TECHNOLOGY2030

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ABOUT THE AUTHORS

This report was written by Ted Abernathy and Sara Casey, with contributions by Missouri Chamber Foundation staff.

Ted Abernathy is the managing Partner of Economic Leadership LLC, a Raleigh, North Carolina-based company that helps businesses, and places, increase their competitiveness. Ted has 38 years of experience directing economic development and workforce development programs. From 2008 to 2013, Ted was the executive director of the Southern Growth Policies Board, a 42-year-old public policy think tank that provided research to states and communities across the South. Before Southern Growth, Ted was a practicing economic developer for 28 years, including eight years as executive vice president/COO for the Research Triangle Regional Partnership. His latest research has focused on reimagining workforce development, making manufacturing more competitive, and analyzing 25 years of rural economic development policy.

Ted received his bachelor's degree from the University of North Carolina at Chapel Hill and his master's from Johns Hopkins University. He is a graduate of the Economic Development Institute and is an Eisenhower Fellow for global economics.

Sara Casey specializes in data collection, analysis and visualization for a variety of economic topics. Her research efforts have included conducting economic impact analysis, determining in-demand workforce needs and characterizing emerging clusters in regional economies. Sara has worked with clients including federal government agencies, international NGOs, research foundations, trade associations and economic development groups. She has worked with Economic Leadership LLC for more than five years. Before joining the Economic Leadership LLC team, Sara was an economist at RTI International.

I. Introduction

Promotion and support of the technology sector offers great economic opportunity for Missouri. In recent years, tech growth has spread from the coastal cities, such as the San Francisco Bay Area, with which it has long been associated, to new markets across America. The decentralization of the tech industry from the coasts is driven by several trends. The first is the permeation of technology into the fabric of almost every company and sector of the economy. Construction foremen are now carrying tablets on the job to communicate and adjust in real time with architects. Manufacturing is being transformed by robotics, automation and digitization. Agriculture is witnessing the era of genetics, drones and sensors. Technology has spread widely, and the competition for technology companies and workers continues to intensify.

Companies are taking advantage of an accelerating trend to secure cost savings by locating outside more recognized, and often more expensive, technology hubs. In the 2018 Scoring Tech Talent Report (CBRE 2018), a 500-employee tech firm in St. Louis and Kansas City cost an estimated $39.6 million and $38.0 million, respectively, in annual operations. The same size tech company would require a total of $59.1 million in annual costs located in the San Francisco Bay Area.

Missouri is well-poised to take advantage of these current trends in the tech industry. The state remains a relatively low-cost option compared to coastal cities. Kansas City and St. Louis have earned national reputations as outstanding locations for tech businesses. All the while, pockets of inspiring innovation are happening in Missouri's mid-size cities and small communities across the state. Missouri is headquarters for corporate employers such as Centene, Cerner, Enterprise, Jack Henry, Panera Bread, Monsanto-Bayer and Energizer. Tech giants have chosen the state as their pilot sites for new technology including Google Fiber and Hyperloop One. Venture capital investment in Missouri tech companies has risen steadily in recent years. For all these reasons, Missouri has quietly become a top growth tech state.

We need to position Missouri to make the most of our growing tech economy. To explore the impact of the tech sector and its potential for Missouri, the Missouri Chamber Foundation commissioned Economic Leadership LLC to conduct a review of the tech industry. This report also provides comparisons of Missouri to other states, including tech research and development infrastructure, venture capital and entrepreneurship. The Technology 2030 Report aims to understand tech trends in Missouri and highlight areas where the state could improve its knowledge economy to be even more attractive to tech firms seeking to relocate or expand.

II. Executive Summary

The Technology 2030 Report is part of the Missouri Chamber Foundation's overall strategic plan to reposition our state as a global economic leader. The strategic plan is called Missouri 2030, and it revealed that technology is one of the greatest areas of opportunity for our state. Missouri has a rich and growing technology sector, and the state can be even more competitive, grow even faster and be more broadly recognized as a leading technology state.

To explore the impact of the tech sector and its potential for the state's economy, the Missouri Chamber Foundation contracted Economic Leadership LLC to conduct a review of the tech industry. This report reviews employment, growth, concentration and wages for the tech sector in Missouri. The state's performance is measured against other states for comparison. The report also evaluates a variety of technology infrastructure indicators to gauge the state's competitiveness in the tech sector.

The total technology sector was divided into four subcategories that were most relevant:

- Energy Technology
- Environmental Technology
- Life Sciences/ Biopharmaceuticals/Agriculture Tech
- IT (Tech Core)

These sectors were chosen based on several definitions of the technology industry. The primary source for defining the technology industry is TechAmerica Foundation's 2013 Technology Industry Classification. Other state and city industry reports were evaluated, and this report maintains a definition that is comparable to these reports.

Overall, tech accounted for just under 5 percent of the state's total employment and just over 5 percent of the state's establishments. However, the tech industry has almost twice as much impact when wages and sales are evaluated. In 2017, the tech industry earned over $41.6 billion in sales revenue, which accounted for 7.9 percent of all sales in the state.

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Missouri Total Tech Sector, 2017

Indicator	Technology Sector	State Total	Percentage of State Total
Employees	143,707	2,931,331	4.9%
Establishments	10,570	207,013	5.1%
Wages (millions)	$13,674	$158,477	8.6%
Sales (millions)	$41,565	$528,078	7.9%

Source: EL calculations based on EMSI 2018.4

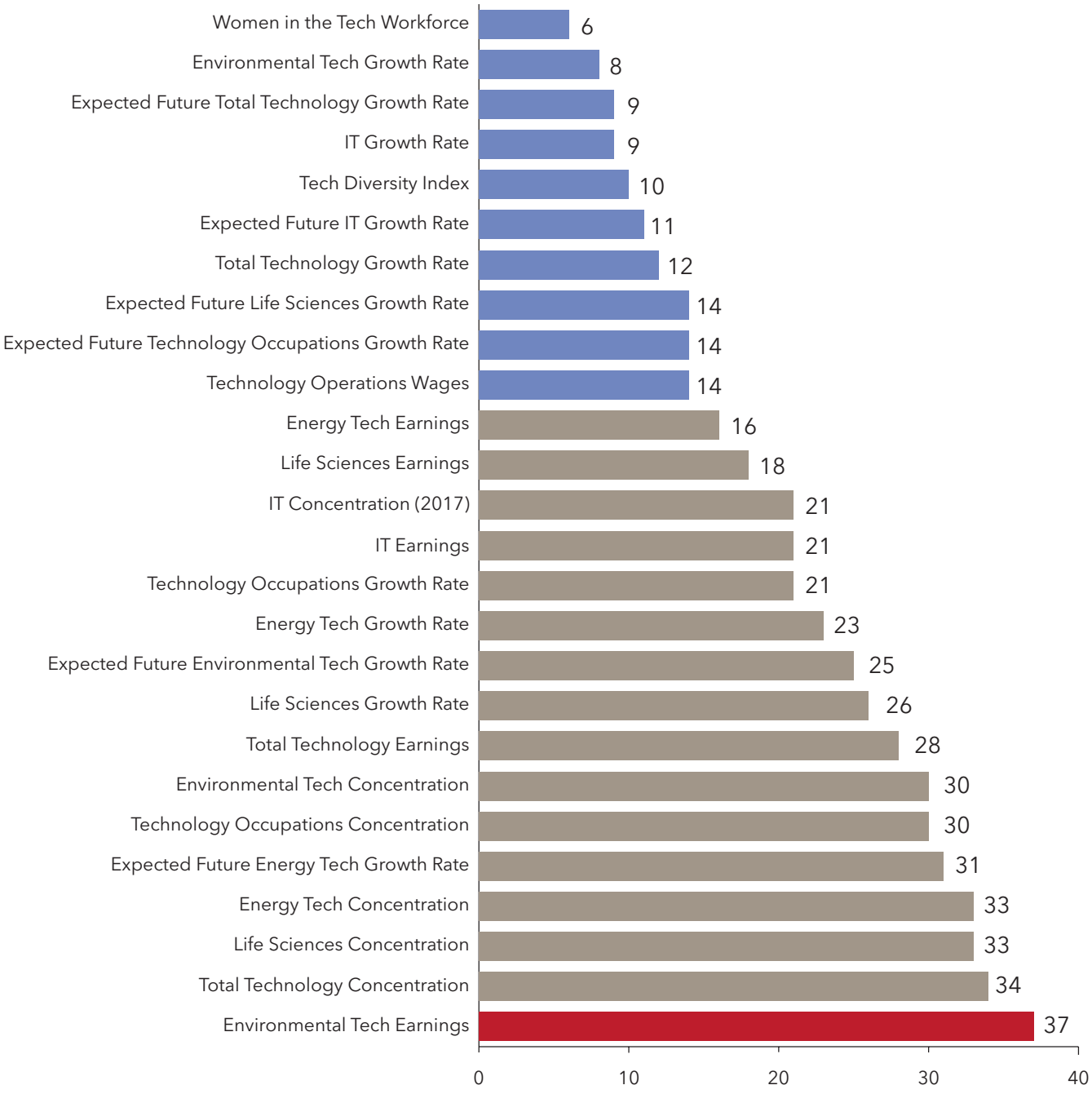
Missouri Subcategories of Total Tech Sector, 2017

Technology Categories	Jobs, 2017	Job Change, 2016-2017	Job Change, 2012-2017	Establishments, 2017	Sales, 2017 (millions)	National Location Quotient
Energy Tech	10,867	1.3%	-4.5%	347	$6,461	0.53
Environmental Tech	12,582	3.5%	19.7%	910	$2,212	0.93
Life Sciences	39,305	1.2%	4.8%	2,533	$11,105	0.75
IT	80,953	2.6%	16.8%	6,781	$21,787	0.90
Output	**Jobs, 2017**	**Job Change, 2016-2017**	**Job Change, 2012-2017**	**Establishments, 2017**	**Sales, 2017 (millions)**	**National Location Quotient**
Tech Services	119,983	1.7%	8.7%	10,101	$33,450	0.84
Tech Manufacturing	23,724	4.5%	29.7%	469	$8,115	0.69
TOTAL	**143,707**	**2.2%**	**11.7%**	**10,570**	**$41,565**	**0.81**

Source: EL calculations based on EMSI 2018.4

Missouri's robust technology sector includes more than 10,000 employers employing more than 140,000 people and paying over $13 billion in annual wages.

Missouri State Rankings for Tech Performance Indicators



Deeper analysis reveals economic performance in specific tech catagories. IT makes up the largest share of jobs, accounting for 56 percent of jobs for a total of 81,000 employees. It is also fast-growing, expanding at a rate of 16.8 percent over the last five years. Environmental tech is the smallest share but is the fastest-growing, with nearly 20 percent growth.

The tech sector was also divided between manufacturing and services. Tech manufacturing in Missouri has grown by nearly 30 percent in the last five years compared to a negative national growth rate of -0.7 percent. Driving growth in Missouri is the manufacturing of electronic components, automatic environmental controls, biopharmaceuticals, battery storage and pesticides.

Tech industries spark significant economic activity in other sectors of the economy. The tech sector in Missouri has a job multiplier of 2.84, meaning for every job created, nearly two additional jobs were added.

These statistics are positive; however, the future looks even brighter. The tech industry is expected to grow jobs by 2.9 percent, ahead of the U.S. estimated tech job growth of 2.1 percent.

High tech wages are the reason growing our tech economy is important. The average earnings for all jobs in Missouri was $57,000 in 2017. The average earnings for a tech worker in the state are nearly double that, at $101,470 annually.

The total tech sector and each of its subsectors were compared to those of other states in the country. The economic performance of the Missouri tech sector was strongest in recent growth rates and anticipated growth over the next five years. For 10 of the 26 technology performance indicators, Missouri ranked in the top 15 states.

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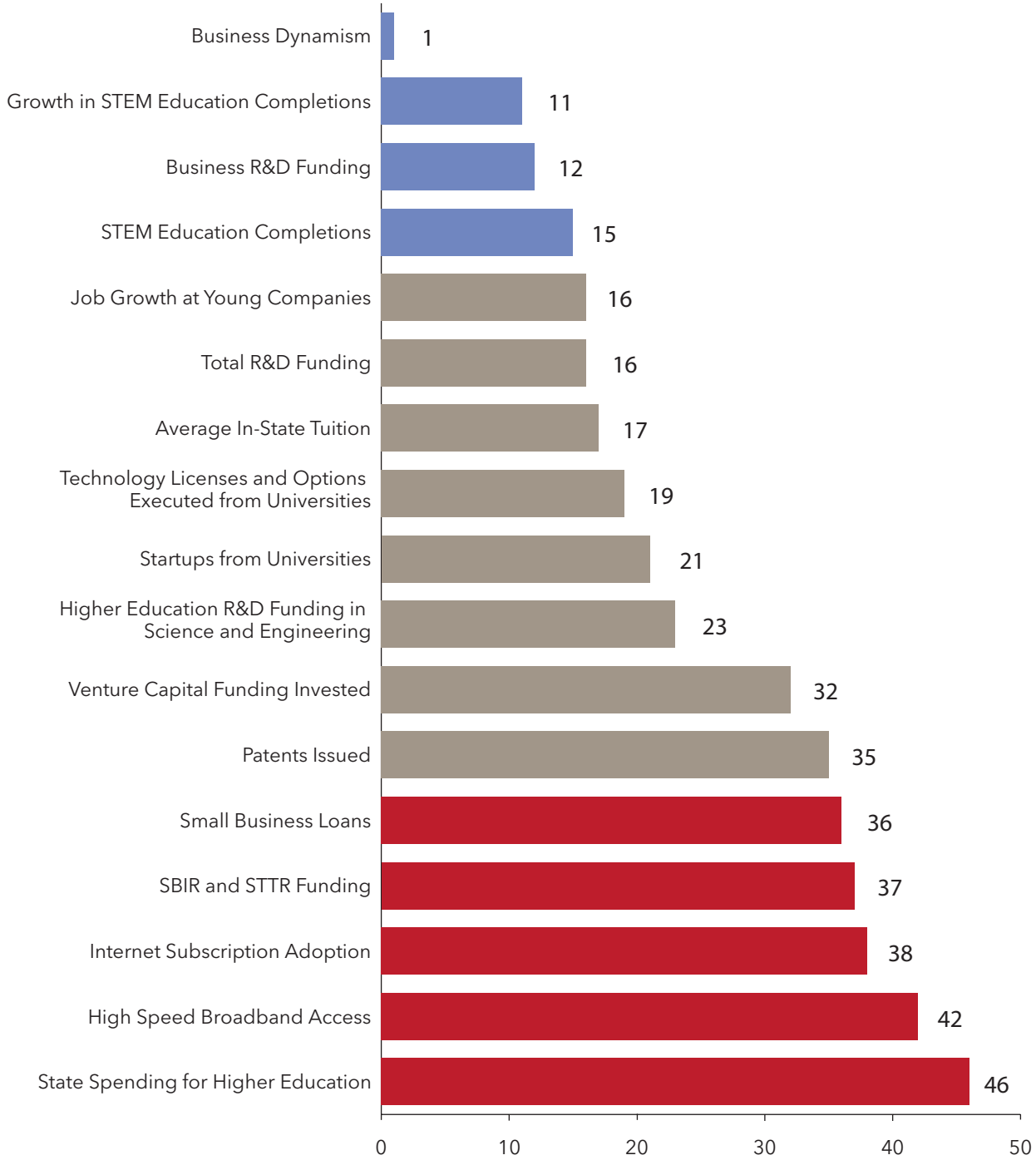
Missouri State Rankings for Tech Infrastructure Indicators



A second set of state comparisons measured Missouri's technology infrastructure, the foundation of a vibrant knowledge economy. Missouri ranked in the top 15 states for four of these indicators, including ranking as the top state for business dynamism (the rate of new businesses versus the rate of closing businesses). Missouri also scored low in some factors, including broadband access, internet adoption and small-business funding.

Tech jobs are not created only by technology industries. Tech permeates nearly every industry, and an economic analysis must also include a look at these occupations. Tech occupation growth has not been quite as strong as tech industry job growth in Missouri, but the data still reflects an emerging market. Looking forward, Missouri is predicted to have the 14th-fastest five-year growth of tech occupations.

The results of this analysis reveal that Missouri's tech sector is currently small in concentration compared to more traditional technology states like California or Washington. However, Missouri is an emerging tech hub with high levels of growth and some important assets in place, including high levels of private R&D funding, the presence of corporate headquarters in finance and agriculture, and strong local STEM graduates. With better promotion of the assets and attention to the current weaknesses, the technology sector should be a strong contributor to the Missouri 2030 economy.

Missouri is the number 1 state for business dynamism.

III. Missouri Tech Sector Overview

The review of the 95 separate North American Industry Classification System (NAICS) codes used to define the technology sector of Missouri found that 143,707 workers were employed in the industry in 2017. These workers were spread across 10,570 tech establishments. Overall, tech accounted for just under 5 percent of the state's total employment and just over 5 percent of establishments. However, the tech industry has almost twice as much impact when wages and sales were evaluated. In 2017, the tech industry earned over $41.6 billion in sales revenue, which accounted for 7.9 percent of all sales in the state.

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Source: EL calculations based on EMSI 2018.4

Missouri Total Tech Sector Contributions to Economy, 2017

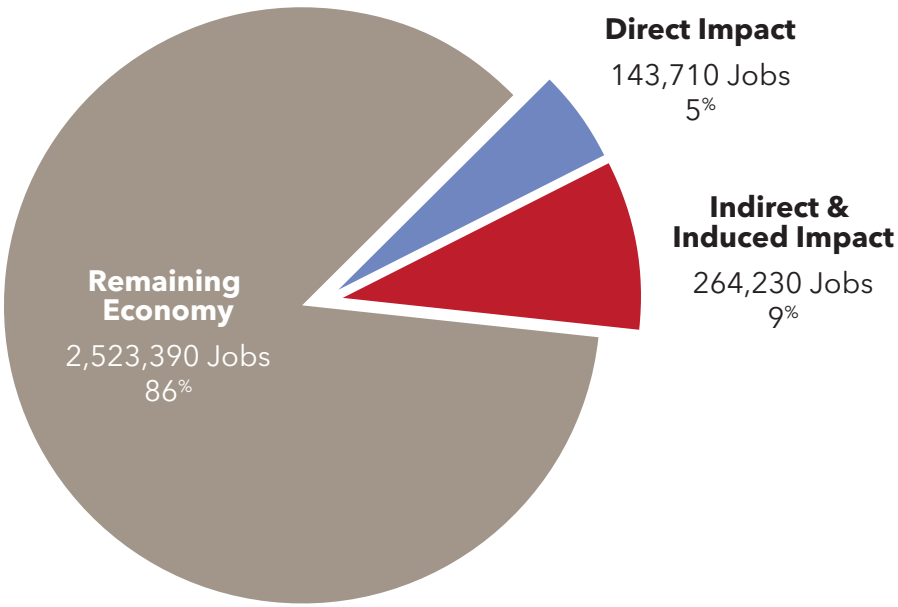
Indicator	Technology Sector	State Total	Percentage of State Total
Taxes Paid (millions)	$1,778	$17,391	10.2%
Exports (millions)	$19,862	$331,352	6.0%
GSP (millions)	$28,326	$304,257	9.3%

Source: EL calculations based on EMSI 2018.4

The tech industry's economic impact extends beyond jobs. The industry also contributed to Missouri's economy through exports, tax revenue and gross state product (GSP). Based on the most recent data available, the 95 industry groupings that make up the total tech sector accounted for 10.2 percent of all tax revenue and 9.3 percent of GSP.

The presence of tech industries also helps generate activity in other sectors of the economy. The tech sector in Missouri had a job multiplier of 2.84 in 2017. This means that for every job created in the tech sector, there were almost two additional jobs created or supported in the economy. Accounting for these multiplier effects increases the tech sector's impact on employment from 5 percent to 14 percent. In 2017, 407,940 workers in Missouri were directly or indirectly supported by the tech industry.

Tech Sector Contribution to State Economy, 2017



Source: EL calculations based on EMSI 2018.4

The future looks even brighter. The tech industry in Missouri is expected to grow jobs by 2.9 percent in the next year, significantly faster than the national average.

Investors are taking notice of Missouri's growing presence in the tech space. Venture capital investment has grown sharply in the last six years, outpacing the U.S. average. In 2017, $325 million of venture capital funding was invested in Missouri companies, which was 267 percent higher than 2012 levels.

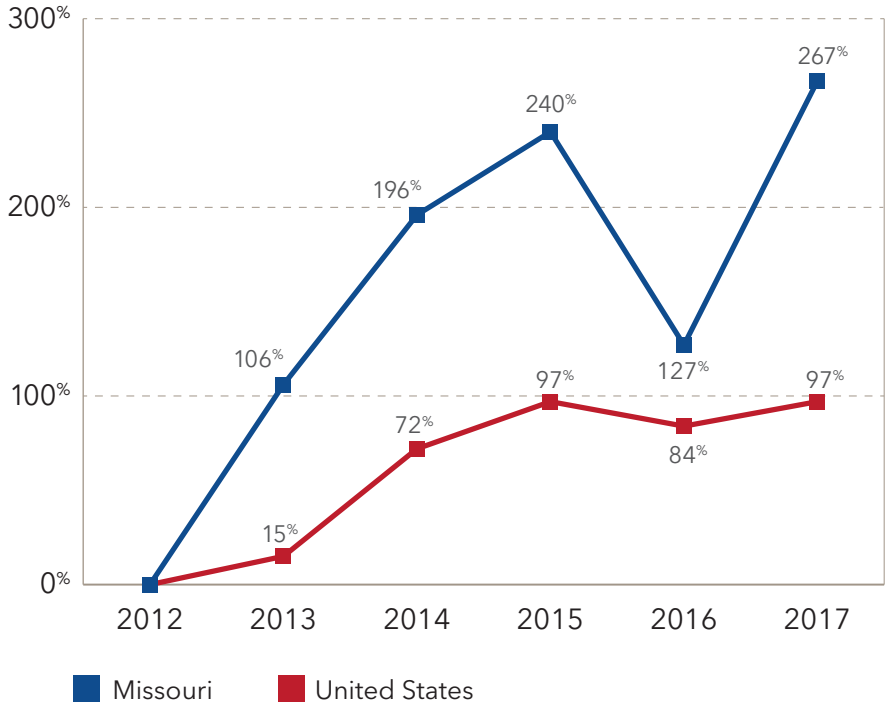
Tech companies want to locate near pockets of concentrated skilled workers and so typically congregate in urban areas. In Missouri, most of the counties where the tech industry has the highest concentration (more than 5 percent of employment) are situated around Kansas City, St. Louis and the Interstate 70 (I-70) corridor. There are some higher concentrations of tech industries in the corners of the state as well.

Missouri's technology manufacturing has grown at a fast pace, almost 30 percent in the past five years.

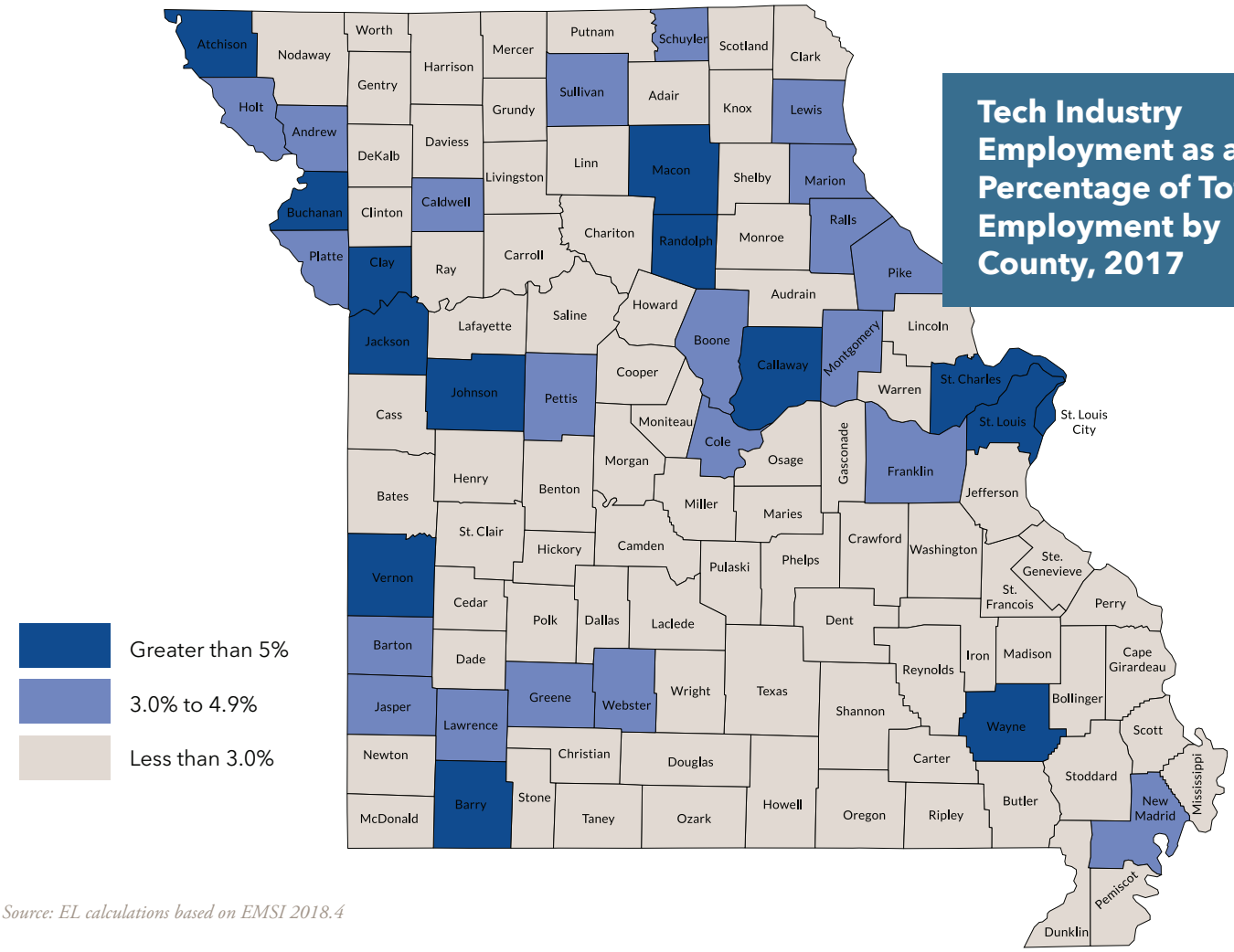
Expected Tech Sector Growth Rate, 2018-2019

Source: EMSI 2018.4

Percentage Change in Venture Capital Investment Relative to 2012 Levels



Source: National Venture Capital Association [NVCA] 2018



Source: EL calculations based on EMSI 2018.4

TECH SUBSECTOR PERFORMANCE

When looking at the four subcategories that make up the tech industry, IT (tech core) accounts for about 56 percent of all tech jobs in Missouri with almost 81,000 employees. The Energy tech grouping was the smallest subcategory with 10,870 employees. In the past year, all subcategories saw moderate growth, with Environmental tech growing the fastest at a rate of 3.5 percent. Looking at the five-year trends, IT and Environmental technology have grown their employment by double-digit figures.

The tech sector was also divided between manufacturing and services. Services make up about 83 percent of the tech industry in Missouri.

Missouri's technology manufacturing in the tech sector has grown at a fast pace, almost 30 percent, in the past five years. At the national level, these industries have seen an employment decline of about 0.7 percent for the same time frame. Driving the growth in tech manufacturing in Missouri are electronic components, automatic environmental controls, biopharmaceuticals, battery storage and pesticides.

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Source: EL calculations based on EMSI 2018.4

Location quotients (LQs) were calculated for each of these subsectors. LQs are measurements of an industry's concentration in a regional market. These metrics are calculated by dividing the percentage of total employment in a region by the percentage at the national level. LQs with a value greater than 1.25 can indicate that a sector is a significant part of a region's economic base. Sectors with high location quotients often generate an economy's exports and wealth.

Overall, the tech sector in Missouri has an LQ of 0.8, indicating that the tech sector is less concentrated in the state. This means that the state economy is not as dependent on the tech industry for economic growth as other states may be.

One reason tech companies are coveted is the high wages they pay employees. In the tech industry, employees are often the largest company expense. This means that money remains in the region, whereas a company in a different industry may spend more on equipment or raw materials that are acquired from outside the region (U.S. Chamber Foundation 2016). This study calculated the average annual earnings for the tech industry in Missouri. This metric of earnings includes all the wages, salaries and supplements received by a worker. Supplements include employee benefits, and on average accounted for about $16,600 of a tech worker's earnings in Missouri.

Wages of Tech Sector Workers, 2017

Technology Categories	Missouri	Missouri (Purchasing Power)	National Average
Energy Tech	$135,418	$151,303	$147,169
Environmental Tech	$64,792	$72,392	$78,887
Life Sciences	$102,445	$114,462	$121,932
IT	$102,142	$114,123	$138,244
All Categories	**Missouri**	**Missouri (Purchasing Power)**	**National Average**
High-Tech Services	$103,503	$115,644	$128,867
High-Tech Manufacturing	$91,193	$101,890	$134,201
TOTAL TECH SECTOR	**$101,471**	**$113,374**	**$129,911**

Source: EL calculations based on EMSI 2018.4

The average earnings for all jobs in the Missouri economy were $57,000 in 2017. The average earnings for a tech worker in the state were about twice that, at $101,470 annually. While significantly higher than the average for all jobs, tech earnings in Missouri are $28,000 lower than the national average for tech industry workers. However, Missouri tends to have lower costs for needs like housing and fuel compared to other tech hot spots in the country. When accounting for this purchasing power in Missouri, the average earnings increase to $113,370, much closer to the national average.

IV. Missouri Tech Sector State Comparisons

To place Missouri's tech performance in context, we calculated performance metrics for all 50 states, the nation and the District of Columbia. The chart below lists the rankings for Missouri's tech sector. In the appendix, detailed charts show Missouri graphed alongside the other states and the nation.

Missouri ranks in the top 15 for four of the six metrics for the tech sector. The highest ranking is for the percentage of women working for tech companies; at 33.7 percent, Missouri has the 6th highest percentage. The state also ranks 10th in the diversity of its tech workforce relative to the diversity of its general population. Missouri is well-positioned to continue to build an inclusive tech sector. Looking forward for the next five years, the Missouri tech sector is expected to grow its workforce by 9.5 percent. This ranks the state in the top 10 for future growth.

Some of the same metrics used for ranking the tech sector across all states were then analyzed for each of the tech subsectors. The rankings for the IT subsector are encouraging. While average in terms of IT concentration in the state economy and wages, Missouri ranked in the top 15 for past job growth and predicted job growth for IT.

State Comparisons for Total Tech Sector

Metric	Value	Rank
Technology Sector Concentration (2017)	0.81	34
Technology Sector Employment Change (2012-2017)	11.7%	12
Expected Technology Sector Employment Change (2018-2023)	9.5%	9
Avg. Annual Wage for Technology Sector Employees with Purchasing Power (2017)	$113,374	28
Percentage of Women in the Technology Workforce	33.7%	6
Tech Diversity Index	86.5	10

Source: EL calculations based on EMSI 2018.4

State Comparisons for IT Industries

Metric	Value	Rank
IT Industry Concentration (2017)	0.90	21
IT Job Change (2012-2017)	16.8%	9
Expected IT Job Change (2018-2023)	10.5%	11
Average Annual Wage for IT Workers with Purchasing Power (2017)	$114,123	21

Source: EL calculations based on EMSI 2018.4

Life sciences has a strong ranking for predicted future growth. In the next five years, the subsector is forecast to grow by 10 percent. This ranks as the 14th-highest rate among all states. Adjusted earnings for Life sciences workers in Missouri were also ranked in the top half of states.

Jobs in Environmental tech grew almost 20 percent in the last five years. This ranks Missouri as the eighth-fastest-growing state in this subsector. Environmental tech is also the subsector with the highest concentration of workers relative to the national average in this analysis. However, earnings are still low compared to other states, even after accounting for cost of living.

Missouri is not a large energy-producing state, so unsurprisingly, Energy tech rankings are in the middle of the pack. The subsector is predicted to grow very modestly over the next five years.

State Comparisons for Life Sciences

Metric	Value	Rank
Life Sciences Concentration (2017)	0.75	33
Life Sciences Job Change (2012-2017)	4.8%	26
Expected Life Sciences Job Change (2018-2023)	10.0%	14
Average Annual Wage for Life Sciences Workers with Purchasing Power (2017)	$114,461	18

Source: EL calculations based on EMSI 2018.4

State Comparisons for Environmental Tech

Metric	Value	Rank
Environmental Tech Concentration (2017)	0.93	30
Environmental Tech Job Change (2012-2017)	19.7%	8
Expected Environmental Tech Job Change (2018-2023)	9.3%	25
Avg. Annual Earnings for Envir. Tech Workers with Purchasing Power (2017)	$72,392	37

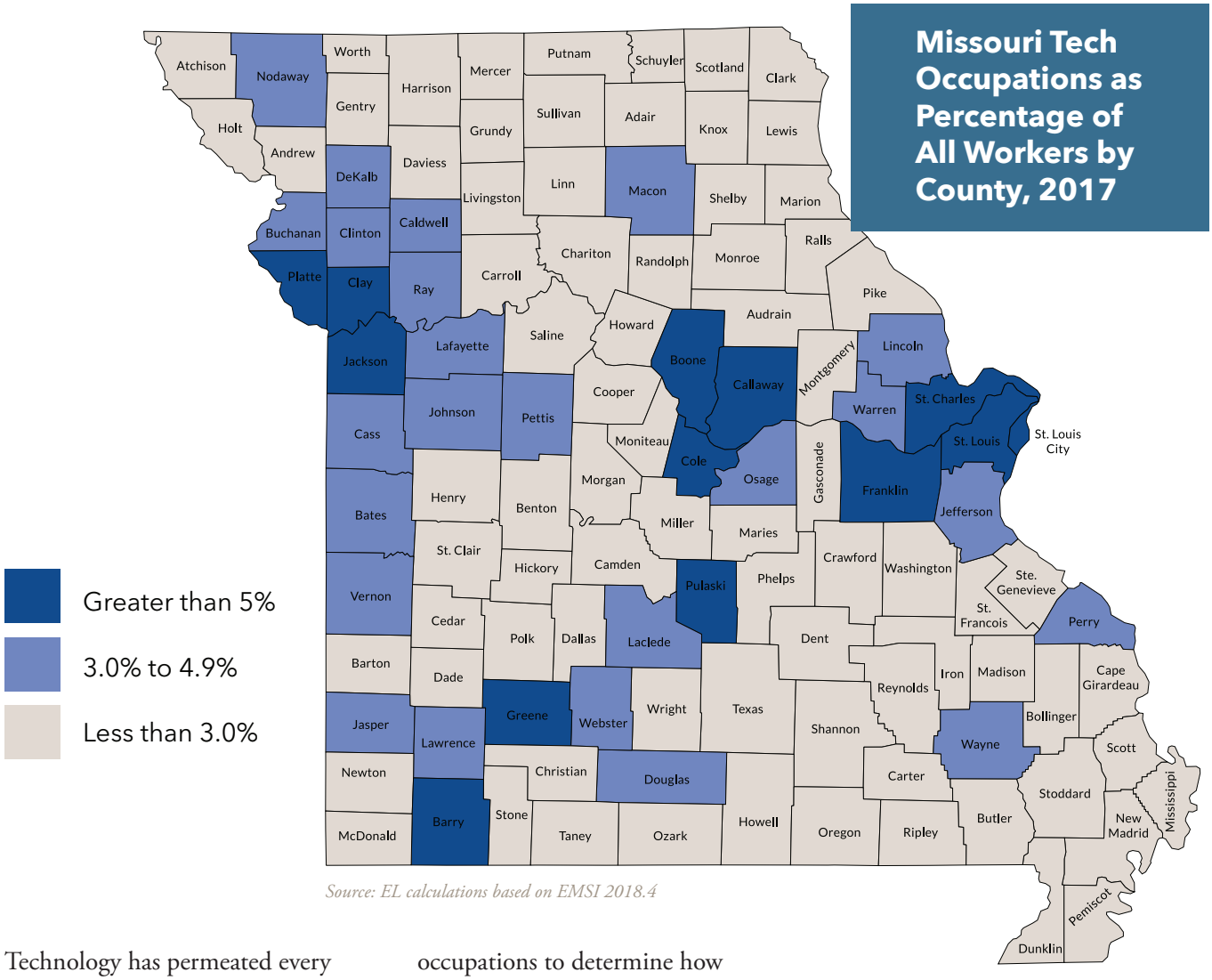
Source: EL calculations based on EMSI 2018.4

State Comparisons for Energy Tech

Metric	Value	Rank
Energy Tech Concentration (2017)	0.53	33
Energy Tech Job Change (2012-2017)	-4.4%	23
Expected Energy Tech Job Change (2018-2023)	1.3%	31
Avg. Annual Earnings for Energy Tech Workers with Purchasing Power (2017)	$151,302	16

Source: EL calculations based on EMSI 2018.4

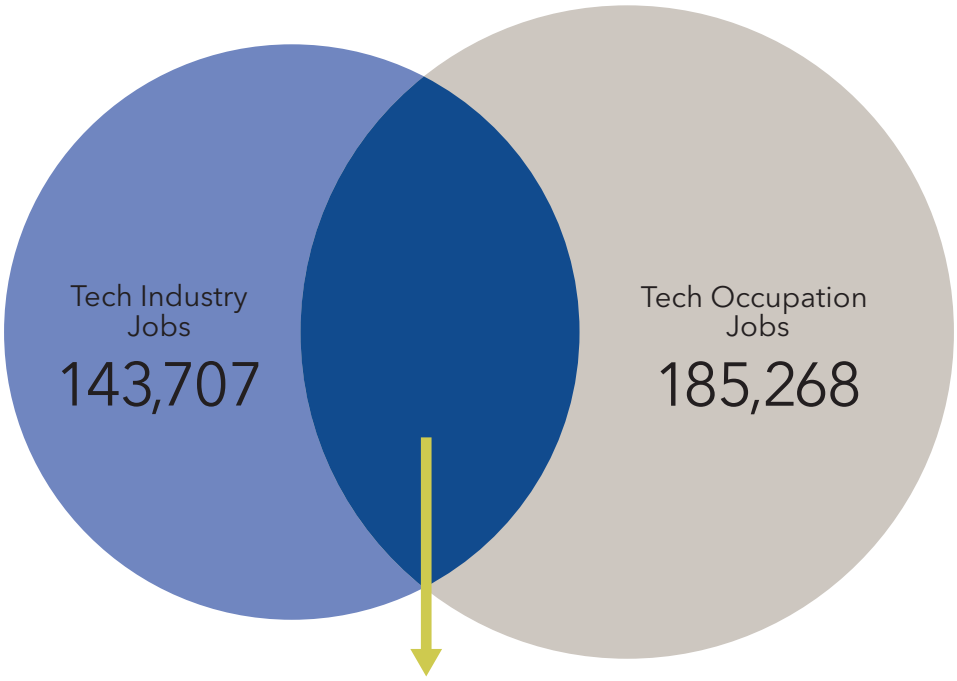
V. Missouri Tech Occupations



Source: EL calculations based on EMSI 2018.4

Technology has permeated every industry and has become critical to company performance. This section of the analysis reviews 77 separate 5-digit Standard Occupational Classification (SOC) codes across computer, science and engineering occupations to determine how many tech workers exist in Missouri across all industries. A complete list of occupations and detailed data for the top 15 tech occupations are included in the appendix.

Staffing Patterns of Tech Industries and Tech Occupations, 2017



34% of tech occupation jobs are employed in tech industries

Source: EL estimates based on EMSI 2018.4

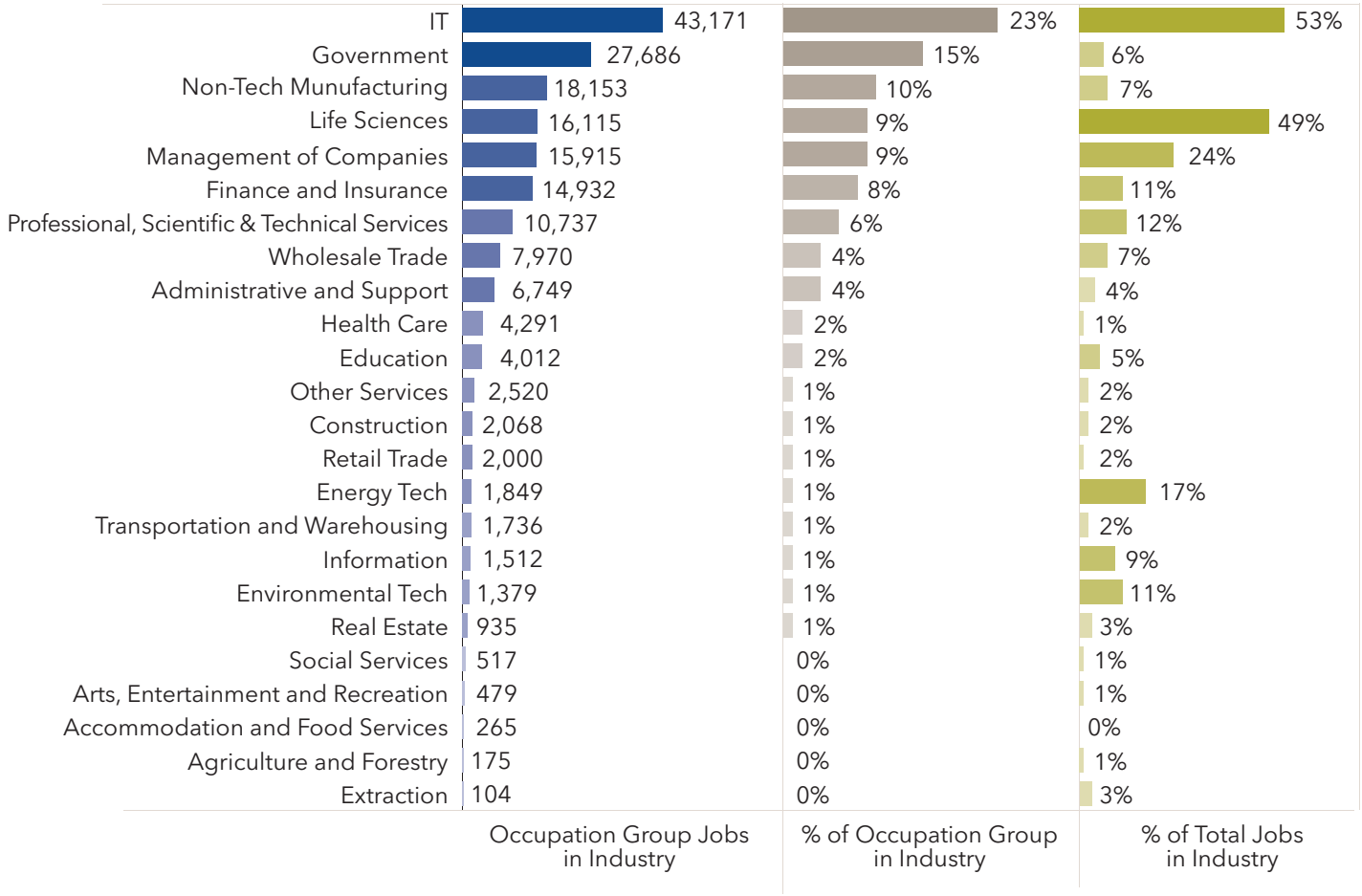
There are approximately 185,270 tech workers throughout the Missouri economy. In the past five years, jobs have grown at a rate of 15 percent. These tech positions offer about 20,000 annual job openings. Tech occupations are more concentrated in the urban and suburban counties of Missouri compared to tech industry employment. The southeastern and northeastern portions of the state have lower percentages of tech occupations. Thirteen counties have tech occupations that account for more than 5 percent of total employment.

Through data that matches occupations to their company's industry, we were able to map the industries that employ the highest number of tech occupations. We found that 34 percent of tech workers are employed by a tech sector company. The rest of the tech occupation workforce is spread all across the economy.

The IT subsector is the largest employer of tech occupations. Tech workers at IT companies account for 23 percent of all tech occupations. These are not the only workers at IT companies. At IT companies, 53 percent of all occupations are tech occupations. This means that IT companies, while tech-focused, also have workforce demands in many positions including human resources, sales and legal jobs. A region's ability to support an internet-based company is not based only on its availability of computer programmers but also on its ability to provide a variety of skilled workers.

Other top employers of tech occupations include manufacturing, management, finance, life sciences and government employers. This shows how tech has spread beyond innovative companies and become a crucial part of the whole economy.

Top Industries Employing Tech Workers, 2017



Source: EL estimates based on EMSI 2018.4

Missouri tech occupations data was then compared to data from the other states and the nation. Tech occupation growth has not been quite as strong as tech industry job growth in Missouri, but the data still reflects an emerging market. Looking forward, Missouri is predicted to have the 14th-fastest five-year growth of tech occupations. The state also scored well on tech occupation wages. Anticipating future employer needs is a key component of the Workforce 2030 strategy that the Chamber Foundation released in 2018.

State Comparisons for Technology Occupations

Metric	Value	Rank
Technology Occupations Concentration (2017)	0.87	30
Technology Occupations Growth (2012-2017)	15.0%	21
Expected Technology Occupations Growth (2018-2023)	8.8%	14
Median Hourly Wage for Technology Occupations with Purchasing Power (2017)	$39.57	14

Source: EL calculations based on EMSI 2018.4

VI. Missouri Tech Infrastructure

Similar to other industries, the technology sector needs a solid infrastructure to flourish. A strong technology infrastructure is often referred to as a "knowledge-based economy." The World Bank defines strong knowledge-based economies on four pillars:

- Entrepreneurship incentives,
- Skilled and educated labor force,
- Physical infrastructure access for technology and communications, and
- Innovation ecosystem that fosters collaboration between academia, private sector and government.

Using this framework, we evaluated the technology infrastructure in Missouri by collecting data on factors such as funding access, patents, STEM education and university technology transfer. The chart below compares Missouri's position on technology infrastructure indicators with the District of Columbia and all 50 states.

Of the 17 technology infrastructure metrics, Missouri ranked in the top 15 states for four. Missouri ranked as the No. 1 state for the rate of new businesses versus the rate of business decline, or business dynamism. The state ranked in the bottom third of all states for five metrics. Opportunities exist to improve broadband, educational funding and funding to small businesses. Detailed charts that show the tech infrastructure performance for each state and the national average are located in the appendix.

State Comparisons for Technology Occupations

Technology Infrastructure		
Metric	**Value**	**Rank**
Total R&D as a Percentage of GSP (2015)	2.5%	16
Business Performed R&D as a Percentage of Private Industry Output (2015)	2.4%	12
Higher Education R&D in S&E Fields as a Percentage of GSP (2017)	0.37%	23
Patents Issued per 1,000 Science & Engineering Workers (2016)	10.4	35
Venture Capital Invested per $1 Million of GSP (2012-2017)	$788	32
Technology Licenses & Options Executed From Universities (2017)	173	19
Startups from Universities (2017)	15	21
SBIR and STTR Funding per $1 Million of GSP (2012-2017)	$54	37
Small Business Opening Rate vs. Closing Rate (2016)	3.1%	1
Small Business Loans per 100,000 People (2015)	1,557	36
Change in Employment by Young Companies (2014-2016)	7.4%	16
Completed STEM Education Programs per 1,000 Enrolled Students (2017)	30.8	15
Percent Change in Tech & STEM Education Program Completions (2012-2017)	40%	11
Average In-State Tuition Cost (2018-2019)	$8,670	17
State Spending per Student for Higher Education (2018)	$5,101	46
Percentage of Population Without High Speed Broadband Access (2016)	16.5%	42
Percentage of Households Without an Internet Subscription (2017)	18.4%	38

VII. Conclusion

The findings of this report show Missouri as an emerging hub for the tech sector. Beyond being a low-cost alternative to major tech cities, the state has particular competitive advantage in subcategories of the tech industry. Growth in IT and Environmental tech are among the top in the nation. The state's resources show that Missouri could become a major player in the emerging tech subsectors, such as advanced manufacturing, agtech and fintech.

In order to continue growth in the state, deficiencies will need to be addressed, including expanding technology transfer from universities and increasing small-business funding to help round out the entrepreneurial strengths of the region. The tech sector will grow only in the urban areas of the state until broadband access is available and adopted in the rural portions of the state.

Appendix

APPENDIX I: METHODOLOGY

Measurements of the tech industry are greatly influenced by how the sector is defined. Unlike sectors such as health care or retail trade, the tech industry is not neatly categorized in the country's current economic North American Industry Classification System (NAICS). The knowledge economy exists across several of the broader industry groupings. Therefore, to measure the technology industry in Missouri, we identified 95 separate 6-digit NAICS code (highest level of detail) sectors to characterize the total technology sector for the state and to compare it with that of other U.S. states. A full list of each 6-digit sector is available in the appendix of this report.

The total technology sector was divided into four subcategories:

- Energy Technology
- Environmental Technology
- Life Sciences/ Biopharmaceuticals/Agriculture Tech
- IT (Tech Core)

These sectors were chosen based on several definitions of the technology industry. The primary source for defining the technology industry was TechAmerica Foundation's 2013 Technology Industry Classification. Other state and city industry reports were evaluated, and this report maintains a definition that is comparable to these reports.

OCCUPATIONS VS. INDUSTRIES

A common critique when evaluating technology companies and technology jobs is the reality that within a tech company there are plenty of workers whose responsibilities are not necessarily tech-related (for example, an accountant at Amazon) and vice versa; there are tech-focused positions embedded in many industries like finance and health care. To demonstrate both vantage points of technology in the state, we also evaluated the number of tech occupations that exist across all industries. For this section, we reviewed 77 separate 5-digit SOC codes across computer, science, and engineering occupations in Economic Modeling Specialists International (EMSI) to determine how many tech workers exist in Missouri across all industries. Using technology occupations data, we mapped those employees back to the industries where they are employed. These staffing patterns can help quantify some of the emerging tech subsectors.

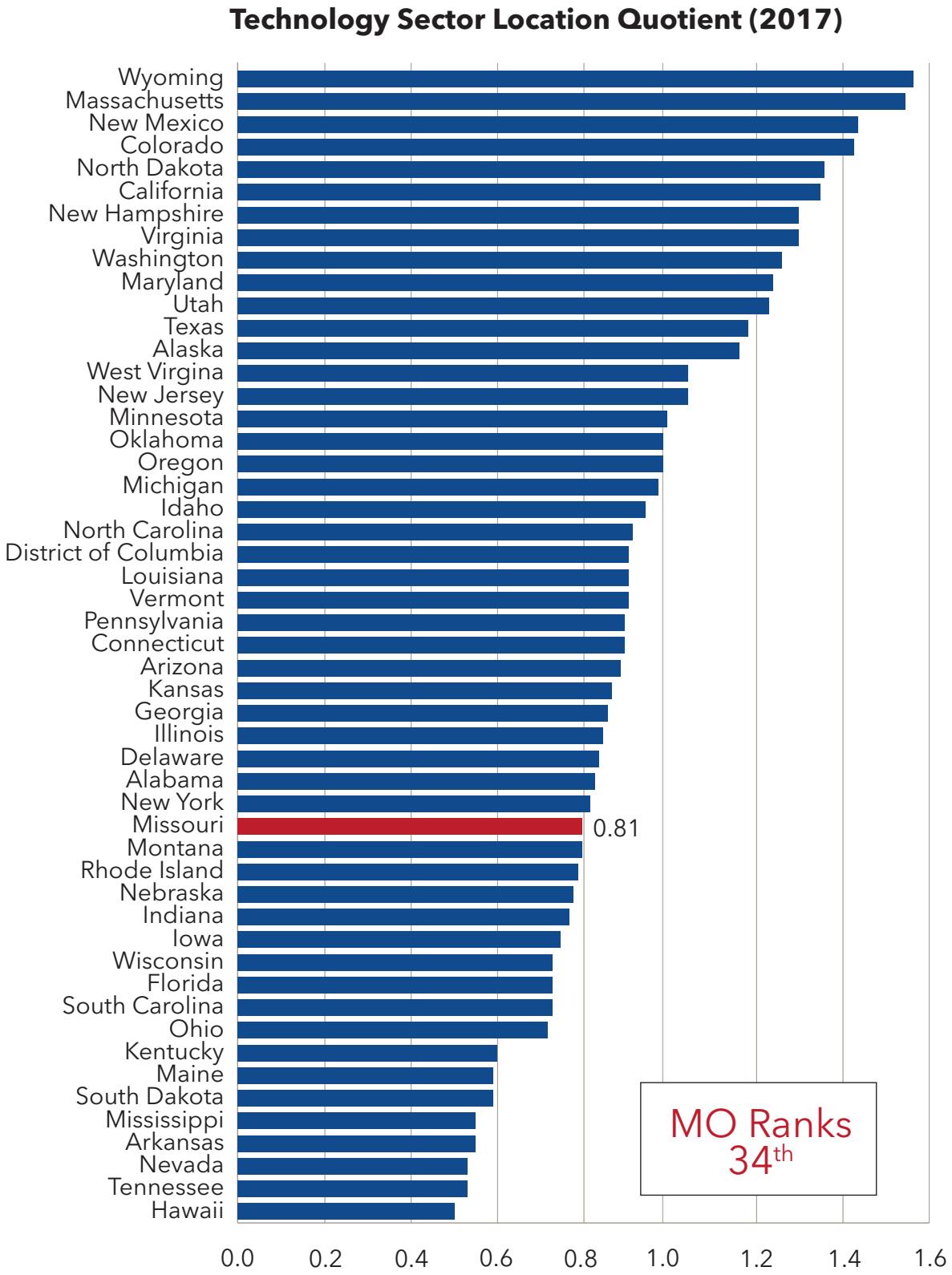
DATA COLLECTION

Once the parameters were established, data for employment, wages and establishments were collected. Economic Leadership used data developed by EMSI, which is largely based on the Bureau of Labor Statistics (BLS) Quarterly Census of Employment and Wages. EMSI data fills in gaps from BLS' nondisclosure policy by amalgamating several economic data sources to provide the best estimates. EMSI data is calculated for the years 2001-2017, and predictive data is calculated for the upcoming 10 years. Future estimates of growth in this report are determined by EMSI's predictive models.

The majority of the technology sector data presented in this report are calculations based on EMSI data for the year 2017. Most trend data presented is for the five-year period from 2012 to 2017. We also looked at the one-year change in the technology sector to evaluate the short-term trends in the industry. The input-output model used to determine the technology sector's overall economic impact for this study is also based on EMSI multiplier estimates.

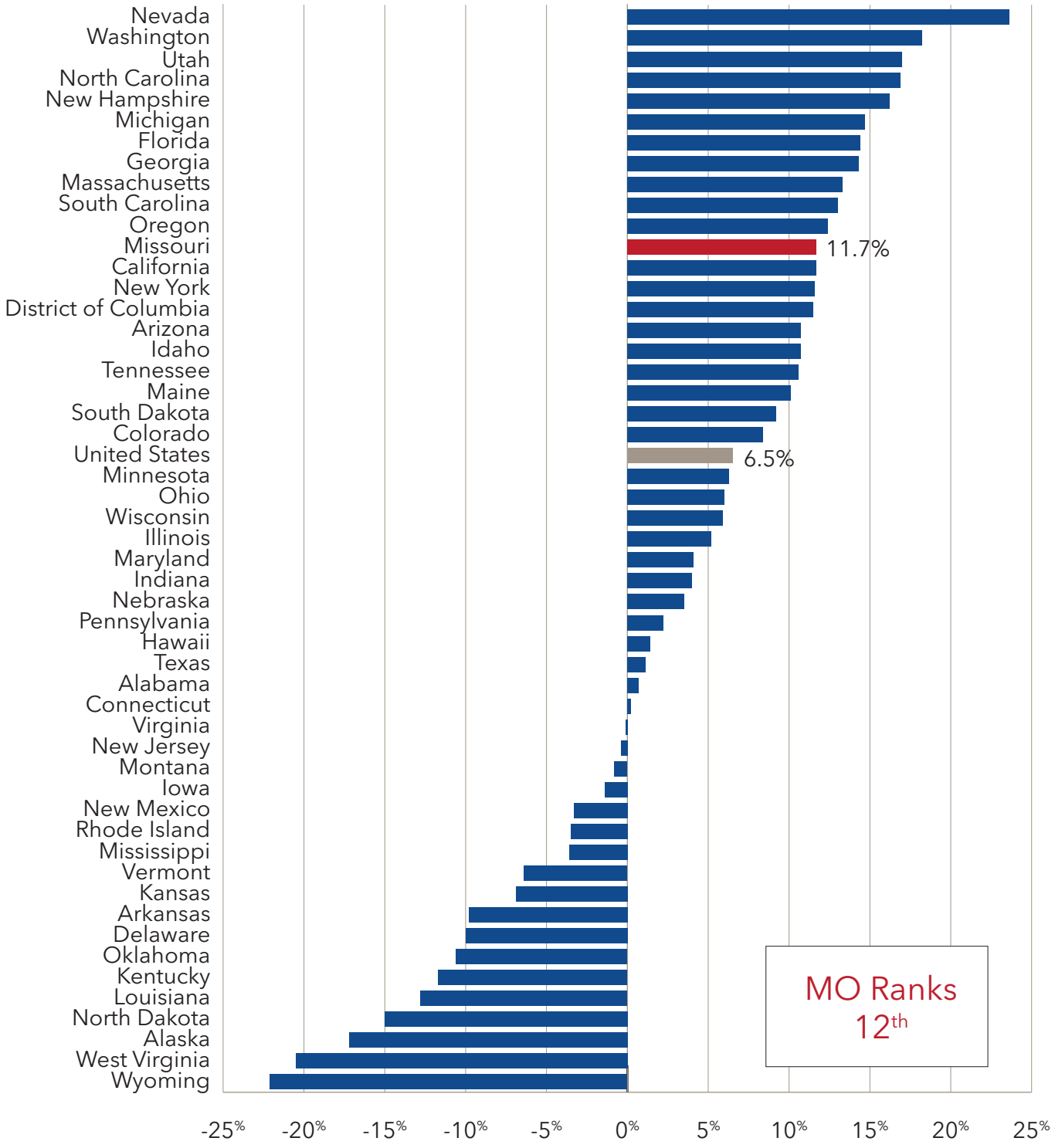
Data for the technology infrastructure state comparisons comes directly from publicly available resources such as the National Science Foundation, Bureau of Economic Analysis and the U.S. Census Bureau. This ensures consistent and comparable data across all the states.

APPENDIX II: TOTAL TECH SECTOR STATE RANKINGS



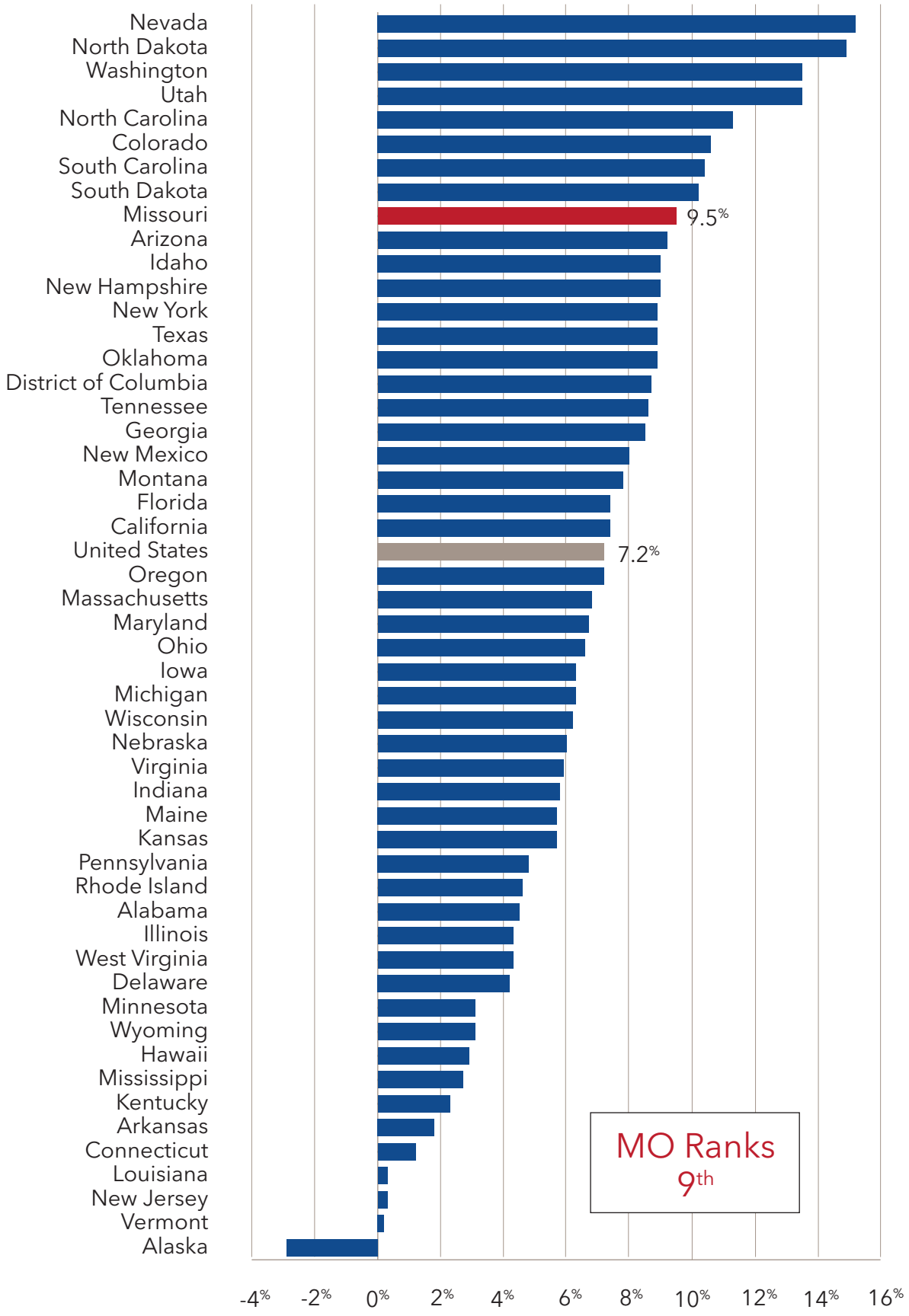
Source: EL calculations based on EMSI 2018.14

Technology Sector Employment Growth (2012-2017)



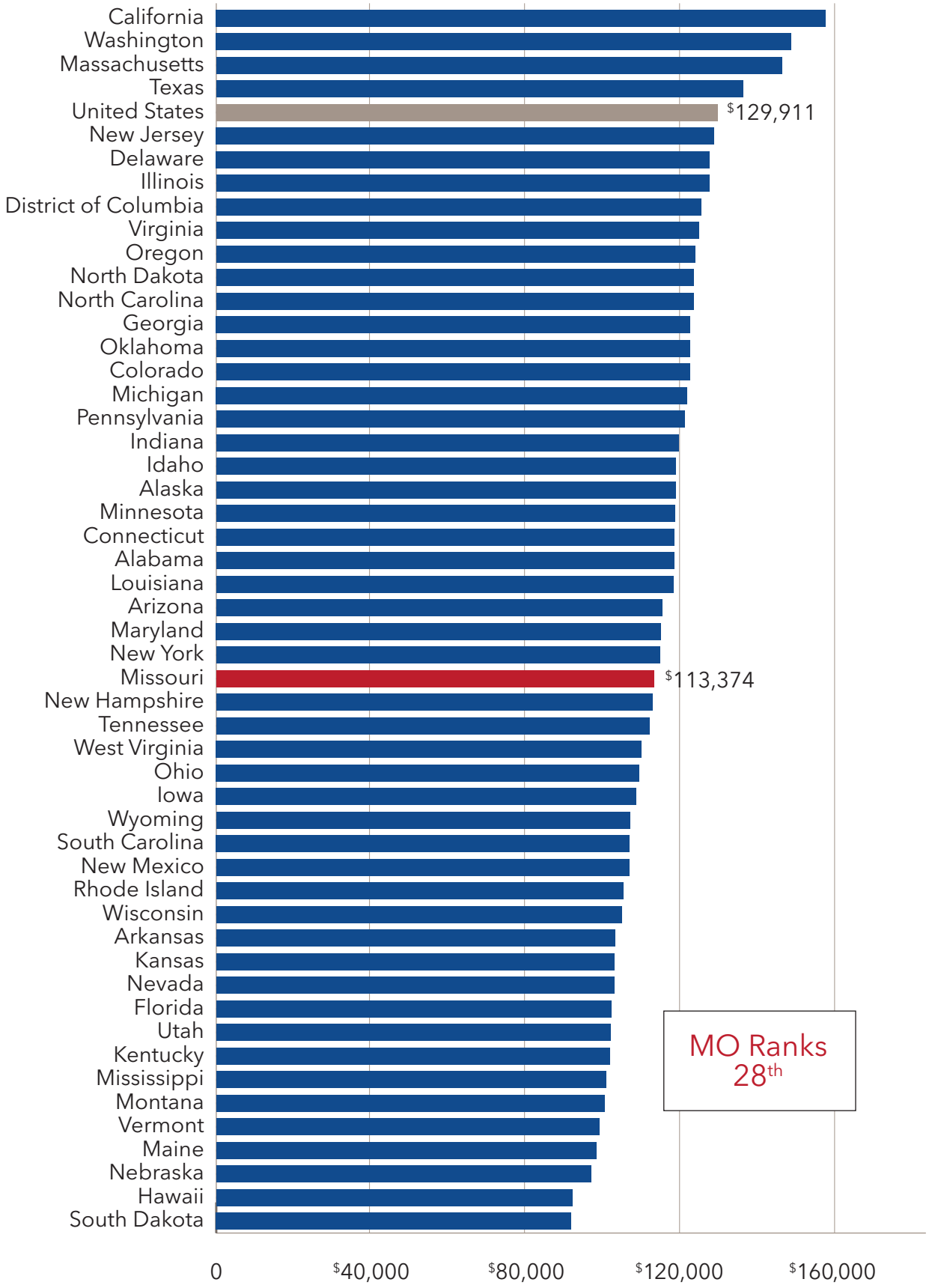
Source: EL calculations based on EMSI 2018.14

Expected Technology Sector Employment Growth (2018-2023)



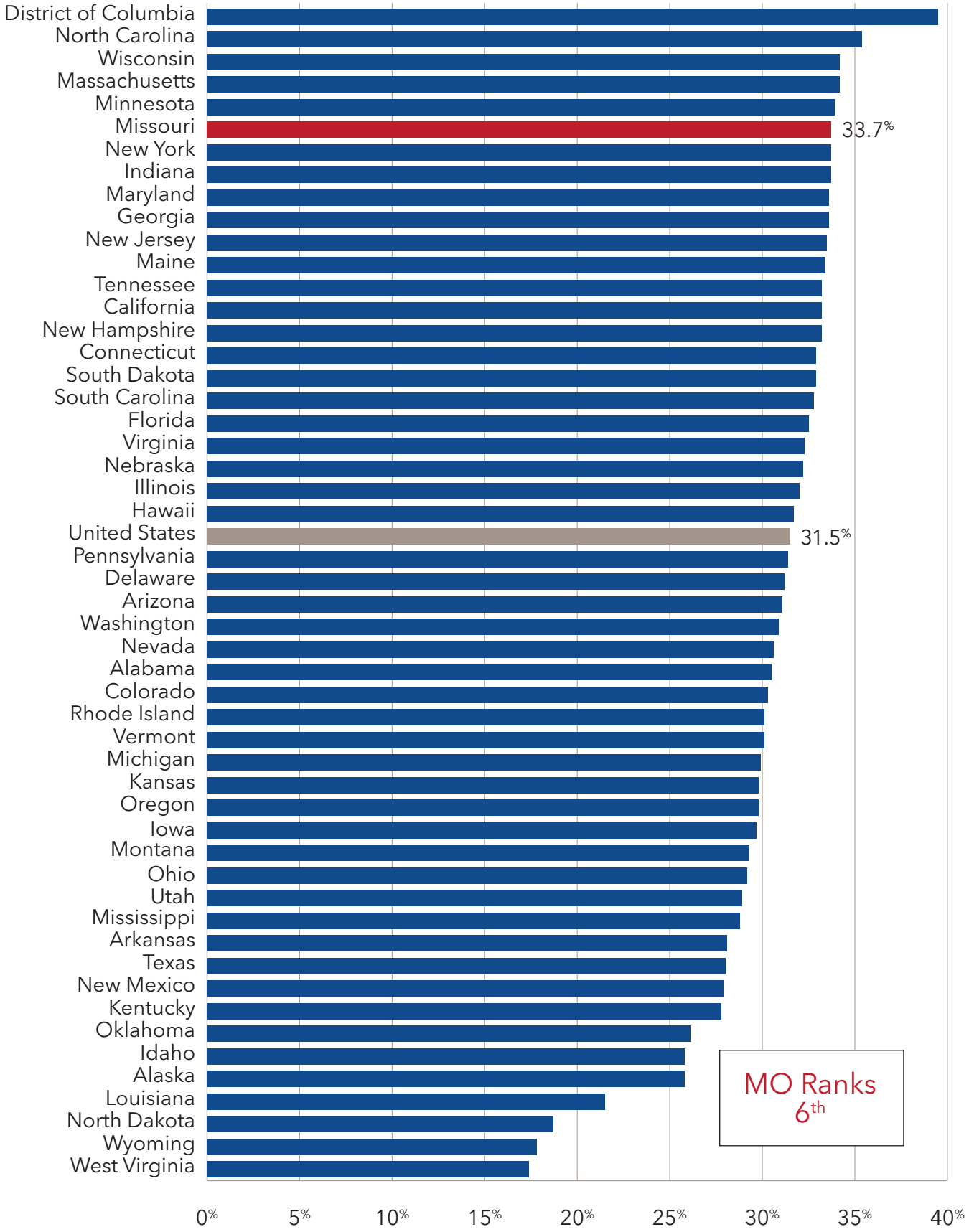
Source: EL calculations based on EMSI 2018.4

Average Annual Wage for Technology Sector Employees with Purchasing Power (2017)



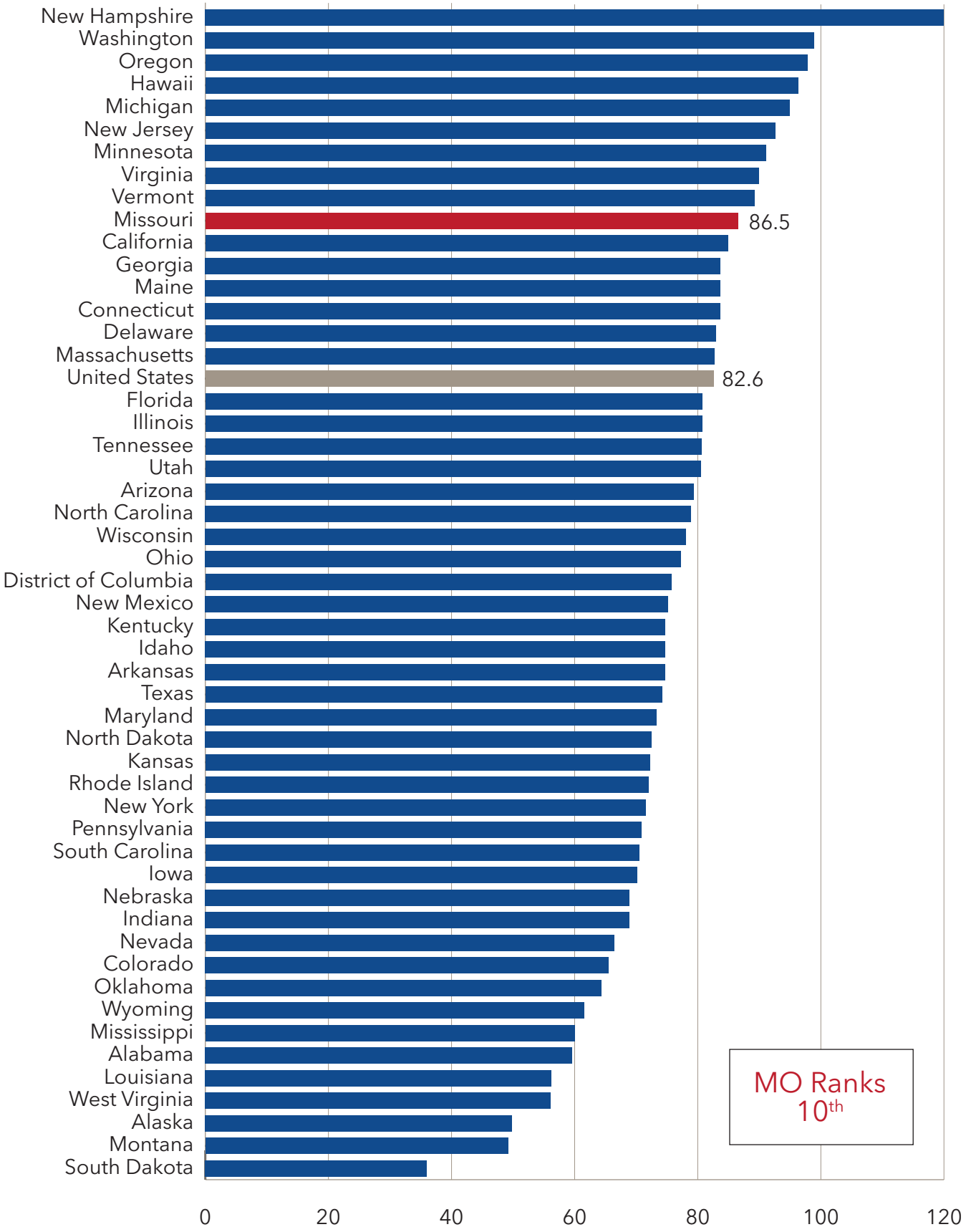
Source: EL calculations based on EMSI 2018.4

Percentage of Women in Technology Workforce



Source: EL calculations based on EMSI 2018.4

Tech Diversity Index



Source: EL calculations based on EMSI 2018.4 and Census (2018)

Technology Occupations

Missouri Top 15 Tech Occupations, 2017

Description	2017 Occupations	2012-2017 % Change	Median-Hourly Wage[a]	Annual Openings
Business Operations Specialists, All Other	15,460	4.5%	$32.36	1,621
Computer User Support Specialists	14,812	14.8%	$21.26	1,505
Software Developers, Applications	14,308	44.9%	$45.56	1,637
Computer Systems Analysts	11,463	20.1%	$41.81	1,081
Market Research Analysts and Marketing Specialists	10,318	48.5%	$28.21	1,473
Network and Computer Systems Administrators	8,644	8.0%	$37.07	698
Management Analysts	6,890	18.4%	$36.01	778
Computer Programmers	6,761	-17.6%	$37.93	534
Computer Occupations, All Other	6,608	67.5%	$38.79	867
Computer and Information Systems Managers	6,455	15.9%	$59.68	631
Computer Network Support Specialists	6,208	17.5%	$24.99	660
Software Developers, Systems Software	5,628	6.1%	$46.23	484
Civil Engineers	5,581	15.0%	$36.57	568
Industrial Engineers	5,034	27.9%	$39.31	537
Financial Analysts	4,248	18.5%	$38.96	476
All Tech Occupations[b]	185,268	15.0%	$35.42	19,989

Source: EL estimates based on EMSI 2018.4

[a] *Wage estimate is different from the average annual wage values in the previous charts. The average annual wage value is calculated across all occupations in the technology sector and measures the average versus the median.*

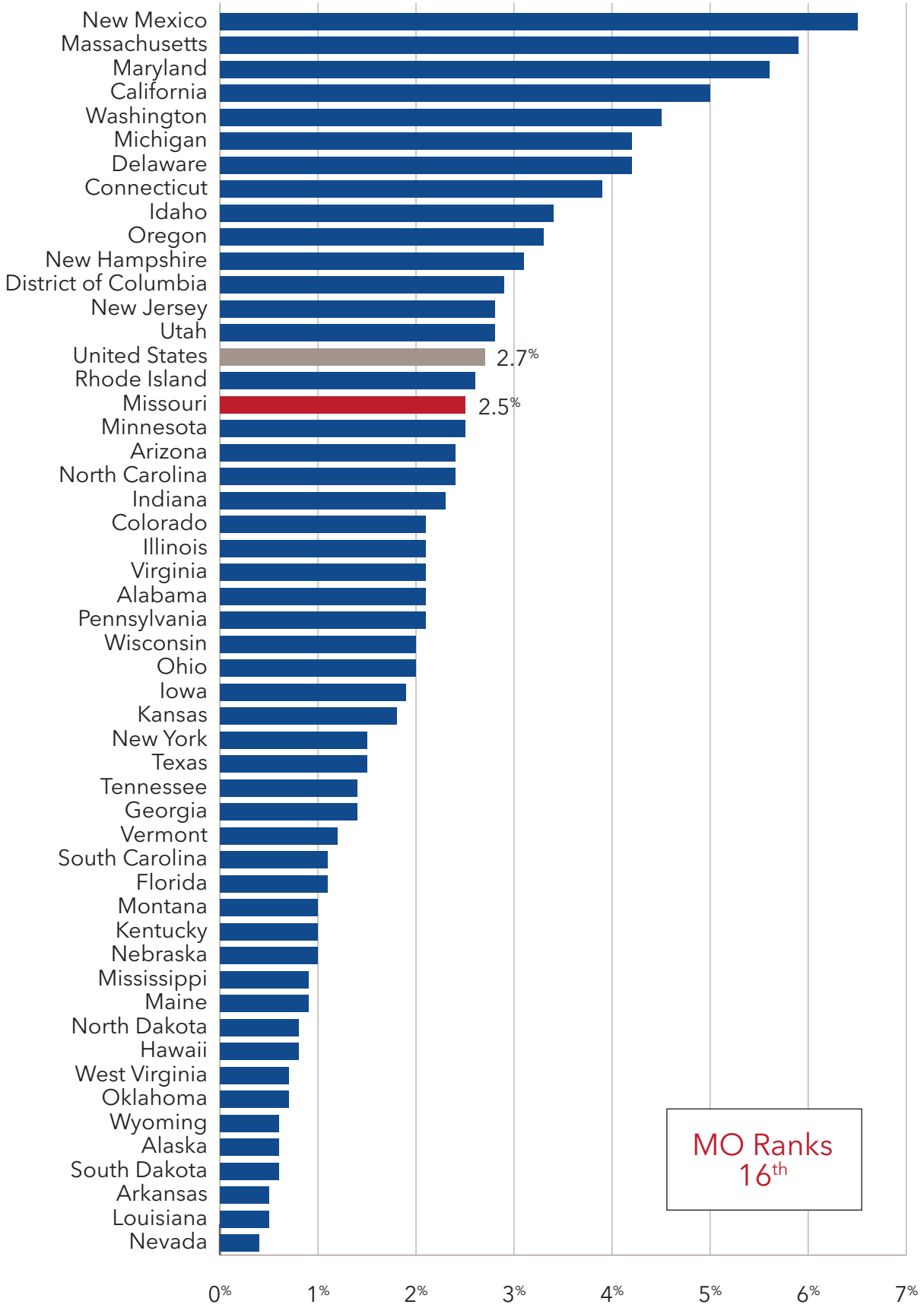
[b] *This is a sum of the 78 SOC codes (see appendix) not only the 15 most common occupations displayed in the table above.*

Tech Sector Economic Impact Analysis

	Employees	Earnings (millions)	Sales (millions)
Direct Impact	143,710	$13,700	$41,600
Multiplier	2.84	1.87	1.80
Indirect & Induced Impact	264,230	$11,900	$33,300
Total Impact	407,940	$25,500	$74,800
Percentage of MO Economy	*14%*	*16%*	*14%*

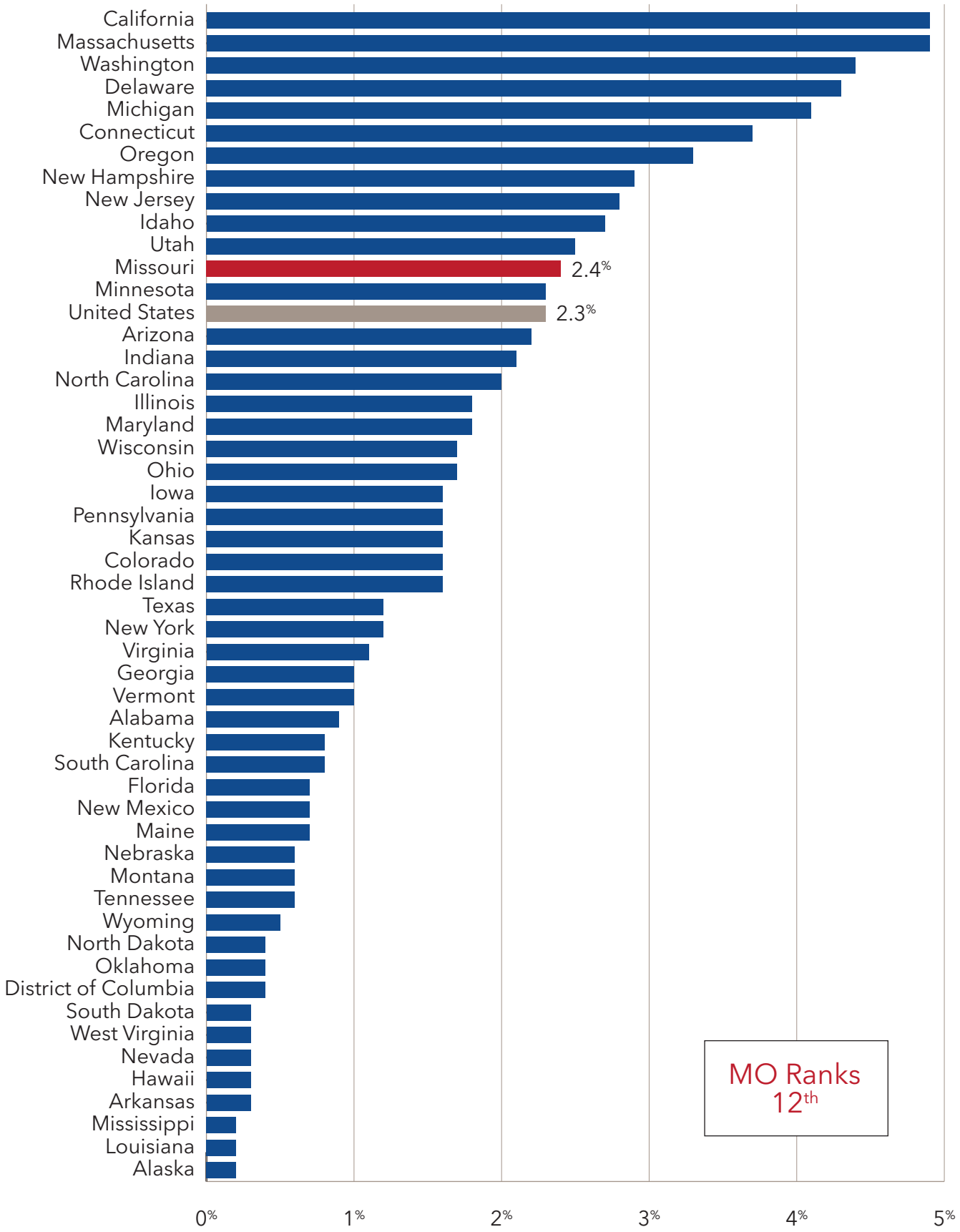
Source: EL calculations based on EMSI 2018.4

Total R&D as a Percentage of GSP (2015)



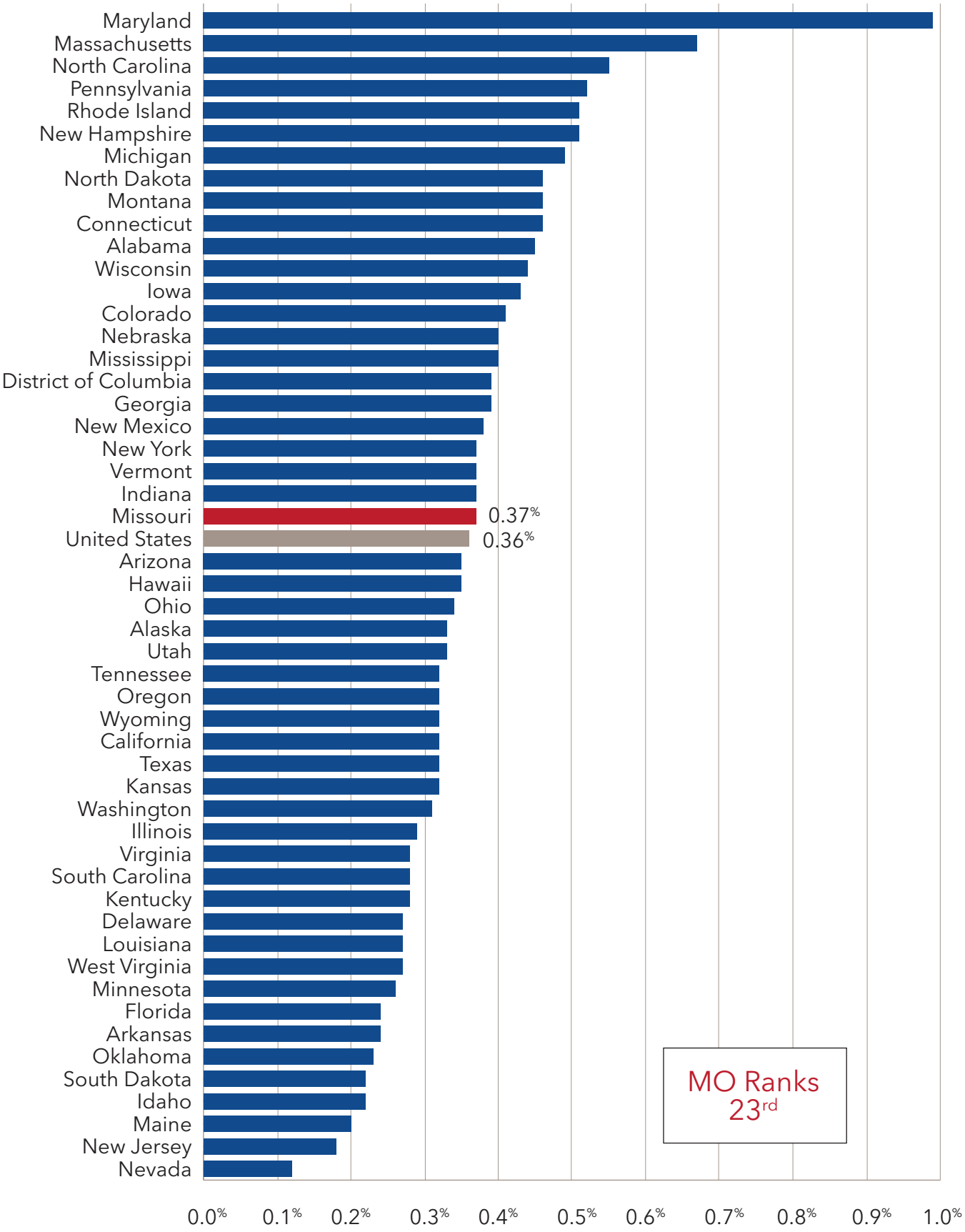
Source: NSF (2018)

Business Performed R&D as a Percentage of Private Industry Output (2015)



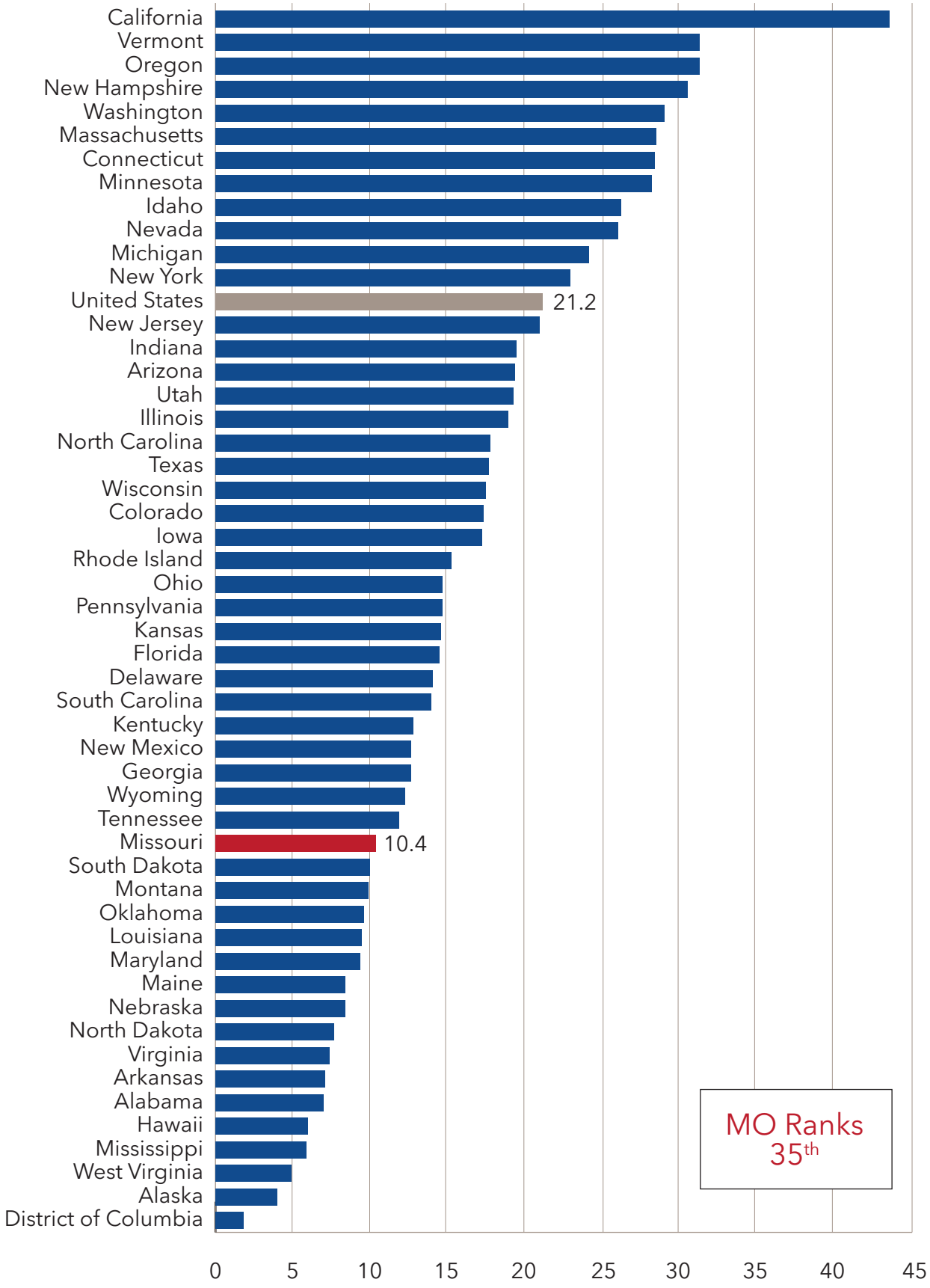
Source: NSF (2018)

Higher Education R&D in S&E Fields as a percentage of GSP (2017)



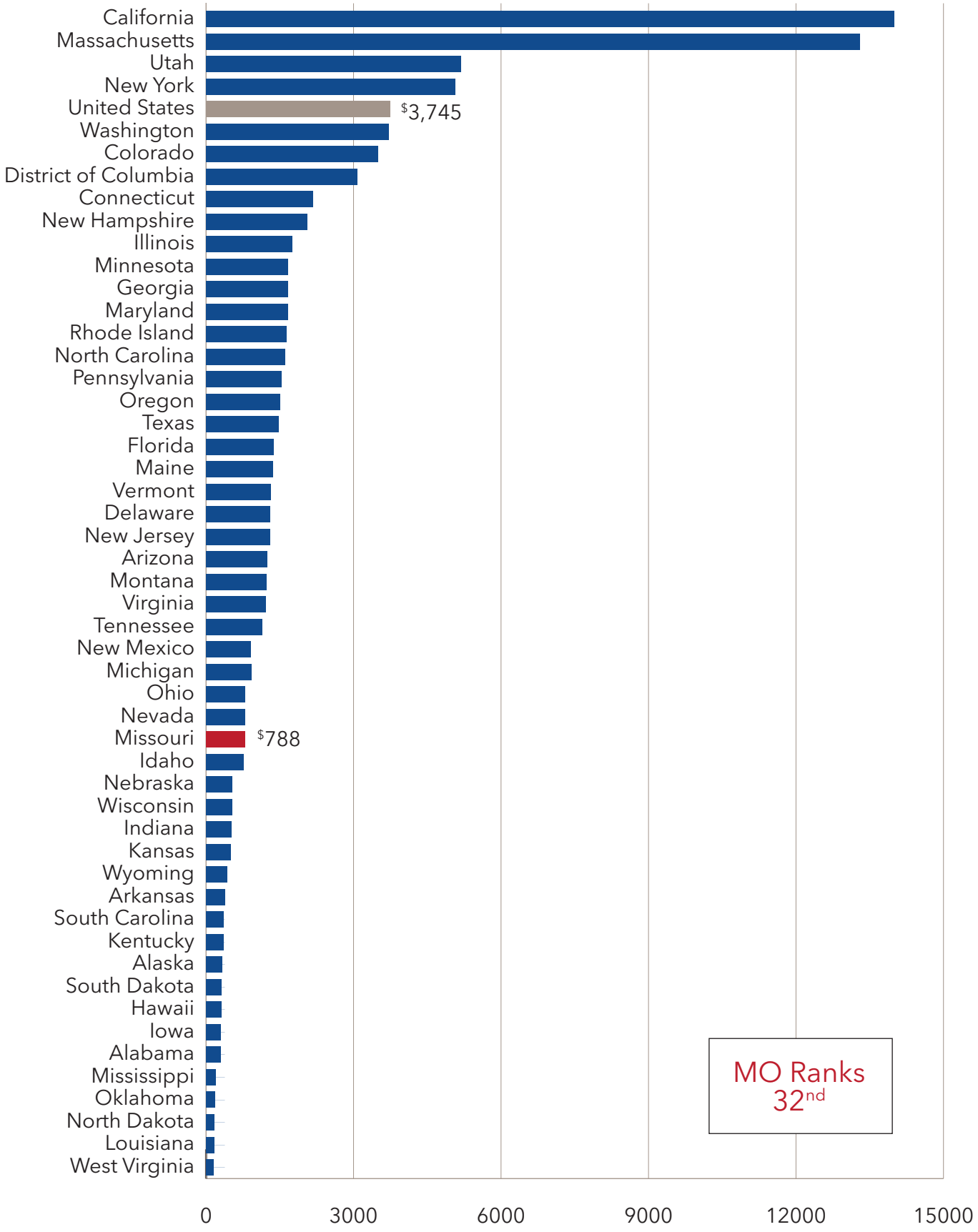
Source: NSF (2018)

Patents Issued per 1,000 Science & Engineering Workers (2016)



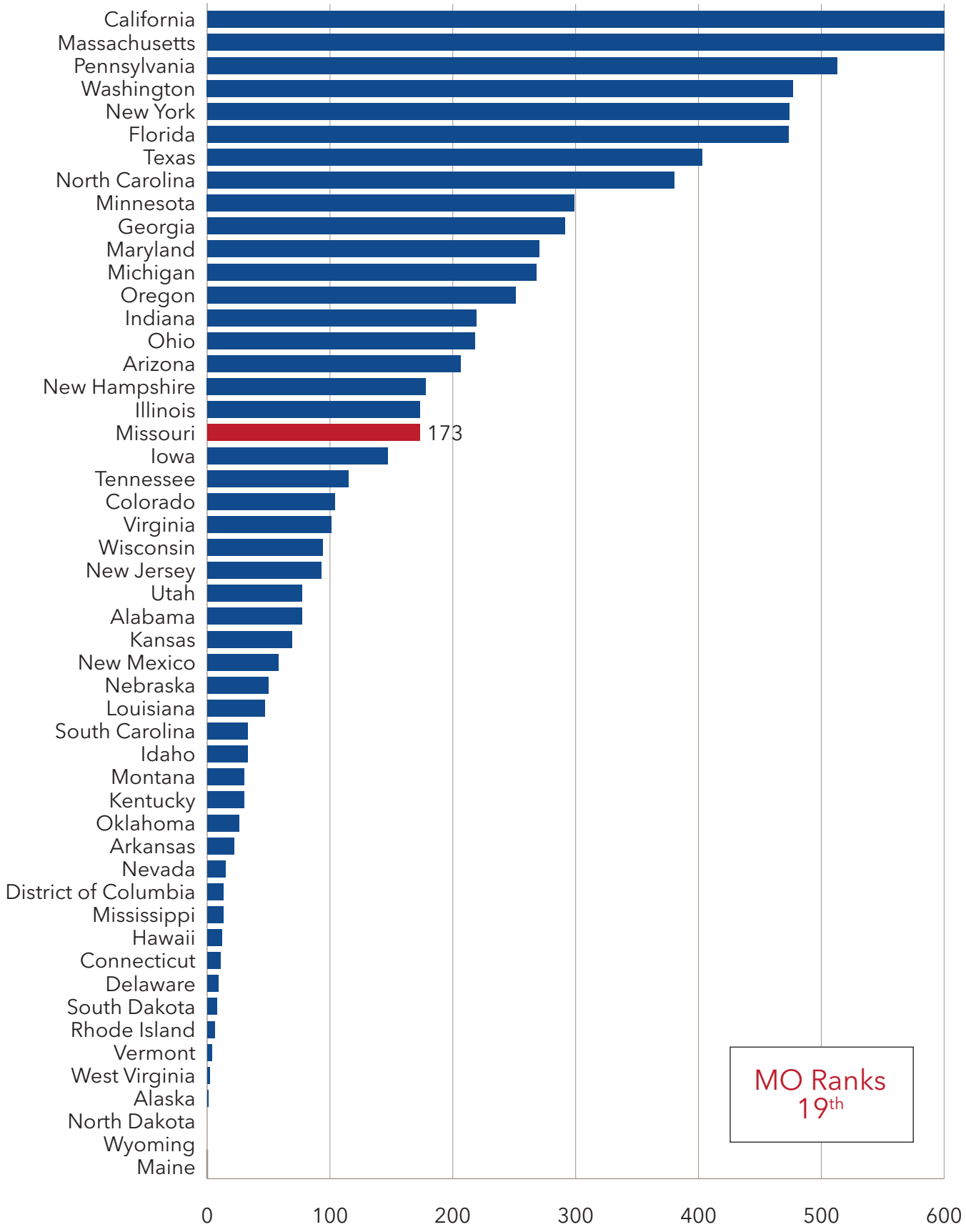
Source: NSF (2018)

Venture Capital Invested Per $1 Million of GSP (2012-2017)



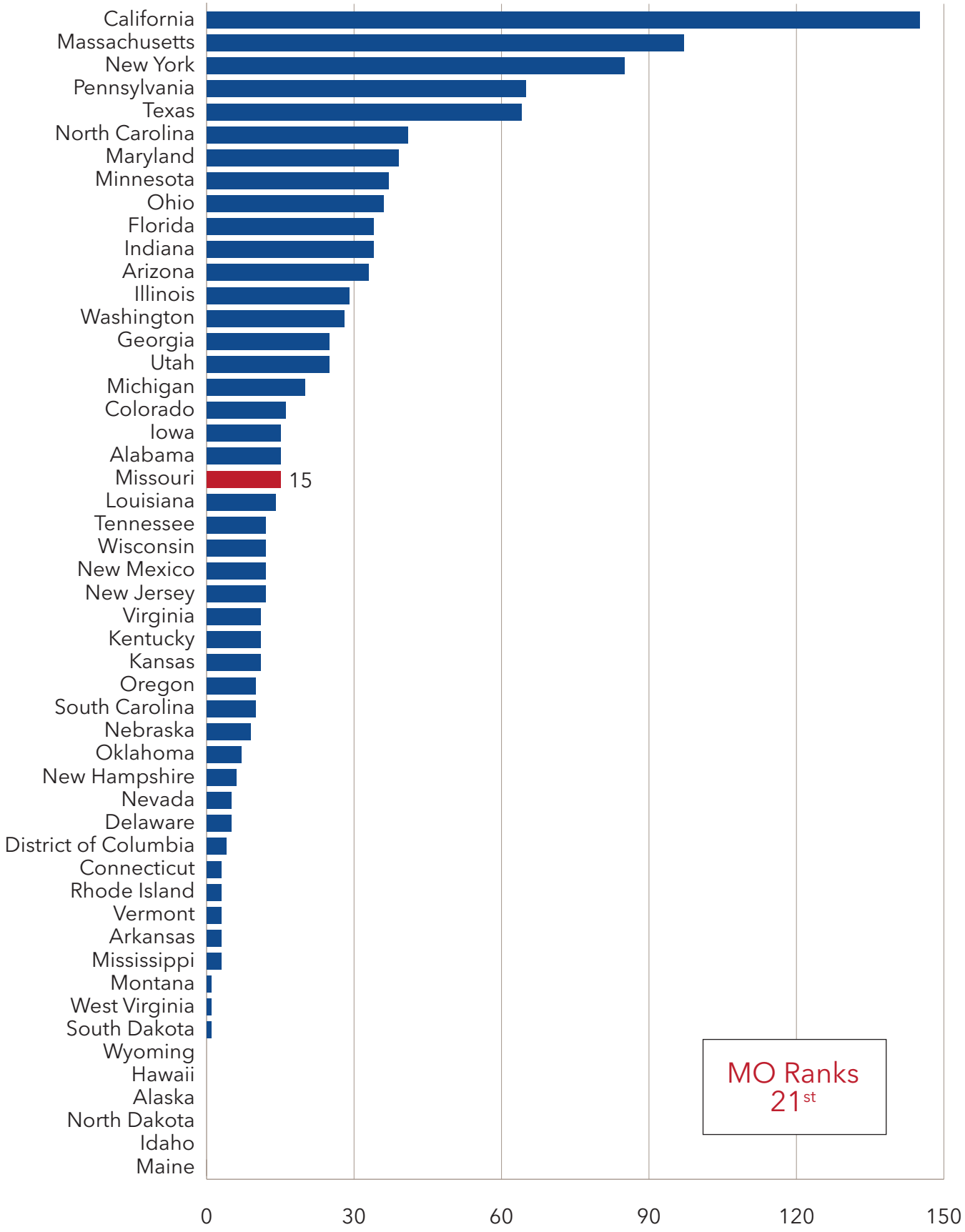
Source: National Venture Capital Association (NVCA) [2018]

Technology Licenses and Options Executed from Universities (2017)



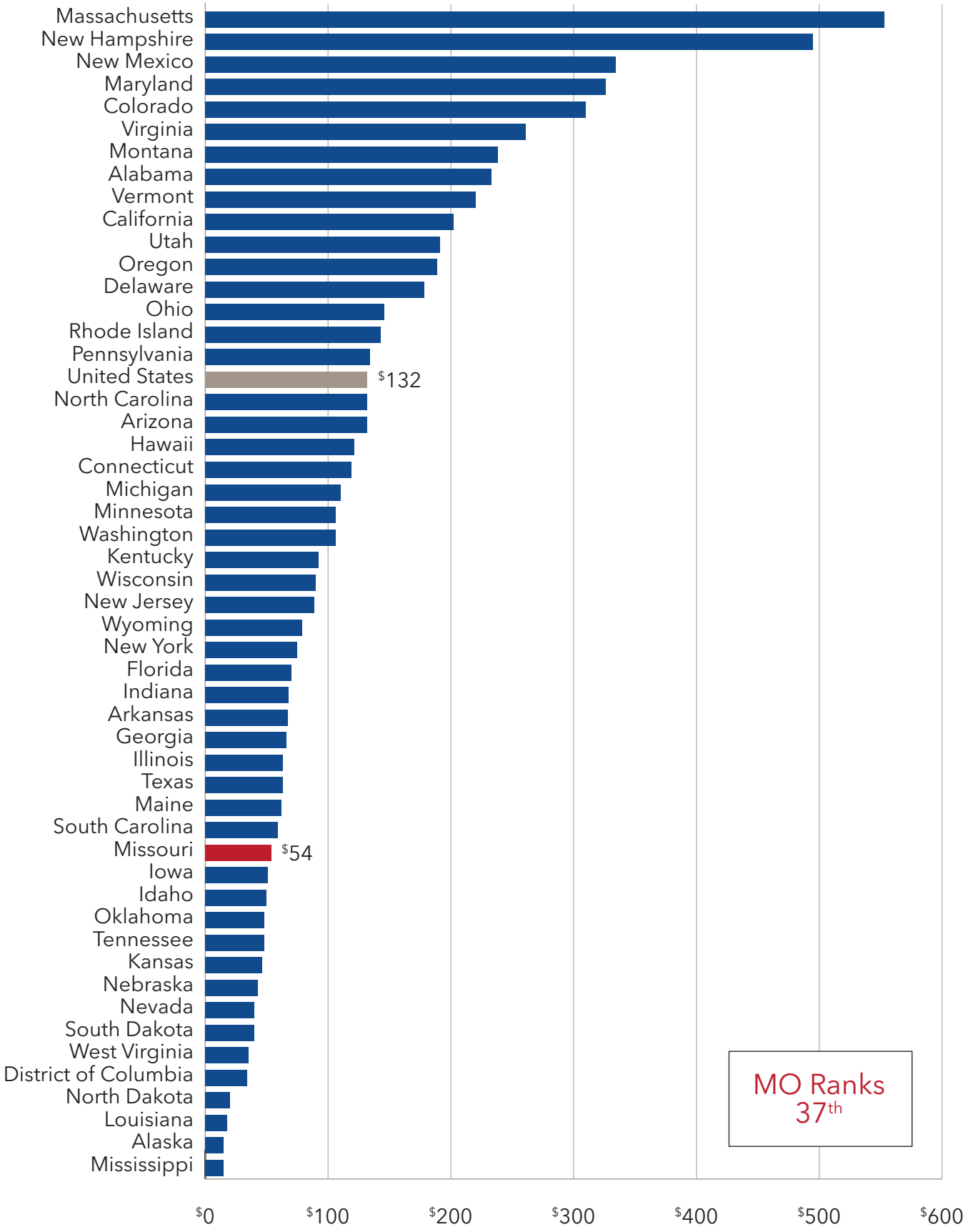
Source: Association of University Technology Managers (AUTM) [2018]

Startups from Universities (2017)



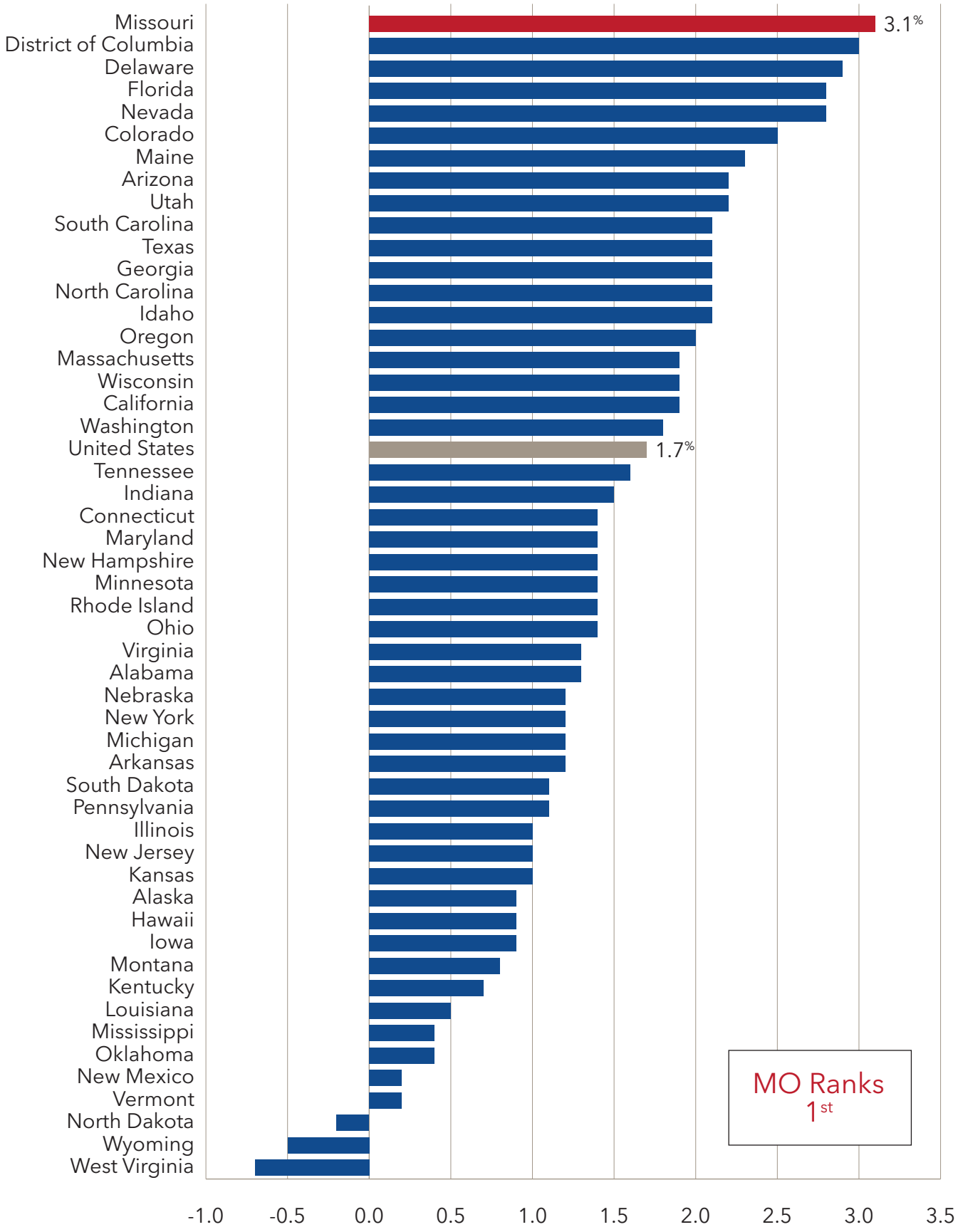
Source: Association of University Technology Managers (AUTM) [2018]

SBIR and STTR Funding per $1 Million of GSP (2012-2017)



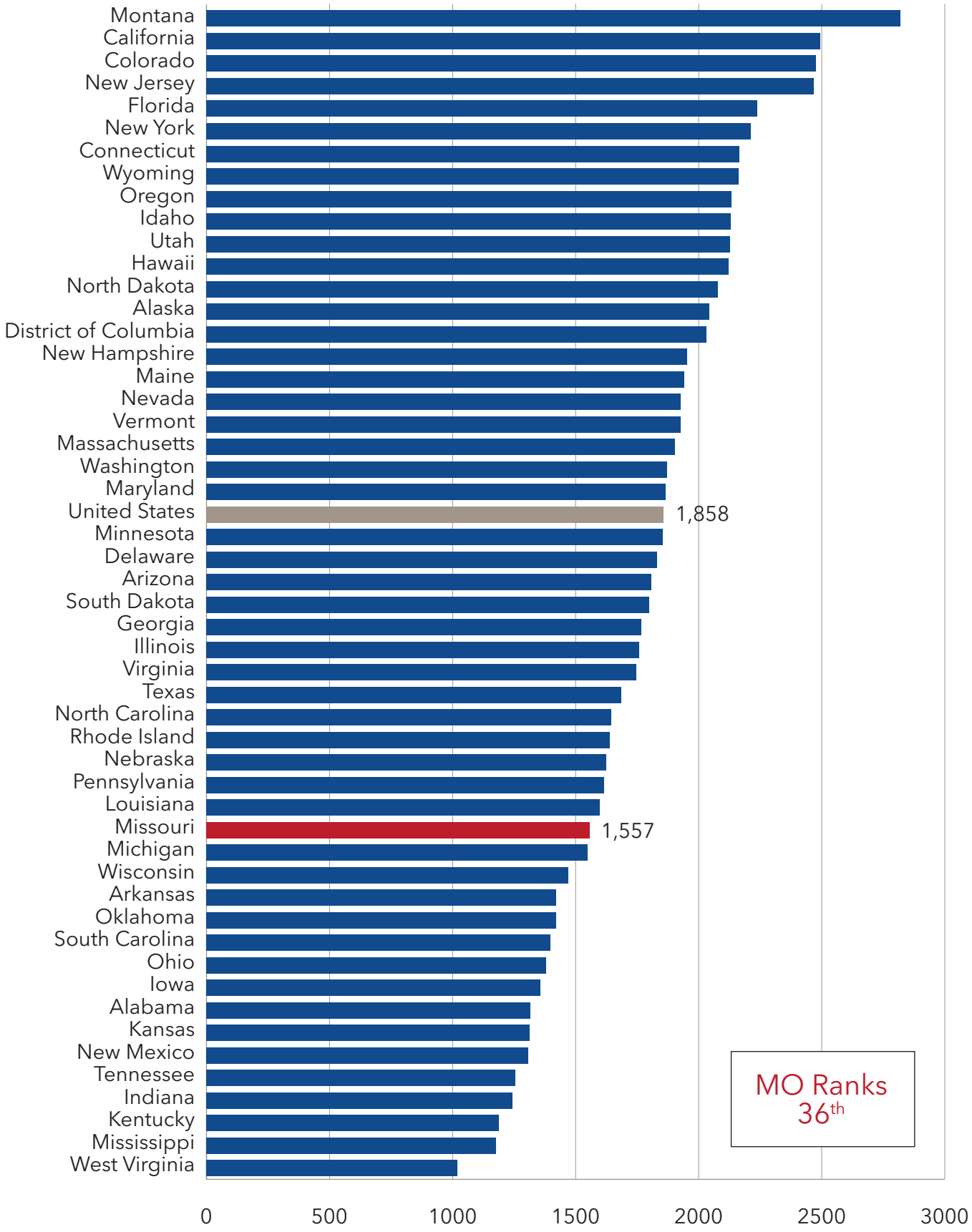
Source: Small Business Innovation Research (SBIR) [2018]

Small Business Opening Rate vs. Closing Rate (2016)



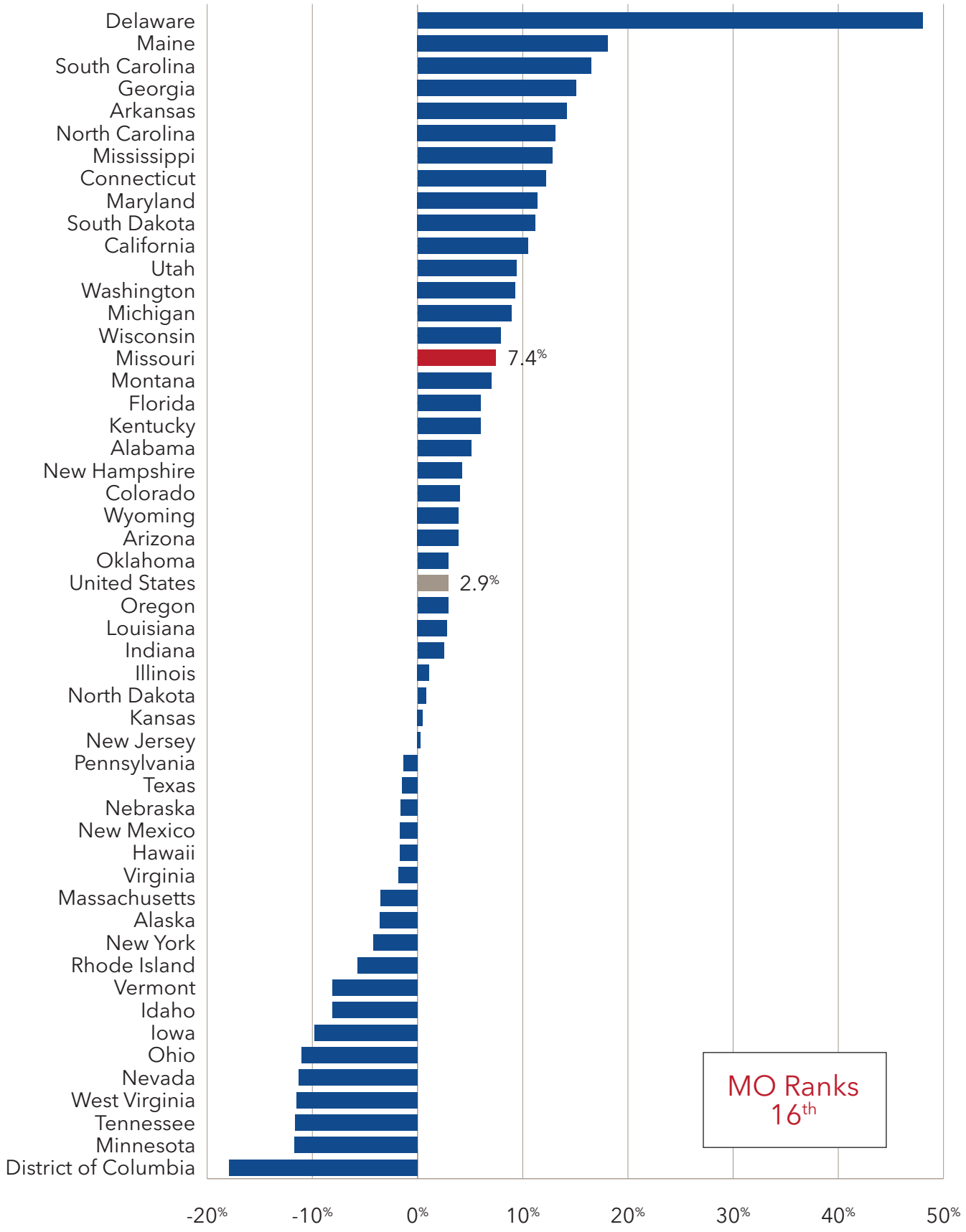
Source: US Census Bureau (2018)

Small Business Loans per 100,000 People (2015)



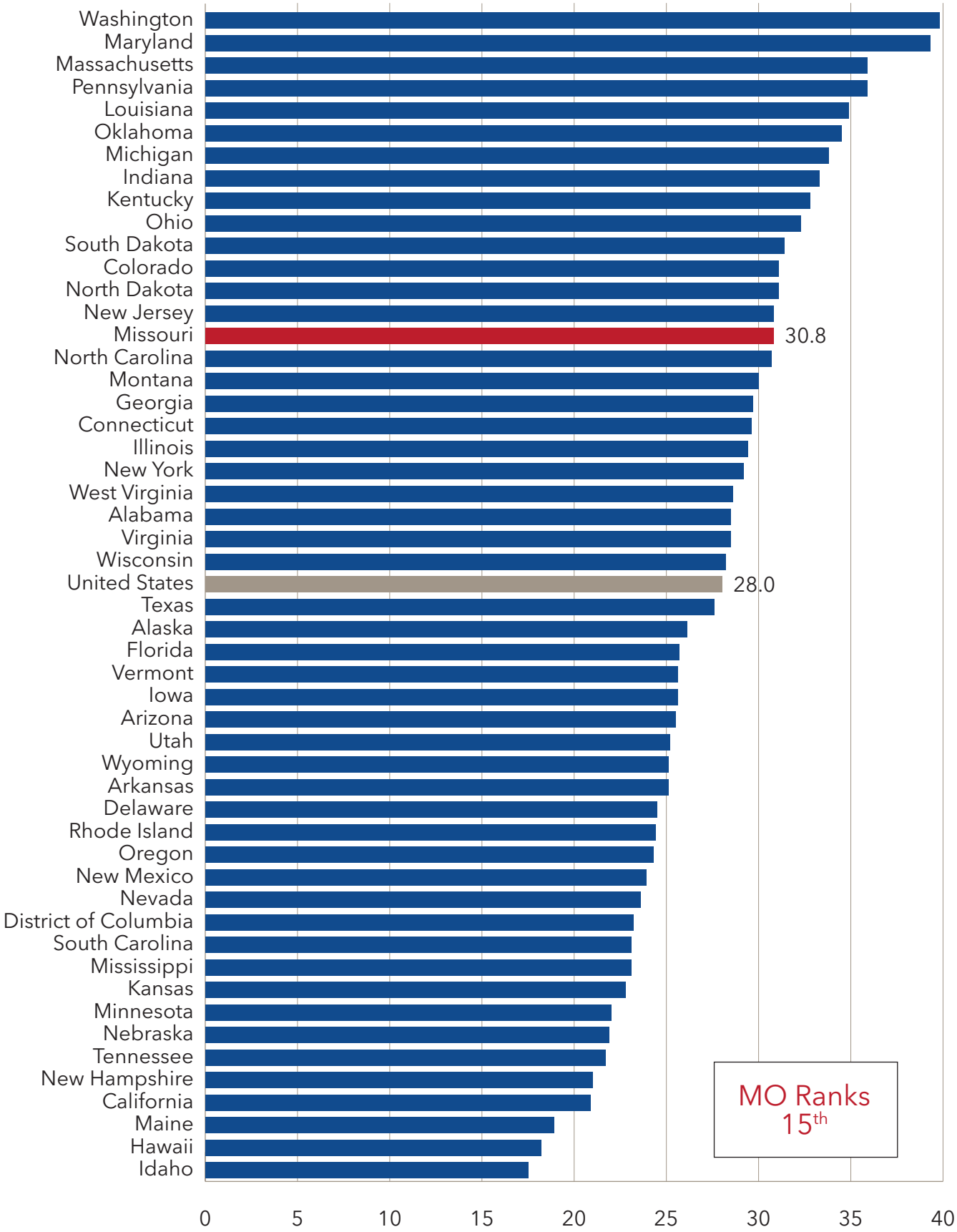
Source: Small Business Administration (2018)

Change in Employment by Young Companies (2014-2016)



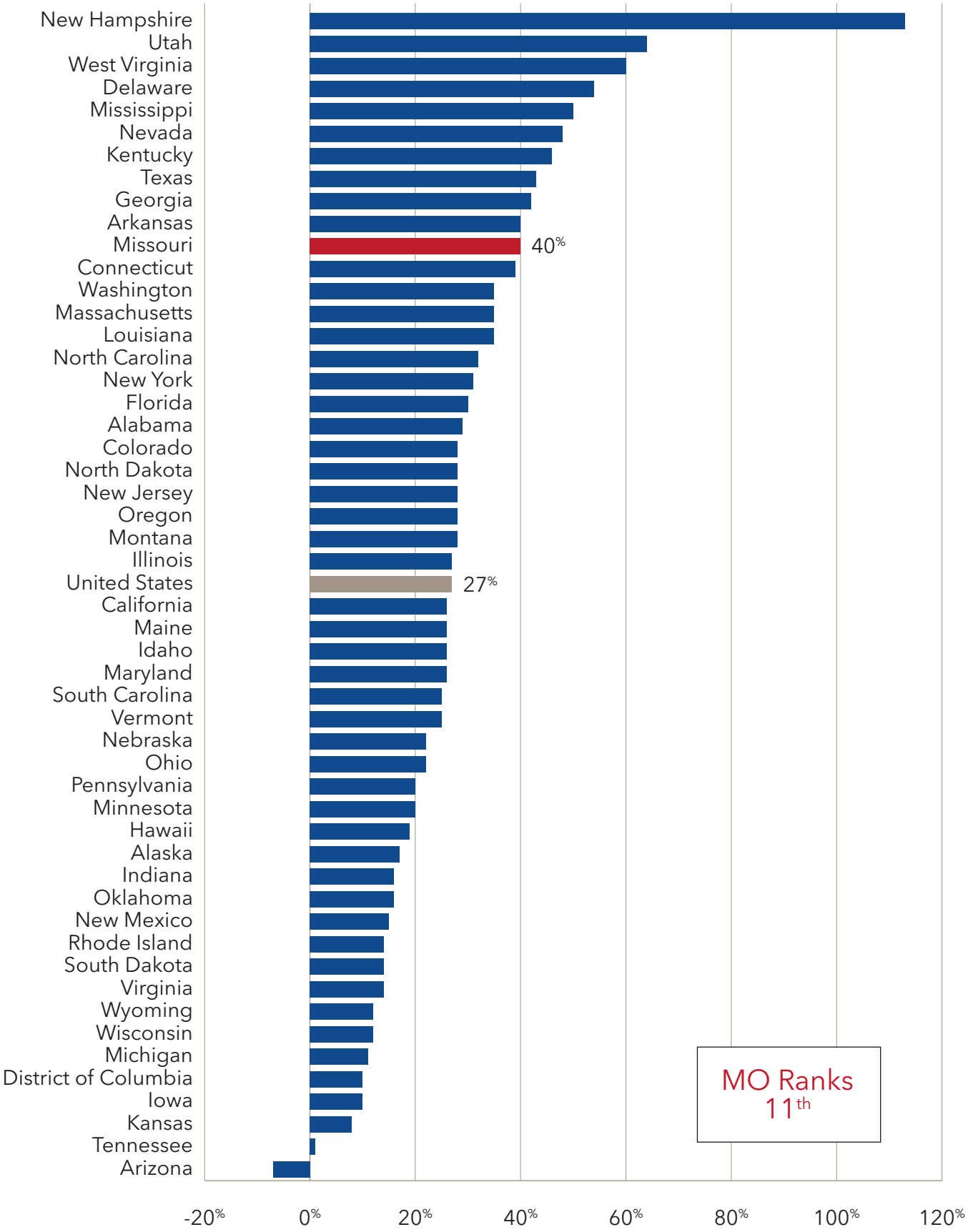
Source: US Census Bureau (2018)

Completed STEM Education Programs per 1,000 Enrolled Students (2017)



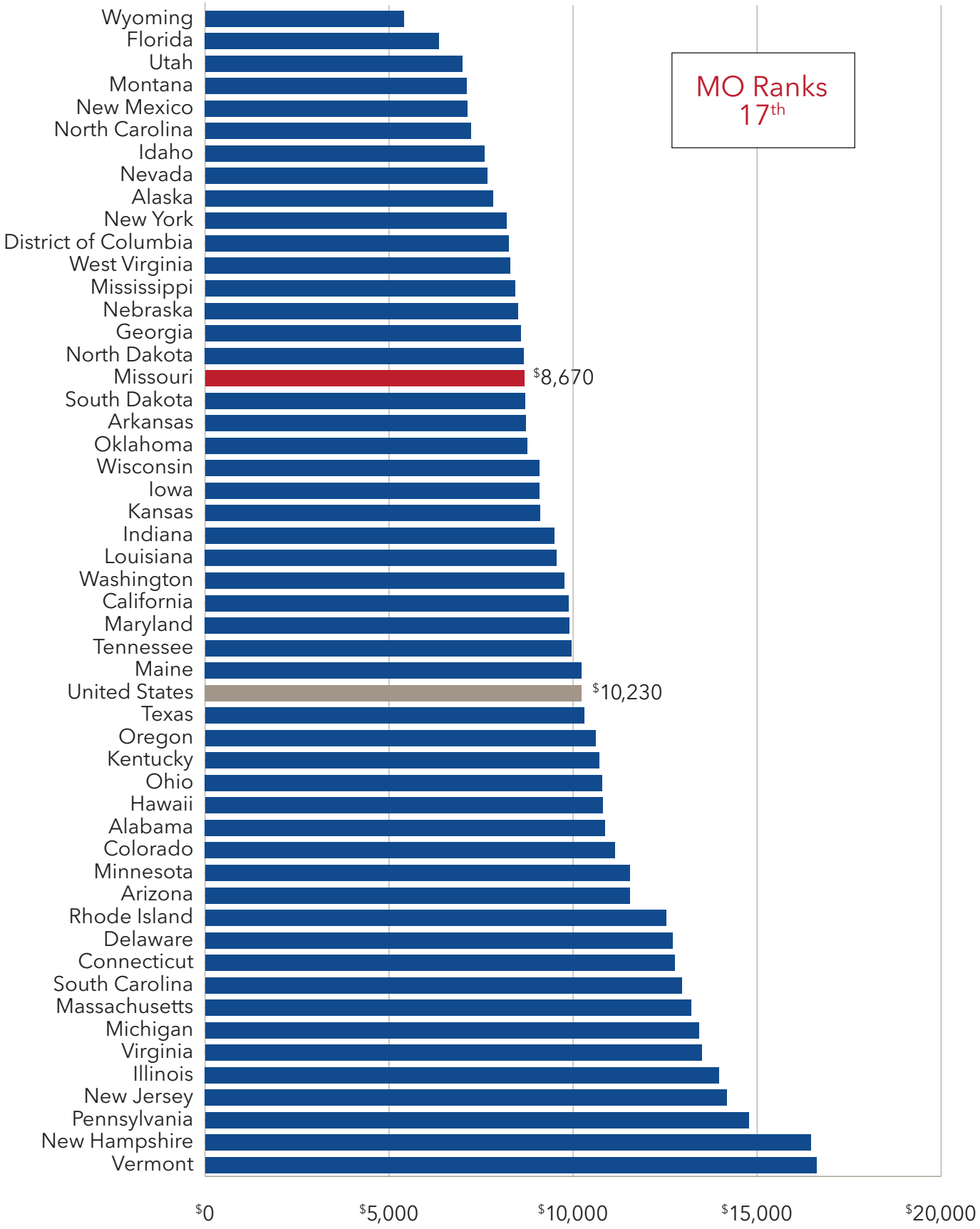
Source: EMSI 2018.4 & NCES (2018)

Percent Change in Tech & STEM Education Program Completions (2012-2017)



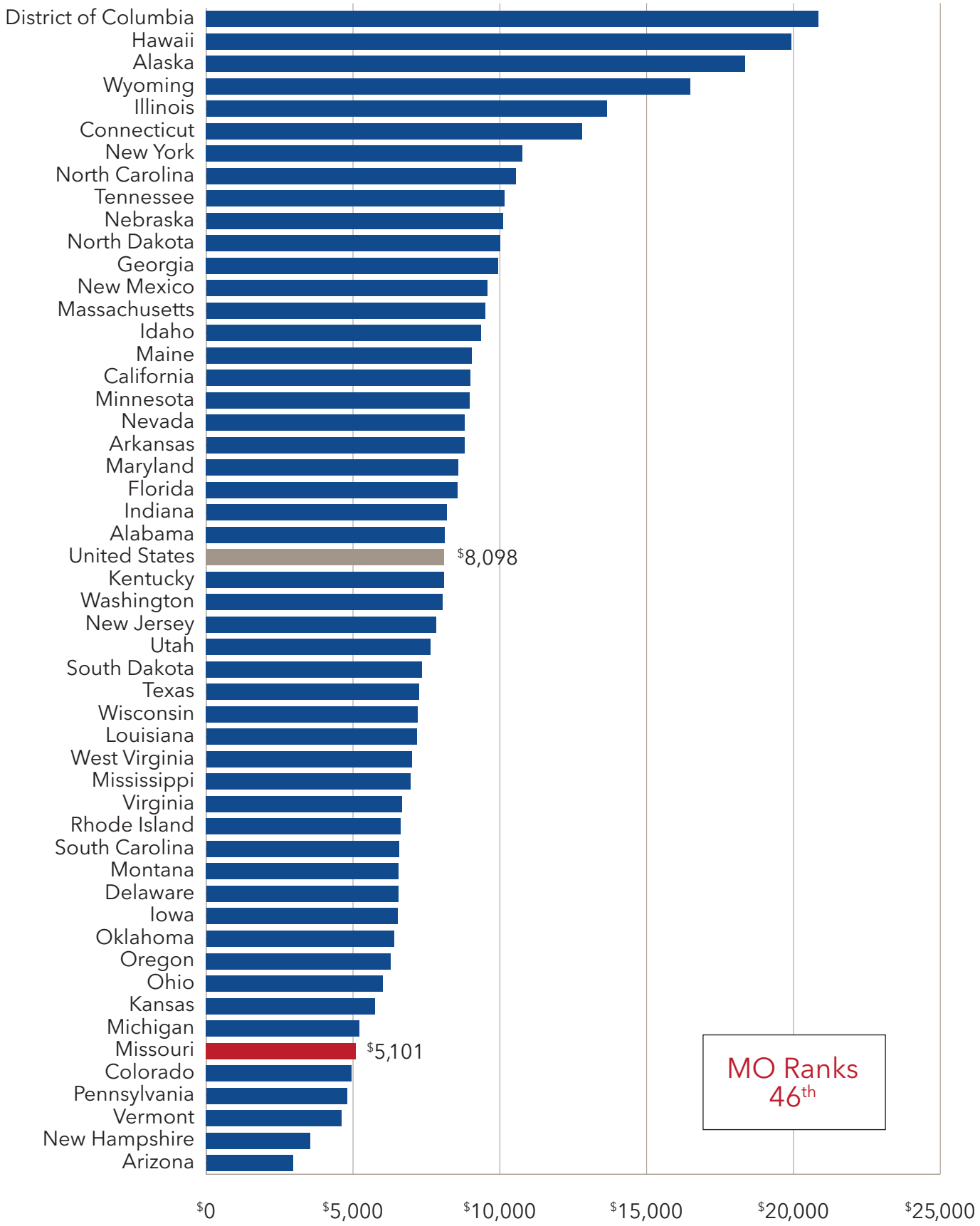
Source: EMSI 2018.4

Average In-State Tuition Cost (2018-2019)



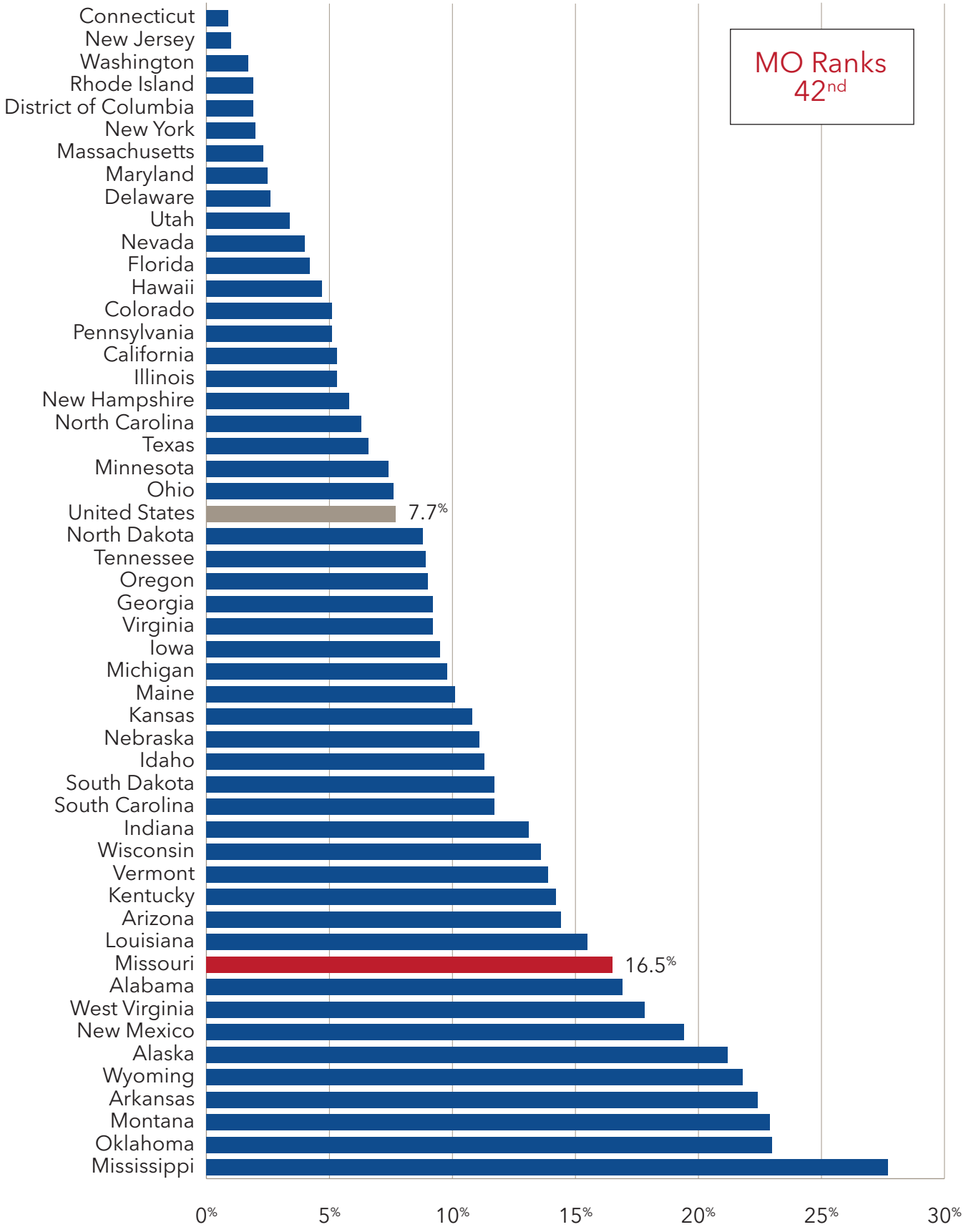
Source: College Board (2018)

State Spending per Student for Higher Education (2018)



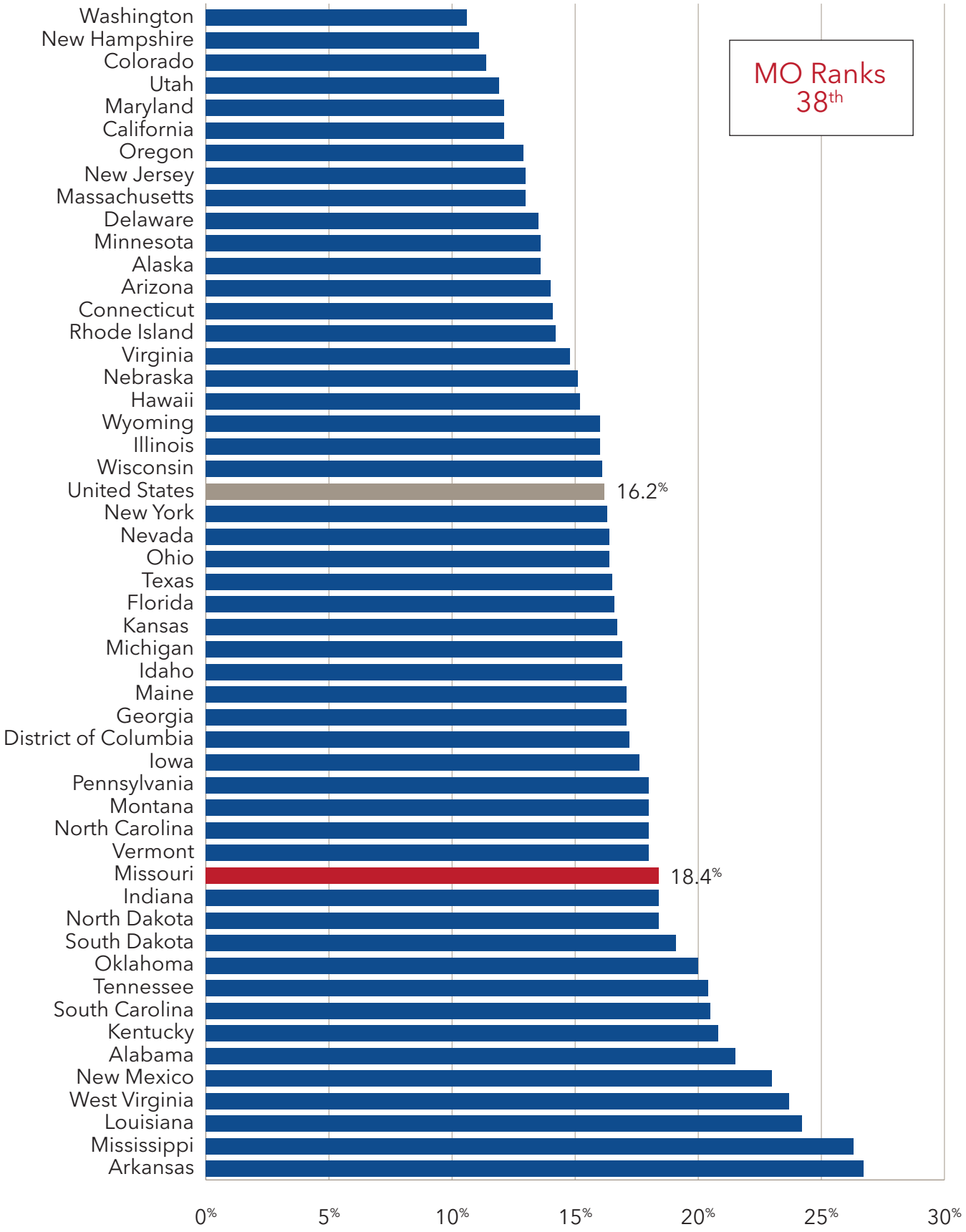
Source: Center on Budget and Policy Priorities (2018)

Percentage of Population Without High Speed Broadband Access (2016)



Source: Federal Communications Commission (2018)

Percentage of Households Without an Internet Subscription (2017)



Source: US Census Bureau (2018)

Tech Industry Groupings

NAICS Code	NAICS Description	Subcategory	Manufacturing or Service
211120	Crude Petroleum Extraction	Energy Technology	High-Tech Services
211130	Natural Gas Extraction	Energy Technology	High-Tech Services
212111	Bituminous Coal and Lignite Surface Mining	Energy Technology	High-Tech Services
212112	Bituminous Coal Underground Mining	Energy Technology	High-Tech Services
212113	Anthracite Mining	Energy Technology	High-Tech Services
213111	Drilling Oil and Gas Wells	Energy Technology	High-Tech Services
213112	Support Activities for Oil and Gas Operations	Energy Technology	High-Tech Services
213113	Support Activities for Coal Mining	Energy Technology	High-Tech Services
221111	Hydroelectric Power Generation	Energy Technology	High-Tech Services
221112	Fossil Fuel Electric Power Generation	Energy Technology	High-Tech Services
221113	Nuclear Electric Power Generation	Energy Technology	High-Tech Services
221114	Solar Electric Power Generation	Energy Technology	High-Tech Services
221115	Wind Electric Power Generation	Energy Technology	High-Tech Services
221116	Geothermal Electric Power Generation	Energy Technology	High-Tech Services
221117	Biomass Electric Power Generation	Energy Technology	High-Tech Services
221118	Other Electric Power Generation	Energy Technology	High-Tech Services
221121	Electric Bulk Power Transmission and Control	Energy Technology	High-Tech Services
221122	Electric Power Distribution	Energy Technology	High-Tech Services
221210	Natural Gas Distribution	Energy Technology	High-Tech Services
324110	Petroleum Refineries	Energy Technology	High-Tech Services
221310	Water Supply and Irrigation Systems	Environmental Technology	High-Tech Services
221320	Sewage Treatment Facilities	Environmental Technology	High-Tech Services
221330	Steam and Air-Conditioning Supply	Environmental Technology	High-Tech Services
334512	Automatic Environmental Control Manufacturing for Residential, Commercial, and Appliance Use	Environmental Technology	High-Tech Manufacturing
334513	Instruments and Related Products Manufacturing for Measuring, Displaying, and Controlling Industrial Process Variables	Environmental Technology	High-Tech Manufacturing
334514	Totalizing Fluid Meter and Counting Device Manufacturing	Environmental Technology	High-Tech Manufacturing
334515	Instrument Manufacturing for Measuring and Testing Electricity and Electrical Signals	Environmental Technology	High-Tech Manufacturing
335911	Storage Battery Manufacturing	Environmental Technology	High-Tech Manufacturing
541620	Environmental Consulting Services	Environmental Technology	High-Tech Services
562111	Solid Waste Collection	Environmental Technology	High-Tech Services

NAICS Code	NAICS Description	Subcategory	Manufacturing or Service
562112	Hazardous Waste Collection	Environmental Technology	High-Tech Services
562119	Other Waste Collection	Environmental Technology	High-Tech Services
562211	Hazardous Waste Treatment and Disposal	Environmental Technology	High-Tech Services
562212	Solid Waste Landfill	Environmental Technology	High-Tech Services
562213	Solid Waste Combustors and Incinerators	Environmental Technology	High-Tech Services
562219	Other Nonhazardous Waste Treatment and Disposal	Environmental Technology	High-Tech Services
562910	Remediation Services	Environmental Technology	High-Tech Services
562920	Materials Recovery Facilities	Environmental Technology	High-Tech Services
562991	Septic Tank and Related Services	Environmental Technology	High-Tech Services
562998	All Other Miscellaneous Waste Management Services	Environmental Technology	High-Tech Services
333242	Semiconductor Machinery Manufacturing	IT	High-Tech Manufacturing
333314	Optical Instrument and Lens Manufacturing	IT	High-Tech Manufacturing
333316	Photographic and Photocopying Equipment Manufacturing	IT	High-Tech Manufacturing
334111	Electronic Computer Manufacturing	IT	High-Tech Manufacturing
334112	Computer Storage Device Manufacturing	IT	High-Tech Manufacturing
334118	Computer Terminal and Other Computer Peripheral Equipment Manufacturing	IT	High-Tech Manufacturing
334210	Telephone Apparatus Manufacturing	IT	High-Tech Manufacturing
334220	Radio and Television Broadcasting and Wireless Communications Equipment Manufacturing	IT	High-Tech Manufacturing
334290	Other Communications Equipment Manufacturing	IT	High-Tech Manufacturing
334310	Audio and Video Equipment Manufacturing	IT	High-Tech Manufacturing
334412	Bare Printed Circuit Board Manufacturing	IT	High-Tech Manufacturing
334413	Semiconductor and Related Device Manufacturing	IT	High-Tech Manufacturing
334416	Capacitor, Resistor, Coil, Transformer, and Other Inductor Manufacturing	IT	High-Tech Manufacturing
334417	Electronic Connector Manufacturing	IT	High-Tech Manufacturing
334418	Printed Circuit Assembly (Electronic Assembly) Manufacturing	IT	High-Tech Manufacturing
334419	Other Electronic Component Manufacturing	IT	High-Tech Manufacturing
334511	Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing	IT	High-Tech Manufacturing

NAICS Code	NAICS Description	Subcategory	Manufacturing or Service
334519	Other Measuring and Controlling Device Manufacturing	IT	High-Tech Manufacturing
335921	Fiber Optic Cable Manufacturing	IT	High-Tech Manufacturing
335999	All Other Miscellaneous Electrical Equipment and Component Manufacturing	IT	High-Tech Manufacturing
511210	Software Publishers	IT	High-Tech Services
517311	Wired Telecommunications Carriers	IT	High-Tech Services
517312	Wireless Telecommunications Carriers (except Satellite)	IT	High-Tech Services
517410	Satellite Telecommunications	IT	High-Tech Services
517911	Telecommunications Resellers	IT	High-Tech Services
517919	All Other Telecommunications	IT	High-Tech Services
518210	Data Processing, Hosting, and Related Services	IT	High-Tech Services
519130	Internet Publishing and Broadcasting and Web Search Portals	IT	High-Tech Services
541511	Custom Computer Programming Services	IT	High-Tech Services
541512	Computer Systems Design Services	IT	High-Tech Services
541513	Computer Facilities Management Services	IT	High-Tech Services
541519	Other Computer Related Services	IT	High-Tech Services
115116	Farm Management Services	Life Sciences	High-Tech Services
325311	Nitrogenous Fertilizer Manufacturing	Life Sciences	High-Tech Manufacturing
325312	Phosphatic Fertilizer Manufacturing	Life Sciences	High-Tech Manufacturing
325314	Fertilizer (Mixing Only) Manufacturing	Life Sciences	High-Tech Manufacturing
325320	Pesticide and Other Agricultural Chemical Manufacturing	Life Sciences	High-Tech Manufacturing
325411	Medicinal and Botanical Manufacturing	Life Sciences	High-Tech Manufacturing
325412	Pharmaceutical Preparation Manufacturing	Life Sciences	High-Tech Manufacturing
325413	In-Vitro Diagnostic Substance Manufacturing	Life Sciences	High-Tech Manufacturing
325414	Biological Product (except Diagnostic) Manufacturing	Life Sciences	High-Tech Manufacturing
333111	Farm Machinery and Equipment Manufacturing	Life Sciences	High-Tech Manufacturing
333241	Food Product Machinery Manufacturing	Life Sciences	High-Tech Manufacturing
334510	Electromedical and Electrotherapeutic Apparatus Manufacturing	Life Sciences	High-Tech Manufacturing
334516	Analytical Laboratory Instrument Manufacturing	Life Sciences	High-Tech Manufacturing
334517	Irradiation Apparatus Manufacturing	Life Sciences	High-Tech Manufacturing
339112	Surgical and Medical Instrument Manufacturing	Life Sciences	High-Tech Manufacturing
339113	Surgical Appliance and Supplies Manufacturing	Life Sciences	High-Tech Manufacturing
339114	Dental Equipment and Supplies Manufacturing	Life Sciences	High-Tech Manufacturing
541330	Engineering Services	Life Sciences	High-Tech Services
541380	Testing Laboratories	Life Sciences	High-Tech Services
541690	Other Scientific and Technical Consulting Services	Life Sciences	High-Tech Services
541713	Research and Development in Nanotechnology	Life Sciences	High-Tech Services
541714	Research and Development in Biotechnology (except Nanobiotechnology)	Life Sciences	High-Tech Services
541715	Research and Development in the Physical, Engineering, and Life Sciences (except Nanotechnology and Biotechnology)	Life Sciences	High-Tech Services

Tech Occupation Groupings

SOC Code	Occupation Description
11-3021	Computer and Information Systems Managers
11-9041	Architectural and Engineering Managers
13-1081	Logisticians
13-1111	Management Analysts
13-1161	Market Research Analysts and Marketing Specialists
13-1199	Business Operations Specialists, All Other
13-2031	Budget Analysts
13-2041	Credit Analysts
13-2051	Financial Analysts
15-1111	Computer and Information Research Scientists
15-1121	Computer Systems Analysts
15-1122	Information Security Analysts
15-1131	Computer Programmers
15-1132	Software Developers, Applications
15-1133	Software Developers, Systems Software
15-1134	Web Developers
15-1141	Database Administrators
15-1142	Network and Computer Systems Administrators
15-1143	Computer Network Architects
15-1151	Computer User Support Specialists
15-1152	Computer Network Support Specialists
15-1199	Computer Occupations, All Other
15-2011	Actuaries
15-2021	Mathematicians
15-2031	Operations Research Analysts
15-2041	Statisticians
15-2098	Miscellaneous Mathematical Science Occupations
17-2011	Aerospace Engineers
17-2021	Agricultural Engineers
17-2031	Biomedical Engineers
17-2041	Chemical Engineers
17-2051	Civil Engineers
17-2061	Computer Hardware Engineers
17-2071	Electrical Engineers
17-2072	Electronics Engineers, Except Computer
17-2081	Environmental Engineers
17-2111	Health and Safety Engineers, Except Mining Safety Engineers and Inspectors
17-2112	Industrial Engineers
17-2121	Marine Engineers and Naval Architects

SOC Code	Occupation Description
17-2131	Materials Engineers
17-2141	Mechanical Engineers
17-2151	Mining and Geological Engineers, Including Mining Safety Engineers
17-2161	Nuclear Engineers
17-2171	Petroleum Engineers
17-2199	Engineers, All Other
17-3021	Aerospace Engineering and Operations Technicians
17-3022	Civil Engineering Technicians
17-3023	Electrical and Electronics Engineering Technicians
17-3024	Electro-Mechanical Technicians
17-3025	Environmental Engineering Technicians
17-3026	Industrial Engineering Technicians
17-3027	Mechanical Engineering Technicians
17-3029	Engineering Technicians, Except Drafters, All Other
19-1042	Medical Scientists, Except Epidemiologists
19-2021	Atmospheric and Space Scientists
19-2031	Chemists
19-2032	Materials Scientists
19-2041	Environmental Scientists and Specialists, Including Health
19-4011	Agricultural and Food Science Technicians
19-4041	Geological and Petroleum Technicians
19-4051	Nuclear Technicians
19-4091	Environmental Science and Protection Technicians, Including Health
43-9011	Computer Operators
43-9111	Statistical Assistants
45-2011	Agricultural Inspectors
19-1013	Soil and Plant Scientists
19-1011	Animal Scientists
19-4099	Life, Physical, and Social Science Technicians
19-4021	Biological Technicians
19-1012	Food Scientists and Technologists
19-1021	Biochemists and Biophysicists
19-1022	Microbiologists
25-9021	Farm and Home Management Advisors
19-2043	Hydrologists
19-1029	Biological Scientists, All Other
19-1099	Life Scientists, All Other
19-2042	Geoscientists, Except Hydrologists and Geographers

SOURCES:

Ag Funder. 2017. "AgFunder AgriFood Tech Investing Report – Mid-Year 2017."
agfunder.com/research/agrifood-tech-investing-report-midyear-2017

Ag Funder. 2017. "Is St. Louis the Silicon Valley of Agtech?"
agfundernews.com/stlouis-silicon-valley-for-agtech.html?utm_source=AgFunder+Updates&utm_campaign=6d737898b1-Nov02_2017&utm_medium=email&utm_term=0_7b0bb00edf-6d737898b1-98301285

Association of University Technology Managers (AUTM). 2018. "Statistics Access for Tech Transfer (STATT) Database."
autm.net/resources-surveys/research-reports-databases/statt-database-(1)

Bureau of Economic Analysis (BEA). 2018. "GDP & Personal Income By State."
bea.gov/regional/index.htm

Bureau of Labor Statistics (BLS). 2018. "Quarterly Census of Employment and Wages."
bls.gov/cew/

CBRE Research. 2018. "2018 Scoring Tech Talent."
cbre.com/research-and-reports/Scoring-Tech-Talent-in-North-America-2018

Center on Budget and Policy Priorities (CBPP). 2018. "Unkept Promises: State cuts to higher education threaten access and equity."
cbpp.org/research/state-budget-and-tax/unkept-promises-state-cuts-to-higher-education-threaten-access-and

Census Bureau. 2018. "Business Dynamics Statistics"
census.gov/ces/dataproducts/bds/data_estab.html

College Board. 2018. "Annual Survey of Colleges."
trends.collegeboard.org/college-pricing/figures-tables

Economic Innovation Group. 2016. "The New Map of Economic Growth and Recovery."
eig.org/recoverymap#mapReport

Economic Modeling Specialists International (EMSI). 2018. Analyst Tool: 2018.4 Class of Worker.
economicmodeling.com/analyst/

Kauffman Foundation. 2014. "AgTech: Challenges and Opportunities for Sustainable Growth."
kauffman.org/what-we-do/research/2014/04/agtech-challenges-and-opportunities-for-sustainable-growth

M25. 2017. "AgTech in the Midwest: Creating Fertile Ground for the Next Unicorn."
medium.com/@M25Group/creating-fertile-ground-in-the-agtech-industry-17580621b08c

National Center for Education Statistics. 2018. "Total fall enrollment in degree-granting postsecondary institutions."
nces.ed.gov/programs/digest/d15/tables/dt15_304.10.asp?current=yes

National Science Foundation (NSF). 2018. "Science & Engineering Indicators 2018."
nsf.gov/statistics/2018/nsb20181/

National Venture Capital Association. 2018. "Pitchbook-NVCA 3Q 2018 Venture Monitor."
nvca.org/research/research-resources/

Small Business Administration. 2018. "Small Business Lending in the United States, 2016."
sba.gov/advocacy/small-business-lending-united-states-2016

Small Business Innovation Research (SBIR). 2018. "State Summary Report."
sbir.gov/analytics-dashboard

St. Louis Regional Chamber (2018). 2017 Greater St. Louis Venture Capital Overview.
stlregionalchamber.com/blog-post/chamber-blog/2018/09/12/st.-louis-region-among-top-in-nation-for-agtech-startup-investments

Tax Foundation. 2018. "The Real Value of $100 in Each State."
taxfoundation.org/real-value-100-state-2018/

Tetra Tech. 2016. "Konza Technopolis 2016-2020 Strategic Plan."
konzacity.go.ke/news-updates/project-documents/

TechAmerica Foundation. 2013. "Definition of The Tech Industry."
techamericafoundation.org/content/wp-content/uploads/2013/06/TechAmerica- Foundation-Cyberstates-2013-NAICS-Tech-Definition.pdf

MISSOURI CHAMBER
FOUNDATION

428 East Capitol Avenue
P.O. Box 149
Jefferson City, MO 65102

573-634-3511

mochamber.com