

# RESEARCH AND TECHNOLOGY TRANSFER ACTIVITY REPORT

FISCAL YEAR 2021



ARIZONA BOARD OF  
**REGENTS**

ASU ♦ NAU ♦ UA



## ABOUT THIS REPORT

The annual Arizona Board of Regents' Research and Technology Transfer Activity Report examines research and technology transfer activities at Arizona's public universities, including facilities used and personnel engaged to support these activities.

Research expenditures are reported in total by funding source and research discipline. Research expenditures data includes comparative national market share and rankings information. Reported technology transfer activities span the technology transfer process from discovery to commercialization.

Data in this report utilizes the definitions and standards established by related national surveys. Research expenditures and research personnel are reported consistent with the annual National Science Foundation Higher Education Research and Development Survey. Research facilities data reflect the biannual National Science Foundation's Survey of Science and Engineering Research Facilities. Technology transfer activities are reported under the annual Association of University Technology Managers' Licensing Activity Survey standards.

Technology transfer portions of this report are required by ABOR Policy 6-909.10.

### ABOUT THE ARIZONA BOARD OF REGENTS

The Arizona Board of Regents is committed to ensuring access for qualified residents of Arizona to undergraduate and graduate institutions; promoting the discovery, application, and dissemination of new knowledge; extending the benefits of university activities to Arizona's citizens outside the university; and maximizing the benefits derived from the state's investment in education.

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John Arnold

September 1, 2022



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## EXECUTIVE SUMMARY

The universities' research missions are crucial as research created at Arizona's public universities is essential to Arizona's economic future. University research also develops leading-edge skill sets that are transferred to the economy via student graduation and employment. In addition, new technologies are created, and discoveries are made, thereby developing new products and enhancing the lives of Arizonans. During fiscal year 2021, the universities' research activities provided wages and tuition support for almost 20,000 faculty, staff and students.

Arizona's public universities' research activity continues to grow. In fiscal year 2021, Arizona public universities' research activity – as measured by research expenditures – grew year-over-year by \$17.5 million or 1.2 percent to exceed \$1.5 billion.

### Arizona State University

ASU's research activity – as measured by research expenditures – totaled over \$677.3 million in fiscal year 2021, exceeding fiscal year 2020's expenditures by \$3.9 million or 0.6 percent. While ASU missed this year's projected metric target, the institution surpassed annual metric targets for the past eight of the last 10 years and cumulatively exceeded its goals by \$143 million during that time.

ASU's total research expenditures ranking continues to improve, rising from No. 44 in 2017 to No. 43 in 2020 among all U.S. universities and from No. 27 in 2017 to No. 26 in 2020 among public universities.

ASU maintains its national ranking in total research expenditures for universities without a medical school at No. 6. ASU ranked No. 6 in NASA funded expenditures and No. 17 in National Science Foundation funded expenditures.

ASU ranks among the top 10 universities in research expenditures in social sciences and geosciences, and atmospheric and ocean sciences, and the university excels at No. 1 in the country in research expenditures for transdisciplinary, multidisciplinary and other sciences expenditures. ASU also ranks among the top 30 universities in research expenditures in engineering, psychology, and non-science and engineering disciplines.

ASU's top disciplines for research expenditures are transdisciplinary, multidisciplinary and other sciences, geological and Earth sciences, and biological and biomedical sciences as well as electrical, electronic and communications engineering. In technology transfer, ASU entered into 79 license and option agreements, earned 157 patents and formed 21 startup companies in fiscal year 2021.

### Northern Arizona University

NAU continues its steady growth in research. The university's research activity – as measured by research expenditures – totaled over \$69.1 million in fiscal year 2021, surpassing its fiscal year 2020 expenditures by \$4.6 million or 7.1 percent. During the past decade, the university expanded its annual research expenditures by \$28.3 million or 92 percent.

NAU's total research expenditure ranking rose significantly, improving from No. 201 in 2017 to No. 183 in 2020 among all U.S. universities, and No. 149 in 2017 to No. 134 in 2020 among U.S. public

universities. NAU ranks No. 64 in Department of Agriculture funded research and No. 74 in NASA funded research. NAU also ranks No. 85 nationally in geoscience, and atmospheric and ocean sciences.

NAU significantly improved its ranking in computer and information sciences, increasing from No. 198 in 2017 to No. 143 in 2020. NAU's top disciplines for research expenditures are in the life sciences, specifically biological and biomedical sciences.

In technology transfer, NAU increased its invention disclosures in 2021, receiving a record 51 disclosures. NAU earned nine patents and formed two startup companies in 2021.

### **University of Arizona**

UArizona's research activity – as measured by research expenditures – totaled \$770 million, surpassing its fiscal year 2020 expenditures by \$8.9 million or 1.2 percent.

UArizona's annual research expenditures increased by \$159.3 million or 26.1 percent over the past 10 years.

UArizona's total research expenditure ranking continues to improve, rising from No. 38 in 2017 to No. 35 in 2020 among all U.S. universities, and from No. 23 in 2017 to No. 20 in 2020 among U.S. public universities.

The university ranks fifth in NASA, No. 26 in Department of Agriculture and No. 32 in National Science Foundation funded research.

UArizona continues to improve its national rankings in physical sciences from sixth in 2017 to fifth in 2020 and maintains top 50 rankings in computer sciences, geosciences, atmospheric and ocean sciences, life sciences, social sciences, and transdisciplinary, multidisciplinary and other sciences.

The university's top disciplines for research expenditures are biological and biomedical sciences, health sciences, and astronomy and astrophysics.

UArizona's technology transfer and commercialization activities, and licenses and option income expanded significantly in 2021 - entering into 124 license and option agreements, representing a 31% increase from 2020. Licensing and options income grew from \$7.3 million to \$8.6 million - an 18% year-over-year increase and an increase of over 218% over the past five years. Over \$5.4 million of the licensing and option income was distributed back to inventors, and the inventors' laboratories and units.

In fiscal year 2021, UArizona earned 100 U.S. patents, and formed 17 startup companies.

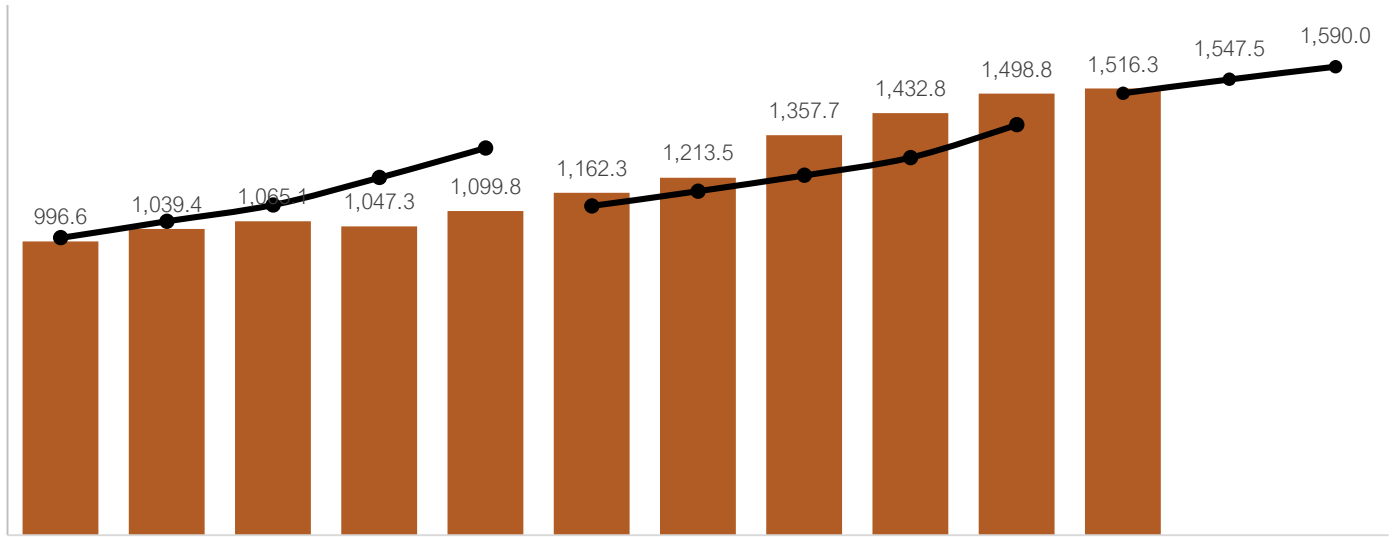


*Jid' dah Ado - Ibrahim, CPhT*

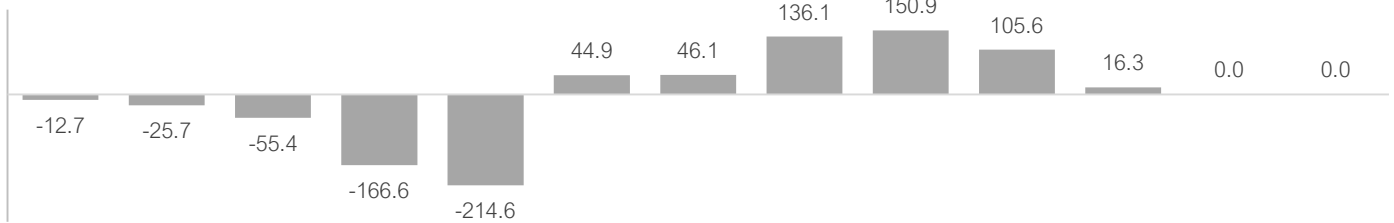
Arizona Public University Enterprise

Exhibit E.R.1: Total Research Expenditures and Enterprise Goals

Total Research Expenditures and Enterprise Goals in Millions



Actual to Enterprise Goal Differences in Millions



Cumulative Actual to Enterprise Goal Differences in Millions

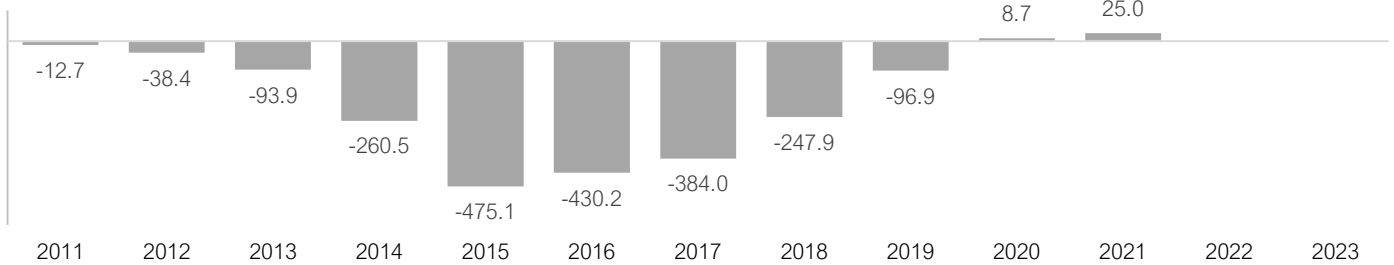
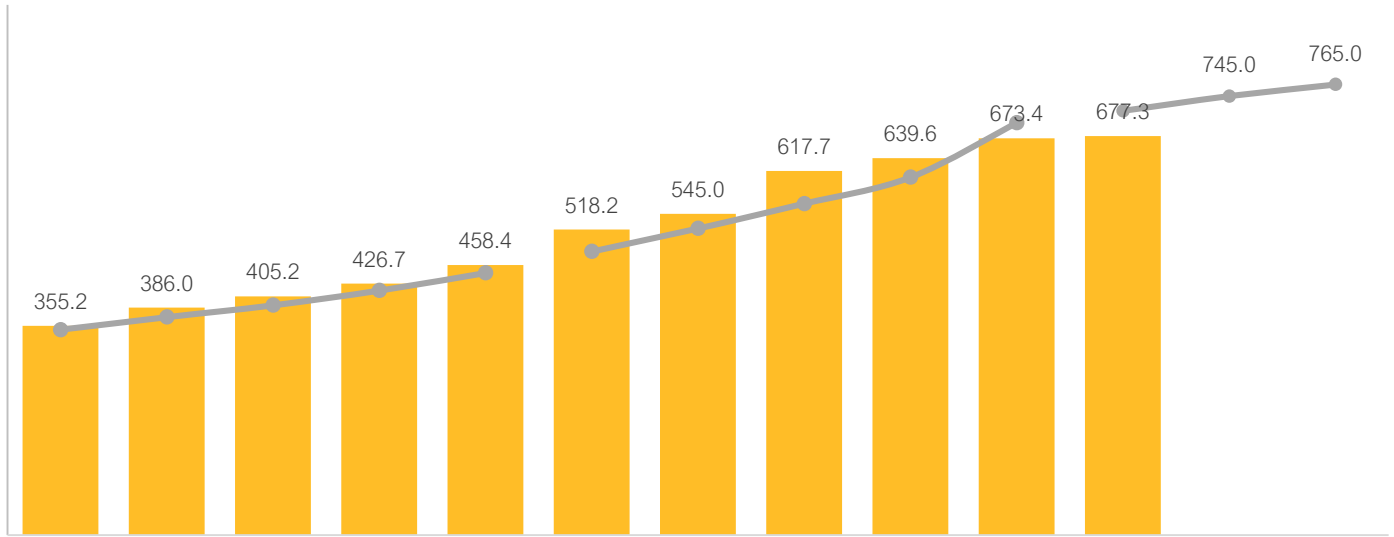


Exhibit ASU.R.1: Research Expenditures and Enterprise Goals

Research Expenditures and Enterprise Plan Goals (in Millions)



Actual to Enterprise Goal Differences (in Millions)

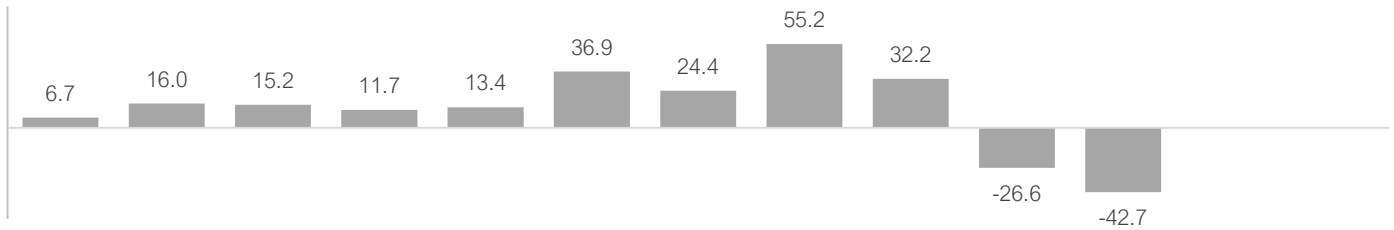
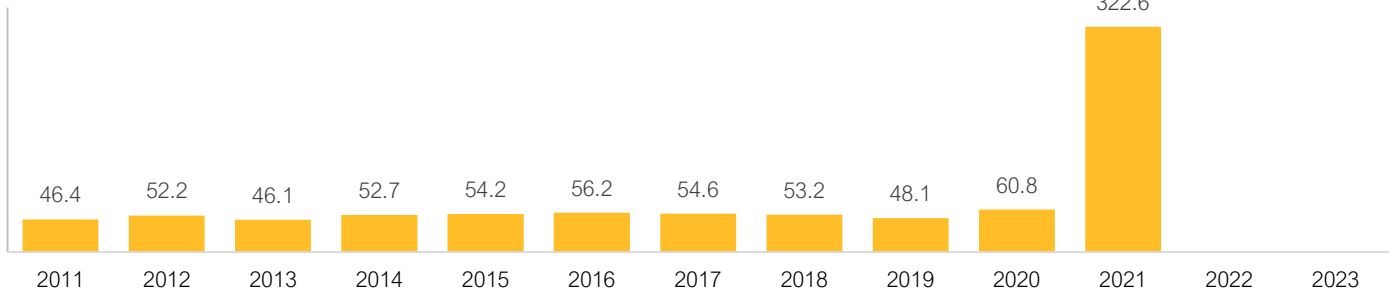


Exhibit ASU.R.2: Other Sponsored Project Expenditures

Other Sponsored Project Expenditures (in Millions)





Arizona State University

Exhibit ASU.R.3: Research Expenditures National Comparisons

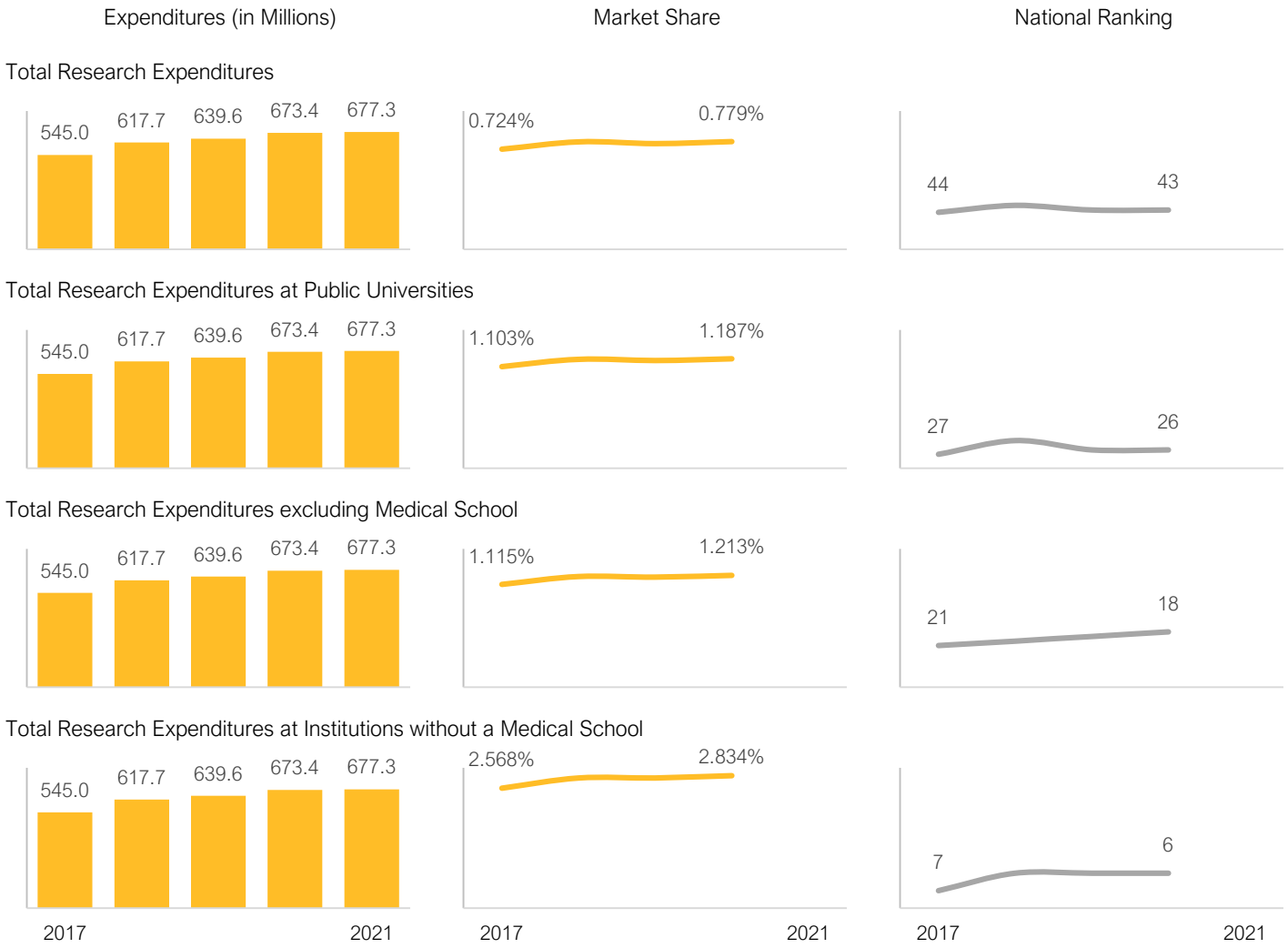
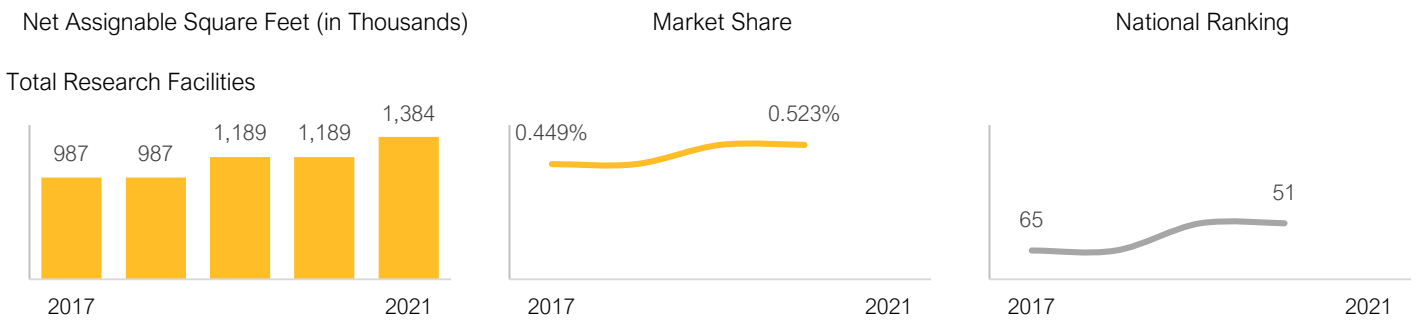
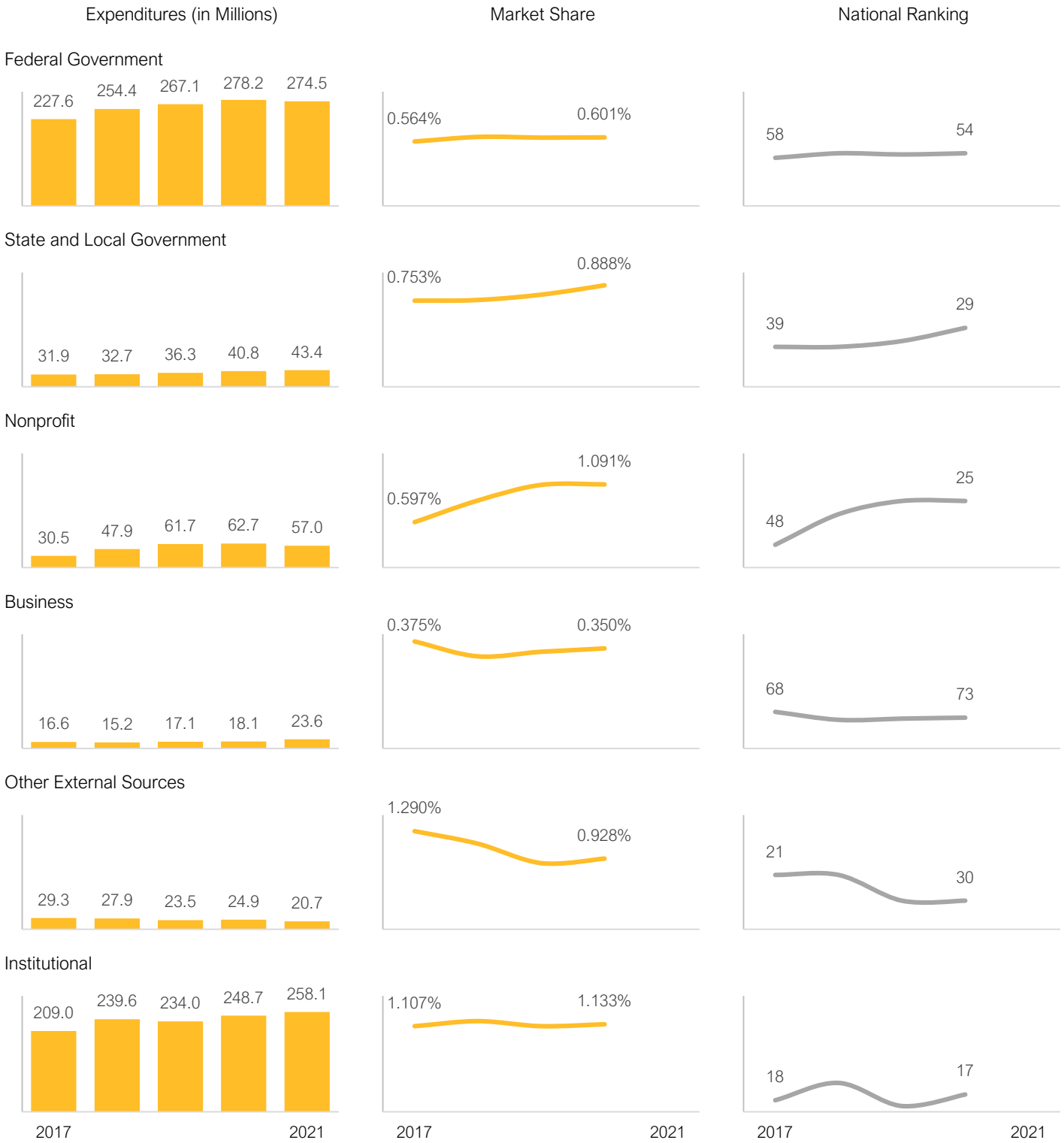


Exhibit ASU.R.4: Research Facilities



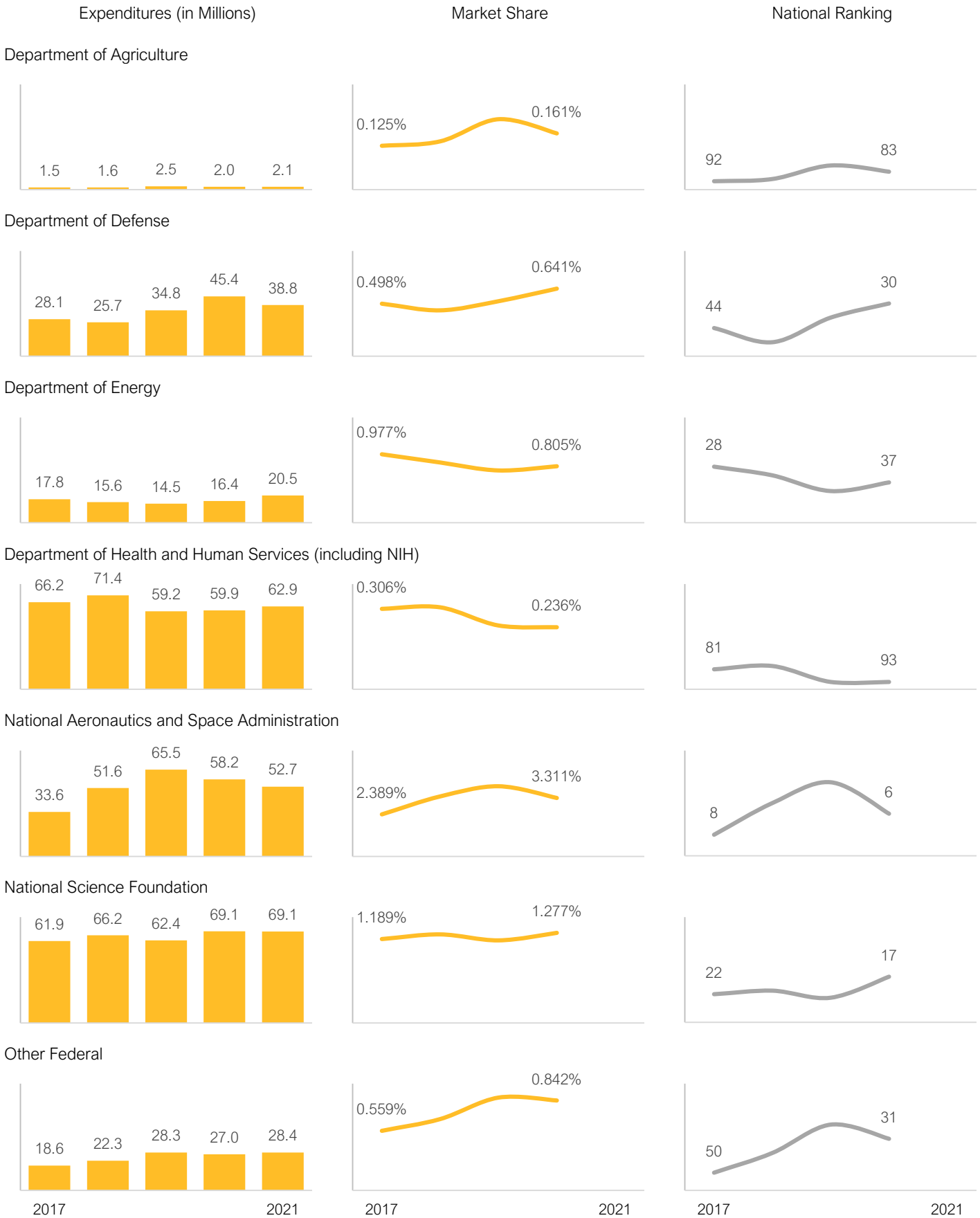
Arizona State University

Exhibit ASU.R.5: Research Expenditures by Sponsor Group



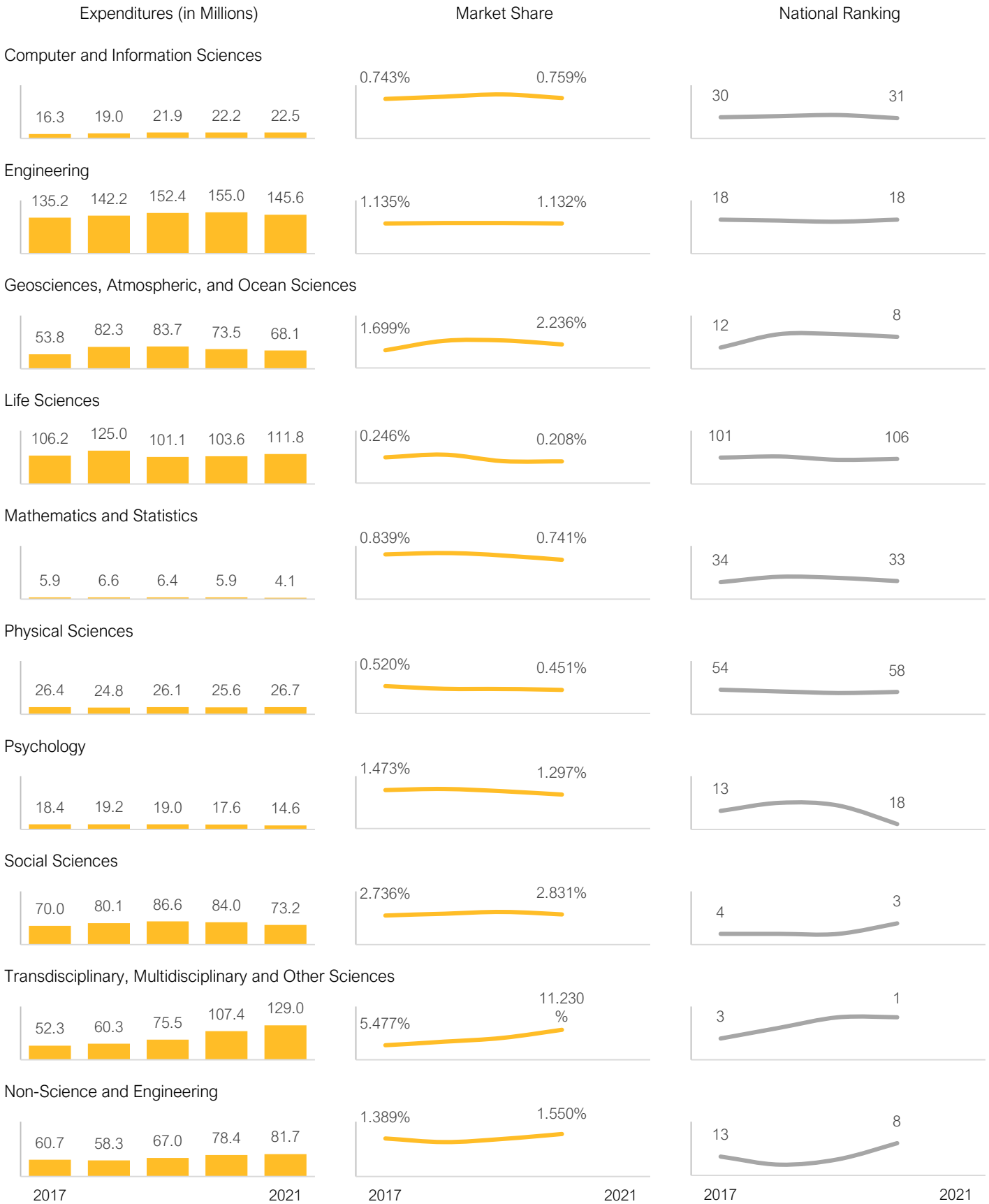
Arizona State University

Exhibit ASU.R.6: Federal Research Expenditures by Federal Agency



Arizona State University

Exhibit ASU.R.7: Total Research Expenditures by Broad Discipline



Arizona State University

Exhibit ASU.R.8: Total Research Expenditures by Detailed Discipline
































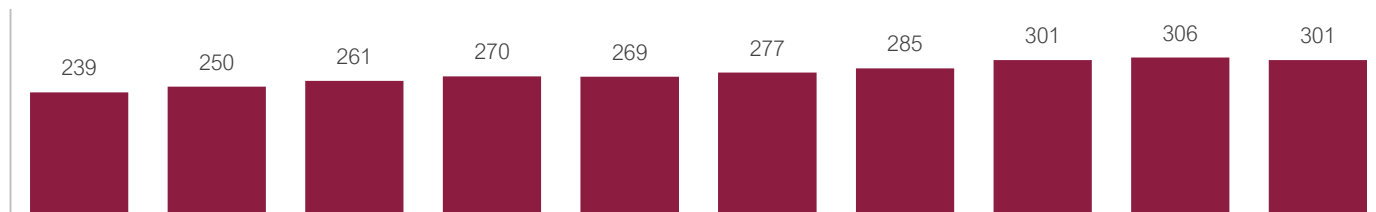
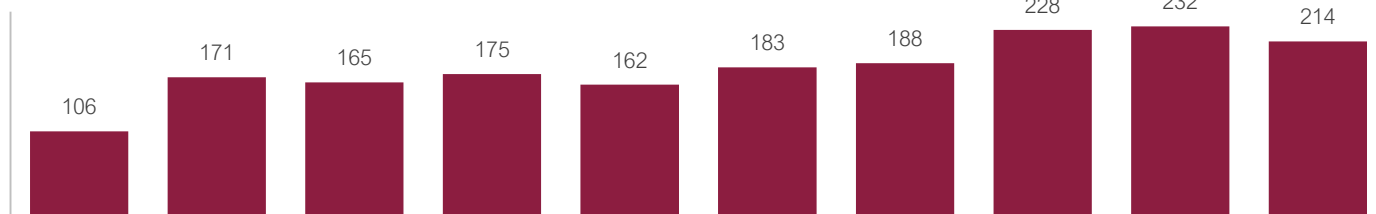
Research Discipline	2021 Expenditures	% of Discipline	% of Total
Computer and Information Sciences	22,498,000	100.0%	3.3%
Computer and Information Sciences	22,498,000 	100.0%	3.3%
Engineering	145,574,000	100%	21.5%
Aerospace, Aeronautical and Astronautical Engineering	0	0.0%	0.0%
Bioengineering and Biomedical Engineering	12,877,000 	8.8%	1.9%
Chemical Engineering	6,943,000 	4.8%	1.0%
Civil Engineering	28,102,000 	19.3%	4.1%
Electrical, Electronic and Communications Engineering	44,972,000 	30.9%	6.6%
Industrial and Manufacturing Engineering	3,255,000 	2.2%	0.5%
Mechanical Engineering	10,462,000 	7.2%	1.5%
Metallurgical and Materials Engineering	8,590,000 	5.9%	1.3%
Other Engineering	30,373,000 	20.9%	4.5%
Geosciences, Atmospheric and Ocean Sciences	68,116,000	100.0%	10.1%
Atmospheric Science and Meteorology	0	0.0%	0.0%
Geological and Earth Sciences	68,116,000 	100.0%	10.1%
Ocean Sciences and Marine Sciences	0	0.0%	0.0%
Other Geosciences, Atmospheric, and Ocean Sciences	0	0.0%	0.0%
Life Sciences	111,790,000	100.0%	16.5%
Agricultural Sciences	0	0.0%	0.0%
Biological and Biomedical Sciences	73,598,000 	65.8%	10.9%
Health Sciences	37,201,000 	33.3%	5.5%
Natural Resources and Conservation	550,000 	0.5%	0.1%
Other Life Sciences	441,000 	0.4%	0.1%
Mathematics and Statistics	4,121,000	100.0%	0.6%
Mathematics and Statistics	4,121,000 	100.0%	0.6%
Physical Sciences	26,742,000	100.0%	3.9%
Astronomy and Astrophysics	0	0.0%	0.0%
Chemistry	11,762,000 	44.0%	1.7%
Materials Science	0	0.0%	0.0%
Physics	14,980,000 	56.0%	2.2%
Other Physical Sciences	0	0.0%	0.0%
Psychology	14,623,000	100.0%	2.2%
Psychology	14,623,000 	100.0%	2.2%
Social Sciences	73,205,000	100.0%	10.8%
Anthropology	12,679,000 	17.3%	1.9%
Economics	7,814,000 	10.7%	1.2%
Political Science and Government	13,141,000 	18.0%	1.9%
Sociology, Demography and Population Studies	3,802,000 	5.2%	0.6%
Other Social Sciences	35,769,000 	48.9%	5.3%
Other Sciences	128,982,000	100.0%	19.0%
Transdisciplinary, Multidisciplinary and Other Sciences	128,982,000 	100.0%	19.0%
Non-Science and Engineering	81,652,000	100.0%	12.1%
Business Management and Business Administration	22,167,000 	27.1%	3.3%
Communication and Communications Technologies	4,074,000 	5.0%	0.6%
Education	33,394,000 	40.9%	4.9%
Humanities	6,877,000 	8.4%	1.0%
Law	4,510,000 	5.5%	0.7%
Social Work	6,789,000 	8.3%	1.0%
Visual and Performing Arts	3,841,000 	4.7%	0.6%
Other Non-Science and Engineering	0	0.0%	0.0%

Exhibit ASU.R.9: Technology Transfer Inputs

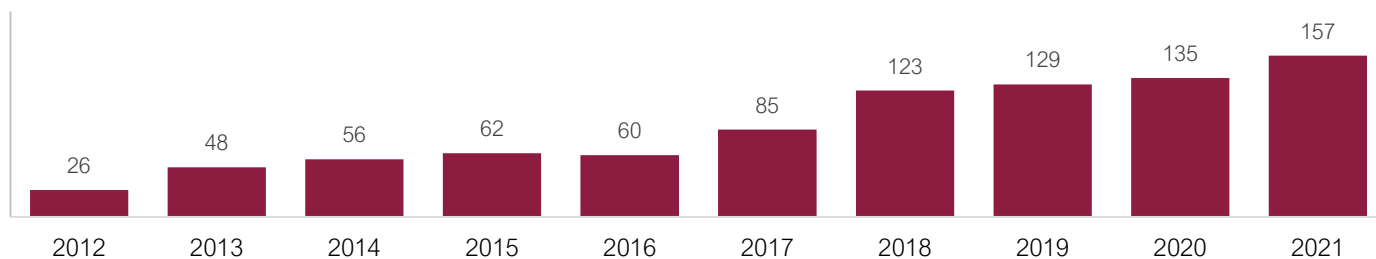
Invention Disclosures Received



New Patent Applications



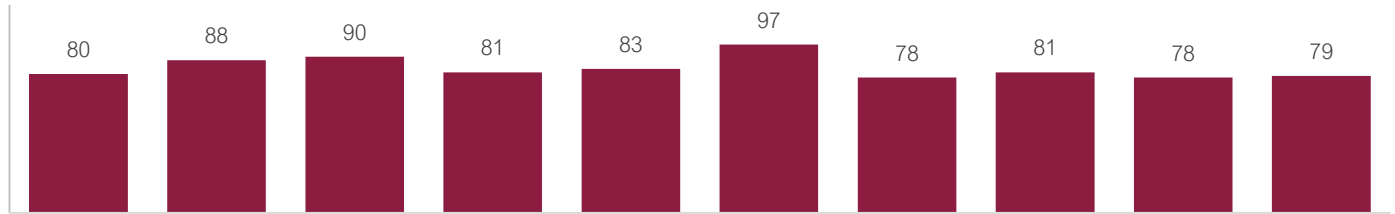
US Patents Issued



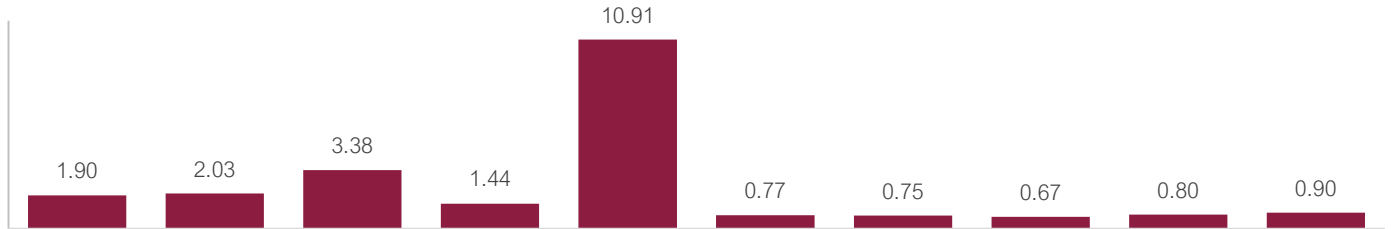
Arizona State University

Exhibit ASU.R.9: Technology Transfer Outputs

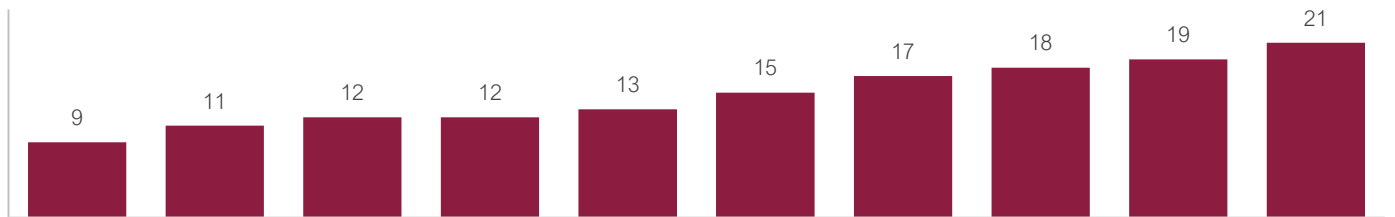
Licenses and Options Executed



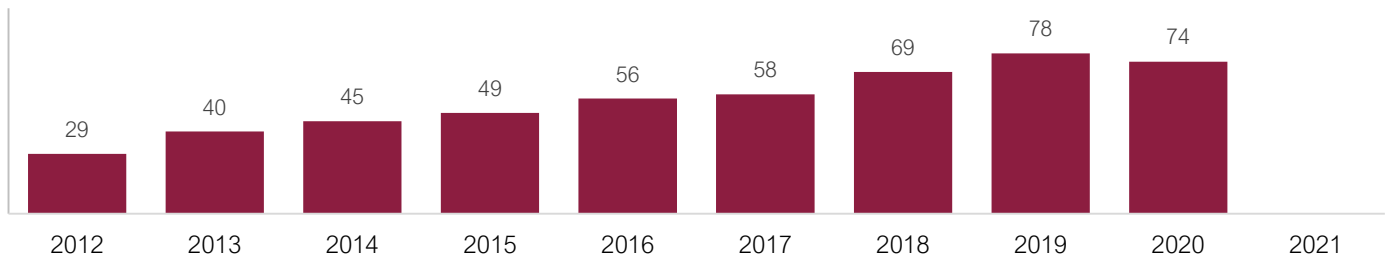
Licences and Options Income (in Millions)



Startups



Cumulative Active Startups

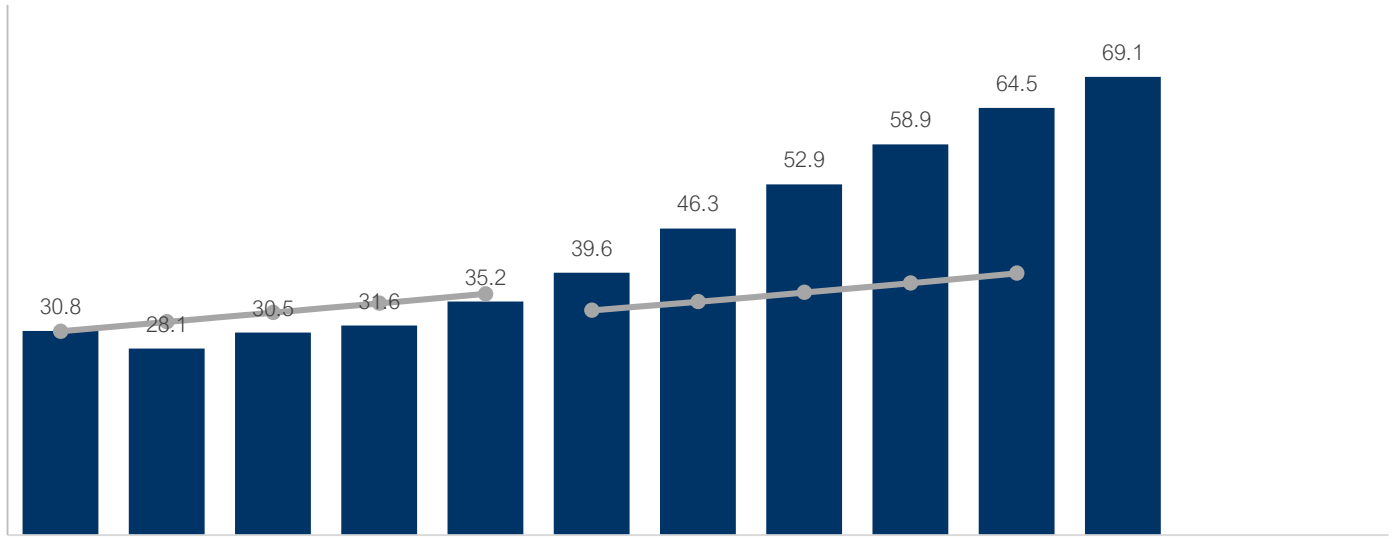


Income and Distributions

Intellectual Property Income	2017	2018	2019	2020	2021
License and Options Income	770,443	750,757	673,945	801,741	903,221
Legal Fees Reimbursed	1,439,171	1,698,294	2,115,725	1,595,385	1,569,821
Other Revenue	219,596	3,608	4,827,623	297,664	136,048
<b>Total</b>	<b>2,429,210</b>	<b>2,452,659</b>	<b>7,617,293</b>	<b>7,617,293</b>	<b>2,609,090</b>
Royalty Distributions	2017	2018	2019	2020	2021
Inventors	-188,875	-258,026	-188,069	-133,068	-236,650
Laboratories and Units	-114,923	-149,979	-130,679	-58,690	-95,173
University	-119,217	-170,570	-128,903	-92,426	-153,765
Undistributed	151,984	14,422	27,200	11,050	49,725
<b>Total</b>	<b>-82,156</b>	<b>-306,127</b>	<b>-232,382</b>	<b>-232,382</b>	<b>-199,213</b>

Exhibit NAU.R.1: Research Expenditures and Enterprise Goals

Research Expenditures and Enterprise Plan Goals (in Millions)



Actual to Enterprise Goal Differences (in Millions)

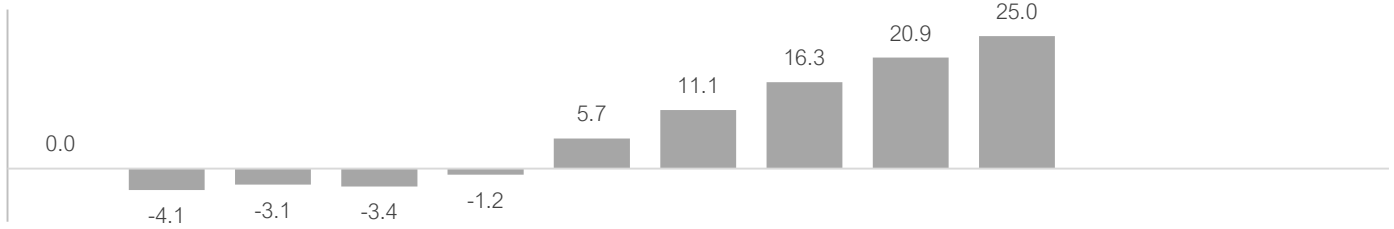
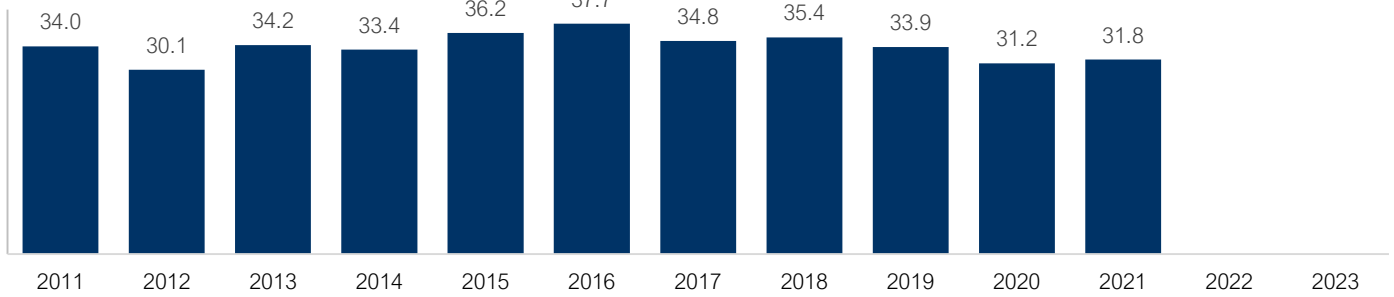


Exhibit NAU.R.2: Other Sponsored Project Expenditures

Other Sponsored Project Expenditures (in Millions)





Northern Arizona University

Exhibit NAU.R.3: Research Expenditures National Comparisons

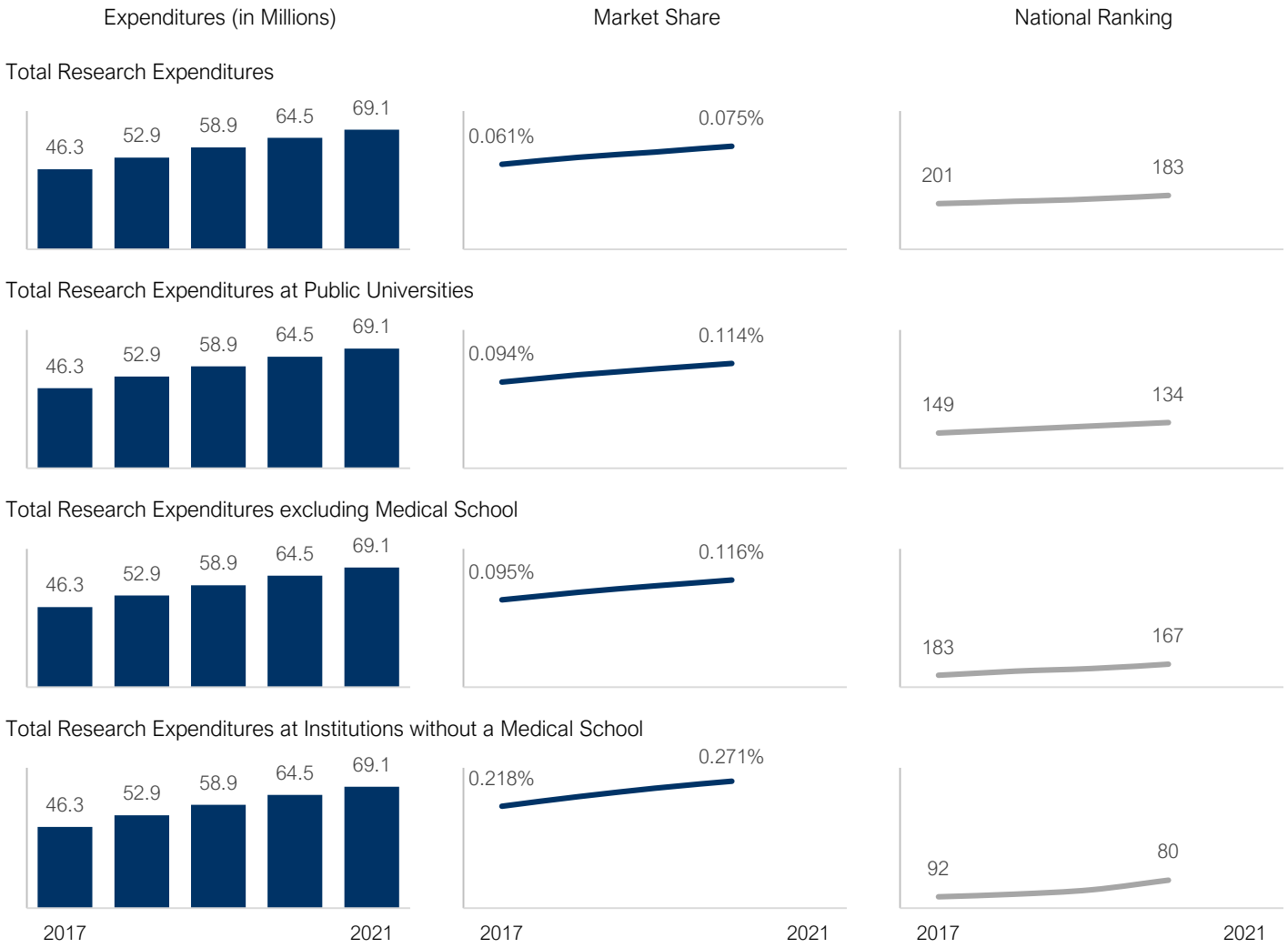
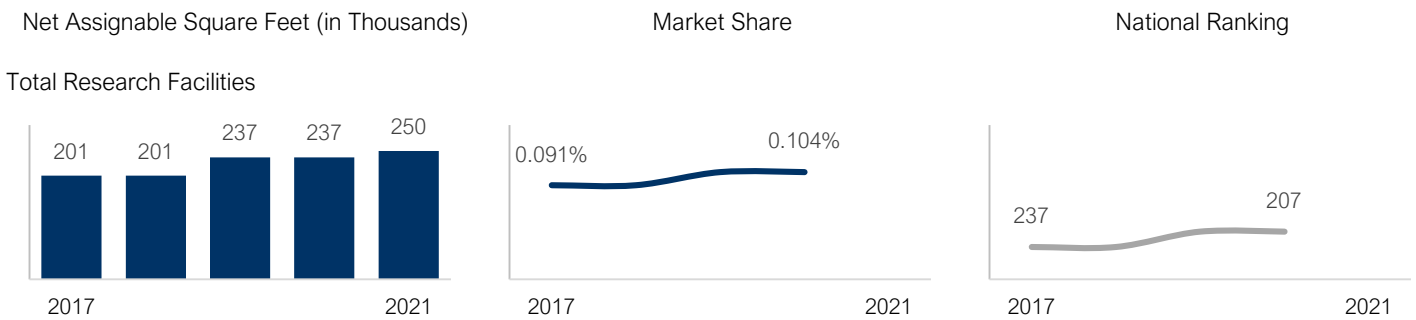


Exhibit NAU.R.4: Research Facilities



Northern Arizona University

Exhibit NAU.R.5: Research Expenditures by Sponsor Group



Northern Arizona University

Exhibit NAU.R.6: Federal Research Expenditures by Federal Agency

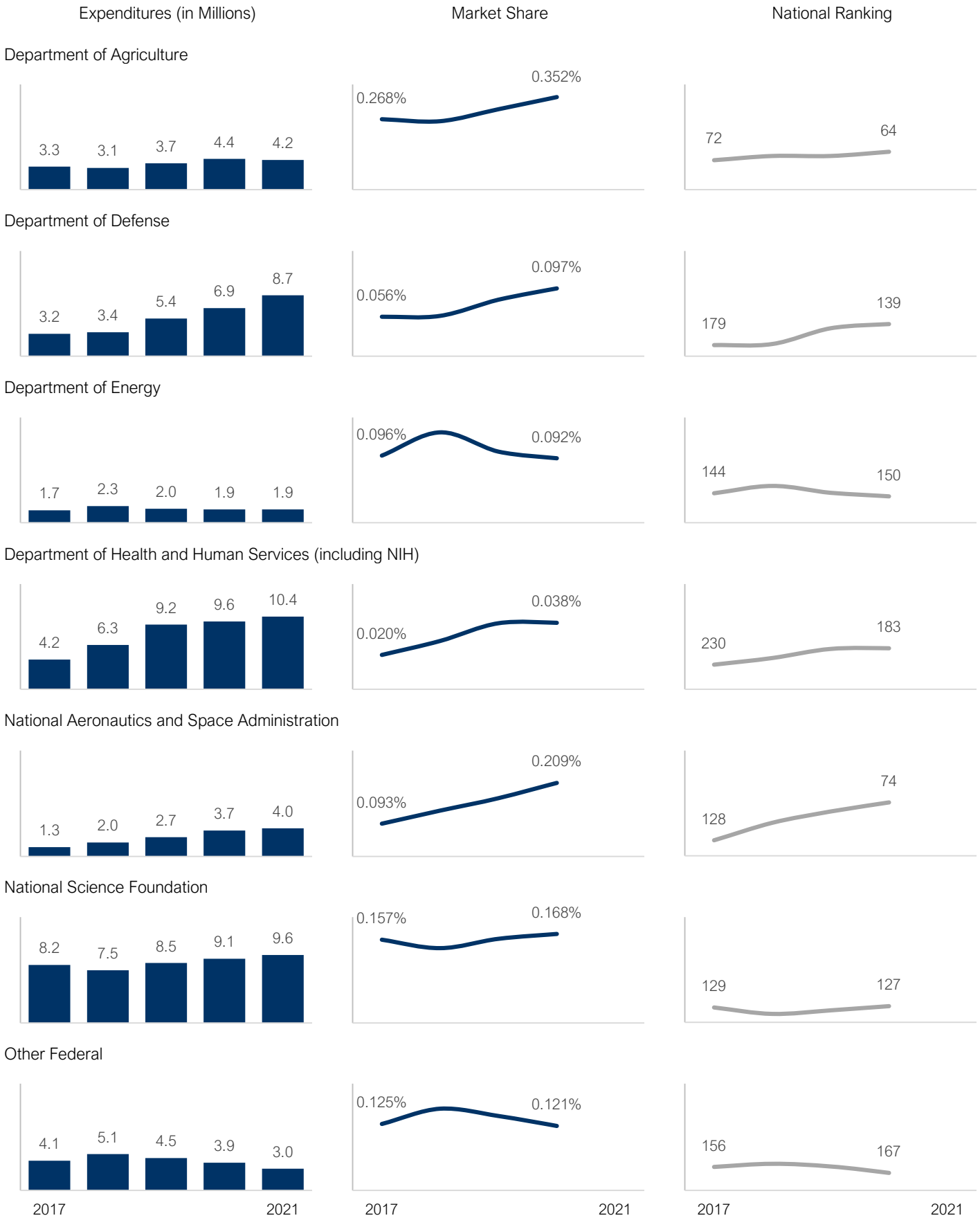
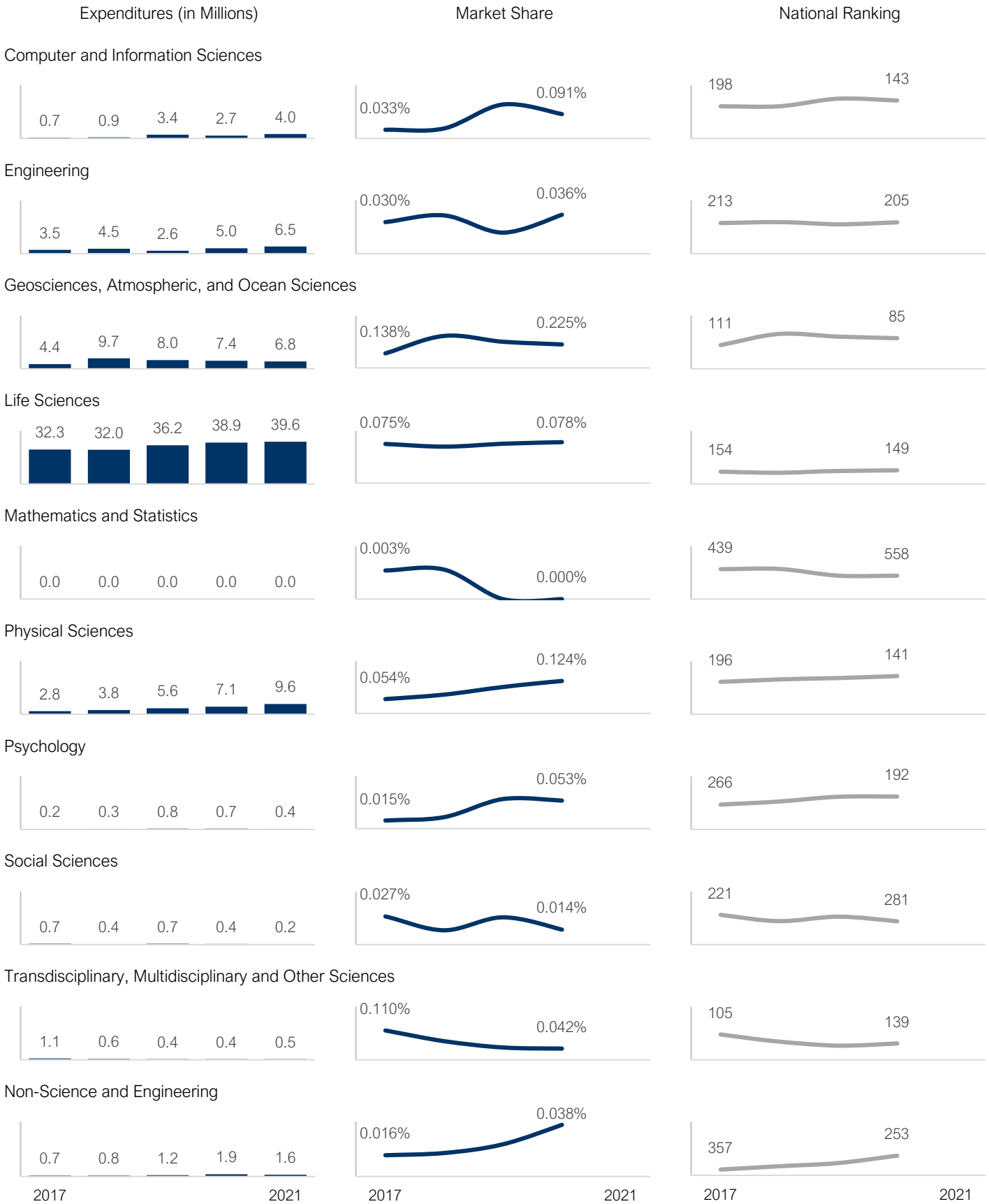


Exhibit NAU.R.7: Total Research Expenditures by Broad Discipline



# Northern Arizona University

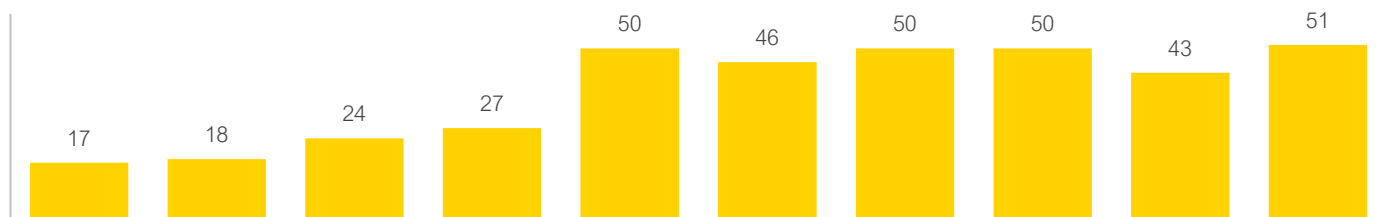
## Exhibit NAU.R.8: Total Research Expenditures by Detailed Discipline

Research Discipline	2021 Expenditures	% of Discipline	% of Total
Computer and Information Sciences	4,037,000	100.0%	6.0%
Computer and Information Sciences	4,037,000	100.0%	6.0%
Engineering	6,496,000	100%	9.6%
Aerospace, Aeronautical and Astronautical Engineering	0	0.0%	0.0%
Bioengineering and Biomedical Engineering	1,213,000	18.7%	1.8%
Chemical Engineering	207,000	3.2%	0.3%
Civil Engineering	322,000	5.0%	0.5%
Electrical, Electronic and Communications Engineering	3,506,000	54.0%	5.2%
Industrial and Manufacturing Engineering	0	0.0%	0.0%
Mechanical Engineering	527,000	8.1%	0.8%
Metallurgical and Materials Engineering	11,000	0.2%	0.0%
Other Engineering	710,000	10.9%	1.1%
Geosciences, Atmospheric and Ocean Sciences	5,261,000	100.0%	7.8%
Atmospheric Science and Meteorology	96,000	1.8%	0.1%
Geological and Earth Sciences	5,124,000	97.4%	7.6%
Ocean Sciences and Marine Sciences	41,000	0.8%	0.1%
Other Geosciences, Atmospheric, and Ocean Sciences	0	0.0%	0.0%
Life Sciences	39,565,000	100.0%	58.5%
Agricultural Sciences	2,170,000	5.5%	3.2%
Biological and Biomedical Sciences	25,622,000	64.8%	37.9%
Health Sciences	5,522,000	14.0%	8.2%
Natural Resources and Conservation	4,940,000	12.5%	7.3%
Other Life Sciences	1,311,000	3.3%	1.9%
Mathematics and Statistics	0	0.0%	0.0%
Mathematics and Statistics	0	0.0%	0.0%
Physical Sciences	9,636,000	100.0%	14.3%
Astronomy and Astrophysics	4,786,000	49.7%	7.1%
Chemistry	780,000	8.1%	1.2%
Materials Science	1,051,000	10.9%	1.6%
Physics	858,000	8.9%	1.3%
Other Physical Sciences	2,161,000	22.4%	3.2%
Psychology	396,000	100.0%	0.6%
Psychology	396,000	100.0%	0.6%
Social Sciences	167,000	100.0%	0.2%
Anthropology	12,000	7.2%	0.0%
Economics	72,000	43.1%	0.1%
Political Science and Government	1,000	0.6%	0.0%
Sociology, Demography and Population Studies	55,000	32.9%	0.1%
Other Social Sciences	27,000	16.2%	0.0%
Other Sciences	468,000	100.0%	0.7%
Transdisciplinary, Multidisciplinary and Other Sciences	468,000	100.0%	0.7%
Non-Science and Engineering	1,572,000	100.0%	2.3%
Business Management and Business Administration	89,000	5.7%	0.1%
Communication and Communications Technologies	203,000	12.9%	0.3%
Education	1,121,000	71.3%	1.7%
Humanities	18,000	1.1%	0.0%
Law	0	0.0%	0.0%
Social Work	66,000	4.2%	0.1%
Visual and Performing Arts	2,000	0.1%	0.0%
Other Non-Science and Engineering	73,000	4.6%	0.1%

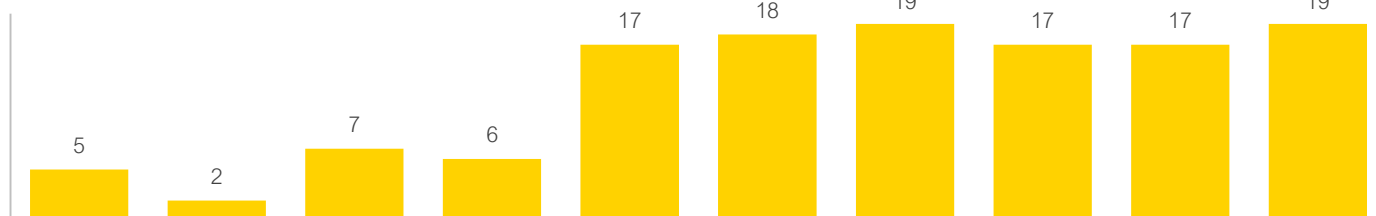
Northern Arizona University

Exhibit NAU.R.9: Technology Transfer Inputs

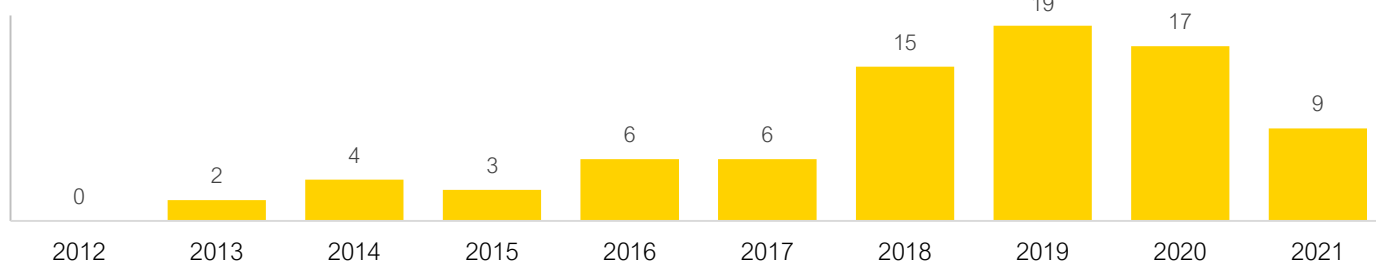
Invention Disclosures Received



New Patent Applications



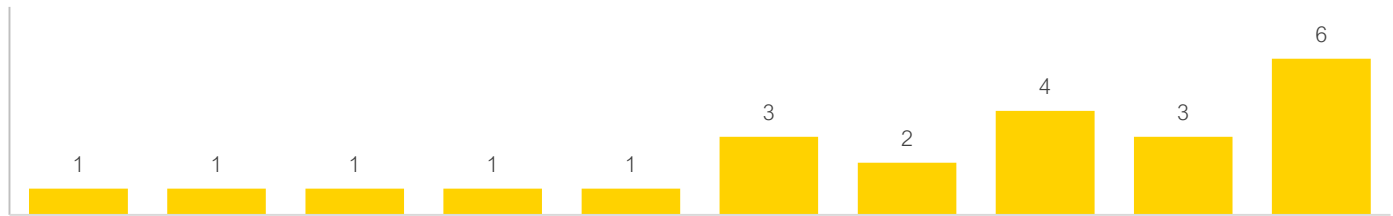
US Patents Issued



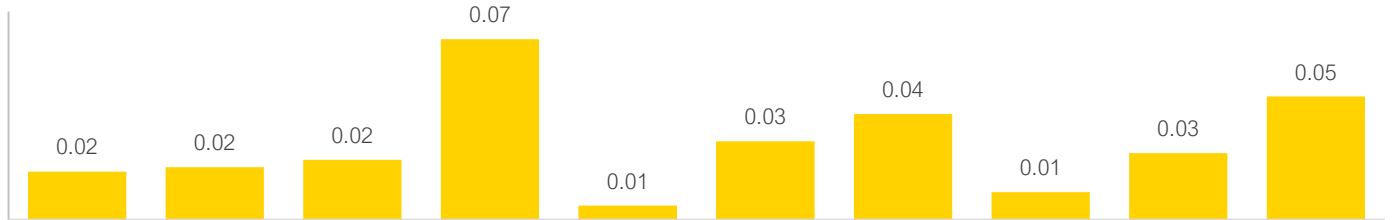
# Northern Arizona University

## Exhibit NAU.R.9: Technology Transfer Outputs

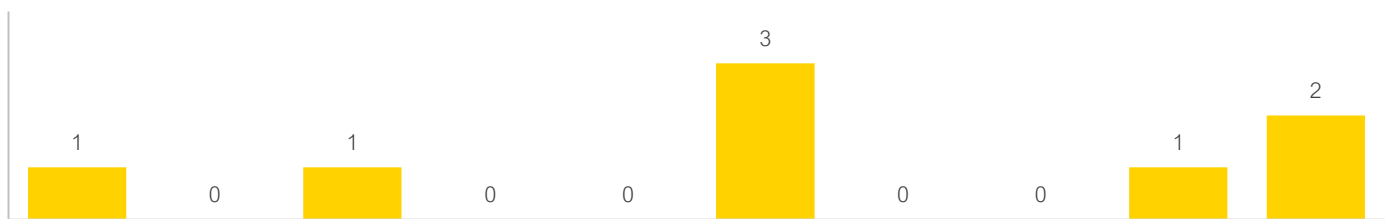
### Licenses and Options Executed



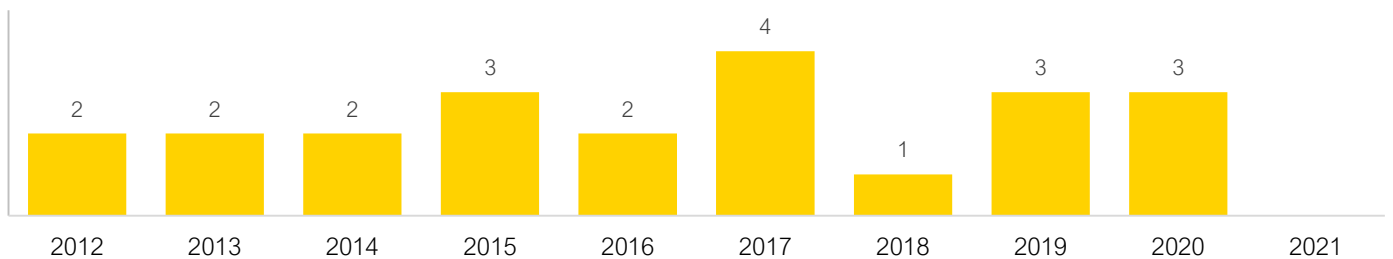
### Licences and Options Income (in Millions)



### Startups



### Cumulative Active Startups

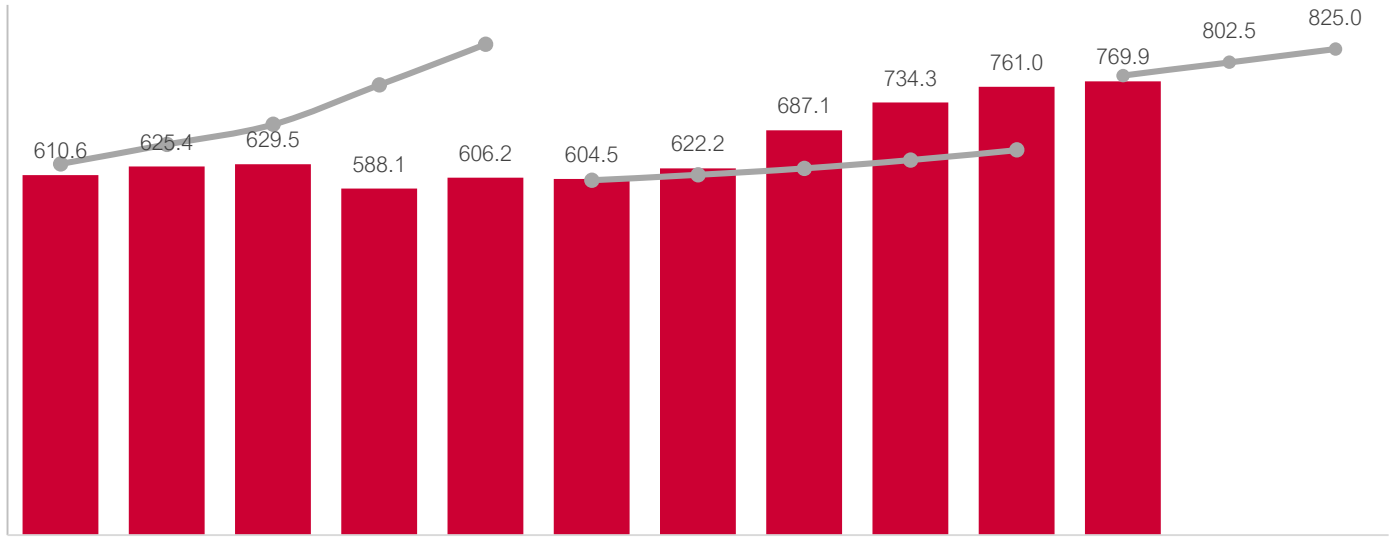


### Income and Distributions

Intellectual Property Income	2017	2018	2019	2020	2021
License and Options Income	30,070	40,549	10,500	25,562	47,315
Legal Fees Reimbursed	14,902	13,079	15,515	5,542	7,511
Other Revenue	0	40,548	0	20,000	0
<b>Total</b>	<b>44,972</b>	<b>94,176</b>	<b>26,015</b>	<b>7,617,293</b>	<b>54,826</b>
Royalty Distributions	2017	2018	2019	2020	2021
Inventors	0	0	-2,619	0	-12,818
Laboratories and Units	0	0	0	0	0
University	0	0	0	0	-3,442
Undistributed	30,070	0	0	0	0
<b>Total</b>	<b>30,070</b>	<b>0</b>	<b>0</b>	<b>-232,382</b>	<b>-3,442</b>

Exhibit UA.R.1: Research Expenditures and Enterprise Goals

Research Expenditures and Enterprise Plan Goals (in Millions)



Actual to Enterprise Goal Differences (in Millions)

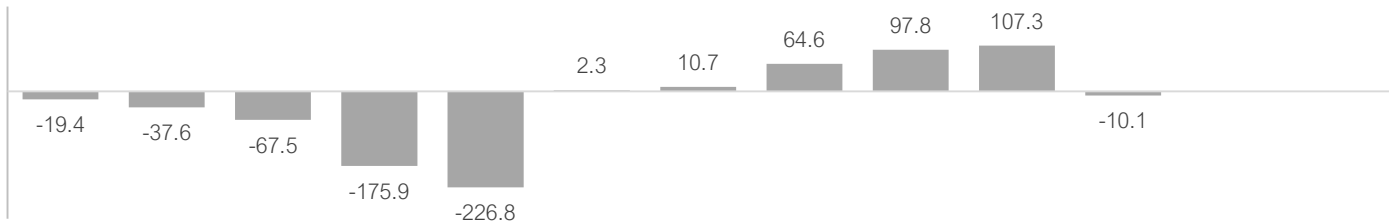


Exhibit UA.R.2: Other Sponsored Project Expenditures

Other Sponsored Project Expenditures (in Millions)

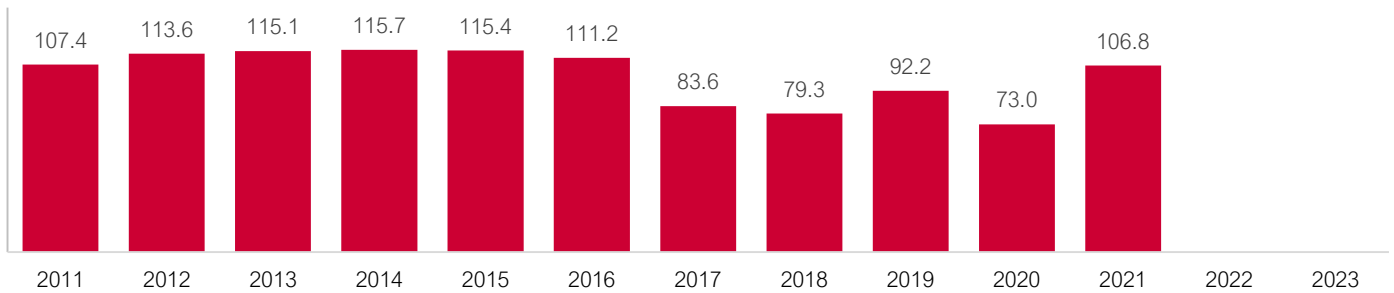




Exhibit UA.R.3: Research Expenditures National Comparisons

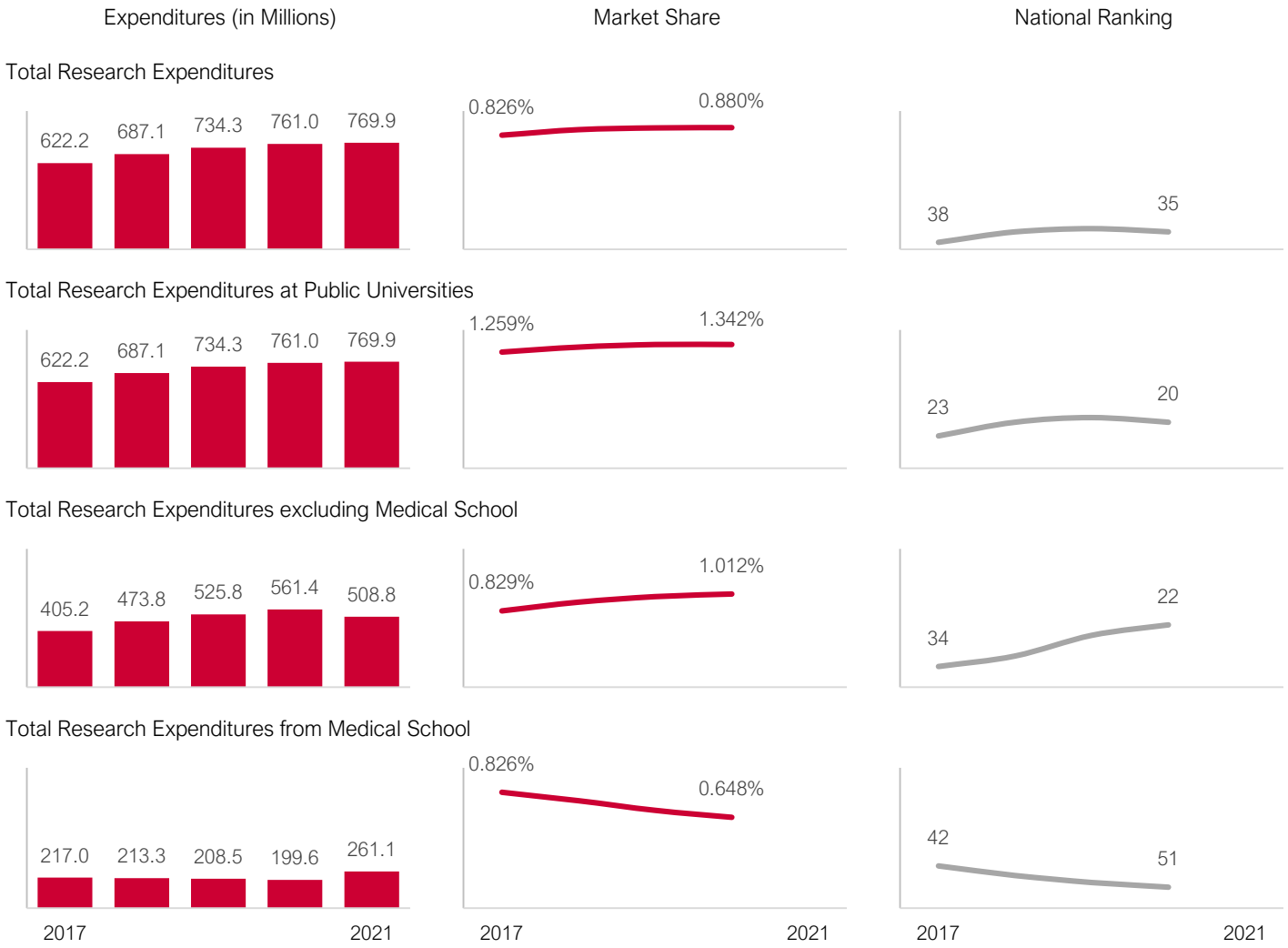


Exhibit UA.R.4: Research Facilities

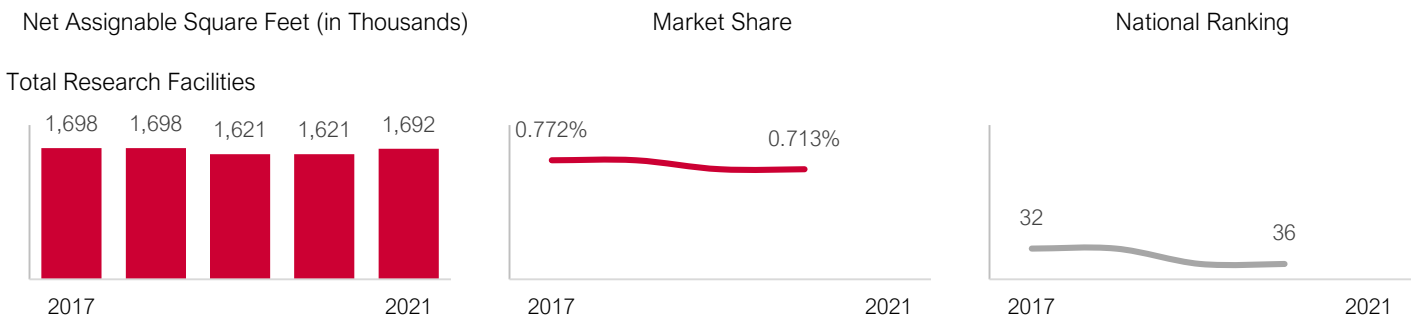


Exhibit UA.R.5: Research Expenditures by Sponsor Group

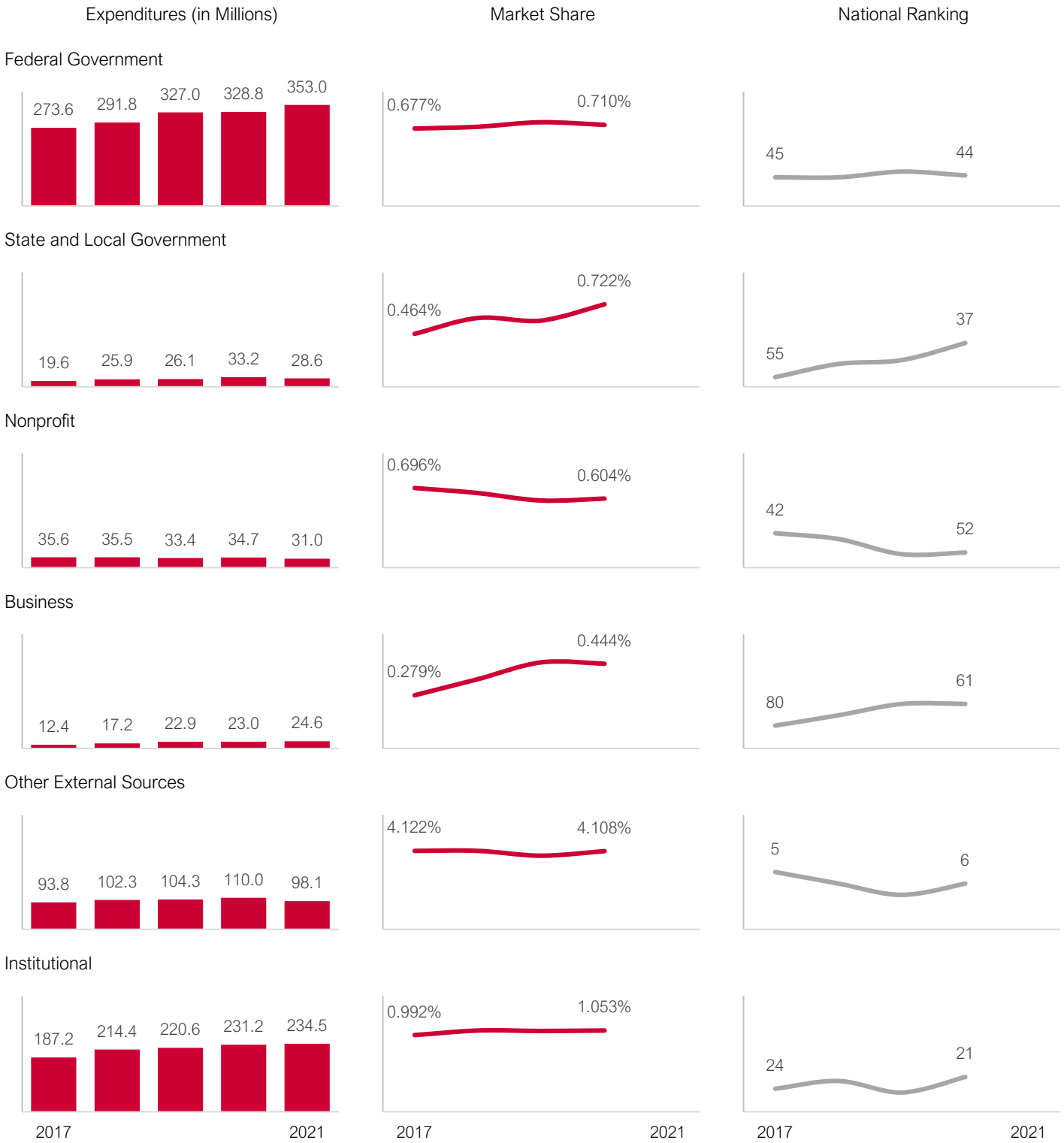


Exhibit UA.R.6: Federal Research Expenditures by Federal Agency

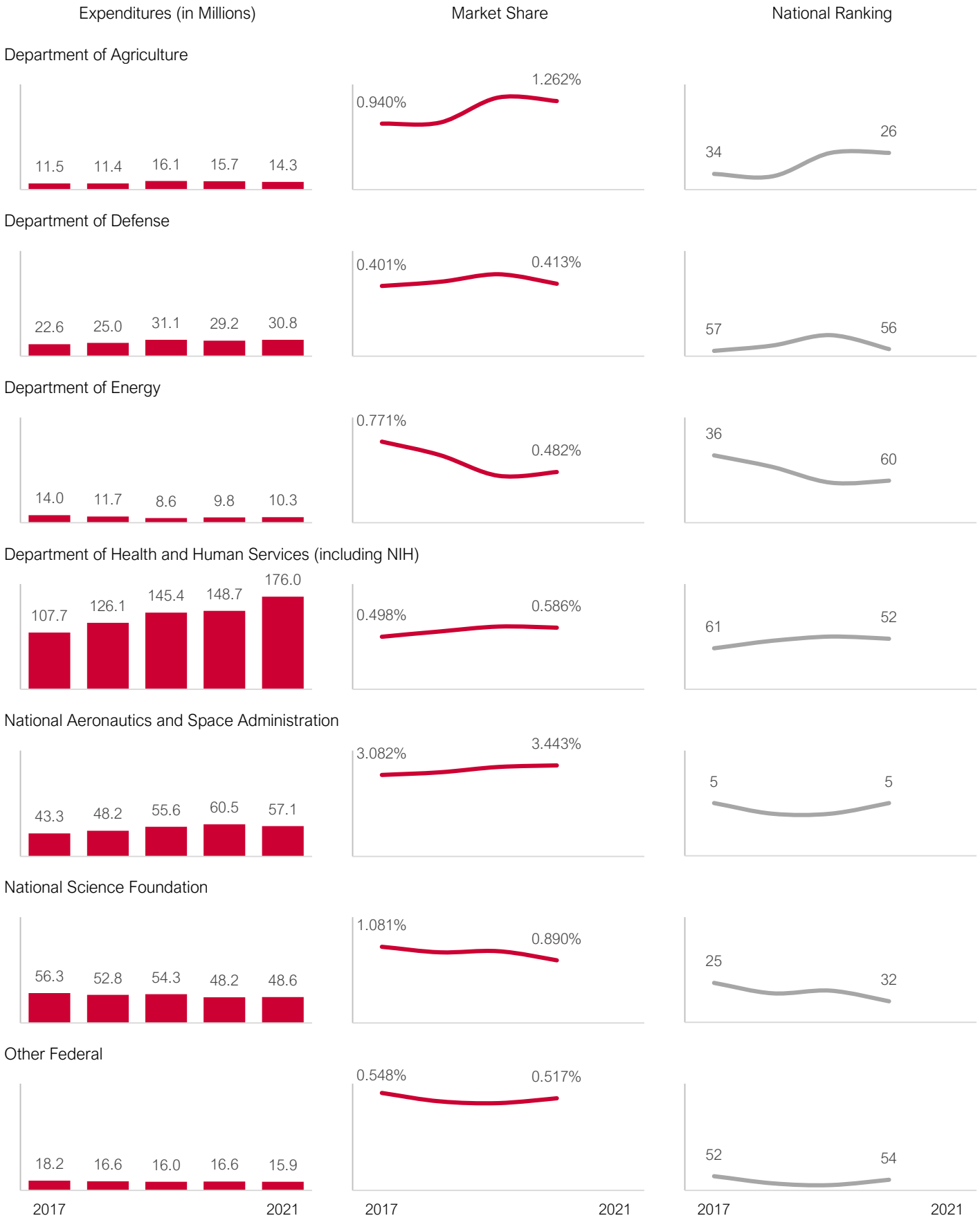


Exhibit UA.R.7: Total Research Expenditures by Broad Discipline



University of Arizona

Exhibit UA.R.8: Total Research Expenditures by Detailed Discipline





































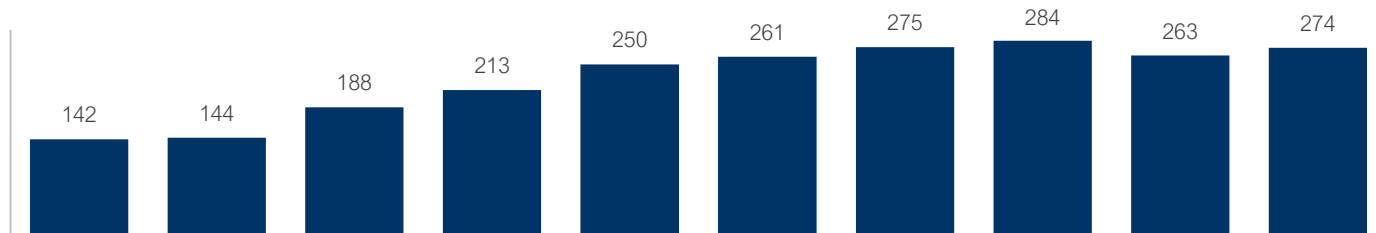
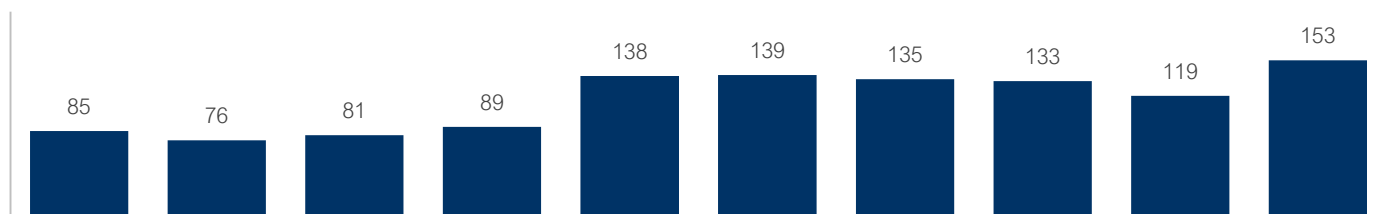
Research Discipline	2021 Expenditures	% of Discipline	% of Total
Computer and Information Sciences	16,499,000	100.0%	2.1%
Computer and Information Sciences	16,499,000 	100.0%	2.1%
Engineering	72,114,000	100%	9.4%
Aerospace, Aeronautical and Astronautical Engineering	1,617,000 	2.2%	0.2%
Bioengineering and Biomedical Engineering	8,350,000 	11.6%	1.1%
Chemical Engineering	5,636,000 	7.8%	0.7%
Civil Engineering	1,572,000 	2.2%	0.2%
Electrical, Electronic and Communications Engineering	34,705,000 	48.1%	4.5%
Industrial and Manufacturing Engineering	4,095,000 	5.7%	0.5%
Mechanical Engineering	3,855,000 	5.3%	0.5%
Metallurgical and Materials Engineering	8,391,000 	11.6%	1.1%
Other Engineering	3,893,000 	5.4%	0.5%
Geosciences, Atmospheric and Ocean Sciences	31,172,000	100.0%	4.1%
Atmospheric Science and Meteorology	7,270,000 	23.3%	0.9%
Geological and Earth Sciences	21,642,000 	69.4%	2.8%
Ocean Sciences and Marine Sciences	2,260,000 	7.3%	0.3%
Other Geosciences, Atmospheric, and Ocean Sciences	0	0.0%	0.0%
Life Sciences	447,558,000	100.0%	58.2%
Agricultural Sciences	50,575,000 	11.3%	6.6%
Biological and Biomedical Sciences	221,765,000 	49.6%	28.8%
Health Sciences	162,740,000 	36.4%	21.2%
Natural Resources and Conservation	12,478,000 	2.8%	1.6%
Other Life Sciences	0	0.0%	0.0%
Mathematics and Statistics	3,345,000	100.0%	0.4%
Mathematics and Statistics	3,345,000 	100.0%	0.4%
Physical Sciences	140,636,000	100.0%	18.3%
Astronomy and Astrophysics	113,361,000 	80.6%	14.7%
Chemistry	15,243,000 	10.8%	2.0%
Materials Science	2,915,000 	2.1%	0.4%
Physics	9,065,000 	6.4%	1.2%
Other Physical Sciences	52,000	0.0%	0.0%
Psychology	4,250,000	100.0%	0.6%
Psychology	4,250,000 	100.0%	0.6%
Social Sciences	18,614,000	100.0%	2.4%
Anthropology	3,481,000 	18.7%	0.5%
Economics	2,777,000 	14.9%	0.4%
Political Science and Government	599,000 	3.2%	0.1%
Sociology, Demography and Population Studies	4,121,000 	22.1%	0.5%
Other Social Sciences	7,636,000 	41.0%	1.0%
Other Sciences	6,155,000	100.0%	0.8%
Transdisciplinary, Multidisciplinary and Other Sciences	6,155,000 	100.0%	0.8%
Non-Science and Engineering	28,636,000	100.0%	3.7%
Business Management and Business Administration	7,942,000 	27.7%	1.0%
Communication and Communications Technologies	122,000 	0.4%	0.0%
Education	5,938,000 	20.7%	0.8%
Humanities	4,600,000 	16.1%	0.6%
Law	3,528,000 	12.3%	0.5%
Social Work	0	0.0%	0.0%
Visual and Performing Arts	5,039,000 	17.6%	0.7%
Other Non-Science and Engineering	1,467,000 	5.1%	0.2%

Exhibit UA.R.9: Technology Transfer Inputs

Invention Disclosures Received



New Patent Applications



US Patents Issued

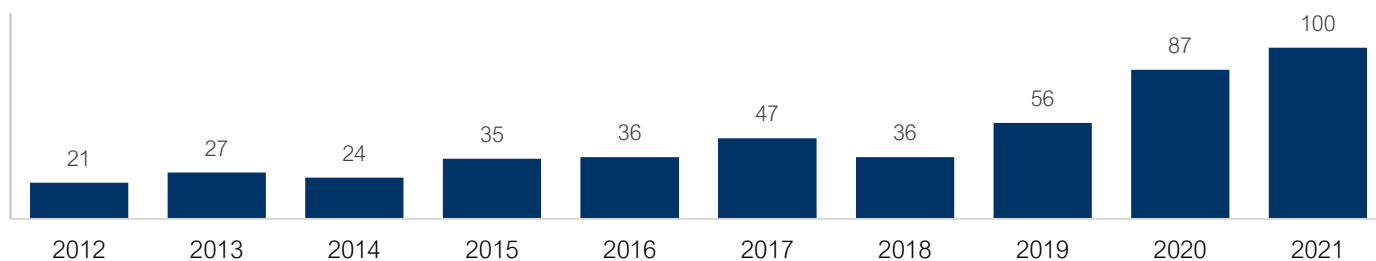
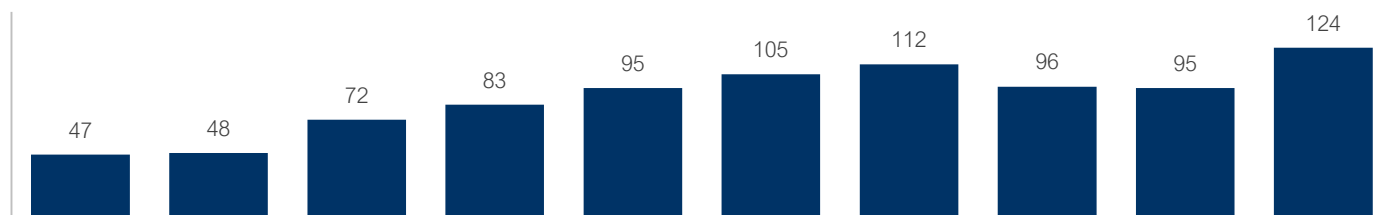
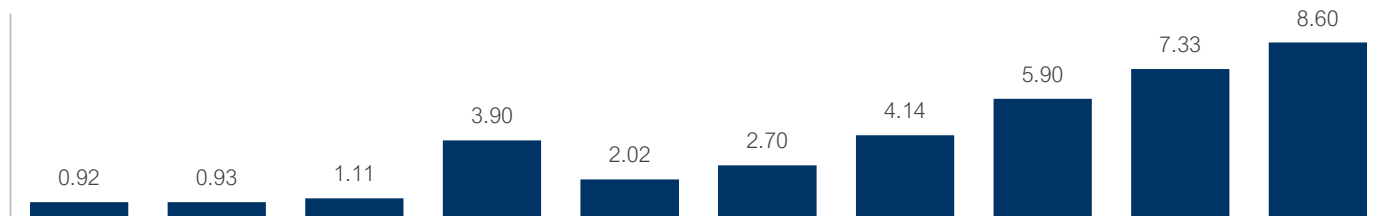


Exhibit UA.R.9: Technology Transfer Outputs

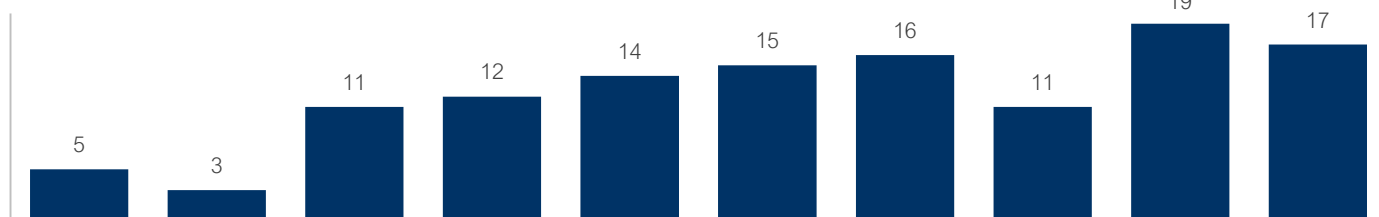
Licenses and Options Executed



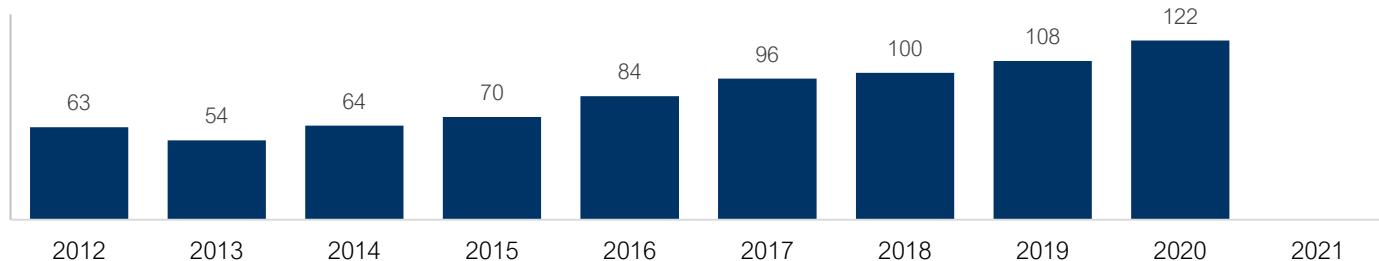
Licences and Options Income (in Millions)



Startups



Cumulative Active Startups



Income and Distributions

Intellectual Property Income	2017	2018	2019	2020	2021
License and Options Income	2,703,261	4,141,604	5,901,957	7,333,122	8,603,693
Legal Fees Reimbursed	629,368	651,410	828,539	993,655	1,021,416
Other Revenue	0	0	0	0	0
<b>Total</b>	<b>3,332,629</b>	<b>4,793,014</b>	<b>6,730,496</b>	<b>7,617,293</b>	<b>9,625,109</b>
Royalty Distributions	2017	2018	2019	2020	2021
Inventors	-946,141	-1,403,012	-1,904,368	-2,435,343	-2,867,783
Laboratories and Units	-865,044	-1,276,847	-1,708,098	-2,157,018	-2,569,805
University	-729,881	-1,383,993	-1,839,490	-2,365,761	-2,866,105
Undistributed	150,000	77,751	450,000	375,000	300,000
<b>Total</b>	<b>-1,444,925</b>	<b>-2,583,089</b>	<b>-3,097,588</b>	<b>-232,382</b>	<b>-5,135,910</b>



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