Spending				
Room and Board	Accommodations/ Households**	Accommodations/ Households**	1.593	1.498
Books and Supplies	Retail trade	Retail trade***	1.883	1.923
Apparel, Food & Grocery, and Other Basic Needs	Retail trade	Retail trade***	1.883	1.923
Off-campus Meals & Entertainment	Food services and drinking places	Food services and drinking places	1.985	2.033

** Industries using the multipliers for "detail" industries; the rest use multipliers for "aggregate" industries.*

*** AEG estimated an average of the accommodation and household multipliers for student room and board expenditures.*

**** AEG estimated an average of the food and beverage stores and general merchandise stores multipliers in place of the previous retail trade multipliers.*

Source: BEA RIMS II 2013 Multipliers

Operational Expenditures Methodology

We did the following to calculate the net economic impact of the URC:

Determined In-State Expenditures. The first step in estimating the net economic impact of the URC's operational expenditures was to determine the payroll and non-payroll expenditures by the URC that went to employees and vendors in the state. We did this in the following steps.

1. We obtained salary, fringe benefit, and non-payroll expenditures for the URC universities for FY 2015 from IPEDS.

2. We obtained spending on athletics from NCAA Equity in Athletics reports, and removed it from the proper IPEDS categories so as not to double-count the spending.
3. We relied on information provided by the universities to determine the percentage of expenditures that went to businesses located outside of Michigan.
4. We obtained the spending occurring between universities, and removed it from the proper IPEDS categories, so as not to double-count the spending. Based on the available data and university resources, we assumed that 75% of this type of spending was in research, while the other 25% was in categories such as student services and institutional support.
5. We used data from the universities and the 2015 Consumer Expenditure Survey from the U.S. Bureau of Labor Statistics to calculate URC student expenditures in Michigan, and to account for a percentage of expenditures that go to firms outside Michigan. We updated this information using room and board information for the 2014-2015 school year provided by the URC universities.[29]

Accounting for what is "Net New" in Michigan. After calculating the non-payroll and payroll expenditures by the URC and student expenditures, we accounted for the spending that was considered net new in Michigan, and therefore do not include spending that would have occurred even if the URC were not part of the state's economy. We show our estimates for the percentage of spending that stays in the state and is net new spending below in our calculations for the URC's net economic impact in the state in Table A-3 on page A-12.

We followed these steps for each of the categories detailed in the URC's economic impact. We used the following methods for these categories of spending:

- Salaries and Wages: We used URC data on employment to estimate that close to 100% of employee wages and benefits remain in the state, and that 66% of faculty and staff worked in Michigan because of the URC.
- Research: Most research dollars come from out-of-state sources. URC universities are responsible for 94% of academic R&D expenditures in the state, and receive 94% of all federal research dollars in Michigan. We estimate that 75% of spending remains in the state, and that 95% of that spending is net new in Michigan.
- Hospital spending: Using UMHS data, we assumed that less than half of spending remains in Michigan, and that around 70% of that spending is net new.
- Athletics: Since URC universities have extensive athletic programs that travel across the country to compete and recruit, we estimated that 44% of spending remained in Michigan, but 100% of that spending was net new.
- Construction: We estimate that 70% of construction spending remained in Michigan, and 85% of that is net new.

29. Student spending was based on the percentage of students who live on- and off-campus, and their estimated spending on room and board; books and supplies; apparel, food and grocery, and other basic needs; and meals and entertainment away from campus.

- Other spending: For student services, instruction and academic support, institutional support, and other expenses, we estimate that about 75% of spending remains in state, and more than 85% of that spending is net new.
- In addition to these assumptions, we used actual expenditure data from the schools. Using these fixed ratios of percent spending in Michigan, we calibrated the percent of each category that was spent in Michigan to ensure that the total spending in Michigan from our model is equal to the total spending reported by the each university.

The impact of this spending is included in Table A-3 on page A-12.

Student Spending Methodology

To calculate the net new students in Michigan, we obtained the number of students from in- and out-of-state at the URC universities, and estimated the percent of students who attend university in Michigan *because of the URC.* We assumed that overall, 80% of in-state students attend universities in Michigan because of the URC. We assume that 100% of out-of-state students are net new students in Michigan because of the URC.

One way to think about this is that 20% of URC students from Michigan would remain in Michigan for their college degree if the URC disappeared, and that the spending associated with their education would also remain in the state. Thus, this is not *new* economic activity caused by the URC. It is unlikely that most out-of-state students would come to Michigan for their bachelor's or advanced degree if the URC were not in operation. We counted the expenditures on the instruction of and spending by these students as new economic activity caused by the URC.

The impact of this spending is included in Table A-3 on page A-12.

TABLE A-3. Net Economic Impact of the URC; URC and Student Spending

Category	2015 Expenditures	% net new in Michigan	Net New $ in Michigan (Direct Impact)	Output Multiplier	Net Economic Impact (Direct and Indirect)	*Memo:Indirect Impact*
URC Payroll Expenditures						
Salaries and Wages	$ 4,692,128,160	69%	$ 3,240,880,067	1.17	$ 3,776,921,630	$ 536,041,563
Employee Benefits	$ 1,425,290,089	69%	$ 984,699,654	1.78	$ 1,751,977,624	$ 767,277,970
Subtotal: Econ Impact from Payroll Expenditures	*$ 6,117,418,249*		*$ 4,225,579,720*		*$ 5,528,899,254*	*$ 1,303,319,533*
URC Nonpayroll Expenditures						
Instruction & Academic Support	$ 354,648,378	51%	$ 182,128,404	2.03	$ 370,522,024	$ 188,393,621
Research	$ 389,153,494	66%	$ 257,830,047	2.18	$ 561,270,229	$ 303,440,182
Public Service, Student Services, Institutional Support, Auxiliary Enterprises, & Other Expenses	$ 372,007,047	61%	$ 225,632,875	2.01	$ 453,522,079	$ 227,889,204
Operation and Maintenance of Plant	$ 406,971,574	55%	$ 222,039,789	1.98	$ 440,260,494	$ 218,220,705
Hospital Services	$ 1,032,486,000	14%	$ 141,307,002	2.08	$ 294,003,348	$ 152,696,346
Athletics	$ 107,880,570	65%	$ 70,519,364	2.03	$ 143,210,723	$ 72,691,360
Construction	$ 1,115,275,139	56%	$ 630,061,873	2.13	$ 1,340,519,641	$ 710,457,768
Subtotal: Econ Impact from Institutional Expenditures	*$ 3,778,422,201*		*$ 1,729,519,353*		*$ 3,603,308,539*	*$ 1,873,789,186*
Student Spending						
Room and Board	$ 1,333,944,784	86%	$ 1,141,565,064	1.50	$ 1,710,064,466	$ 568,499,402
Books and Supplies	$ 135,177,130	60%	$ 80,995,429	1.92	$ 155,746,110	$ 74,750,681
Apparel, Food & Grocery, and other basic needs	$ 209,478,379	87%	$ 182,370,034	1.92	$ 350,679,339	$ 168,309,305
Meal & Entertainment-away from campus	$ 393,043,173	84%	$ 328,268,065	2.03	$ 667,467,457	$ 339,199,392
Subtotal: Econ Impact from Student Expenditures	*$ 2,071,643,465*		*$ 1,733,198,593*		*$ 2,883,957,372*	*$ 1,150,758,780*

Total Economic Impact

	Output
Direct Effects	$ 7,688,297,666
Indirect Effects	$ 4,327,867,498
Total Net New Impact of URC	***$ 12,016,165,164***

Source: AEG analysis using base data from URC Universities; BEA RIMS II 2013 Multipliers; AEG Estimates

Impact of Alumni Earnings

Below we describe the data used to estimate the final component of net economic impact of the URC: incremental alumni earnings attributable to the URC universities.

Alumni Data. We used data from the alumni offices of each of the URC universities. They provided us with aggregated data on the number of known alumni by country, by U.S. state and territory, and by Michigan zip code. We were given the number of alumni by graduation year and highest degree earned at the university. We show the earnings of Michigan URC alumni by age and degree below in Table A-4.

TABLE A-4. Michigan Earnings of URC Alumni by Age and Degree, 2015 (in millions)

	21-24 Years	25-34 Years	35-44 Years	45-64 Years	Over 65 Years	Total
Bachelor Degree	$1,218	$4,953	$5,247	$8,450	$761	$20,629
Advanced Degree	$0	$3,068	$4,546	$7,436	$903	$15,953
Total Earnings	$1,218	$8,021	$9,793	$15,886	$1,665	$36,583
Memo: Earnings as a percentage of wages & salary income in Michigan						*17.0%*

Note: Numbers may not add up due to rounding.

Source: AEG analysis using base data from URC Universities; U.S. Census Bureau; BLS; BEA

Incremental Alumni Earnings in 2015 Caused by URC

Like all educational institutions, URC universities strive to increase the knowledge and skills of the students they teach. How this knowledge impacts a student's lifetime earnings often depends on the student.[30]

Our estimate of the incremental earnings of URC alumni attributable to the URC universities is, at its heart, a comparison of what the alumni currently earn with an estimate of what they would have earned in the state if not for the URC. We used data on URC alumni, outputs from our human capital model simulation (regarding sorting graduates as detailed in Appendix B of our 2007 report), and using other data, such as wage and workforce participation data, which were part of our human capital simulation model used in our 2007 analysis.

We used the following methodology:

1. We estimated the current earnings of URC alumni living in Michigan using the methodology detailed in our 2007 URC economic impact report. In previous

30. For a small share of the URC's students, having access to a research university in Michigan is the difference between going to college and not. For others, it is the difference between remaining in the state for a college degree or pursuing an education outside Michigan. For the remainder of the students, the existence of URC universities means finding the right mix of features, location, and price, whatever their specific reasons for choosing MSU, U-M or WSU.

benchmarking reports we relied on wage data by education level for 2000 and 2009, corrected for inflation. For this report, 2014 data is available, which was brought to 2015 dollars using BLS inflation figures.

2. We estimated the proportion of URC alumni in each counterfactual group. A "counterfactual group" is a group of students who would have exhibited the same labor market outcome without attending the URC, such as working outside the state, attaining less education, or attending another university in the state. (The methodology is detailed in our 2007 URC economic impact report, again using 2014 wage figures.) We further assumed that all past years' graduating classes exhibited the same behavior as our estimates for the current year's graduating class, so the current set of alumni in the state are all characterized by the same set of assumptions about their earnings without the URC.
3. We used census and workforce participation data to estimate each counterfactual group's total earnings.
4. We subtracted the current earnings from the counterfactual earnings to find the *additional* earnings of current URC alumni due to the URC.

See our first annual URC benchmarking study, released in 2007, for our detailed methodology in estimating certain parameters used in alumni earnings, as well as our 2013 report for updates to parameters.

Jobs Impact

To estimate the jobs impact of the URC, we estimated the number of net new FTE employees that work for the URC universities, and UMHS. We then applied the direct-effect employment multipliers from the Bureau of Economic Analysis (BEA) to estimate the additional indirect impact the URC has on employment. The multipliers we used for school faculty and staff were for the junior colleges, colleges, universities, and professional schools category. For hospital faculty and staff, we used the hospitals multiplier. Table A-5 below shows the net jobs impact for the URC.

TABLE A-5. Net Jobs Impact of the URC, FY 2015

Category	2015 Employment (FTE)	% Net New in Michigan	Direct Jobs Impact	Employment Multiplier	Total Net New Employment	*Memo: Indirect Jobs Impact*
URC Non-Hospital Faculty	9,393	88%	8,272	1.54	12,723	4,451
URC Non-Hospital Staff	29,446	63%	18,640	1.54	28,670	10,030
URC Hospital Faculty	2,499	92%	2,299	2.21	5,077	2,778
URC Hospital Staff	15,623	65%	10,155	2.21	22,426	12,271
Total Faculty and Staff Jobs Impact	56,960	69%	39,366	1.75	68,896	29,530

Source: AEG analysis using base data from URC Universities, BEA RIMS II 2013 Multipliers, AEG Estimates

Revisions to Previously Published Economic Impact Estimates

The economic impact estimates that were published in the 2014, 2015, and 2016 reports have been revised since these reports were published. There are two reasons for these revisions:

1. An error in data provided by one of the URC universities, effectively overestimating expenditures; and
2. An error in estimating the amount of URC operations spending in Michigan.

One of the universities found an accounting error in the expenditure data they provided for the 2015 and 2016 reports. This accounting error results in overestimating the university's non-payroll spending during the FY 2013 and FY 2014 fiscal years. For this year's update, the university provided corrected data for these years. We re-estimated the economic impact for these two years using the revised data.

AEG identified an error in how we estimated the amount of university non-payroll expenditures in Michigan in the 2014 and 2015 reports. As we describe in "Operational Expenditures Methodology" on page A-9, we calibrate our estimates for the non-payroll expenditures in Michigan using expenditure data provided by each university. We found that we inconsistently applied this calibration method, which affected our estimates for this spending in FY 2012 and FY 2013. We re-estimated the economic impact using the appropriate calibration method for these two years.

See Table A-6 below for a comparison of the published and corrected economic impact estimates.

TABLE A-6. Economic Impact of the URC, FY2012 - FY2014 (billions)

Report Year	Fiscal Year	Published	Corrected
2014	FY 2012	$16.6	$16.5
2015	FY 2013	$16.8	$16.6
2016	FY 2014	$17.5	$16.8

Source: AEG analysis using base data from URC Universities, BEA RIMS II 2010 Multipliers, AEG Estimates

REGIONAL ECONOMIC IMPACT

Our regional economic impact analysis is meant to give the magnitude of economic impact on a more local level, and is a conservative estimate. To perform the regional economic impact analysis, we include the same expenditures as in the state economic impact, except at a county level. While the universities had county-by-county data, the expenditures were accounted for slightly differently than in IPEDS. We discuss how the direct economic impact by region was estimated below.

Operational Expenditures. Using data provided by the URC universities on wages and vendor payments by county, we calculated the percentage of payroll and non-payroll expenses in each county. We used the university expenditures (after substitution), which we used in the state economic impact, and allocated expenditures by

county using these shares. This gives a rough estimate of university spending in each Michigan county.

Student Local Spending. We used our statewide estimates of URC student expenditures and after accounting for substitution, we attributed a portion of that spending to the counties in which the URC universities are located. We apportioned 100% of spending for students living on campus to the counties in which the schools are located. No data were available that directly report where off-campus students live and spend money. We apportioned spending by students who live off campus based on our knowledge of the campuses and our professional judgment. We distributed 70% of spending by MSU off-campus students to Ingham County, and 30% to Clinton County. We distributed U-M Ann Arbor student expenditures between Washtenaw (97%), Wayne (2%), and Jackson (1%). We apportioned spending from U-M Flint students to Genesee County, U-M Dearborn to Wayne (80%), and Oakland (20%), and for Wayne State, we assumed that 60% of spending was in Wayne County, and 40% was in Oakland.

Regional Alumni Earnings and Incremental Earnings Estimates. An analysis of where URC alumni currently live reveals that different regions of the state account for differing shares of this total. The largest driver of these differences comes from the number of URC alumni living in different parts of the state, but the distribution is also affected by whether the alumni have bachelor's or advanced degrees.

We apportioned alumni earnings based on where they were reported to reside. The best data of this at a local level was zip code data provided by each university's alumni office. We used GIS software to assist us in attributing alumni into a county when a zip code spanned more than one county.

Indirect Economic Impact. We then calculated the regional *indirect* economic impact of URC's expenditures by multiplying the direct expenditures by the U.S. Department of Commerce's Regional Multipliers (RIMS II). It would be a highly complex analysis (and prohibitively expensive) to use the individual set of multipliers for each of Michigan's 83 counties. Instead, we purchased only the county multipliers for the three counties that had the largest share of expenditures, which were also the counties in which the URC universities are located: Washtenaw, Wayne, and Ingham. For these counties, we used the multipliers provided by RIMS II. The remaining counties were put into categories of low, medium, or high population and we estimated those multipliers accordingly. See Table A-7 on page A-17 for the list of multipliers used in the regional economic impact analysis.

TABLE A-7. Multipliers Used in Regional and County-by-County Economic Impact, FY 2015

Spending Category	Multiplier Category	Ingham County	Wash-tenaw County	Wayne County	Low Pop. (<50k)	Medium Pop. (50k-120k)	High Pop. (>120k)
URC Spending							
Salaries and Wages	Households	0.715	0.658	0.730	0.500	0.526	0.658
Employee Benefits	Insurance Carriers*	1.500	1.320	1.348	1.050	1.056	1.320
Instruction & Academic Support	Educational Services	1.519	1.547	1.517	1.063	1.237	1.547
Research	Scientific research and development services	1.557	1.653	1.604	1.090	1.322	1.653
Public Service	Civic organizations*	1.379	1.389	1.497	0.965	1.111	1.389
Student Services, Inst. Support, Auxiliary Enterprises, & Other Expenses	Colleges*	1.519	1.547	1.517	1.063	1.237	1.547
Operation and Maintenance of Plant	Facilities support services*	1.519	1.547	1.517	1.063	1.237	1.547
Hospital Services	Hospitals*	1.515	1.462	1.516	1.060	1.170	1.462
Athletics	Spectator sports *	1.397	1.342	1.512	0.978	1.073	1.342
Construction	Construction	1.344	1.332	1.556	0.941	1.066	1.332
Student Spending							
Room and Board	Accommodations/ Households**	1.070	1.011	1.113	0.749	0.809	1.011
Books and Supplies	Retail trade***	1.454	1.398	1.551	1.018	1.119	1.398
Apparel, Food & Grocery, and Other Basic Needs	Retail trade***	1.454	1.398	1.551	1.018	1.119	1.398
Off-campus Meals & Entertain-ment	Food services and drinking places	1.477	1.411	1.582	1.034	1.129	1.411

** Note: Industries using the multipliers for "detail" industries; the rest use multipliers for "aggregate" industries*

*** AEG estimated an average of the accommodation and household multipliers for student room and board expenditures.*

**** AEG estimated an average of the food and beverage stores and general merchandise stores multipliers in place of the previous retail trade multipliers.*

Source: BEA RIMS II 2013 Multipliers

Economic activity is not contained within the region it occurs. Spending in one region generates activity in nearby regions when that money is re-spent. Therefore, the state's indirect activity generated by the URC is larger than the sum of regional estimates. To correct for this and apportion all indirectly-generated activity to a region, we estimated a factor of economic activity that goes beyond each county's borders. This allows our analysis of indirect economic impact by region in Michigan to sum to the state's economic impact, providing the magnitude of the total impact in Michigan, by region. Each direct expenditure was multiplied by that spending factor, as well as the multiplier. We show the full economic impact by region in Table A-8 on page A-18. We show our estimates of additional URC alumni earnings by region in Table A-9 on page A-20.

Table A-8. Estimate of the URC Economic Impact in Michigan, by Region, FY 2015

Direct Impact of Student and URC Expenditures & Employment in Michigan, by Region

	Net New Payroll Expenditures		Net New Nonpayroll Expenditures		Net New Student Spending		Net New Employment	
	Total	Share	Total	Share	Total	Share	Total	Share
Upper Peninsula Region	$ 4,561,848	0.1%	$ 2,728,072	0.2%	$ -	0.0%	66	0.2%
Northwest Region	$ 6,833,975	0.2%	$ 2,466,696	0.1%	$ -	0.0%	120	0.3%
Northeast Region	$ 3,821,242	0.1%	$ 628,513	0.0%	$ -	0.0%	63	0.2%
West Michigan Region	$ 27,633,253	0.7%	$ 48,527,153	2.8%	$ -	0.0%	297	0.8%
East Central Region	$ 8,171,125	0.2%	$ 33,435,803	1.9%	$ -	0.0%	124	0.3%
East Michigan Region	$ 85,086,789	2.0%	$ 27,933,225	1.6%	$ 78,218,191	4.5%	1,057	2.7%
South Central Region	$ 940,106,308	22.2%	$ 332,447,874	19.2%	$ 579,157,727	33.4%	7,638	19.4%
Southwest Region	$ 10,143,490	0.2%	$ 14,125,746	0.8%	$ -	0.0%	151	0.4%
Southeast Michigan Region	$ 2,259,604,722	53.5%	$ 269,512,944	15.6%	$ 657,540,439	37.9%	20,612	52.4%
Detroit Metro Region	$ 879,616,968	20.8%	$ 997,713,325	57.7%	$ 418,282,236	24.1%	9,238	23.5%
State of Michigan	$ 4,225,579,720		$ 1,729,519,353		$ 1,733,198,593		39,366	

Indirect Impact of Student and URC Expenditures & Employment in Michigan, by Region

	Net New Payroll Expenditures		Net New Nonpayroll Expenditures		Net New Student Spending		Net New Employment	
	Total	Share	Total	Share	Total	Share	Total	Share
Upper Peninsula Region	$ (192,484)	0.0%	$ 1,417,412	0.1%	$ -	0.0%	20	0.1%
Northwest Region	$ (113,413)	0.0%	$ 1,406,865	0.1%	$ -	0.0%	42	0.1%
Northeast Region	$ (109,638)	0.0%	$ 276,845	0.0%	$ -	0.0%	25	0.1%
West Michigan Region	$ 4,708,687	0.4%	$ 49,789,269	2.7%	$ -	0.0%	153	0.5%
East Central Region	$ 1,058,562	0.1%	$ 33,367,298	1.8%	$ -	0.0%	61	0.2%
East Michigan Region	$ 22,832,990	1.8%	$ 27,764,652	1.5%	$ 54,458,823	4.7%	825	2.8%
South Central Region	$ 316,911,536	24.3%	$ 344,559,709	18.4%	$ 392,952,491	34.1%	4,262	14.4%
Southwest Region	$ 2,086,473	0.2%	$ 14,533,100	0.8%	$ -	0.0%	92	0.3%
Southeast Michigan Region	$ 657,887,831	50.5%	$ 278,486,868	14.9%	$ 424,075,549	36.9%	17,220	58.3%
Detroit Metro Region	$ 298,248,990	22.9%	$ 1,118,532,620	59.8%	$ 279,271,917	24.3%	6,830	23.1%
State of Michigan	$ 1,303,319,533		$ 1,870,134,639		$ 1,150,758,780		29,530	

Table A-8. Estimate of the URC Economic Impact in Michigan by Region, FY 2015 (cont.)

Total Impact of Student and URC Expenditures & Employment in Michigan, by Region

	Net New Payroll Expenditures		Net New Nonpayroll Expenditures		Net New Student Spending		Net New Employment	
	Total	Share	Total	Share	Total	Share	Total	Share
Upper Peninsula Region	$ 4,369,364	0.1%	$ 4,145,485	0.1%	$ -	0.0%	86	0.1%
Northwest Region	$ 6,720,561	0.1%	$ 3,873,561	0.1%	$ -	0.0%	162	0.2%
Northeast Region	$ 3,711,605	0.1%	$ 905,358	0.0%	$ -	0.0%	88	0.1%
West Michigan Region	$ 32,341,940	0.6%	$ 98,316,422	2.7%	$ -	0.0%	450	0.7%
East Central Region	$ 9,229,687	0.2%	$ 66,803,102	1.9%	$ -	0.0%	185	0.3%
East Michigan Region	$ 107,919,779	2.0%	$ 55,697,878	1.5%	$ 132,677,014	4.6%	1,882	2.7%
South Central Region	$ 1,257,017,844	22.7%	$ 677,007,583	18.8%	$ 972,110,217	33.7%	11,901	17.3%
Southwest Region	$ 12,229,963	0.2%	$ 28,658,847	0.8%	$ -	0.0%	243	0.4%
Southeast Michigan Region	$ 2,917,492,552	52.8%	$ 547,999,812	15.2%	$ 1,081,615,988	37.5%	37,832	54.9%
Detroit Metro Region	$ 1,177,865,958	21.3%	$ 2,116,245,946	58.8%	$ 697,554,152	24.2%	16,068	23.3%
State of Michigan	$ 5,528,899,254		$ 3,599,653,992		$ 2,883,957,372		68,896	

Source: AEG analysis using base data from URC Universities, BEA RIMS II 2013 Multipliers, AEG Estimates

TABLE A-9. Estimate of Additional URC Alumni Earnings in Michigan by Region[31]

Impact of URC Alumni in Michigan, by Region

	URC Alumni		Share of URC Alumni Earnings		Share of Incremental URC Alumni Earnings		2015 Michigan Population	
	Total	Share	Total	Share	Total	Share	Total	Share
Upper Peninsula Region	5,816	0.9%	$ 329,793,159	0.9%	$ 52,204,926	0.9%	305,731	3.1%
Northwest Region	17,915	2.8%	$ 1,017,646,416	2.8%	$ 162,002,072	2.9%	303,254	3.1%
Northeast Region	5,924	0.9%	$ 333,752,157	0.9%	$ 52,496,398	1.0%	203,164	2.0%
West Michigan Region	50,243	7.7%	$ 2,850,036,006	7.8%	$ 460,689,724	8.4%	1,570,606	15.8%
East Central Region	16,285	2.5%	$ 924,474,094	2.5%	$ 146,973,961	2.7%	565,814	5.7%
East Michigan Region	46,498	7.1%	$ 2,706,484,117	7.4%	$ 409,666,545	7.4%	854,851	8.6%
South Central Region	56,786	8.7%	$ 3,159,937,251	8.6%	$ 535,365,560	9.7%	472,276	4.8%
Southwest Region	20,886	3.2%	$ 1,188,018,024	3.2%	$ 190,815,049	3.5%	780,629	7.9%
Southeast Michigan Region	76,068	11.7%	$ 4,456,363,073	12.2%	$ 669,871,352	12.2%	999,772	10.1%
Detroit Metro Region	354,143	54.4%	$ 19,616,031,435	53.6%	$ 2,833,052,693	51.4%	3,866,479	39.0%
State of Michigan	650,564		$ 36,582,535,732		$ 5,513,138,280		9,922,576	

Total Impact of URC Alumni in Michigan, by Region

	Earnings-Direct Impact		Total Impact	
	Total	Share	Total	Share
Upper Peninsula Region	$ 36,830,575	0.9%	$ 42,922,352	0.9%
Northwest Region	$ 114,292,462	2.9%	$ 133,196,435	2.9%
Northeast Region	$ 37,036,208	1.0%	$ 43,161,997	1.0%
West Michigan Region	$ 325,016,600	8.4%	$ 378,774,346	8.4%
East Central Region	$ 103,690,130	2.7%	$ 120,840,477	2.7%
East Michigan Region	$ 289,019,748	7.4%	$ 336,823,614	7.4%
South Central Region	$ 377,700,402	9.7%	$ 440,172,049	9.7%
Southwest Region	$ 134,620,017	3.5%	$ 156,886,168	3.5%
Southeast Michigan Region	$ 472,594,239	12.2%	$ 550,761,326	12.2%
Detroit Metro Region	$ 1,998,718,675	51.4%	$ 2,329,306,744	51.4%
State of Michigan	$ 3,889,519,057		$ 4,532,845,508	

Source: AEG analysis using base data from URC Universities, BEA RIMS II 2013 Multipliers, AEG Estimates, ACS 5 Year Estimates

31. Alumni population includes those with valid zip codes only and the alumni earnings reflect alumni with valid graduation year information only.

TABLE A-10. Estimate of the URC and Alumni Economic Impact in Michigan by Region

Total Impact of URC in Michigan, by Region

	Net New Economic Impact		Total Jobs Impact	
	Total	Share	Total	Share
Upper Peninsula Region	$ 51,437,201	0.3%	86	0.1%
Northwest Region	$ 143,790,558	0.9%	162	0.2%
Northeast Region	$ 47,778,960	0.3%	88	0.1%
West Michigan Region	$ 509,432,708	3.1%	450	0.7%
East Central Region	$ 196,873,266	1.2%	185	0.3%
East Michigan Region	$ 633,118,285	3.8%	1,882	2.7%
South Central Region	$ 3,346,307,693	20.2%	11,901	17.3%
Southwest Region	$ 197,774,977	1.2%	243	0.4%
Southeast Michigan Region	$ 5,097,869,679	30.8%	37,832	54.9%
Detroit Metro Region	$ 6,320,972,800	38.2%	16,068	23.3%
State of Michigan	**$ 16,545,356,126**		**68,896**	

Source: AEG analysis using base data from URC Universities, BEA RIMS II 2013 Multipliers, AEG Estimates

ALUMNI EARNINGS

Alumni Earnings Methodology

We used individual and aggregate alumni data provided by Michigan State, University of Michigan, and Wayne State to estimate alumni earnings. We excluded from our analysis recipients of honorary degrees and certificates.

We estimated the 2015 earnings by URC alumni in three steps:

1) Estimate Age Distribution. We divided the existing alumni into seven age brackets, using data from each school on the number of graduates by year in their current alumni databases.[32] We used the alumni's year of graduation to approximate the age of the graduates. We used average age by graduation year for each school using survey data collected in the course of writing our URC-commissioned 2013 report "Michigan's University Research Corridor: Embracing Entrepreneurship." Based on this data, we assumed the following average age of graduates:

TABLE A-11. Average Age of URC Graduates Used in Analysis

	Bachelors	Advanced Degree
Michigan State University	22	27
University of Michigan	22	26
Wayne State University	24	28

Source: URC university alumni offices; Alumni survey cited in "Michigan's University Research Corridor: Embracing Entrepreneurship."

2) Estimate Workforce Participation and Wage. We estimated the workforce participation rate using our professional judgment based on data from the 2000 Decennial Census, the 2010 Decennial Census, and information from the American Community Survey. We estimated the average wage of URC alumni in each age bracket using data from the 2015 Current Population Survey Tables for Personal Income. This data provides separate, age-bracketed estimates for U.S. workers with bachelor's degrees and with advanced degrees. We used the following assumptions in conjunction with this data:

- We adjusted the average wage in each age bracket by the relative difference in the average wage in Michigan and the average wage in the U.S. using 2014 data from the U.S. Bureau of Labor Statistics.
- We assumed that wages grew in Michigan at either the rate of inflation between 2014 and 2015 or stayed constant, whichever is higher. We used the U.S. Bureau of Labor Statistics' Detroit-Ann Arbor-Flint Consumer Price Index (CPI).
- We assumed that alumni who are not in the labor force have no personal income.
- We assumed that some URC alumni earned a higher wage than the average wage for Michigan workers with bachelor and advanced degrees for each age bracket. This

32. The age brackets are 21-24 years, 25-34 years, 35-44 years, 45-54 years, 55-64 years, 65-74 years, and 75 years and over.

assumption is a professional estimate based on these universities' reputations for higher-than-average admissions standards within Michigan (improving their graduates' reputation among potential employers), and the fact that URC students' choices to attend a URC university reveals that they believe it will improve their employment prospects more than their next-favorite school. Our assumption implies that the higher admissions standards of these schools translates to higher earning power throughout the graduates' careers.

3) Estimate Total Earnings. The final step consisted of multiplying the number of alumni for each school in each age bracket by the estimated workforce participation rate and estimated wage, then summing the earnings across schools and ages as necessary to estimate total earnings.

Sorting Graduates into Types

In order to estimate what portion of URC alumni earnings were caused by the URC, we must consider what the graduates' earnings would have been without the URC. To do this, we place all URC graduates in one of three categories that allows us to compare their lifetime earnings with their URC education to their likely lifetime earnings without their URC education.

1. Graduates Earning Lower Wages Without the URC.

This includes:

- In-state students who otherwise would have gone to another college or university in Michigan. If not for the URC universities, these graduates would earn the average wage for a person of their age and the same level of education. These college- and graduate-school-bound students chose their school because it fit their educational needs and goals better than other schools. Without it, they would attain the same level of education, but would earn slightly less throughout their careers.
- In-state URC students who otherwise would not have completed the degree they are currently seeking (i.e. a bachelor's degree for undergraduates, an advanced degree for graduate students). If not for their URC university, these graduates would earn the average wage for a person of their age with one level less education: a high school graduate's wage for undergraduates, and a bachelor's degree wage for graduate students.

2. Graduates Earning Identical Wages Without the URC.

This includes:

- In-state URC students who otherwise would have gone to an out-of-state college similar to a URC university, and returned to Michigan to work, earning the same wage in either case. The school therefore has no impact on their lifetime wages earned in Michigan.
- Out-of-state URC students who will work outside Michigan when they graduate whether or not they would attend another Michigan college if the URC universities did not exist. The URC universities therefore have no impact on their lifetime wages earned in Michigan.

3. Graduates Earning No Wages in Michigan Without the URC.

- In-state URC students who otherwise would have gone to a college outside Michigan, as a result would have stayed outside of Michigan to work. Without the URC universities, these graduates would have earned no wages in Michigan.
- Out-of-state URC students who will work in Michigan when they graduate, but would not work in Michigan if they did not attend a URC university. If not for the URC universities, these students would earn no lifetime wages in Michigan.

Alumni Earnings in 2015 Caused by URC

We estimated the additional 2015 earnings of the existing URC alumni using the following methodology:

1. Estimate the current earnings of Michigan-based URC alumni as detailed in "Alumni Earnings" on page A-22.
2. Estimate the proportion of URC alumni in each counterfactual group (types 1 through 6, as detailed in "Sorting Graduates into Types" on page 23 of this appendix) by assuming that all past years' graduating classes exhibited the same behavior as our estimates for the current year's graduating class.
3. Use census and workforce participation data to calculate each counterfactual category's total earnings.
4. Subtract the current earnings from the counterfactual earnings to find the *additional* earnings of current URC alumni due to the URC.

ESTIMATING ADDITIONAL TAX REVENUE

We estimate new tax revenue by first calculating the new wage and salary income that URC employees and alumni receive because of the URC. Then, we estimate the additional tax revenue to the state for several important state-level taxes: income, sales, property, and transportation taxes.

We estimate that $5.4 billion in wages of URC employees in Michigan were *caused by* the URC in 2015. This figure accounts for substitution of URC employees for other Michigan wages that would have been paid in the absence of the URC. After taxes and savings, we estimate the new alumni earnings in Michigan to be $3.9 billion in the state due to the URC.

We categorize the earnings of employees and alumni caused by the URC into *marginal* and *average* income. The portion of alumni earnings that is earned *in addition to* what would have been earned without the URC is treated as "marginal income."

We treat entire new salary and wage income for an employee or alum that is earned only because of the URC as "average income." This matters because people spend their first $1,000 of income differently than their last, and the state government taxes this income differently because of exemptions. Our methodology for this analysis is detailed in "Methodology" on page A-1. The assumptions for this methodology have been updated from those we have used since our first annual benchmarking study, released in 2007; these updates are detailed in our 2013 report.

Employee Earnings

The income of URC employees is treated as average income. The earnings of URC employees come largely from out-of-state income sources, so it is reasonable as a first approximation to treat URC employee jobs as jobs that would not exist without the URC, meaning each employee's entire income generates net new tax revenue.[33] While it is possible that some of the income of URC employees could be treated as marginal income, treating it as average income is more conservative because average income is taxed at a lower average rate than is marginal income, as shown below in Table A-12.

URC Alumni

For some graduates, attending a URC university likely had no impact on their annual Michigan earnings (and therefore to the taxes they pay to the State of Michigan). Other graduates will earn extra income due to the URC, and therefore will pay additional taxes to the state. The proportion of their additional income that goes to Michigan taxes depends on whether their additional income due to the URC represents a pay boost (for graduates who would still be working in Michigan without the URC) or if their entire Michigan income is due to the URC (for graduates who otherwise would not be working in Michigan). As described below, we apply different effective tax rates to "average" and "marginal" income.

EFFECTIVE TAX RATES ON INCOME

This analysis recognizes that average and marginal income are taxed and spent differently. To account for this difference, we estimate an "effective rate" for each type of income that is taxed, which is the amount we anticipate people will pay in taxes divided by their income.[34]

Table A-12 on page A-26 shows the percentage of income we assume is paid to the State of Michigan. Note that our analysis includes major taxes such as income, sales, state-level property, and gasoline taxes, but does not consider additional, non-sales taxes on alcohol and tobacco, or other state taxes and fees.

33. The out-of-state income sources we refer to as supporting instruction and research expenses for URC employees includes tuition from out-of-state students and R&D funding (60% of which comes from the federal government).

34. For example, if someone makes $10,000 and spends $7,000 of that on items subject to the 6% state sales and use tax, he or she will pay 6% of $7,000, or $420 in taxes. His or her effective sales tax rate is $420 divided by $10,000, or 4.2%.

TABLE A-12. Percentage of Income Paid to the State of Michigan

Tax	On Additional Marginal Income	On Additional Average Income
Personal Income Tax	4.25%	2.27%
Sales and Use Tax	1.51%	2.62%
Property Tax	0.47%	0.47%
Transportation Tax	0.13%	0.29%

Source: AEG analysis using base data from 2015 Consumer Expenditure Survey

Income Tax

In October 2012, the personal income tax rate changed from 4.35% to 4.25%. For our analysis, we used the income tax rate of 4.25%. We do not attempt to estimate the proportion of marginal income going toward tax exempt expenditures. To calculate the 2.27% income tax rate on average income, we divided the state's revenue from the income tax in FY 2014-15 by the state's personal income.[35]

Sales and Use Tax

We calculate the sales and use tax burden using data from the U.S. Bureau of Labor Statistics' Consumer Expenditure Survey. First, we identified spending categories subject to the sales and use tax.[36] We estimate that consumers in the middle 20% of earners spend approximately 43.7% of their income on goods subject to the sales and use tax, yielding an effective rate on *income* of 43.7% times the 6% sales tax rate, or 2.62% of their entire income. This is the effective sales tax rate on additional average income.

To calculate the effective rate on marginal income, we calculated the proportion subject to sales tax of the additional spending done by people in the middle 20% of earners and the second-highest 20% of earners. We estimate that 25.1% of this additional income is spent in sales-taxable categories, resulting in an effective sales tax on marginal income of 25.1% times the 6% sales tax, or 1.51%.

Property Tax

We estimate the proportion of expenditures that goes toward property taxes on average using the 2015 Consumer Expenditure Survey. We find that, on average, people in the middle 20% of income spend 2.8% of their income on property taxes. We multiply 2.8% by the ratio of state property taxes to all state and local property

35. Base data source for the income tax in FY 2014-2015 was the Michigan Senate Fiscal Agency. Revenue from income tax in 2015 was $9.65 billion. According to the U.S. Bureau of Economic Analysis, personal income was $424.8 billion in 2015.

36. We identified 15 such spending categories, including travel; alcoholic beverages; housing maintenance; repairs, and other household expenses; postage and stationery; clothing; vehicles and vehicle maintenance; entertainment; personal care products, and others. Although we are aware that some expenditures currently are subject to the state's sales and use tax, but are not reported, we did not account for evasion or avoidance in this analysis.

taxes (16.7%) to arrive at an effective rate on income of 0.47%.[37] We also find that 2.8% of the additional income earned by earners in the second-highest quintile goes toward property taxes. Again multiplying by 16.7% of taxes going to the state government, we estimate the effective property tax rate on marginal income to be 0.47%.

Transportation Taxes

We estimate the proportion of expenditures that goes toward gasoline using the Consumer Expenditure Survey. We find that, on average, people in the middle 20% of income spend 4.62% of their income on gasoline. We multiply this rate by 6.33%, the effective rate of the gasoline tax,[38] resulting in an effective rate on income of 0.29%. We also find that 2.0% of the additional income earned by earners in the second-highest quintile goes toward fuel. Again multiplying by the 6.33% effective gas tax rate, we estimate the effective gas tax rate on marginal income to be 0.13%.

37. U.S. Census of Governments State and Local Finance data.

38. Gasoline is not taxed as a percentage of its price, but rather at a per-unit rate of $0.19 per gallon. The gasoline tax of $0.19 per gallon is divided by $3 per gallon of gasoline to yield a 6.33% effective rate.

Appendix B. Additional Data and Tables

This appendix contains additional detailed data for some of the numbers, tables, and figures presented throughout the report.

EDUCATION AND TALENT BENCHMARKS

The following tables present additional data for students and degrees for the URC and its peer clusters.

Enrollment

TABLE B-1. Student Enrollment for the URC and Peer Clusters, 2007-2015

	2007	2008	2009	2010	2011	2012	2013	2014	2015
URC	150,067	151,903	151,327	153,995	155,083	156,328	156,432	155,763	155,607
Northern Cal.	60,891	64,001	61,941	63,428	64,281	62,615	63,548	64,451	63,498
Southern Cal.	104,739	106,441	108,196	111,145	112,467	114,651	116,445	120,986	124,506
Illinois	83,477	83,892	84,676	85,874	88,425	89,335	90,051	90,932	91,080
Mass.	83,120	83,859	85,510	85,325	86,581	87,099	88,948	88,928	89,885
N. Carolina	80,003	84,655	86,030	87,371	89,229	89,772	89,367	88,324	88,029
Penn.	138,826	140,105	143,001	145,215	143,880	142,272	139,830	140,610	140,215
Texas	120,614	117,770	118,995	124,095	126,804	130,483	134,511	139,696	142,875

Source: AEG analysis using base data from IPEDS Enrollment, 12-Month Enrollment 2006-2007 to 2014-2015

Degrees

TABLE B-2. Number of Degrees Conferred for the URC and Peer Clusters, 2007-2015

	2007	2008	2009	2010	2011	2012	2013	2014	2015
URC	30,043	30,702	31,032	31,242	31,683	32,483	32,563	34,141	34,547
Northern Cal.	15,420	15,592	15,833	15,946	16,599	16,856	17,050	16,872	17,044
Southern Cal.	27,147	28,392	28,599	29,582	31,401	32,180	32,552	33,265	34,208
Illinois	20,497	21,256	21,340	22,129	22,618	23,061	23,207	23,730	24,154
Mass.	18,317	19,167	19,115	19,420	19,676	20,008	20,140	20,464	20,576
N. Carolina	17,062	17,370	18,000	18,524	19,381	20,727	21,105	21,744	21,553
Penn.	26,409	26,695	27,240	29,642	30,458	30,286	30,255	31,885	31,095
Texas	24,638	25,378	25,689	25,913	26,705	26,951	31,763	32,769	33,264

Source: AEG analysis using base data from IPEDS Completions, 2007-2015

TABLE B-3. Number of Undergraduate Degrees Conferred by Field of Study, 2015

	Phys. Sci. Agriculture, & Natural Resources	Engineering, Math. & Comp. Sci.	Business, Manag-ement, & Law	Liberal Arts	Medicine & Biological Sci.	Other	Total
URC	897	3,141	2,965	7,730	5,094	1,258	21,085
Northern Cal.	656	2,342	454	4,271	1,537	60	9,320
Southern Cal.	724	3,414	1,751	8,497	4,340	18	18,744
Illinois	1,014	2,889	1,020	4,408	1,973	321	11,625
Mass.	273	1,601	886	2,877	1,406	8	7,051
N. Carolina	1,040	2,377	1,187	4,289	2,551	576	12,020
Penn.	1,173	4,863	3,595	6,225	4,409	1,439	21,704
Texas	1,964	4,118	2,994	7,970	3,781	1,301	22,128

Source: AEG analysis using base data from IPEDS Completions, 2015

TABLE B-4. Number of Advanced Degrees Conferred by Field of Study, 2015

	Phys. Sci., Agriculture, & Natural Resources	Engineering, Mathematics, & Comp. Sci.	Business, Manage-ment, & Law	Liberal Arts	Medicine & Biological Sci.	Other	Total
URC	617	2,795	2,804	3,398	3,541	307	13,462
Northern Cal.	438	2,315	1,983	1,282	1,537	169	7,724
Southern Cal.	401	4,093	2,864	5,220	2,886	0	15,464
Illinois	481	1,972	5,044	3,307	1,349	376	12,529
Mass.	394	2,559	3,943	3,769	2,598	262	13,525
N. Carolina	594	1,803	2,553	1,998	2,364	221	9,533
Penn.	357	3,204	1,758	2,108	1,831	133	9,391
Texas	661	2,557	3,254	2,997	1,467	200	11,136

Source: AEG analysis using base data from IPEDS Completions, 2015

TABLE B-5. Number of High-Tech Degrees Conferred by Cluster, 2015

	Ag. & Related Sci.	Arch. & Related Services	Bio. & Biomed. Sci.	Comm. Tech., Comp. & Info. Sci. & Support Serv.	Eng., Eng. Tech. & Eng.-related Fields	Math. & Stat.	Phys. Sci.
URC	400	394	2,447	1,039	4,348	576	683
Northern Cal.	20	311	1,358	818	3,156	601	665
Southern Cal.	0	612	3,105	1,495	4,551	849	938
Illinois	652	269	1,141	764	3,497	591	715
Mass.	0	503	1,538	1,057	2,167	433	571
N. Carolina	525	157	1,859	909	2,843	491	566
Penn.	368	159	1,663	2,480	5,099	551	987
Texas	1,217	452	2,200	1,181	4,753	653	1,017

Source: AEG analysis using base data from IPEDS Completions, 2015

TABLE B-6. Medical Degrees Conferred by Cluster, 2015[a]

	MD	DO	DDS	DVM	Other Dentistry	Nursing	Physician Assistant
URC	685	290	112	106	64	1,092	43
Northern Cal.	256	0	112	0	27	171	0
Southern Cal.	452	0	258	0	77	256	52
Illinois	260	0	0	121	0	0	30
Mass.	328	0	260	0	60	0	0
N. Carolina	267	0	81	79	59	708	87
Penn.	279	0	82	0	23	983	39
Texas	189	0	105	128	52	345	0

Source: AEG analysis using base data from IPEDS Completions 2015

a. For a list of degrees included in these categories, see “Benchmarking Metrics” on page A-1.

TABLE B-7. Number of Medical Degrees Conferred for the URC and Peer Clusters, 2008-2015[a]

	2008	2009	2010	2011	2012	2013	2014	2015	% Change, 2008-2015
URC	1,742	1,994	2,034	2,193	2,109	2,186	2,332	2,392	37.3%
Northern Cal.	564	525	610	621	609	572	550	566	0.4%
Southern Cal.	1,123	1,073	1,075	1,054	1,107	1,086	1,111	1,095	-2.5%
Illinois	361	384	377	401	408	383	416	411	13.9%
Mass.	584	578	608	573	609	610	572	648	-11.0%
N. Carolina	898	954	948	749	1,177	1,115	1,206	1,281	42.7%
Penn.	940	931	946	1,069	1,147	1,499	1,322	1,406	49.6%
Texas	549	545	605	648	698	714	805	819	49.2%

Source: AEG analysis using base data from IPEDS Completions 2008 - 2015

a. For a list of degrees included in these categories, see "Benchmarking Metrics" on page A-1

RESEARCH AND DEVELOPMENT

The following tables present additional data for research and development funding and expenditures for the URC and its peer clusters.

TABLE B-8. R&D Funding by Source, FY 2015 (thousands)

	Total R&D Expenditures	Federal Gov't	State & Local Gov't	Institution	Industry[a]	Non-Profits	All Other Sources
URC	$2,150,155	52%	2%	37%	4%	4%	2%
Northern Cal.	$2,937,676	53%	4%	18%	8%	12%	6%
Southern Cal.	$2,813,724	54%	3%	18%	6%	10%	9%
Illinois	$1,717,045	60%	2%	23%	5%	8%	1%
Mass.	$2,332,808	55%	0%	20%	9%	10%	5%
N. Carolina	$2,471,772	54%	5%	20%	13%	6%	1%
Penn.	$1,904,892	66%	3%	17%	4%	5%	4%
Texas	$1,665,720	44%	13%	27%	9%	5%	2%
All U.S. Universities	$68,807,857	55%	6%	24%	6%	6%	3%

Source: AEG analysis using base data from NSF HERD Survey, 2015

a. This category is labeled "business" in the NSF survey, but we have kept the category label "industry," as we have in prior reports.

TABLE B-9. Growth in Total Academic R&D Expenditures for URC and Peer Clusters, FY 2014-FY 2015

	R&D Expenditures (millions)			
	FY 2014	FY 2015	Growth 2014-2015	Rank Growth 2014-2015
URC	$2,104	$2,150	2.2%	6
Northern Cal.	$2,788	$2,938	5.4%	2
Southern Cal.	$2,703	$2,814	4.1%	4
Illinois	$1,657	$1,717	3.6%	5
Mass.	$2,209	$2,333	5.6%	1
N. Carolina	$2,473	$2,472	0.0%	7
Penn.	$1,921	$1,905	-0.8%	8
Texas	$1,581	$1,666	5.4%	3
All U.S. Universities	$67,304	$68,808	2.2%	

Source: AEG analysis using base data from NSF HERD Survey, 2014-2015

TABLE B-10. Growth in Science and Engineering R&D Expenditures for URC and Peer Clusters, FY 2014-FY 2015

	S&E R&D Expenditures (millions)			
	FY 2014	FY 2015	Growth 2014-2015	Rank Growth 2014-2015
URC	$1,994	$2,036	2.1%	6
Northern Cal.	$2,622	$2,844	8.5%	1
Southern Cal.	$2,631	$2,736	4.0%	4
Illinois	$1,598	$1,650	3.2%	5
Mass.	$2,045	$2,186	6.9%	2
N. Carolina	$2,427	$2,431	0.1%	7
Penn.	$1,882	$1,878	-0.2%	8
Texas	$1,490	$1,578	5.9%	3
All U.S. Universities	$63,861	$65,158	2.0%	

Source: AEG analysis using base data from NSF HERD Survey, 2014-2015

TABLE B-11. R&D Spending by Field, FY 2015 (thousands)

	Env. Sci.	Life Sci.	Math & Comp. Sci.	Phys. Sci.	Psycho -logy	Social Sci.	Other Sci.	Engin.	All Non-S&E Fields
URC	$17,881	$1,197,080	$50,191	$201,927	$36,469	$192,580	$15,257	$324,578	$114,192
Northern Cal.	$42,615	$1,934,722	$42,603	$316,173	$26,405	$68,414	$94,249	$319,221	$93,274
Southern Cal.	$218,865	$1,773,019	$166,272	$146,803	$46,069	$81,728	$34,257	$269,237	$77,474
Illinois	$17,656	$948,104	$145,076	$162,752	$32,381	$65,777	$31,597	$246,203	$67,499
Mass.	$98,314	$914,221	$110,283	$225,992	$21,686	$124,985	$148,750	$542,199	$146,378
N. Carolina	$71,690	$1,781,540	$78,596	$66,775	$58,344	$127,084	$12,881	$233,882	$40,980
Penn.	$70,695	$986,948	$187,650	$94,090	$49,200	$50,041	$13,900	$425,928	$26,440
Texas	$191,031	$406,895	$114,607	$219,600	$14,895	$43,110	$10,780	$577,125	$87,677

Note: Fields determined by NSF. See "R&D Expenditures" on page A-15 for further description of S&E fields.

Source: AEG analysis using base data from NSF HERD Survey, 2015

Appendix C. Summary of Past URC Sector Reports

In 2013 the URC commissioned a study exploring the impact alumni entrepreneurs of MSU, U-M, and WSU have on the Michigan, U.S. and global economies. The URC has also commissioned annual industry sector reports. Key findings from those reports include:

ENGAGING DETROIT (2016)

Engaging Detroit: URC's Contributions to Resurgence in the Motor City, Public Sector Consultants

- The URC accounts for one in twenty jobs in Detroit and had a $958 million economic impact in 2015.
- More than 340 URC programs are in Detroit focused on community building, economic revitalization, public education, and public health.
- There are more than 28,000 URC students being educated in Detroit, contributing to economic activity and retention.
- The URC conducted $263 million in Detroit-related research in 2015.

TALENT FOR THE GLOBAL ECONOMY (2015)

Attracting, Fostering, and Inspiring Talent for the Global Economy, Alex L. Rosaen and Patrick L. Anderson, Anderson Economic Group

- Among eight top research university clusters in 2013, URC universities ranked first in enrollment, degrees awarded, and medical degrees awarded.
- The URC produces more than 32,000 talented graduates each year and has over 617,000 known alumni in Michigan.
- The URC universities sustain almost 12,000 world-class faculty and more than 35,000 graduate students with over $2.1 billion in annual research and development expenditures. As a result, the URC universities are a similar asset for Michigan as other notable research clusters, such as those in California and Texas.
- The URC universities maintain the state's connection to a broad, global network of talented individuals. The schools have significant alumni networks in several notable talent destinations in the U.S., with over 582,000 alumni outside the state.

BLUE ECONOMY (2014)

Innovating for the Blue Economy: Water Research at the URC, Alex L. Rosaen, Anderson Economic Group

- One in five Michigan jobs (718,700) are associated with water-enabled or water-related industries.
- From 2009-2013, the three URC universities received 2,100 awards for water-related research and outreach, totaling nearly $300 million, supporting 341 researchers from dozens of departments.

- Each year, the URC universities produce more than 3,400 graduates prepared to analyze and find solutions to water-related issues in academia, government, and the private sector.

ALUMNI ENTREPRENEURSHIP (2013)

Embracing Entrepreneurship: The URC's Growing Support for Entrepreneurs in Michigan and Throughout the World, Erin A. Grover, Colby S. Cesaro, Samantha Superstine and Patrick L. Anderson, Anderson Economic Group

- URC alumni entrepreneurs started or acquired businesses at double the national average rate among college graduates since 1996.
- Fifty percent of the companies created by URC entrepreneurs are located in Michigan with the rest in every other state and more than 100 different countries.
- Compared to the most recently available five-year success rate for U.S. firms, URC alumni-started firms were nearly 1.5 times more likely to remain in operation.
- Most URC entrepreneurs start a business in an area outside their major areas of study.

AUTOMOTIVE INNOVATION (2012)

The URC's Contributions to Automotive Innovation, Caroline M. Sallee, Alex L. Rosaen and Erin A. Grover, Anderson Economic Group

- The URC universities supply talented workers to the auto industry, conferring more than 3,600 degrees annually in auto-ready disciplines.
- URC universities play a direct role in auto industry innovation by spending $60 million annually of their R&D dollars on auto-related research and development.
- Between FY 2007 and 2011, the URC universities spent $300 million on more than 1,400 auto projects. Nearly two-thirds of this research was funded by federal and state governmental agencies.
- Private industry funded 28% of all auto research at the URC universities in the past five years, which is nine times the average share of industry funding for all university R&D at these institutions.
- URC researchers have helped automakers improve vehicle quality and safety, improve engine efficiency and performance, and reduce fossil fuel use through new auto approaches. Specific examples include:
    - The 2mm project that involved U-M and WSU that limited and controlled the gaps between auto components;
    - The connected vehicle research at U-M and WSU that promises improved safety by allowing vehicles to "talk" to one another and the infrastructure;
    - Biofuels research that is currently being done by MSU on new types of feedstock that can be grown more economically to lower fuel costs and improve fuel efficiency.

INFORMATION AND COMMUNICATION TECHNOLOGY (2011)

The University Research Corridor's Support for Information and Communication Technology in Michigan, Caroline M. Sallee, Erin Agemy, and Patrick L. Anderson, Anderson Economic Group

- The URC universities spent nearly $74 million on research projects with a strong IT focus in FY2010.
- Of the nearly 150 start-ups the URC has assisted in creating since 2001, approximately 40% have had a distinct ICT component.
- Information technology employs about 3.5% of the state's workforce, or about 135,000 workers, and is significant not only as its own sector but as the underpinning for much of the major industry activity and growth represented in previous sector reports.
- The industry pays high wages, with employees earning about $20,000 more than other workers in the private sector.

ADVANCED MANUFACTURING (2010)

The University Research Corridor's Support for Advanced Manufacturing in Michigan, Caroline M. Sallee, Erin Agemy, Alex L. Rosaen and Patrick L. Anderson, Anderson Economic Group

- Michigan's advanced manufacturing industry employs 381,351 workers, accounting for 10.3% of all employment (2007 data). Fully one-third of advanced manufacturing jobs in the Midwest are in Michigan.
- The average wage in the advanced manufacturing industry was $64,122.
- URC universities spent $101 million on advanced manufacturing R&D in 2009.
- URC universities are educating more than 14,000 students in engineering.

LIFE SCIENCES (2009)

Life Sciences Industry in Michigan and the University Research Corridor, Caroline M. Sallee, Hilary A. Doe and Patrick L. Anderson, Anderson Economic Group

- Michigan's life sciences industry employed more than 79,000 workers, accounting for 2.1% of all employment (2006 data).
- Between 1999 and 2006, life sciences industry employment grew by 10.7% while during that same time period manufacturing employment dropped by 24%.
- Life sciences wages averaged $83,494 in 2006.
- In 2008, URC universities spent $887 million on life sciences research and development.
- R&D expenditures grew 69% since the founding of the Life Sciences Corridor in 1999.

ALTERNATIVE ENERGY RESEARCH AND DEVELOPMENT (2008)

Preliminary Report: Alternative Energy Research and Development in the URC, Caroline M. Sallee, Rebecca A. Cohen and Patrick L. Anderson, Anderson Economic Group

- Michigan has a comparative advantage in biomass and wind compared to the energy potential in the other 49 states.
- URC universities spent more than $79.5 million on R&D related to alternative energy in 2007.
- Federal funding provided 71% ($56.8 million) of total R&D funding in alternative energy.
- More than 50% of all alternative energy R&D supported the auto industry.

These reports can be found at the URC's website at www.urcmich.org. For further information on the authors the URC commissioned for these reports, see www.AndersonEconomicGroup.com and www.pscinc.com.

Appendix D. About the Authors

ANDERSON ECONOMIC GROUP

Anderson Economic Group, LLC is a boutique consulting firm founded in 1996, with offices in East Lansing, Chicago, and Istanbul. Our team has a deep understanding of advanced economic modeling techniques and extensive experience in multiple industries in multiple states and countries. We are experts across a variety of fields in tax policy, strategy and business valuation, public policy and economic analysis, and market and industry analysis.

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