

# RESEARCH AND TECHNOLOGY TRANSFER ACTIVITY REPORT

FISCAL YEAR 2022





## 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.

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

May 12, 2023



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## EXECUTIVE SUMMARY

Research and knowledge created at Arizona's public universities are essential to our state'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 2022, the universities' research activities attracted funding to provide wages and tuition support for almost 20,000 faculty, staff and students.

Note: A large portion of research funding is competitively awarded by the federal government with additional support from industry and other sources. The benchmark national metric is annual research expenditures, rather than overall research award amounts that often cover multiple years.

### ENTERPRISE

Arizona's public universities' research activity continues to grow, exceeding targets set by the board in each of the last seven years. In fiscal year 2022, Arizona public universities' research activity – as measured by research expenditures – grew year-over-year by \$171.8 million or 11.3 percent to exceed \$1.6 billion. Other (non-research) sponsored projects totaled \$455.5 million in fiscal year 2022, which combined with research totals over \$2.1 billion dollars in overall sponsored project expenditures at the enterprise level.

### ARIZONA STATE UNIVERSITY

ASU's funded research activity – as measured by research expenditures – totaled over \$797.2 million in fiscal year 2022, exceeding fiscal year 2021's expenditures by \$119.9 million or 17.7 percent. ASU exceeded this year's projected metric target set by the board and has cumulatively exceeded its goals by \$171.9 million over the past 10 years.

ASU's total research expenditures ranking stayed about the same, descending from No. 41 in 2018 to No. 42 in 2021 among all U.S. universities and from No. 24 in 2018 to No. 25 in 2021 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. 18 in National Science Foundation funded expenditures.

ASU ranks among the top 10 universities in research expenditures in social sciences, geosciences, and atmospheric and ocean sciences. The university excels at No. 1 in the country in research expenditures for transdisciplinary, multidisciplinary and other sciences. ASU also ranks among the top 50 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, biological and biomedical sciences, as well as electrical, electronic and communications engineering.

In technology transfer, ASU entered into 75 license and option agreements, earned 167 patents and formed 21 startup companies in fiscal year 2022.



## **NORTHERN ARIZONA UNIVERSITY**

NAU's research activity – as measured by research expenditures – totaled \$66.7 million in fiscal year 2022, falling short of its fiscal year 2021 expenditures by \$2.4 million or 3.5 percent. While this decrease means that NAU narrowly missed its metric target in 2022, note that the university recently revised its projected metric targets and these reflect substantial increases over previous targets; the university cumulatively exceeded its goals by \$70.2 million over the past 10 years.

NAU's total research expenditure ranking rose significantly, improving from No. 196 in 2018 to No. 178 in 2021 among all U.S. universities, and No. 144 in 2018 to No. 129 in 2022 among U.S. public universities. NAU ranks No. 63 in Department of Agriculture funded research and No. 62 in NASA funded research. NAU also ranks No. 88 nationally in geoscience, and atmospheric and ocean sciences.

NAU significantly improved its ranking in computer and information sciences, increasing from No. 196 in 2018 to No. 123 in 2021. NAU's top disciplines for research expenditures are in the life sciences, specifically biological and biomedical sciences. In technology transfer, NAU slightly decreased its invention disclosures in 2022, receiving 48 disclosures. NAU earned 19 patents and formed two startup companies in 2022.

## **UNIVERSITY OF ARIZONA**

UArizona's research activity – as measured by research expenditures – totaled \$824.3 million, surpassing its fiscal year 2021 expenditures by \$54.3 million or 7.1 percent.

UArizona's annual research expenditures increased by \$198.9 million or 31.8 percent over the past 10 years. UArizona achieved its projected metric target for this year, as it has done in most years since 2016. However, unrealistically high targets in the early part of the last decade meant it cumulatively missed its goals by \$175.7 million over the past 10 years.

UArizona's total research expenditure ranking remains stable, slightly decreasing from No. 35 in 2018 to No. 36 in 2021 among all U.S. universities, and staying at No. 20 in 2018 to 2021 among U.S. public universities. The university ranks No. 5 in NASA, No. 29 in Department of Agriculture and No. 35 in National Science Foundation funded research. UArizona continues to maintain its national rankings in physical sciences from No. 5 in 2018 to No. 6 in 2021 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, astronomy and astrophysics.

UArizona's technology transfer and commercialization activities, and licenses and options income were the second highest on record in 2022 - entering into 116 license and option agreements, representing a 6.5 percent decrease from 2021. Licensing and options income grew from \$8.6 million to \$10.48 million – a 21.9 percent year-over-year increase and an eleven-fold increase over the past 10 years. Over \$9.5 million of the licensing and option income was distributed back to inventors, and their laboratories and units.

In fiscal year 2022, UArizona earned 87 U.S. patents and formed 10 startup companies.



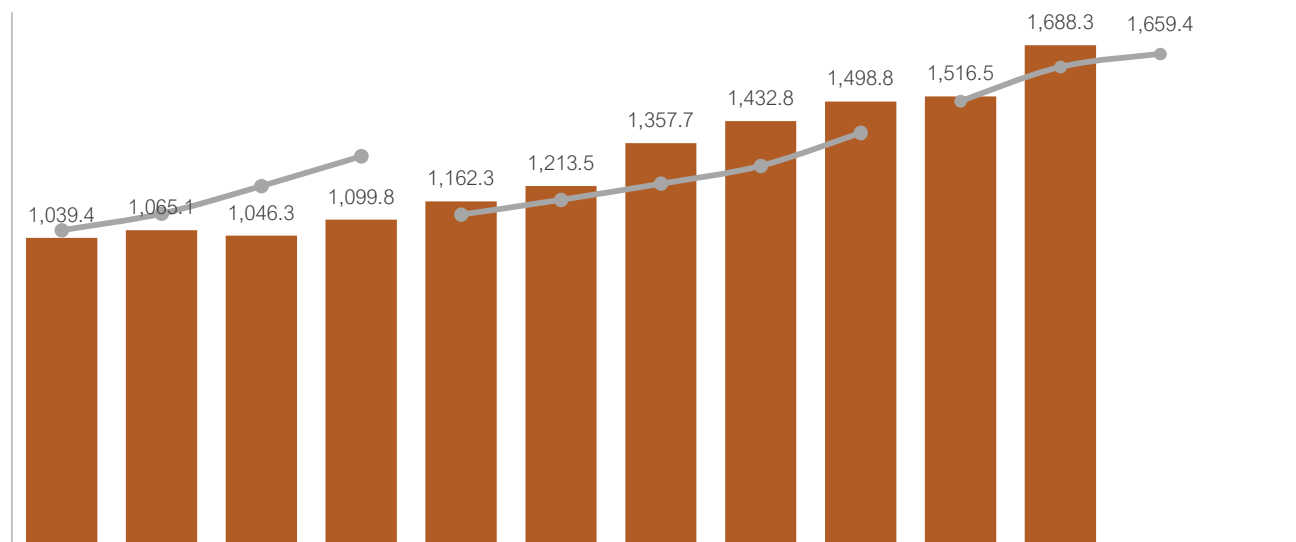




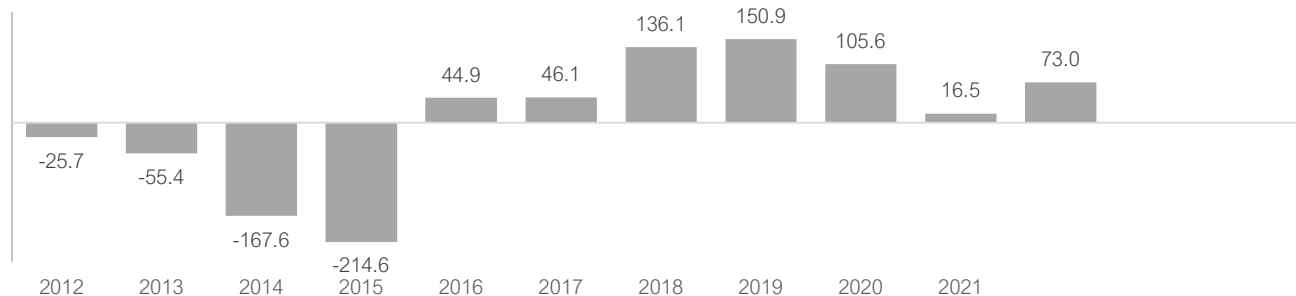
## Enterprise

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

Research Expenditures and Enterprise Plan Goals (in Millions)



Actual to Enterprise Goal Differences (in Millions)



### Exhibit E.R.2: Other Sponsored Project Expenditures

Other Sponsored Project Expenditures (in Millions)

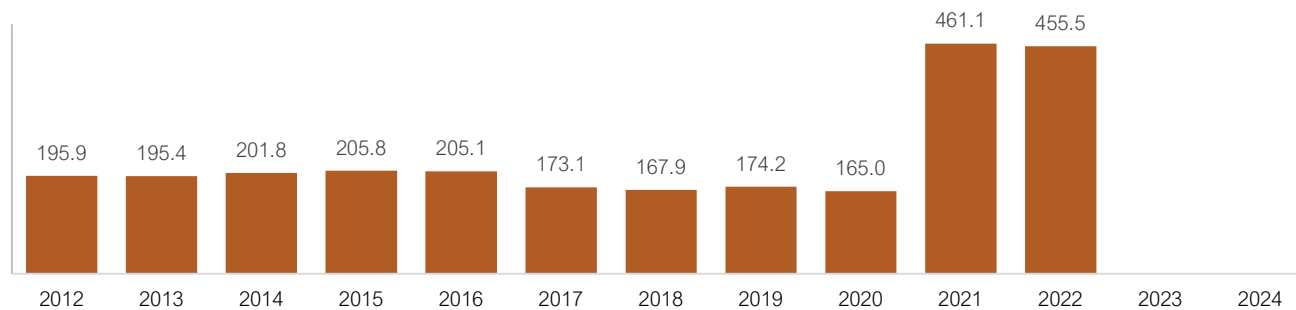
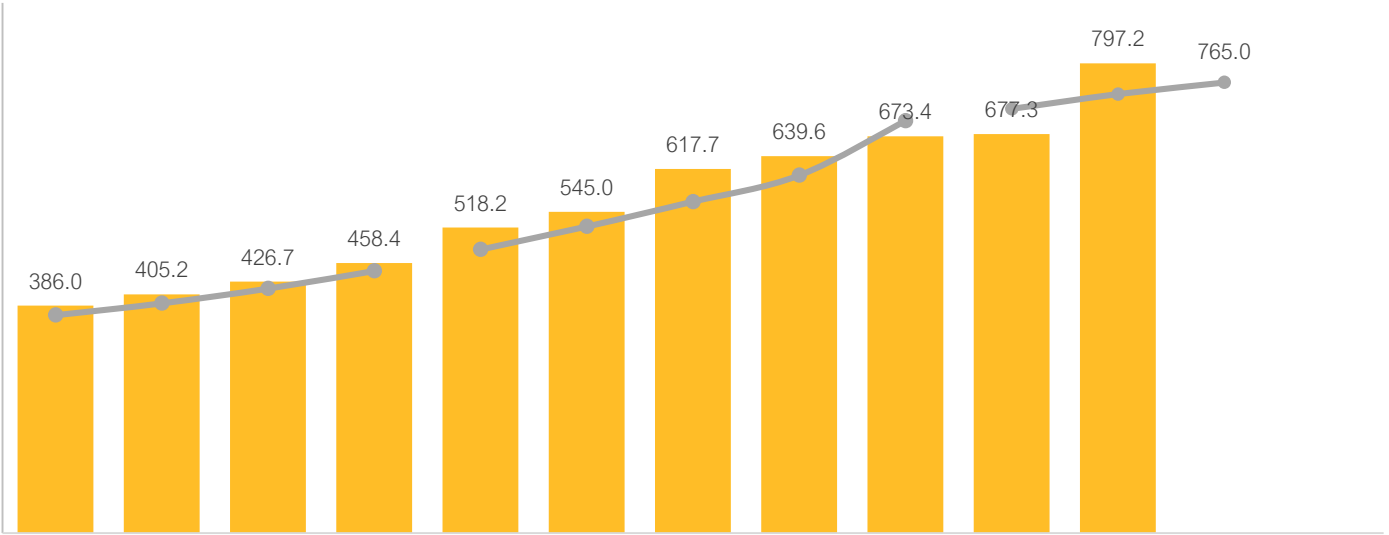


Exhibit ASU.R.1: Research Expenditures and Enterprise Goals

Research Expenditures and Enterprise Plan Goals (in Millions)



Actual to Enterprise Goal Differences (in Millions)

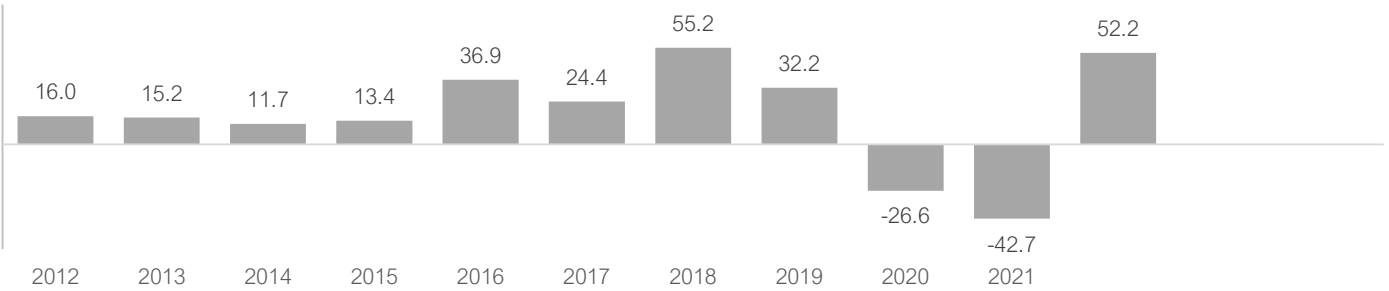
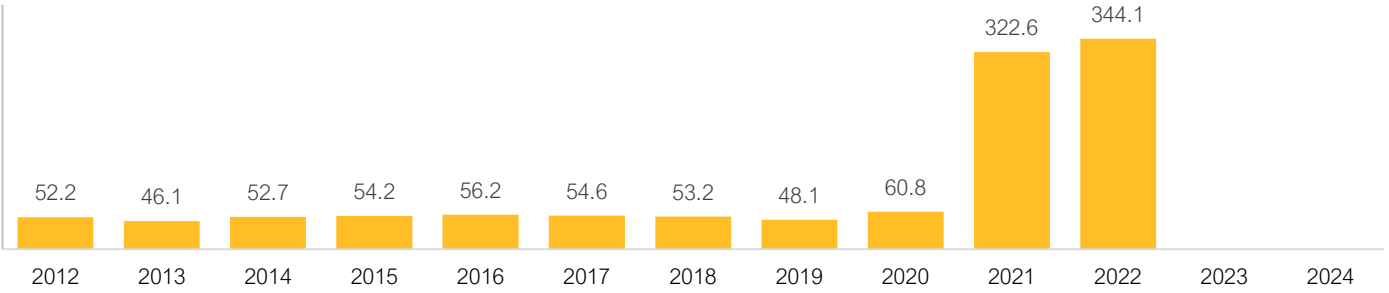


Exhibit ASU.R.2: Other Sponsored Project Expenditures

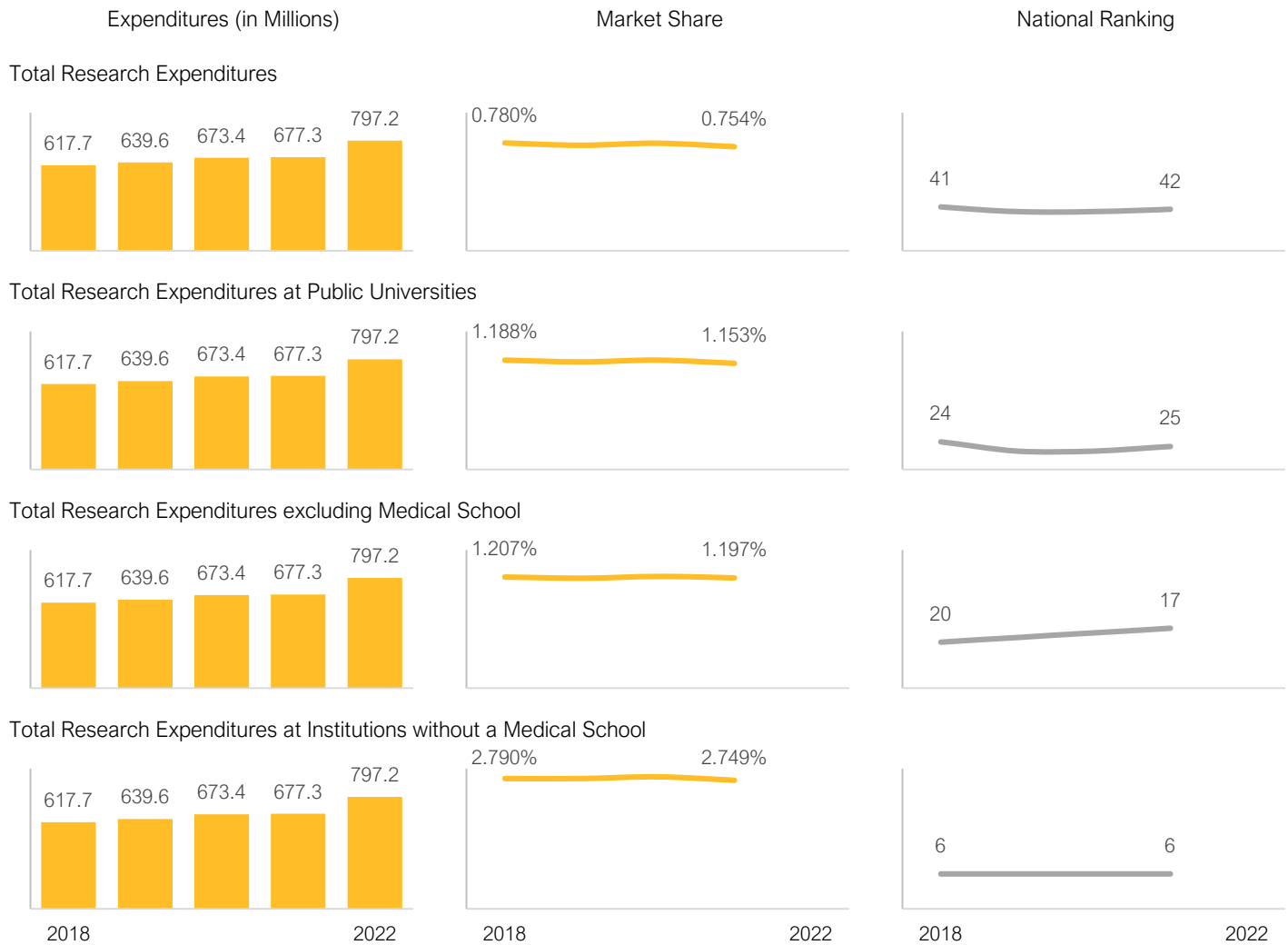
Other Sponsored Project Expenditures (in Millions)



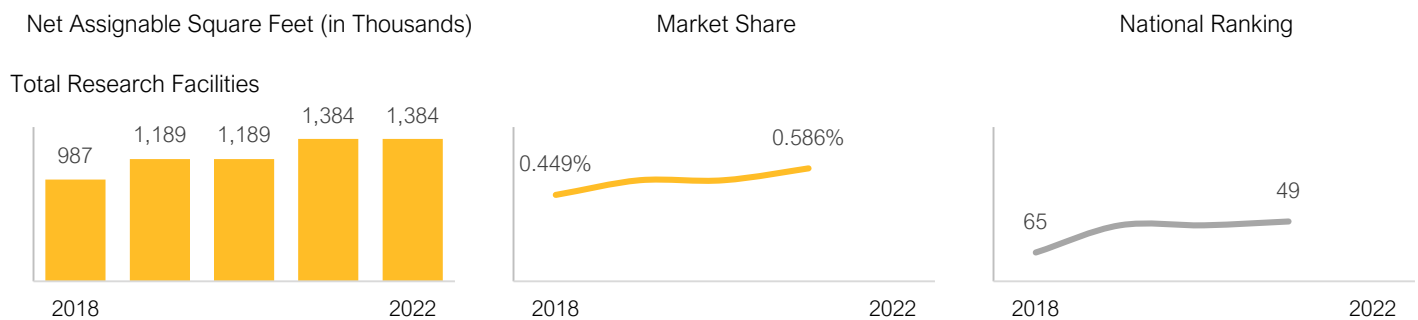


## Arizona State University

### 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

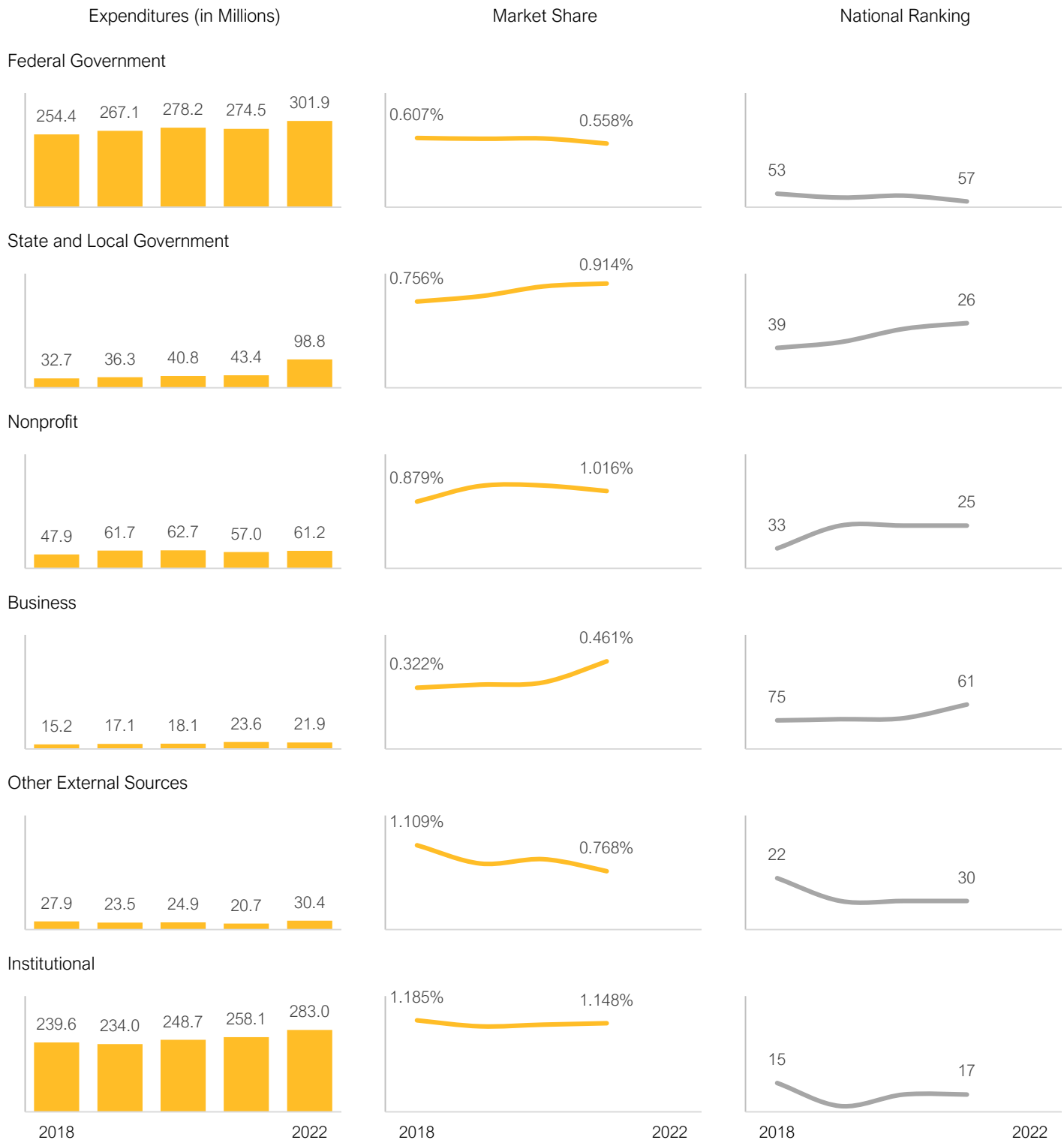


Exhibit ASU.R.6: Federal Research Expenditures by Federal Agency

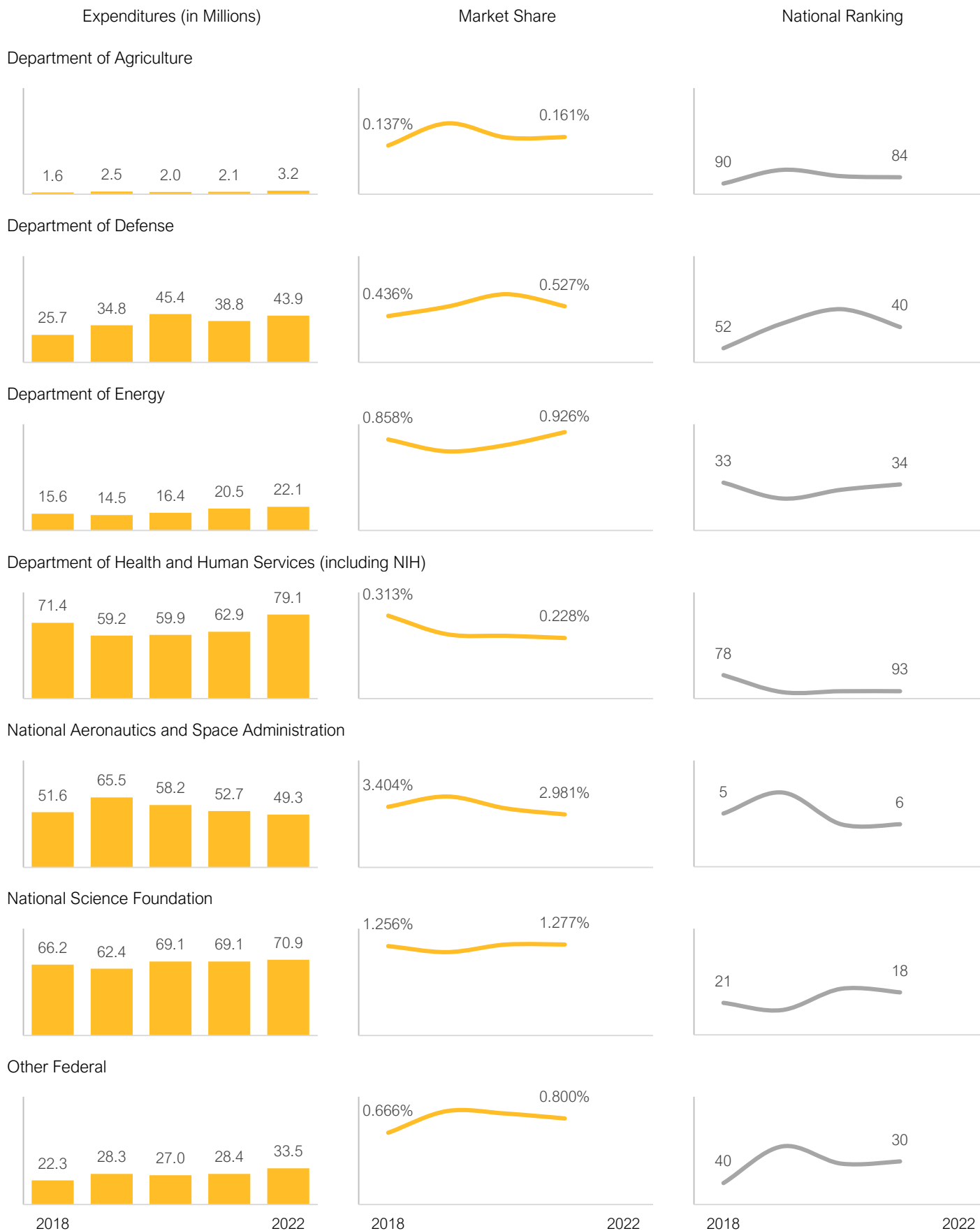
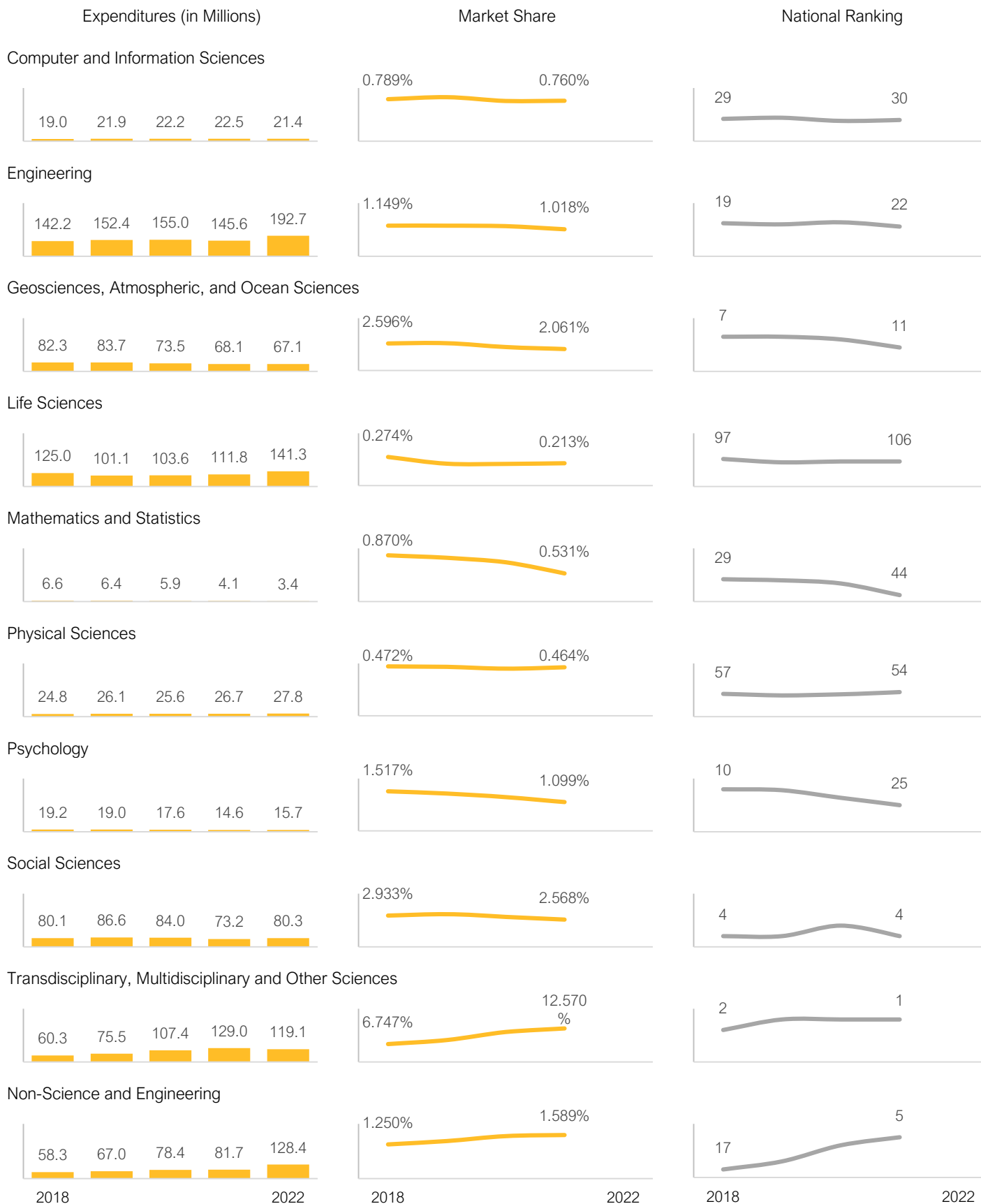


Exhibit ASU.R.7: Total Research Expenditures by Broad Discipline





# Arizona State University

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

































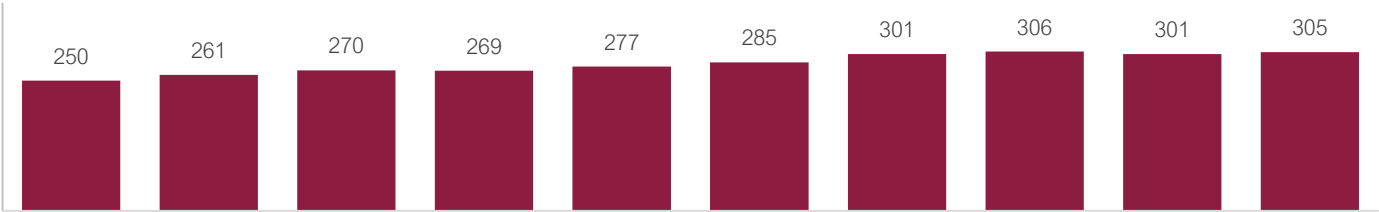
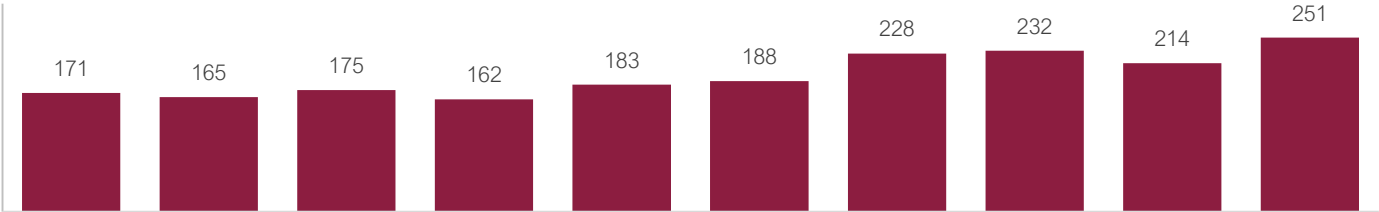
Research Discipline	2022 Expenditures	% of Discipline	% of Total
Computer and Information Sciences	21,414,000	100.0%	2.7%
Computer and Information Sciences	21,414,000 	100.0%	2.7%
Engineering	192,681,000	100%	24.2%
Aerospace, Aeronautical and Astronautical Engineering	0	0.0%	0.0%
Bioengineering and Biomedical Engineering	15,232,000 	7.9%	1.9%
Chemical Engineering	7,780,000 	4.0%	1.0%
Civil Engineering	36,223,000 	18.8%	4.5%
Electrical, Electronic and Communications Engineering	52,683,000 	27.3%	6.6%
Industrial and Manufacturing Engineering	12,354,000 	6.4%	1.5%
Mechanical Engineering	10,404,000 	5.4%	1.3%
Metallurgical and Materials Engineering	6,583,000 	3.4%	0.8%
Other Engineering	51,422,000 	26.7%	6.5%
Geosciences, Atmospheric and Ocean Sciences	67,062,000	100.0%	8.4%
Atmospheric Science and Meteorology	0	0.0%	0.0%
Geological and Earth Sciences	67,062,000 	100.0%	8.4%
Ocean Sciences and Marine Sciences	0	0.0%	0.0%
Other Geosciences, Atmospheric, and Ocean Sciences	0	0.0%	0.0%
Life Sciences	141,307,000	100.0%	17.7%
Agricultural Sciences	0	0.0%	0.0%
Biological and Biomedical Sciences	95,702,000 	67.7%	12.0%
Health Sciences	42,576,000 	30.1%	5.3%
Natural Resources and Conservation	2,543,000 	1.8%	0.3%
Other Life Sciences	486,000 	0.3%	0.1%
Mathematics and Statistics	3,417,000	100.0%	0.4%
Mathematics and Statistics	3,417,000 	100.0%	0.4%
Physical Sciences	27,777,000	100.0%	3.5%
Astronomy and Astrophysics	0	0.0%	0.0%
Chemistry	10,253,000 	36.9%	1.3%
Materials Science	0	0.0%	0.0%
Physics	15,121,000 	54.4%	1.9%
Other Physical Sciences	2,403,000 	8.7%	0.3%
Psychology	15,720,000	100.0%	2.0%
Psychology	15,720,000 	100.0%	2.0%
Social Sciences	80,307,000	100.0%	10.1%
Anthropology	15,618,000 	19.4%	2.0%
Economics	8,692,000 	10.8%	1.1%
Political Science and Government	19,345,000 	24.1%	2.4%
Sociology, Demography and Population Studies	5,788,000 	7.2%	0.7%
Other Social Sciences	30,864,000 	38.4%	3.9%
Other Sciences	119,141,000	100.0%	14.9%
Transdisciplinary, Multidisciplinary and Other Sciences	119,141,000 	100.0%	14.9%
Non-Science and Engineering	128,398,000	100.0%	16.1%
Business Management and Business Administration	44,875,000 	34.9%	5.6%
Communication and Communications Technologies	4,076,000 	3.2%	0.5%
Education	47,317,000 	36.9%	5.9%
Humanities	11,005,000 	8.6%	1.4%
Law	4,787,000 	3.7%	0.6%
Social Work	10,981,000 	8.6%	1.4%
Visual and Performing Arts	5,357,000 	4.2%	0.7%
Other Non-Science and Engineering	0	0.0%	0.0%

Exhibit ASU.R.9: Technology Transfer Inputs

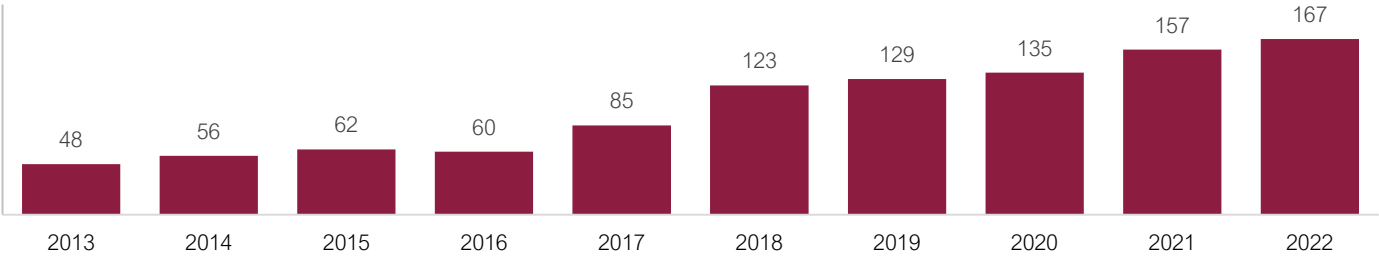
Invention Disclosures Received



New Patent Applications



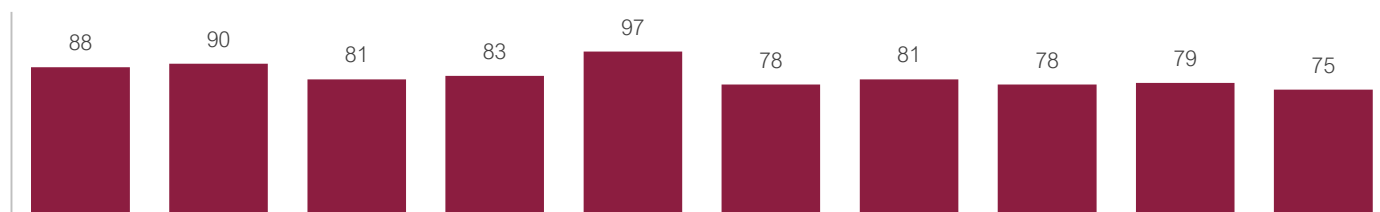
US Patents Issued



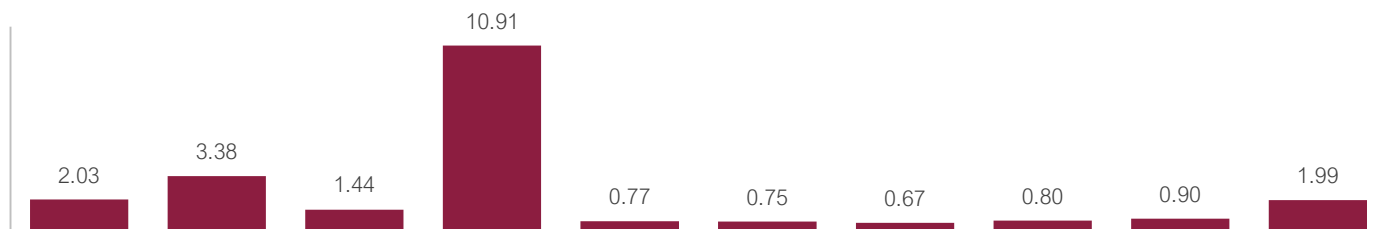
# Arizona State University

## Exhibit ASU.R.10: Technology Transfer Outputs

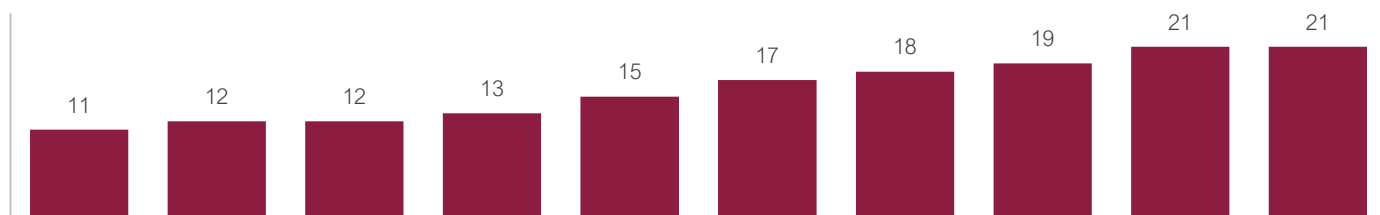
### Licenses and Options Executed



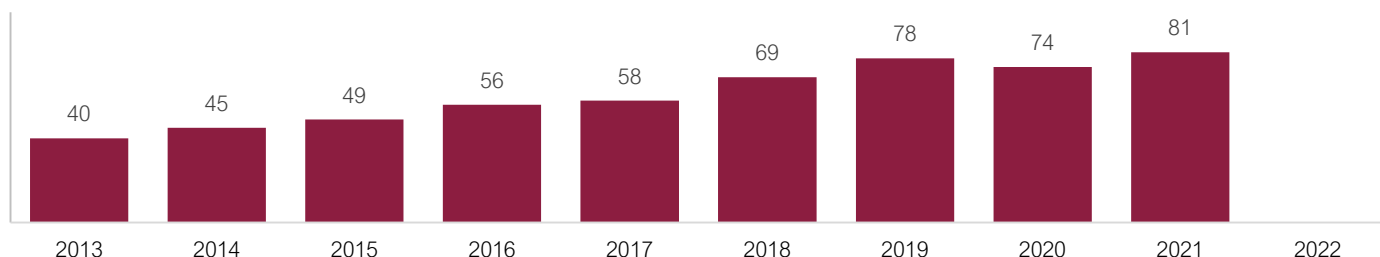
### Licences and Options Income (in Millions)



### Startups



### Cumulative Active Startups

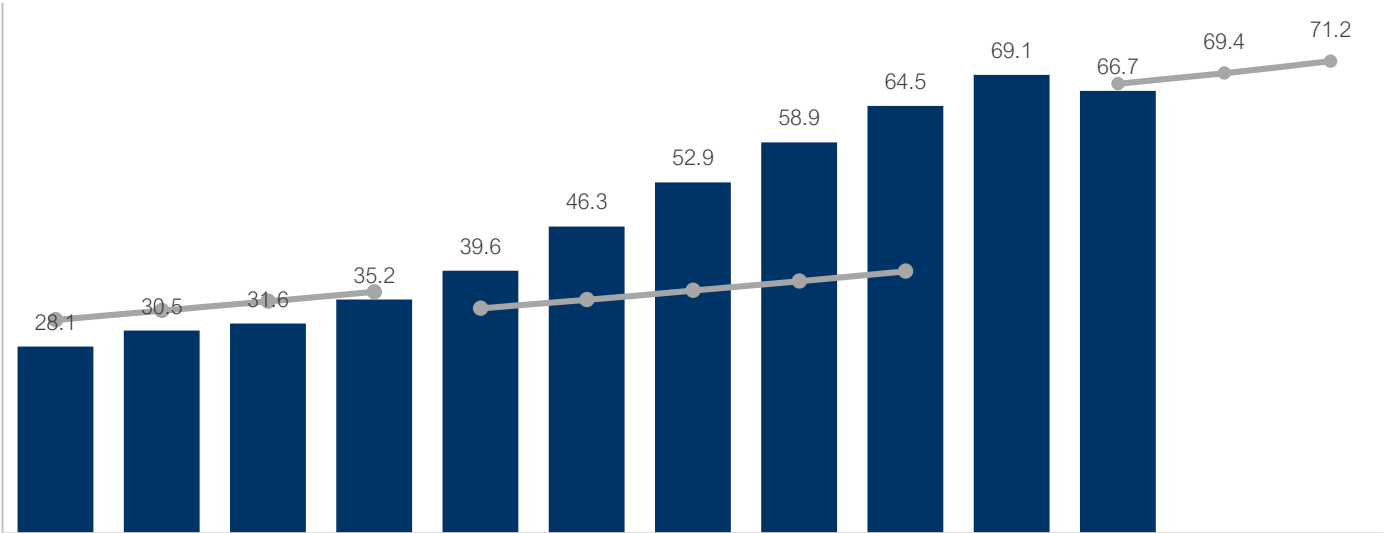


### Income and Distributions

Intellectual Property Income	2018	2019	2020	2021	2022
License and Options Income	750,757	673,945	801,741	903,221	1,989,382
Legal Fees Reimbursed	1,698,294	2,115,725	1,595,385	1,569,821	1,705,337
Other Revenue	3,609	4,827,623	297,664	136,048	85,728
<b>Total</b>	<b>2,452,660</b>	<b>7,617,293</b>	<b>2,694,790</b>	<b>2,609,090</b>	<b>3,780,447</b>
Royalty Distributions	2018	2019	2020	2021	2022
Inventors	-258,026	-188,069	-133,068	-236,650	-653,435
Laboratories and Units	-149,979	-130,679	-58,690	-95,173	-238,903
University	-170,570	-128,903	-92,426	-153,765	-441,094
Undistributed	14,422	27,200	11,050	49,725	77,118
<b>Total</b>	<b>-564,153</b>	<b>-420,451</b>	<b>-273,134</b>	<b>-435,863</b>	<b>-1,256,314</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)

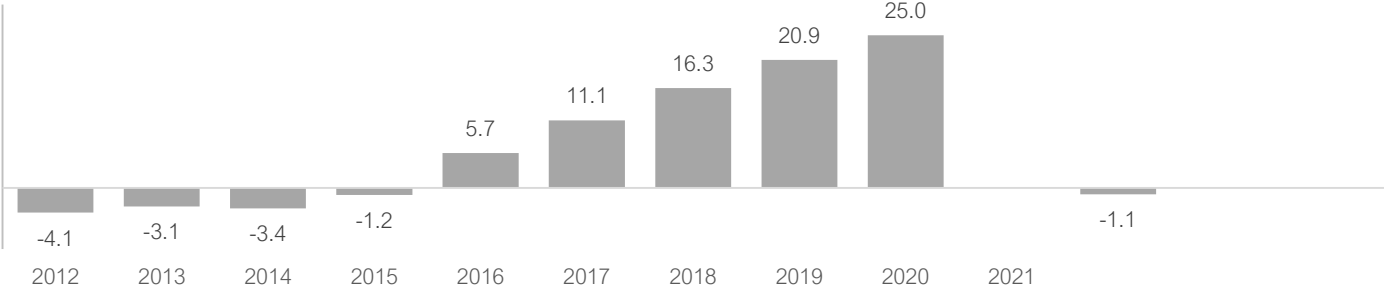
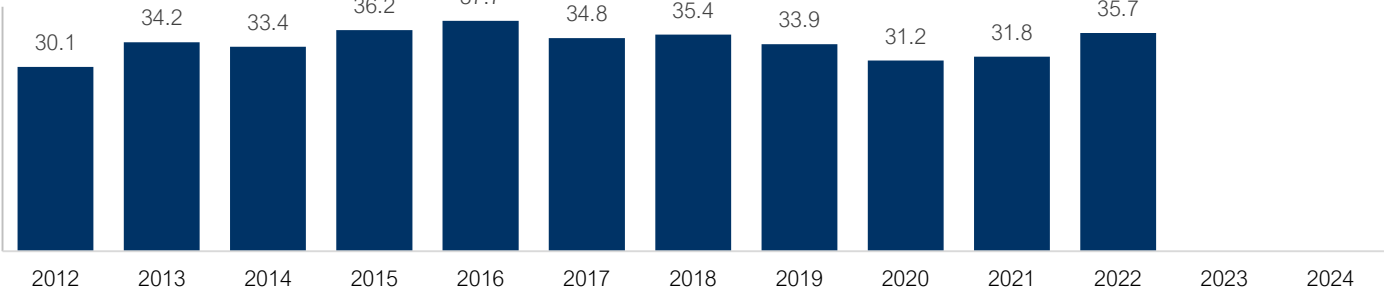


Exhibit NAU.R.2: Other Sponsored Project Expenditures

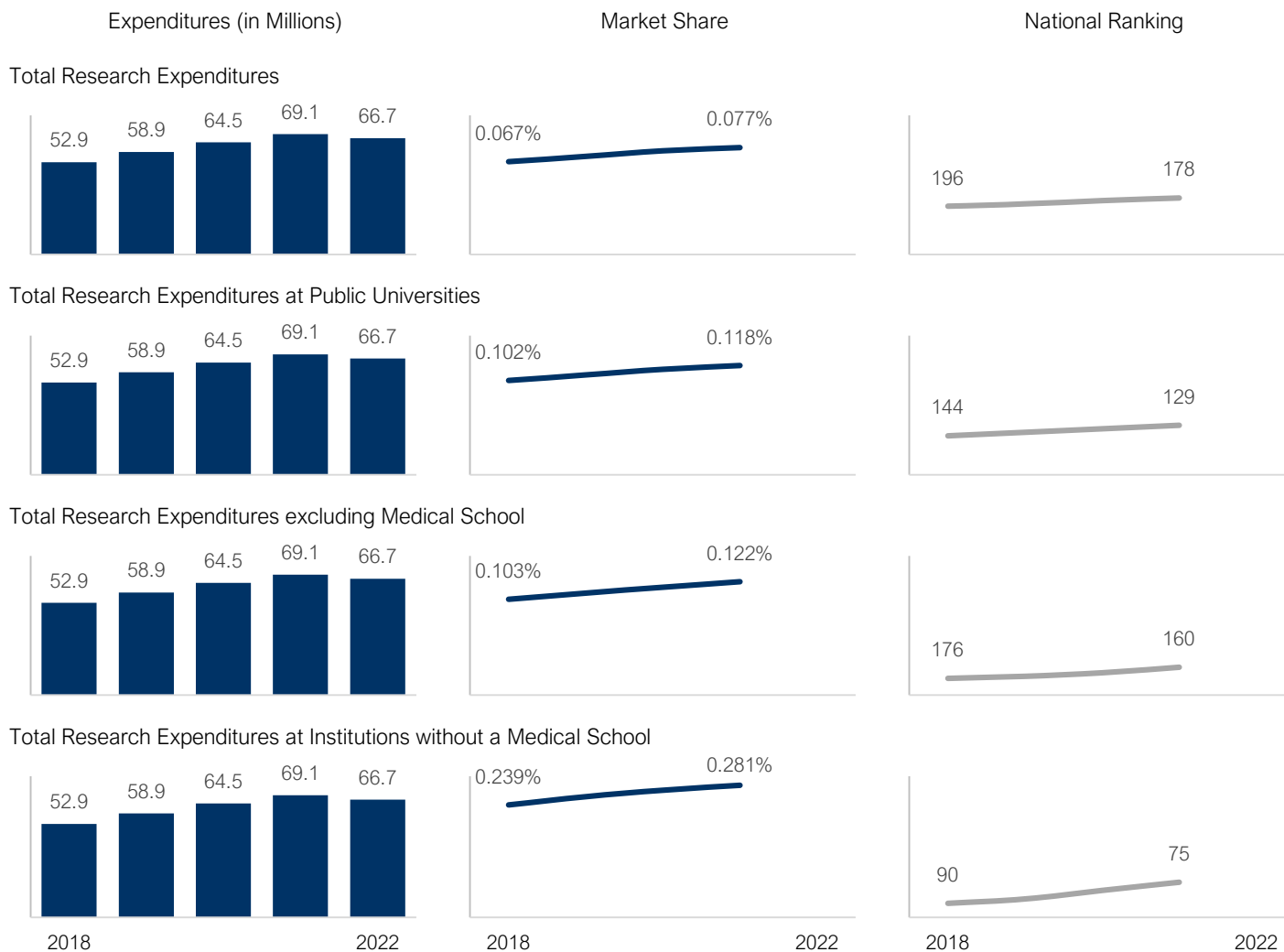
Other Sponsored Project Expenditures (in Millions)



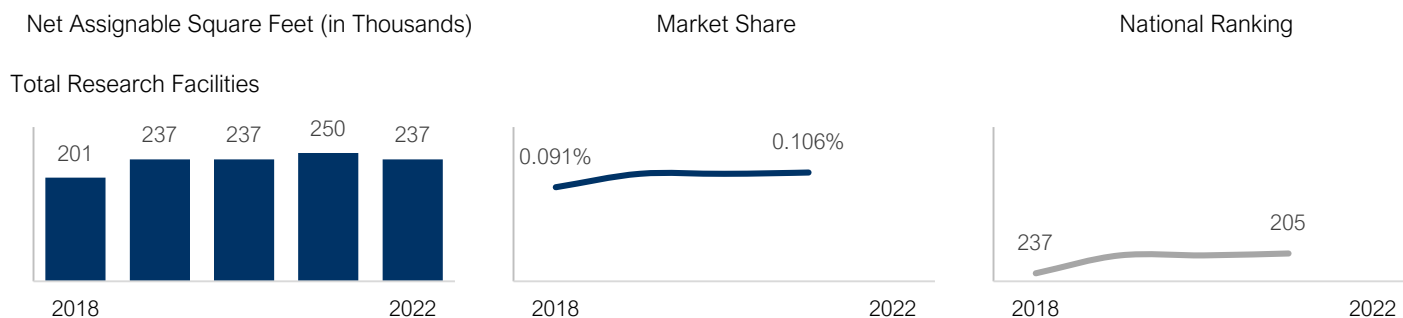


# Northern Arizona University

## Exhibit NAU.R.3: Research Expenditures National Comparisons

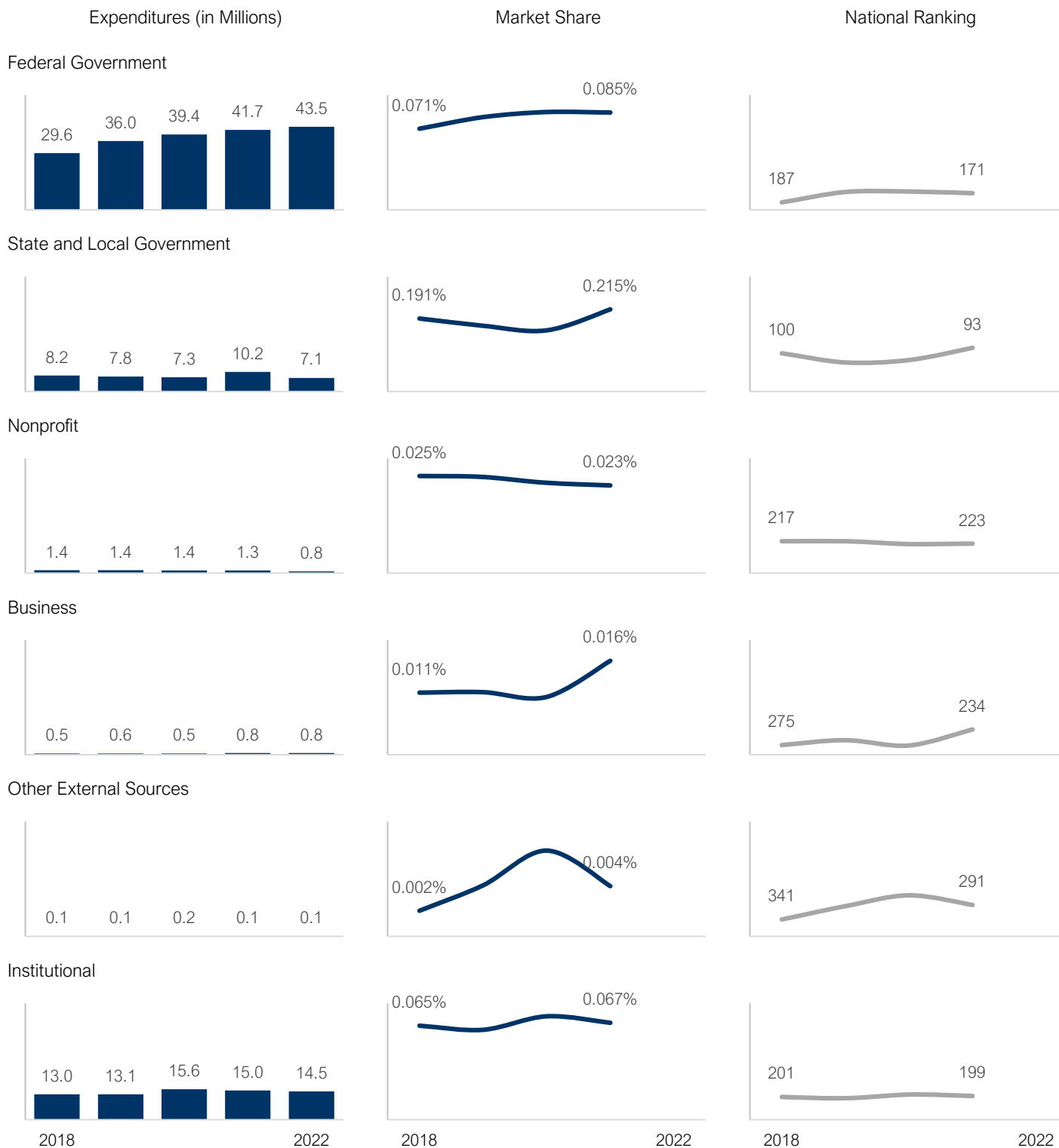


## Exhibit NAU.R.4: Research Facilities



# 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

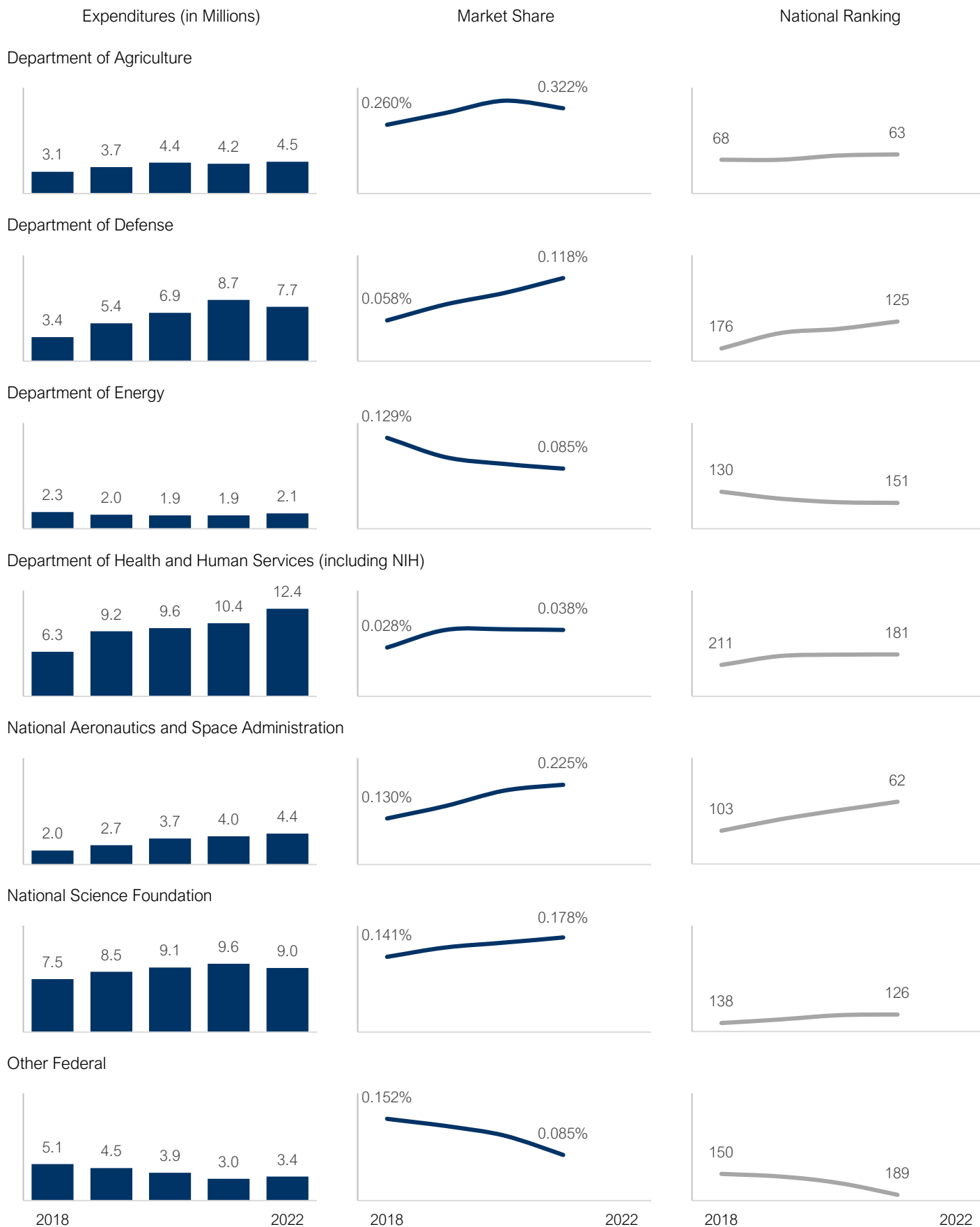
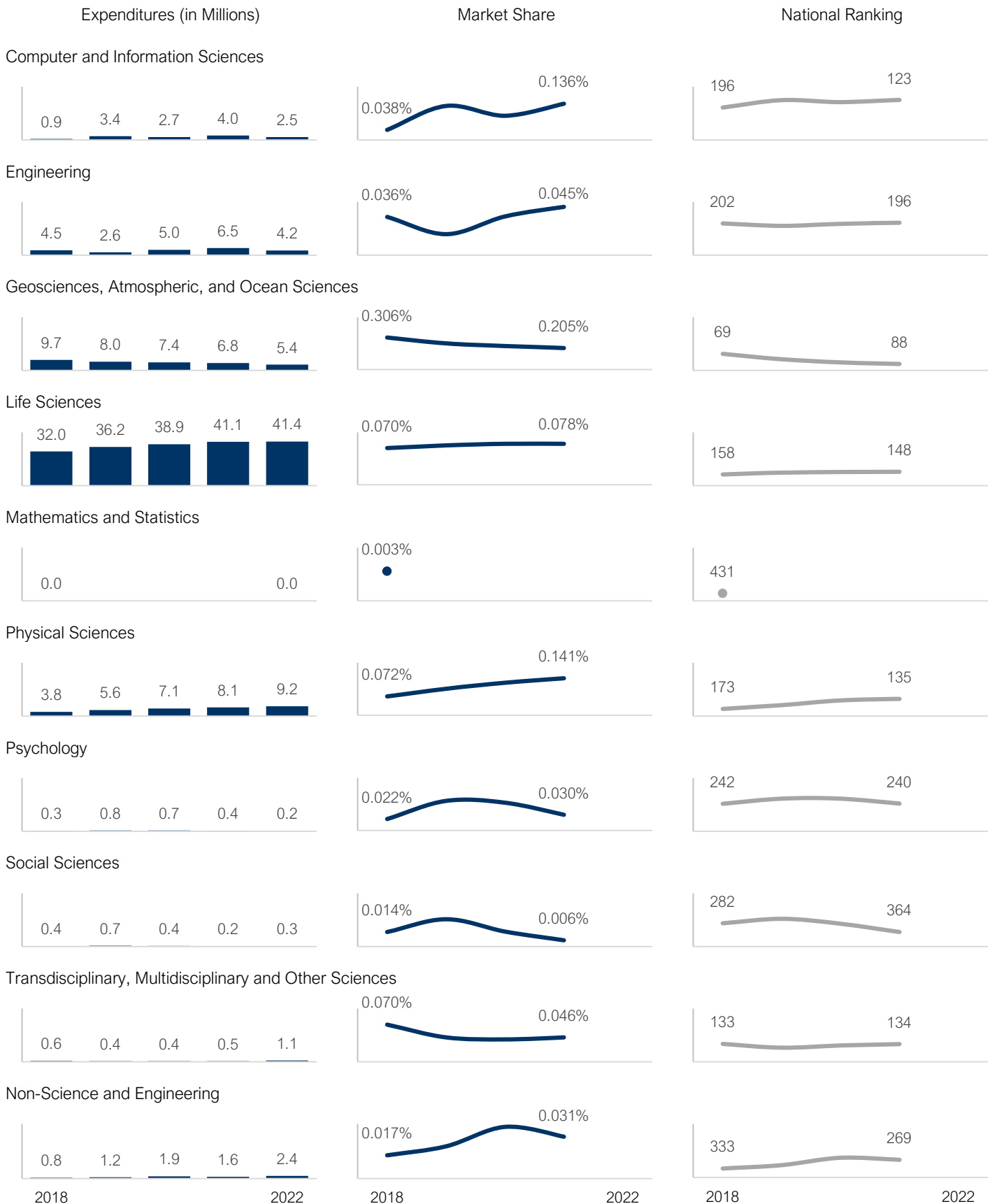
































Exhibit NAU.R.7: Total Research Expenditures by Broad Discipline



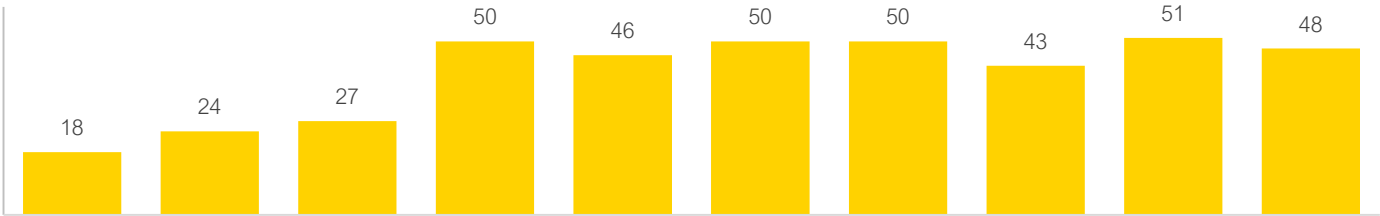


# Northern Arizona University

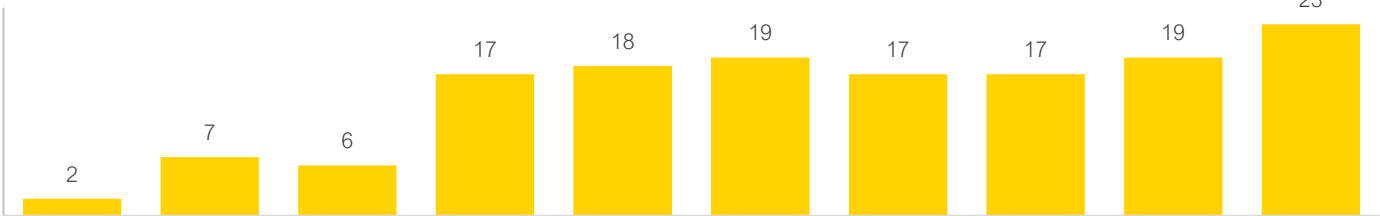
## Exhibit NAU.R.8: Total Research Expenditures by Detailed Discipline

Research Discipline	2022 Expenditures	% of Discipline	% of Total
Computer and Information Sciences	2,492,000	100.0%	3.8%
Computer and Information Sciences	2,492,000 	100.0%	3.8%
Engineering	4,194,000	100%	6.4%
Aerospace, Aeronautical and Astronautical Engineering	0	0.0%	0.0%
Bioengineering and Biomedical Engineering	1,139,000 	27.2%	1.7%
Chemical Engineering	158,000 	3.8%	0.2%
Civil Engineering	369,000 	8.8%	0.6%
Electrical, Electronic and Communications Engineering	1,579,000 	37.6%	2.4%
Industrial and Manufacturing Engineering	0	0.0%	0.0%
Mechanical Engineering	278,000 	6.6%	0.4%
Metallurgical and Materials Engineering	3,000	0.1%	0.0%
Other Engineering	668,000 	15.9%	1.0%
Geosciences, Atmospheric and Ocean Sciences	3,958,000	100.0%	6.1%
Atmospheric Science and Meteorology	183,000 	4.6%	0.3%
Geological and Earth Sciences	3,766,000 	95.1%	5.8%
Ocean Sciences and Marine Sciences	9,000	0.2%	0.0%
Other Geosciences, Atmospheric, and Ocean Sciences	0	0.0%	0.0%
Life Sciences	41,401,000	100.0%	63.4%
Agricultural Sciences	1,129,000 	2.7%	1.7%
Biological and Biomedical Sciences	30,317,000 	73.2%	46.4%
Health Sciences	4,639,000 	11.2%	7.1%
Natural Resources and Conservation	4,064,000 	9.8%	6.2%
Other Life Sciences	1,252,000 	3.0%	1.9%
Mathematics and Statistics	5,000	100.0%	0.0%
Mathematics and Statistics	5,000	100.0%	0.0%
Physical Sciences	9,170,000	100.0%	14.0%
Astronomy and Astrophysics	3,946,000 	43.0%	6.0%
Chemistry	287,000 	3.1%	0.4%
Materials Science	573,000 	6.2%	0.9%
Physics	633,000 	6.9%	1.0%
Other Physical Sciences	3,731,000 	40.7%	5.7%
Psychology	178,000	100.0%	0.3%
Psychology	178,000 	100.0%	0.3%
Social Sciences	345,000	100.0%	0.5%
Anthropology	31,000 	9.0%	0.0%
Economics	240,000 	69.6%	0.4%
Political Science and Government	51,000 	14.8%	0.1%
Sociology, Demography and Population Studies	3,000	0.9%	0.0%
Other Social Sciences	20,000 	5.8%	0.0%
Other Sciences	1,148,000	100.0%	1.8%
Transdisciplinary, Multidisciplinary and Other Sciences	1,148,000 	100.0%	1.8%
Non-Science and Engineering	2,397,000	100.0%	3.7%
Business Management and Business Administration	50,000 	2.1%	0.1%
Communication and Communications Technologies	142,000 	5.9%	0.2%
Education	2,000,000 	83.4%	3.1%
Humanities	174,000 	7.3%	0.3%
Law	26,000 	1.1%	0.0%
Social Work	0	0.0%	0.0%
Visual and Performing Arts	0	0.0%	0.0%
Other Non-Science and Engineering	5,000	0.2%	0.0%

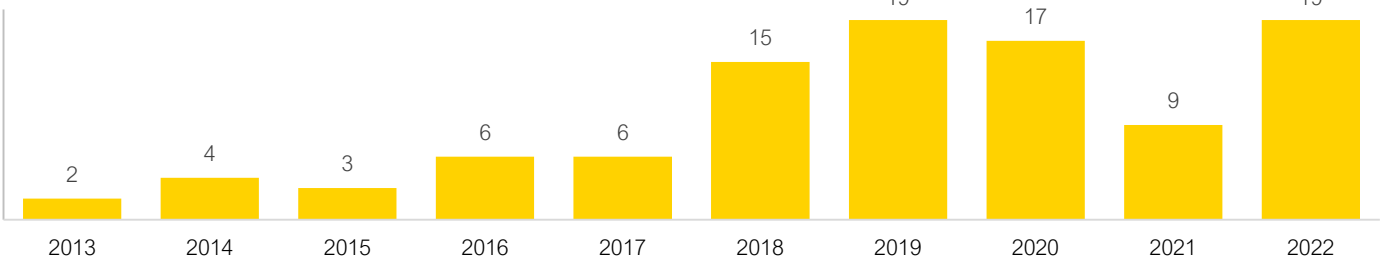
Invention Disclosures Received



New Patent Applications



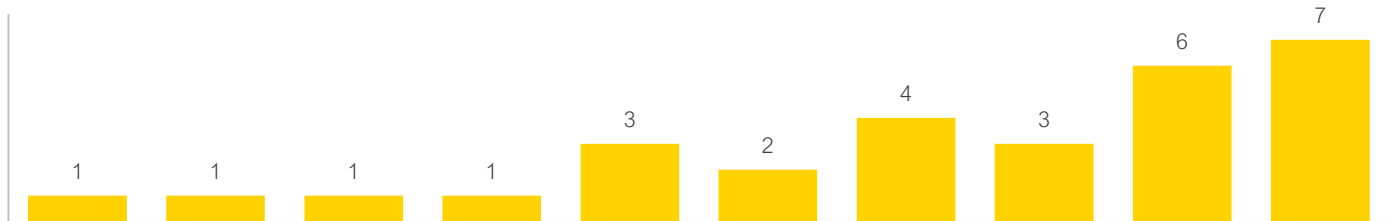
US Patents Issued



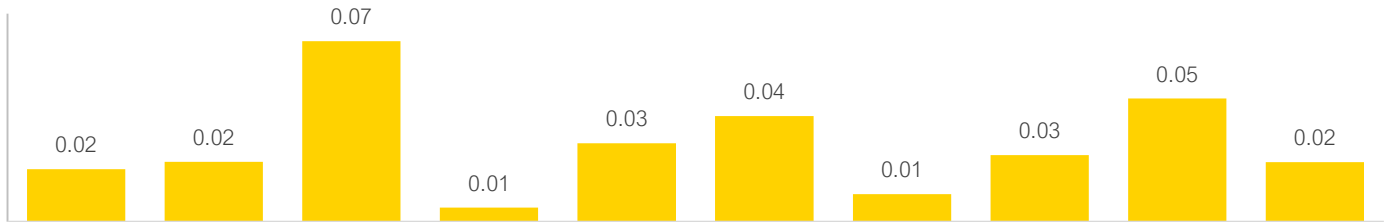
# Northern Arizona University

## Exhibit NAU.R.10: Technology Transfer Outputs

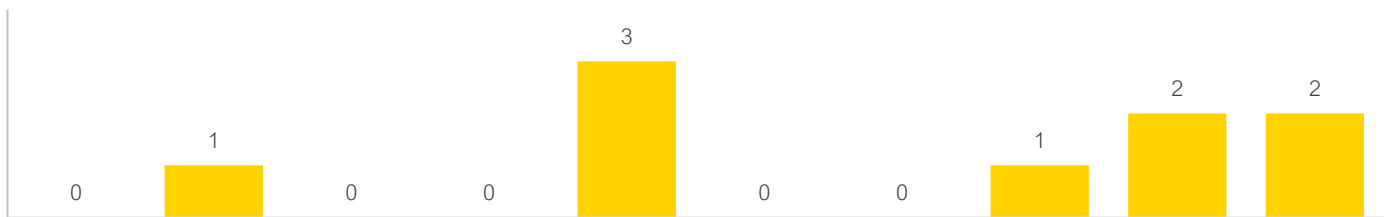
### Licenses and Options Executed



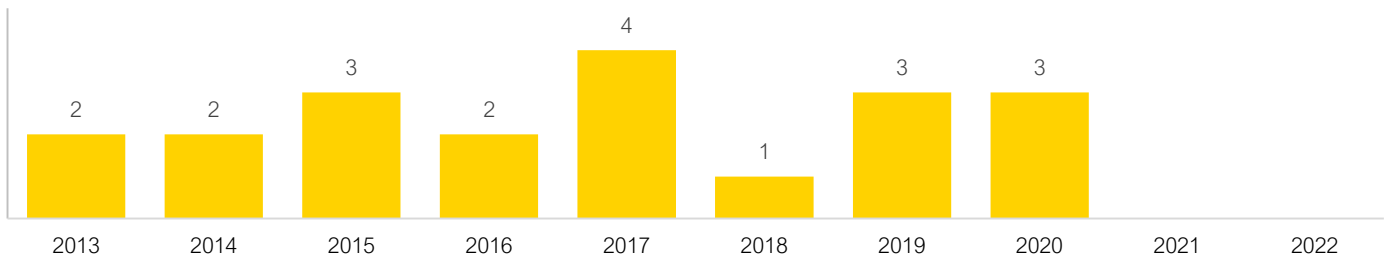
### Licences and Options Income (in Millions)



### Startups



### Cumulative Active Startups

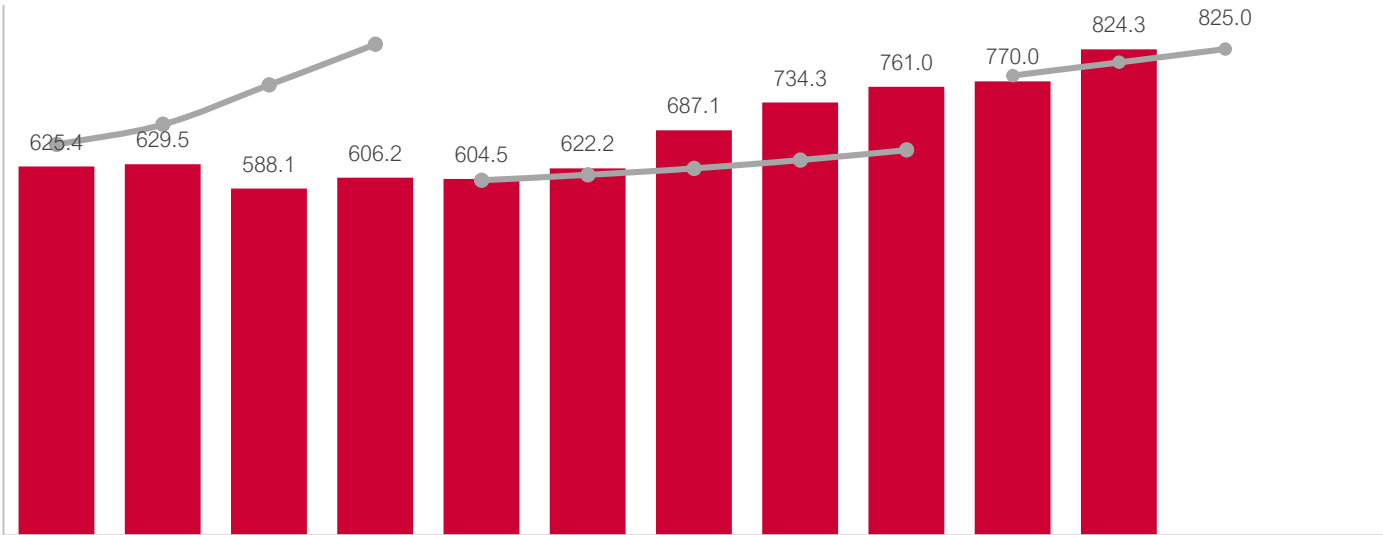


### Income and Distributions

Intellectual Property Income	2018	2019	2020	2021	2022
License and Options Income	40,549	10,500	25,562	47,315	22,864
Legal Fees Reimbursed	13,079	15,515	5,542	7,511	33,966
Other Revenue	40,549	0	20,000	0	0
Total	94,177	26,015	51,104	54,826	56,830
Royalty Distributions	2018	2019	2020	2021	2022
Inventors	0	-2,620	0	-12,818	-5,002
Laboratories and Units	0	0	0	0	0
University	0	0	0	-3,442	-5,002
Undistributed	0	0	0	0	0
Total	0	-2,620	0	-16,260	-10,004

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

Research Expenditures and Enterprise Plan Goals (in Millions)



Actual to Enterprise Goal Differences (in Millions)

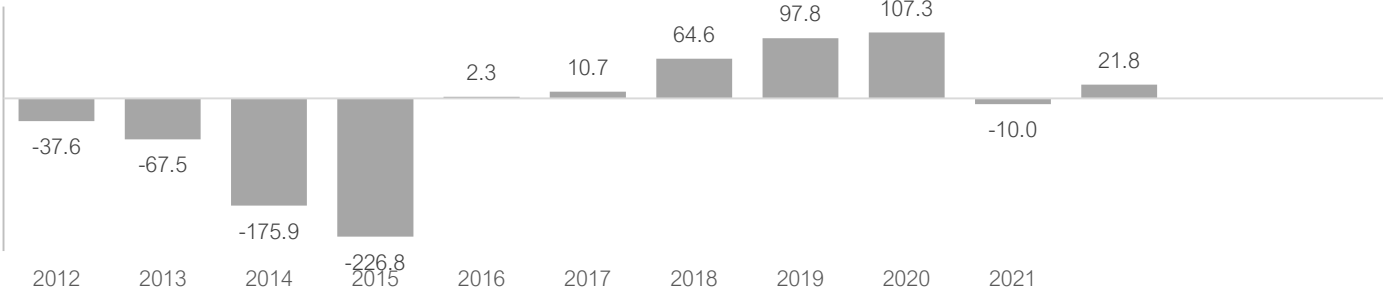
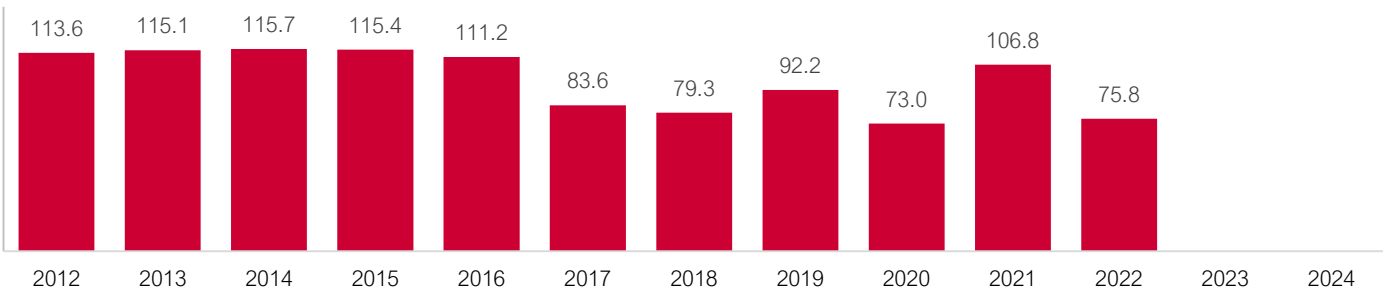


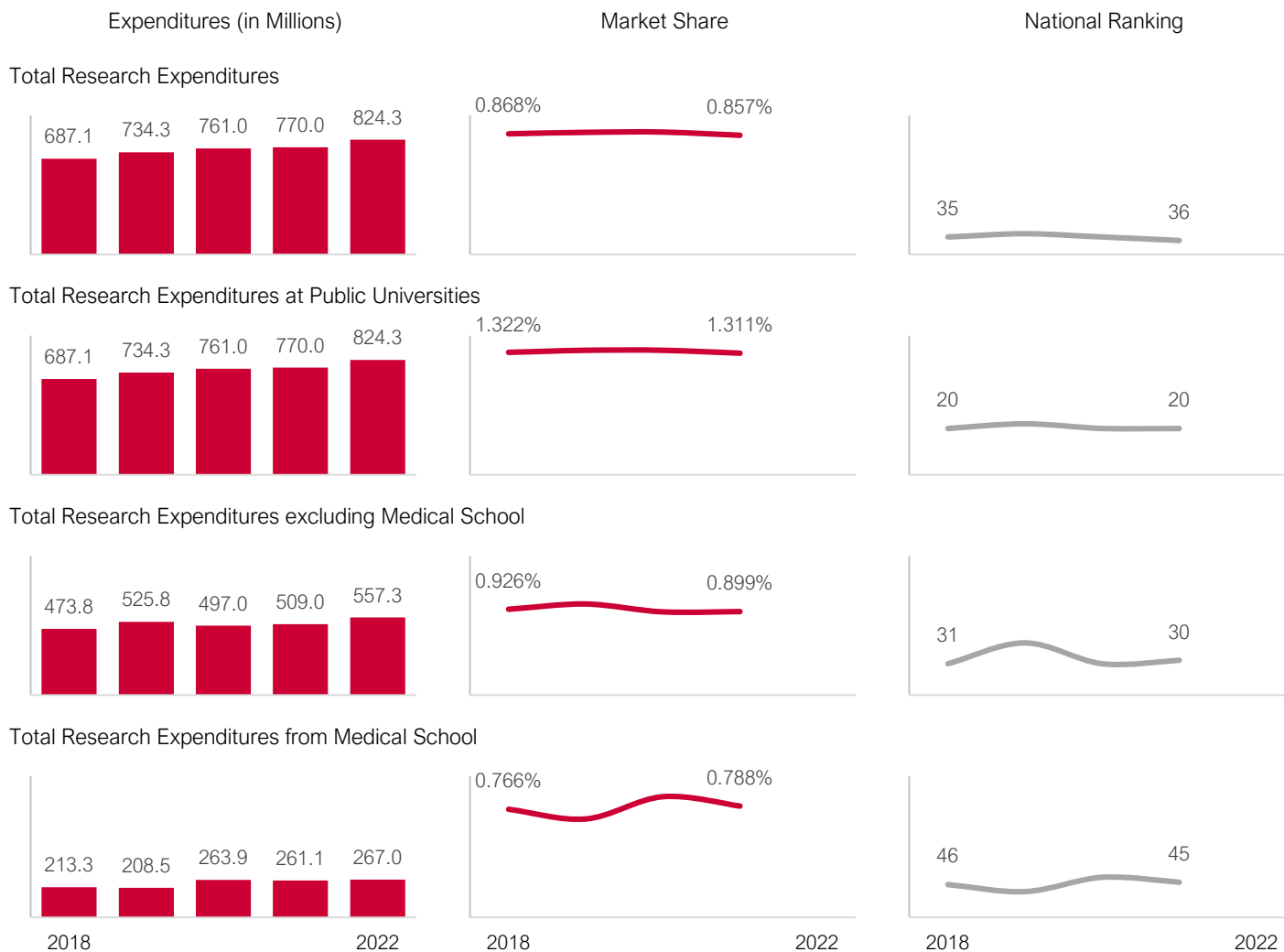
Exhibit UA.R.2: Other Sponsored Project Expenditures

Other Sponsored Project Expenditures (in Millions)



# University of Arizona

## Exhibit UA.R.3: Research Expenditures National Comparisons



## Exhibit UA.R.4: Research Facilities

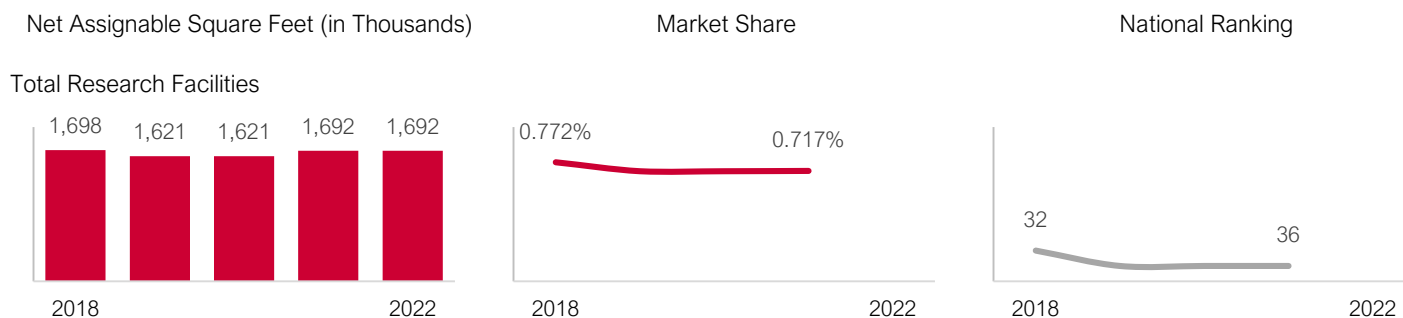
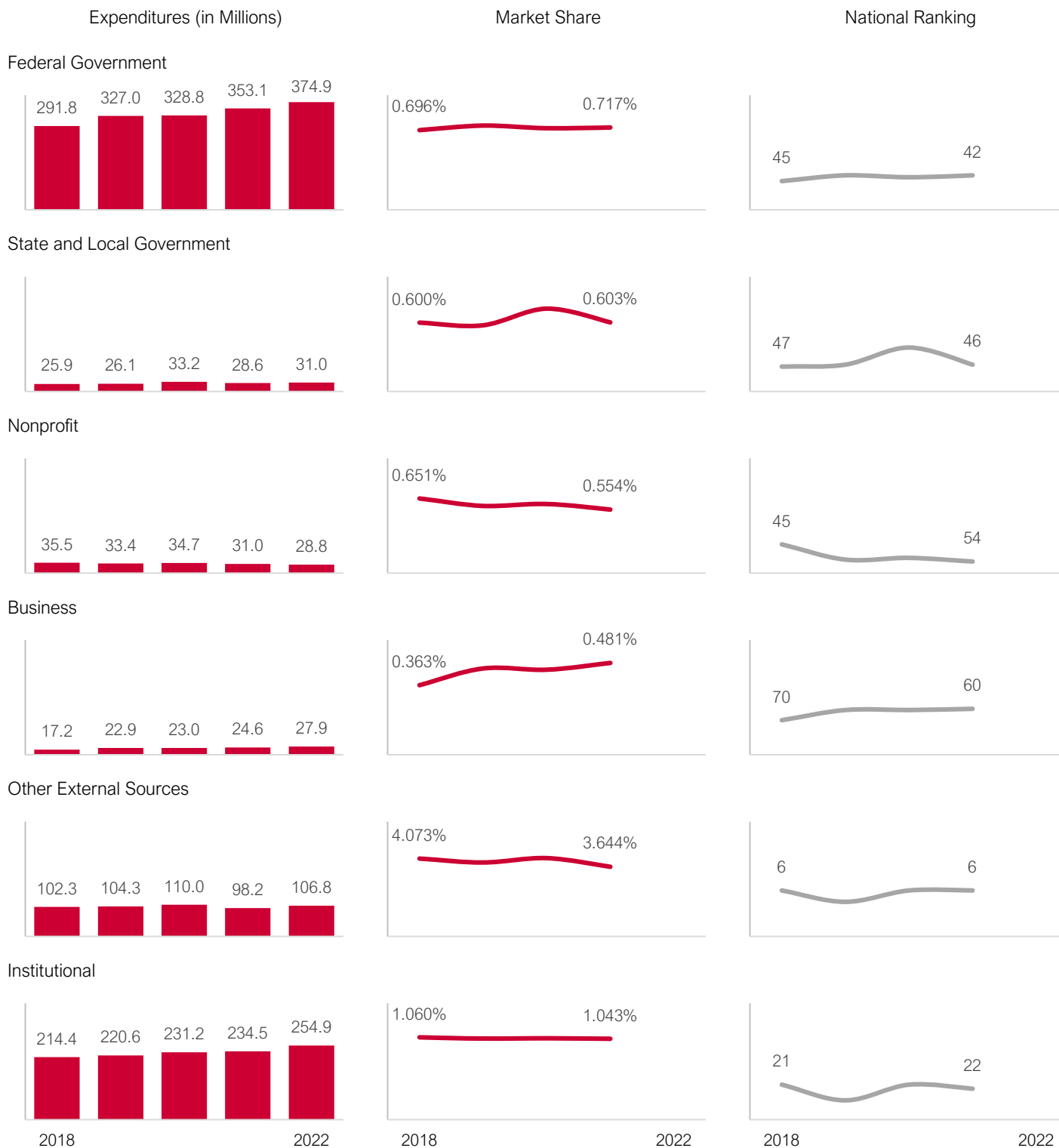


Exhibit UA.R.5: Research Expenditures by Sponsor Group



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

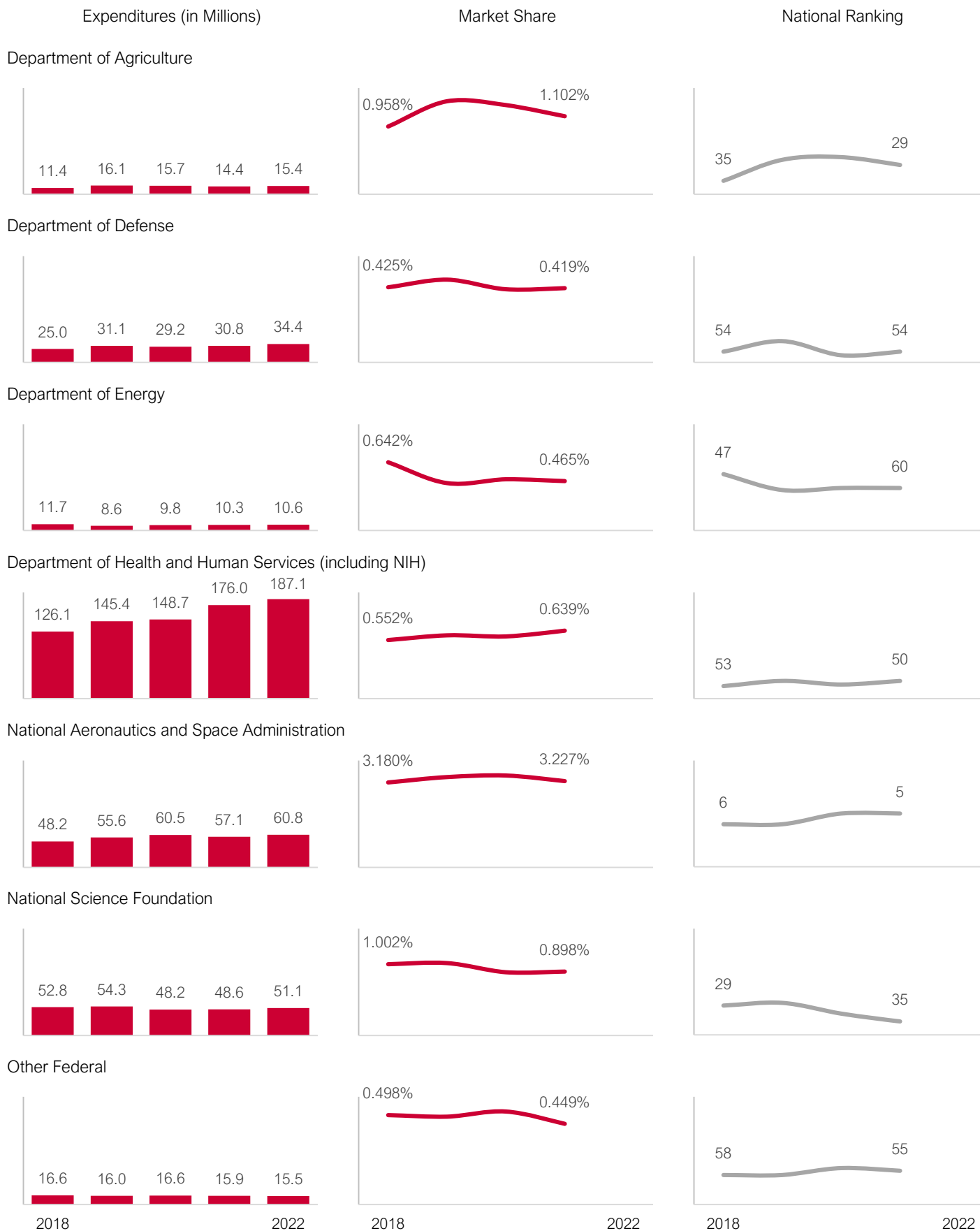


Exhibit UA.R.7: Total Research Expenditures by Broad Discipline





# University of Arizona

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





































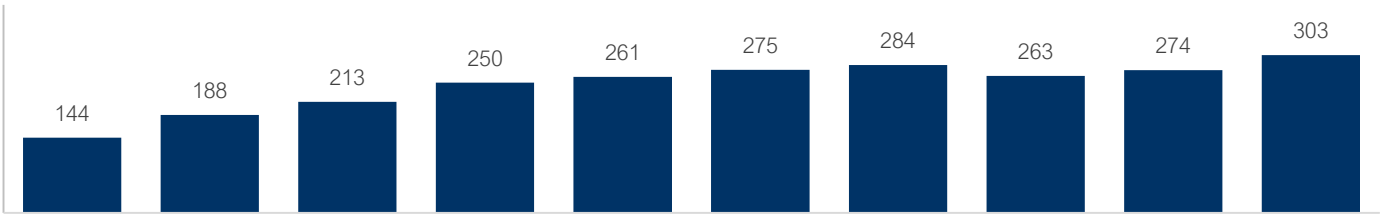
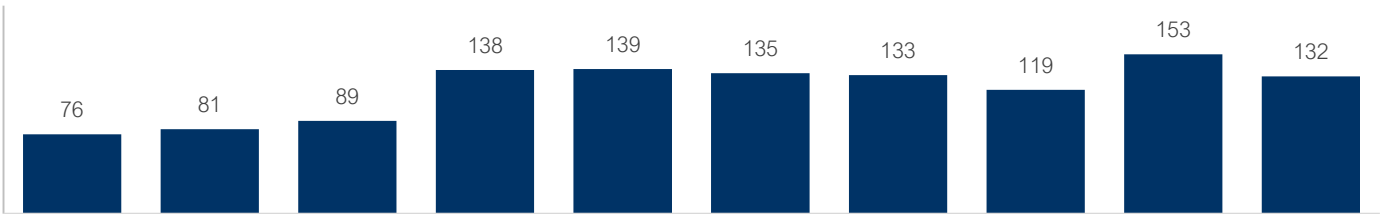
Research Discipline	2022 Expenditures	% of Discipline	% of Total
Computer and Information Sciences	18,270,000	100.0%	2.2%
Computer and Information Sciences	18,270,000 	100.0%	2.2%
Engineering	84,682,000	100%	10.3%
Aerospace, Aeronautical and Astronautical Engineering	2,561,000 	3.0%	0.3%
Bioengineering and Biomedical Engineering	8,817,000 	10.4%	1.1%
Chemical Engineering	5,579,000 	6.6%	0.7%
Civil Engineering	2,386,000 	2.8%	0.3%
Electrical, Electronic and Communications Engineering	43,553,000 	51.4%	5.3%
Industrial and Manufacturing Engineering	4,463,000 	5.3%	0.5%
Mechanical Engineering	4,268,000 	5.0%	0.5%
Metallurgical and Materials Engineering	7,398,000 	8.7%	0.9%
Other Engineering	5,657,000 	6.7%	0.7%
Geosciences, Atmospheric and Ocean Sciences	32,881,000	100.0%	4.0%
Atmospheric Science and Meteorology	8,419,000 	25.6%	1.0%
Geological and Earth Sciences	22,276,000 	67.7%	2.7%
Ocean Sciences and Marine Sciences	2,186,000 	6.6%	0.3%
Other Geosciences, Atmospheric, and Ocean Sciences	0	0.0%	0.0%
Life Sciences	471,045,000	100.0%	57.2%
Agricultural Sciences	55,219,000 	11.7%	6.7%
Biological and Biomedical Sciences	218,490,000 	46.4%	26.5%
Health Sciences	183,398,000 	38.9%	22.3%
Natural Resources and Conservation	13,933,000 	3.0%	1.7%
Other Life Sciences	5,000	0.0%	0.0%
Mathematics and Statistics	4,105,000	100.0%	0.5%
Mathematics and Statistics	4,105,000 	100.0%	0.5%
Physical Sciences	142,519,000	100.0%	17.3%
Astronomy and Astrophysics	123,039,000 	86.3%	14.9%
Chemistry	9,869,000 	6.9%	1.2%
Materials Science	3,663,000 	2.6%	0.4%
Physics	5,890,000 	4.1%	0.7%
Other Physical Sciences	58,000	0.0%	0.0%
Psychology	6,573,000	100.0%	0.8%
Psychology	6,573,000 	100.0%	0.8%
Social Sciences	22,491,000	100.0%	2.7%
Anthropology	3,965,000 	17.6%	0.5%
Economics	3,345,000 	14.9%	0.4%
Political Science and Government	779,000 	3.5%	0.1%
Sociology, Demography and Population Studies	4,859,000 	21.6%	0.6%
Other Social Sciences	9,543,000 	42.4%	1.2%
Other Sciences	10,723,000	100.0%	1.3%
Transdisciplinary, Multidisciplinary and Other Sciences	10,723,000 	100.0%	1.3%
Non-Science and Engineering	30,075,000	100.0%	3.7%
Business Management and Business Administration	9,268,000 	30.8%	1.1%
Communication and Communications Technologies	190,000 	0.6%	0.0%
Education	6,009,000 	20.0%	0.7%
Humanities	4,904,000 	16.3%	0.6%
Law	3,505,000 	11.7%	0.4%
Social Work	0	0.0%	0.0%
Visual and Performing Arts	4,575,000 	15.2%	0.6%
Other Non-Science and Engineering	1,624,000 	5.4%	0.2%

Exhibit UA.R.9: Technology Transfer Inputs

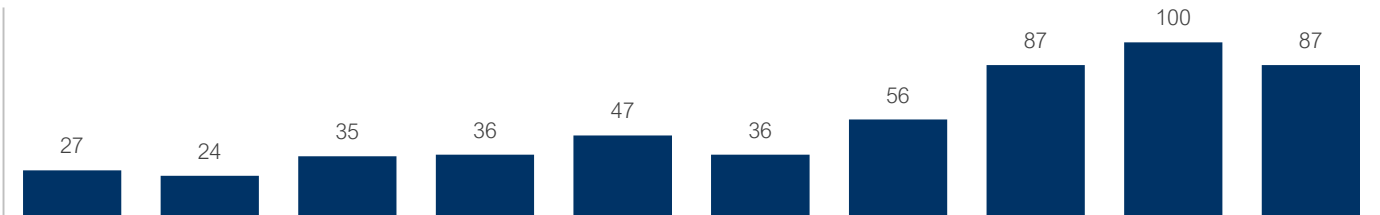
Invention Disclosures Received



New Patent Applications



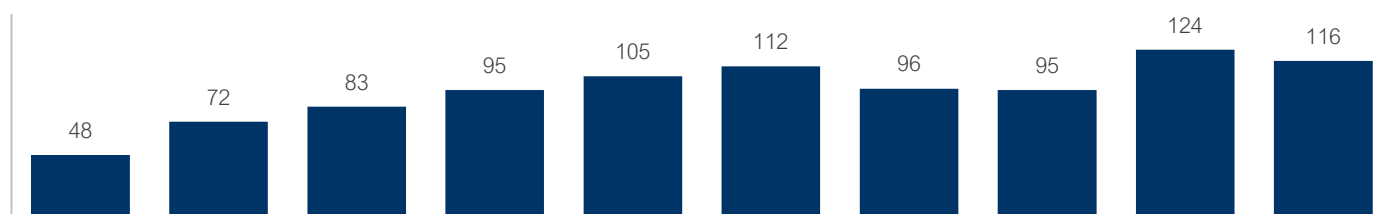
US Patents Issued



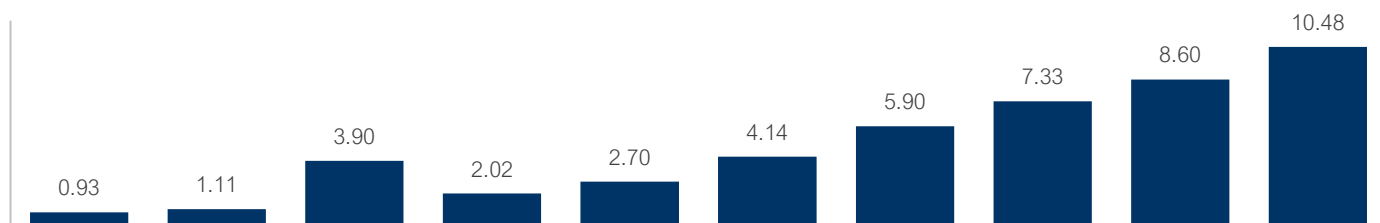
2013      2014      2015      2016      2017      2018      2019      2020      2021      2022

## Exhibit UA.R.10: Technology Transfer Outputs

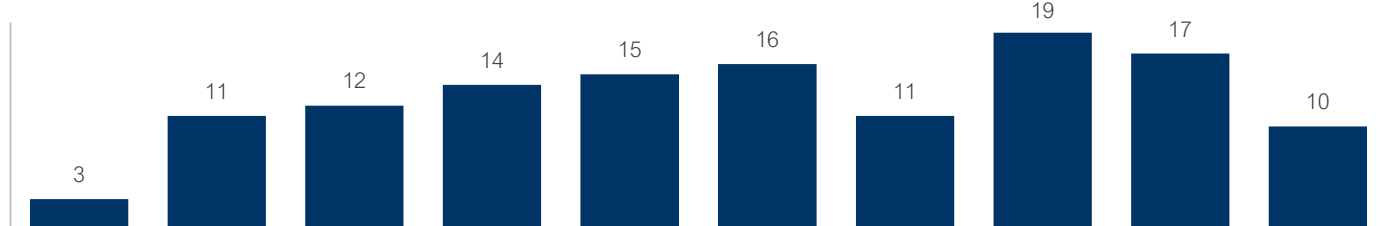
## Licenses and Options Executed



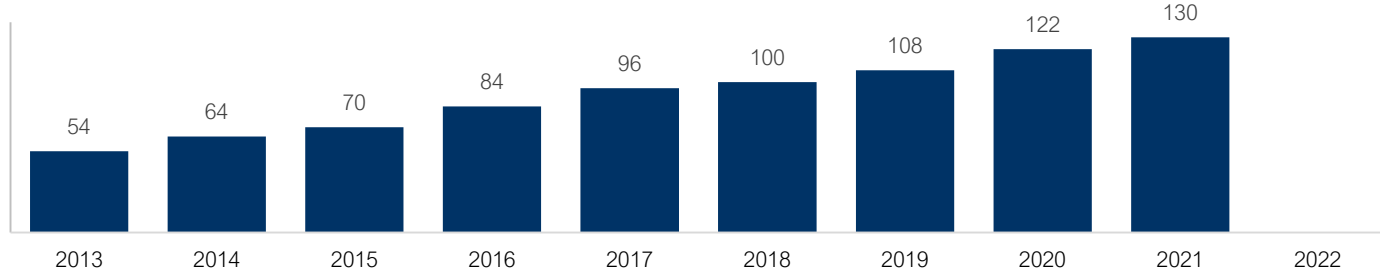
## Licences and Options Income (in Millions)



## Startups



## Cumulative Active Startups



## Income and Distributions

Intellectual Property Income	2018	2019	2020	2021	2022
License and Options Income	4,141,604	5,901,957	7,333,122	8,603,693	10,478,208
Legal Fees Reimbursed	651,410	828,539	993,655	1,021,416	971,579
Other Revenue	0	0	0	0	0
<b>Total</b>	<b>4,793,014</b>	<b>6,730,496</b>	<b>8,326,777</b>	<b>9,625,109</b>	<b>11,449,787</b>
Royalty Distributions	2018	2019	2020	2021	2022
Inventors	-1,403,012	-1,904,369	-2,435,343	-2,867,783	-3,518,608
Laboratories and Units	-1,276,847	-1,708,098	-2,157,018	-2,569,805	-2,992,094
University	-1,383,994	-1,839,490	-2,365,761	-2,866,105	-3,492,506
Undistributed	77,751	450,000	375,000	300,000	475,000
<b>Total</b>	<b>-3,986,102</b>	<b>-5,001,957</b>	<b>-6,583,122</b>	<b>-8,003,693</b>	<b>-9,528,208</b>

