IUCRC Program Findings from The Center Structure Database

FY2020

Data collected from 73 out of 73 total active centers

Trends from Center Structure Database: FY1980-2020

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IUCRC Evaluation Project at

North Carolina State University

Overview

- Fast Facts*
  - Slides 3-5
- Data collection methodology and timeframe
  - Slides 6-9
- Number of Centers through FY2021
  - Slides 10-11
- Detailed analyses through FY2020 (membership, structural, outcomes)*
  - Slides 12-69
- CISE and ENG breakdowns*
  - Slides 70-78
- Comparison by program Phase (I, II, III)*
  - Slides 79-89

*Includes data from the 73/73 centers that reported data.

Industry/University Cooperative Research Centers

FY20 Member Fast Facts
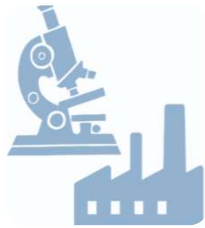
1152 Memberships
219 new and 316 terminated memberships

$49M Provided by Members
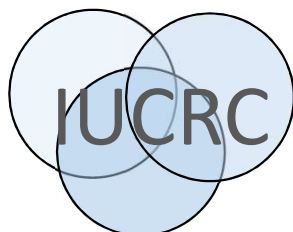62% of total IUCRC program funding

~16 Memberships per Center
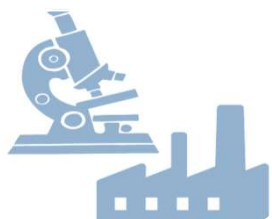
Membership fee leveraging ratio 1:27

Industry/University Cooperative Research Centers

FY20 IUCRC Center Structural Fast Facts

IUCRC

Industry/University Cooperative Research Centers

73 active Centers at 223 University sites

1152 Memberships

1385 Researchers + 1893 students

$$$

$78.6M in Total Program Funding; $1.1M per center
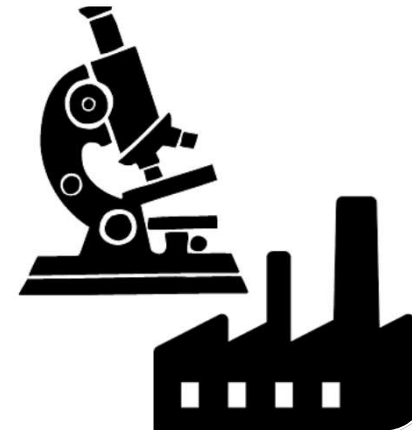
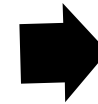**NSF invests $21.5M; $287K per Center**

NSF Leveraging ratio 1:2.5

IUCRC Student Fast Facts: FY2020

Industry/University Cooperative Research Centers

1893 Students Trained

~26 students per center

650 Students Graduated

• ~9 graduates per center
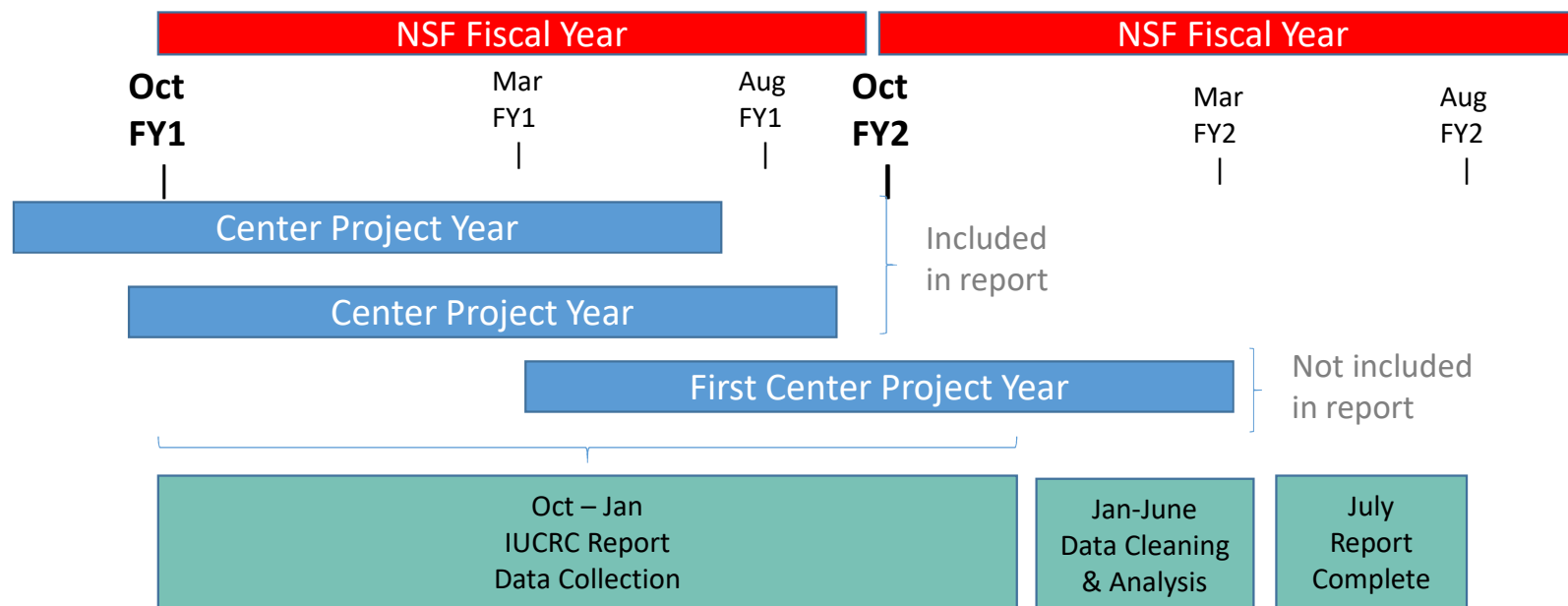• 34% of trainees annually

315 Alumni Hired by Industry

• 48% of graduates
• 24% by member organizations

NSF and Center Budgeting Life Cycle

- Structural report includes activities for most recently completed award year
- Excludes centers with less 1 complete year in operation

Methodology

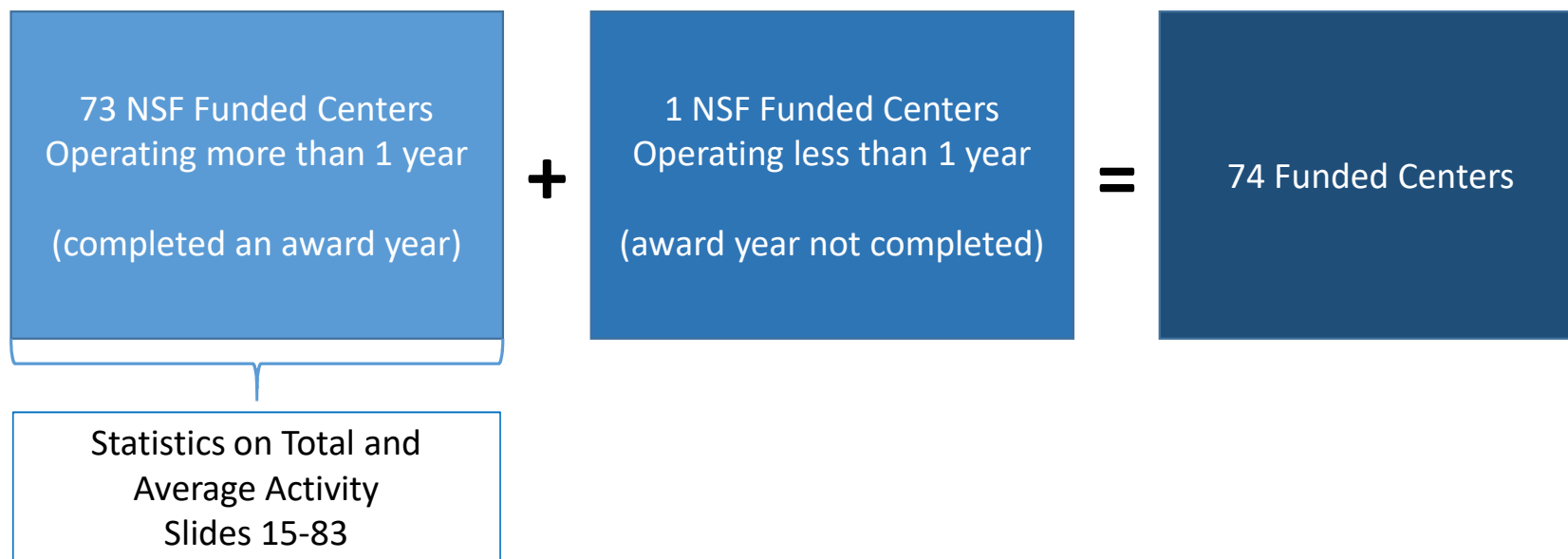Industry/University Cooperative Research Centers

- Collection of FY2019-20 structural data from centers and sites completed between March 2020 and September 2020.
  - Centers were asked to report on their award year ending during FY2019 (10/1/19-9/30/20)
  - Data request synched with award end date and NSF annual reporting timeline for each center
  - Includes centers on NCE

- Data on number of funded centers collected from NSF (through 2020)

- Reporting issues
  - Need to develop decision rule for reporting time frame when a center gets a new award that changes their reporting time frame
  - Sometimes change in award dates can cause overlap or gaps between fiscal years

Understanding Center Counts Through FY2020

Industry/University
Cooperative Research
Centers

FY 2020

73 NSF Funded Centers Operating more than 1 year (completed an award year)	**+**	1 NSF Funded Centers Operating less than 1 year (award year not completed)	**=**	74 Funded Centers

Statistics on Total and
Average Activity
Slides 15-83

Understanding Center Counts Through FY2021

Industry/University Cooperative Research Centers

FY 2020

73 NSF Funded Centers Operating more than 1 year (completed a project year)	+ 1 NSF Funded Centers Operating less than 1 year (project year not completed)	- 5 Centers Graduated/Closed	= 69 Funded Centers

Slides 11-13
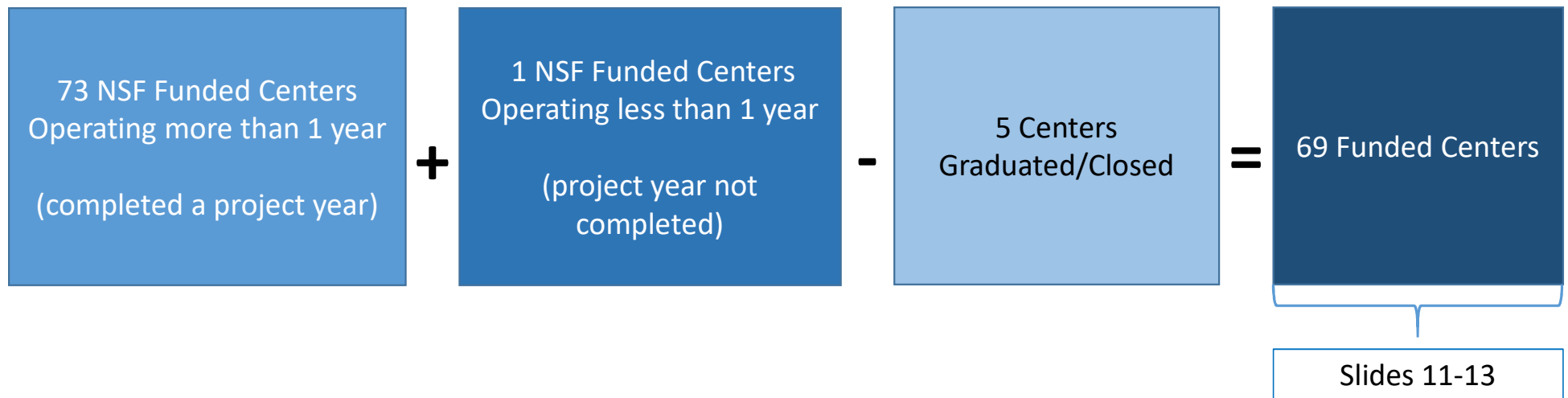
Centers & Sites

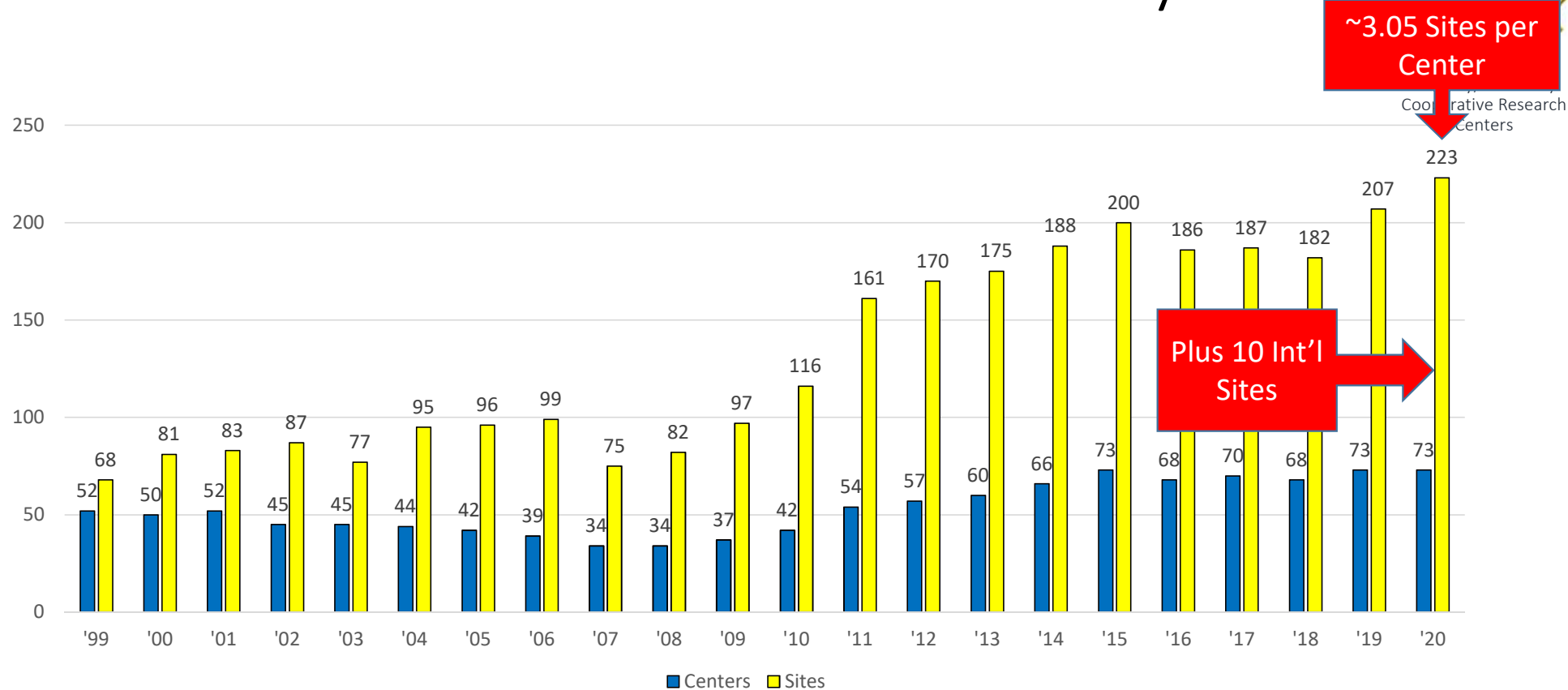# Number of Active and Phased-Out Centers by Year
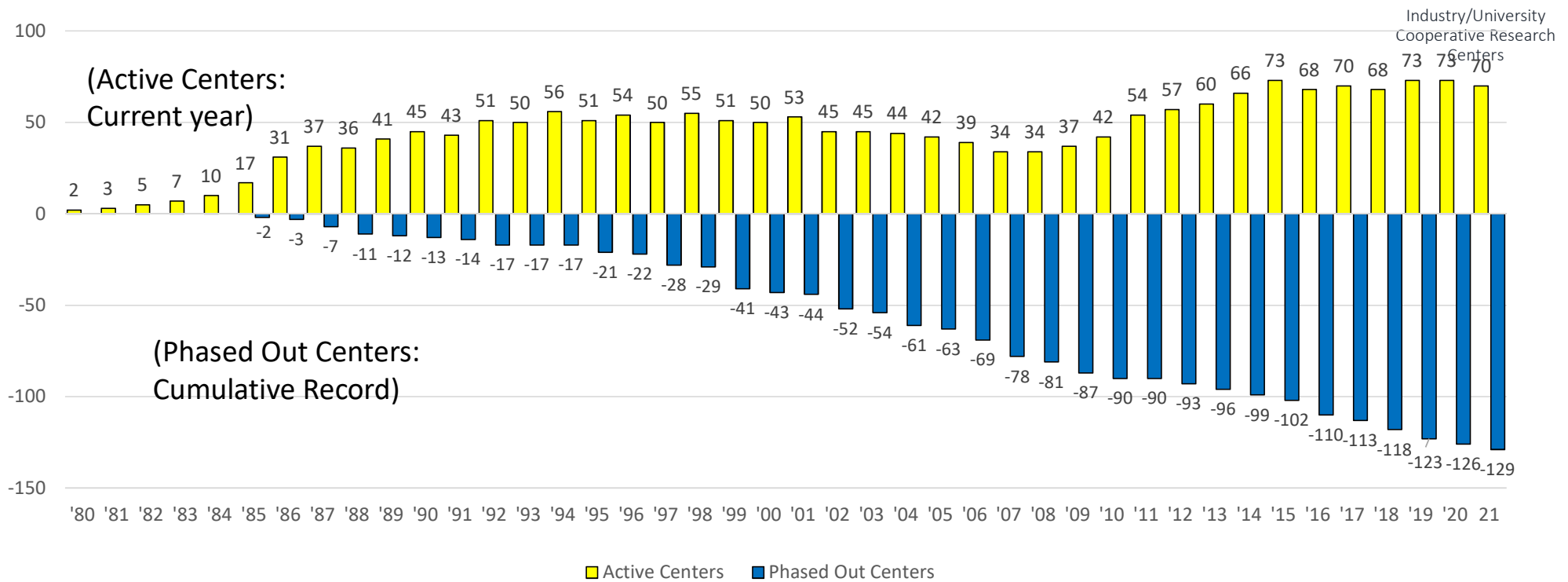
Number of Active Centers and Sites by Year

Number of Single & Multi-Site Centers by Year
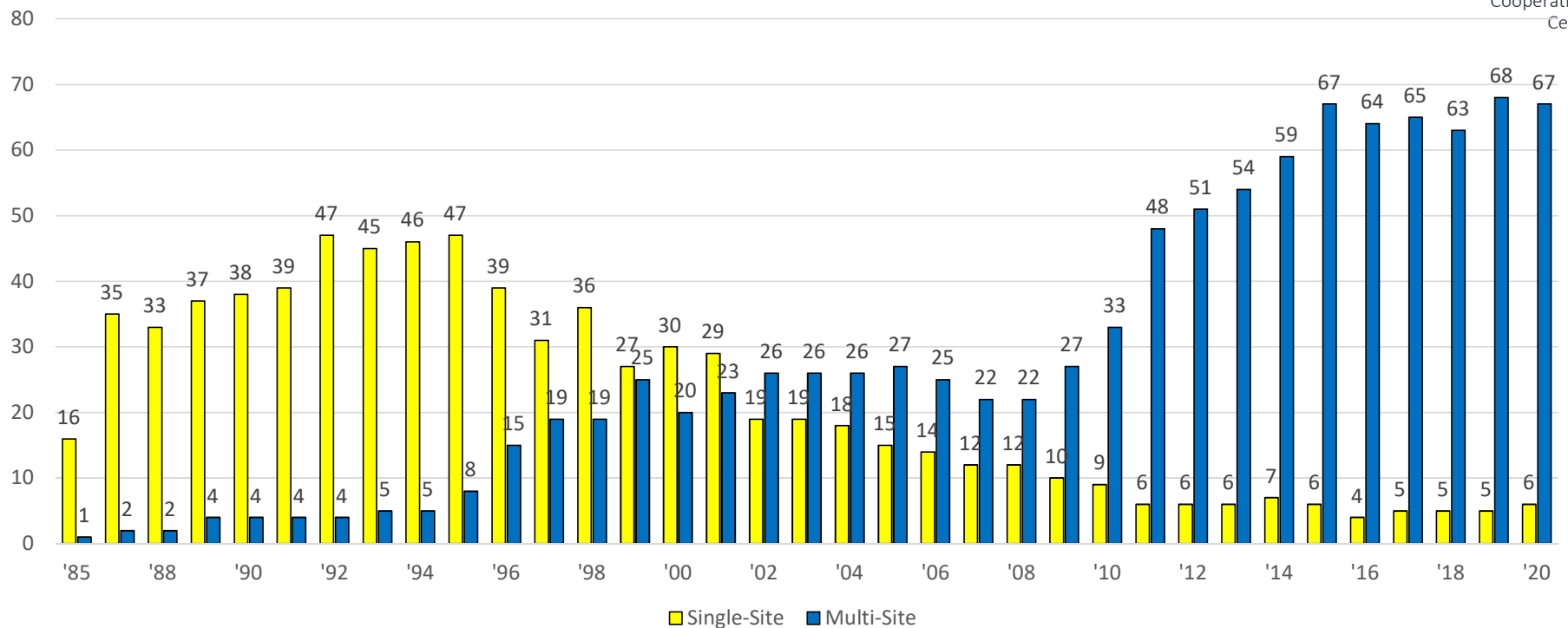
Program & Center Funding

IUCRC Evaluation Project @ NCSU ~ FY2020 ~ DO NOT COPY

NSF IUCRC Program Budget by Year: Total Dollars

Millions

NSF IUCRC Program Budget includes funding to active IUCRC awards, supplemental award funding, planning grants, evaluation, and other program budget items.

$21.5M

☐ Total Dollars in Millions
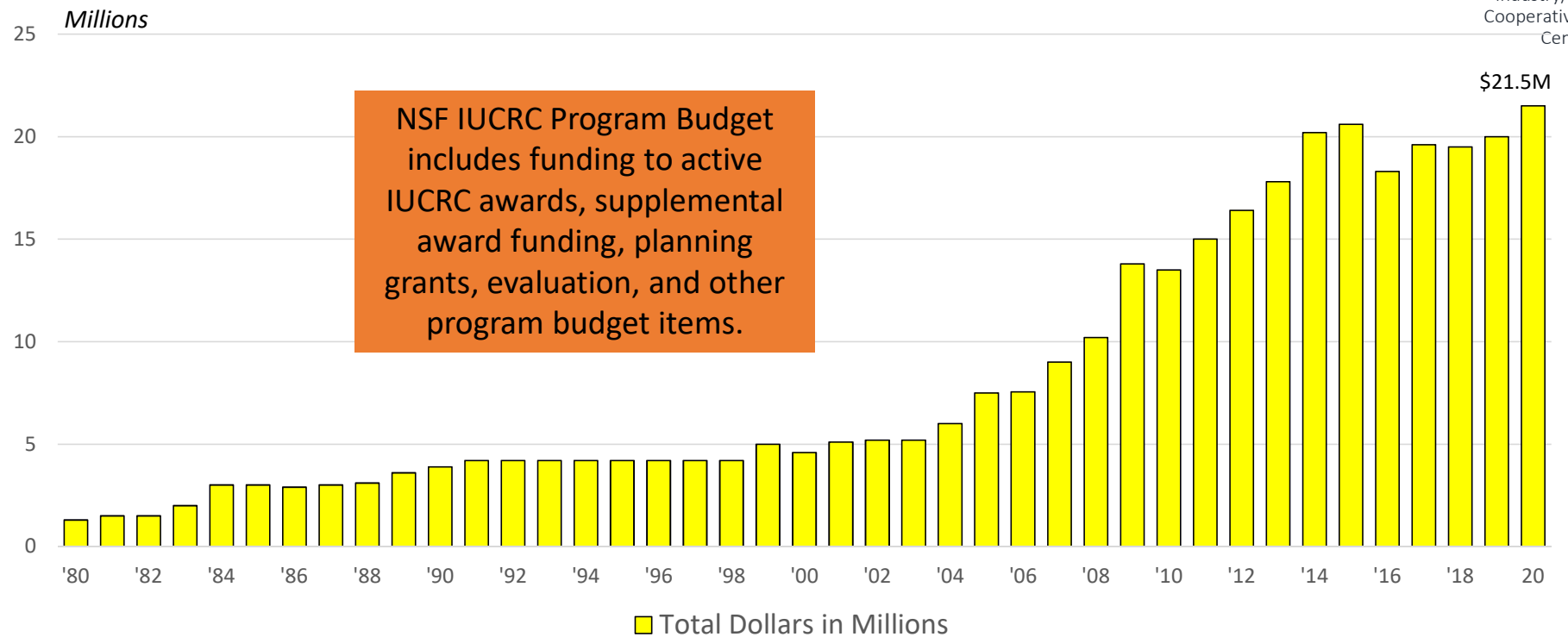
NSF IUCRC Program Budget by Year: Total Dollars by Source
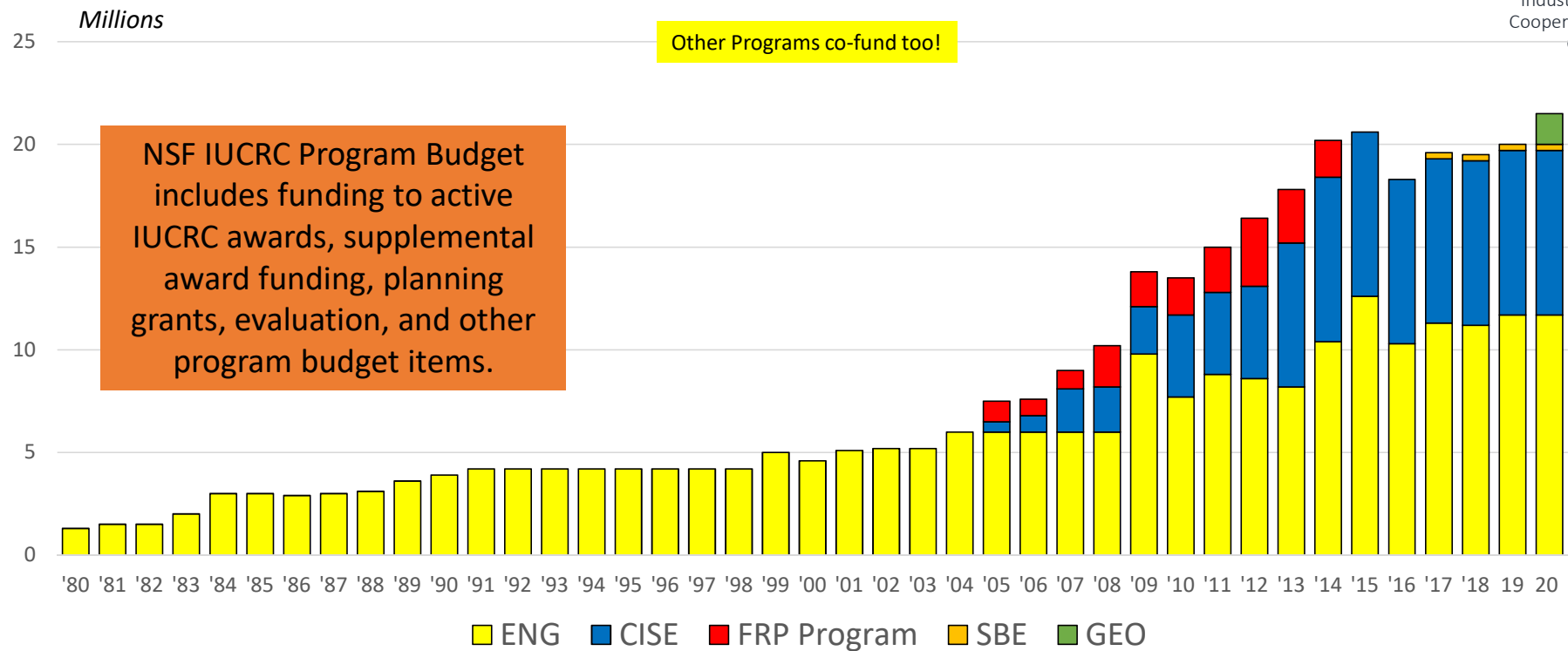
IUCRC Center Funding Sources

| Income Sources |
| --- |
| **NSF IUCRC Investment** |
| IUCRC Award & Supplements: Annual base IUCRC award and grant supplements |
| **Program Income** |
| Member Fees: Fees paid by member organizations (large and small industry, federal, state, and local govt, and non-profits), including fed membership fees paid via IAA/MIPR, for IAB voted funding pool |
| Add'l Member Support: Add'l funding from member organizations, not voted, but results shared with the IAB, including (but not limited to) additional fed funds transferred via IAA/MIPR by member agencies |
| **Additional Center-Catalyzed Funding Support** |
| Other NSF: Any other grant funding from NSF for research that is shared with the IAB, not included in the IUCRC award & supplements |
| Other Federal: Other grant funding from federal agencies for research that is shared with the IAB |
| Other Non-federal: Funding from non-federal sources (e.g. foundations) for research that is shared with the IAB |
| Other State/local: Funding from state or local government agencies for research that is shared with the IAB |

University
e Research
ters

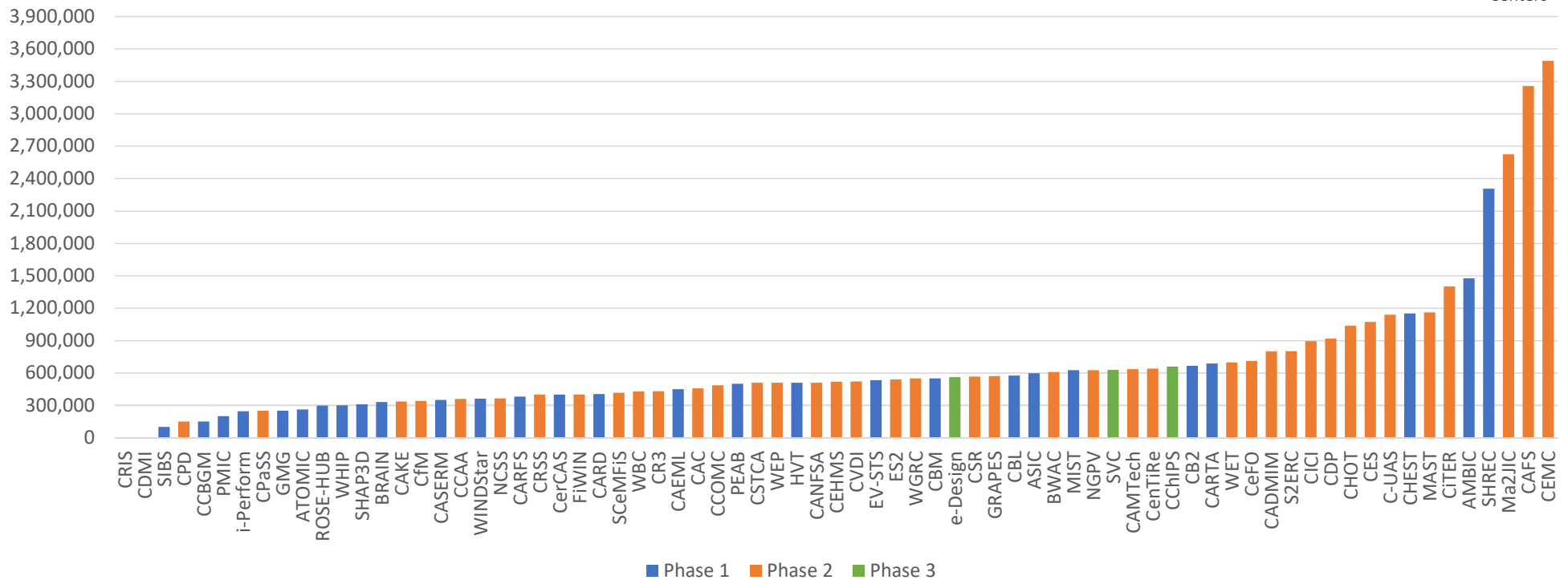# FY2020 Total Center Funding by Center
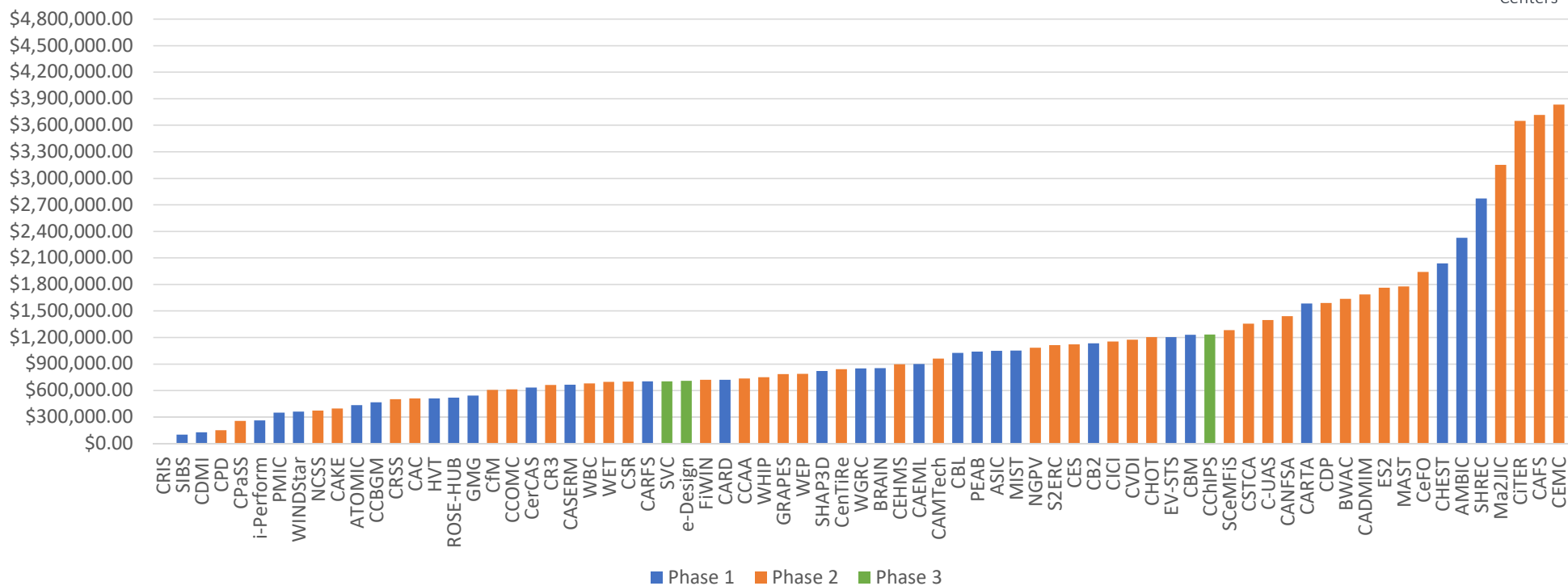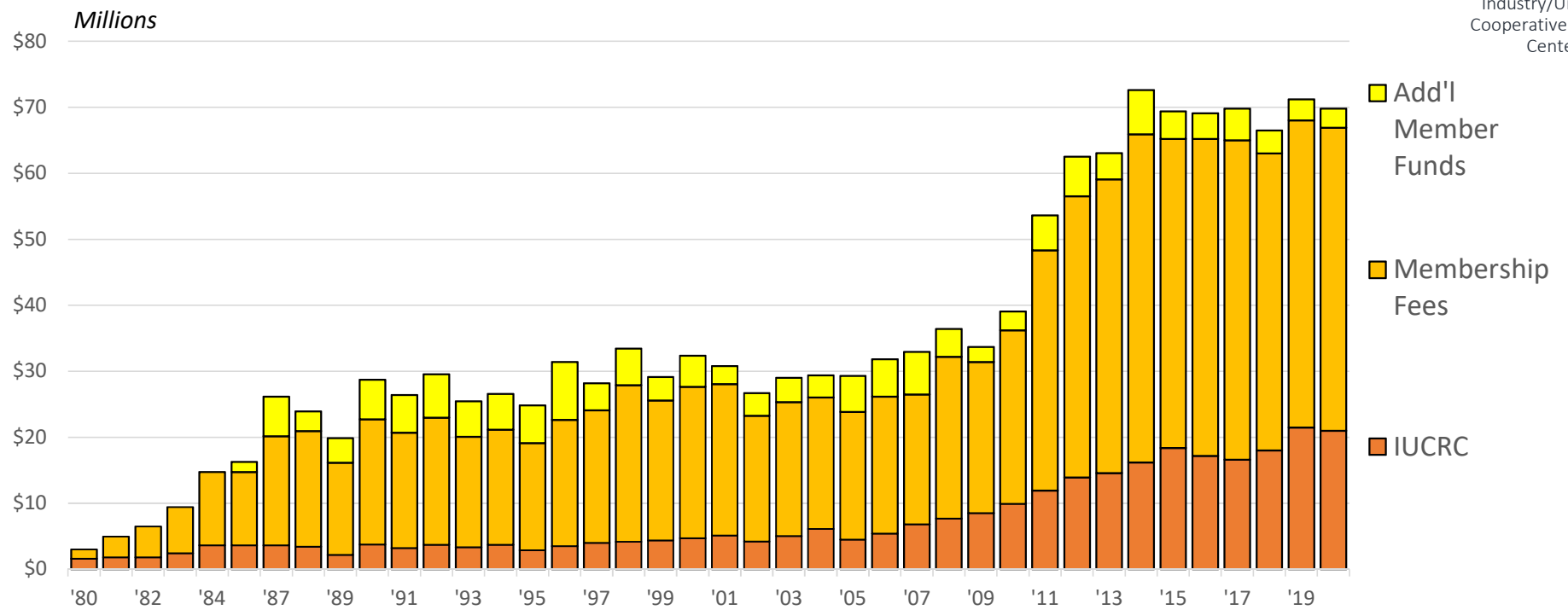
FY2020 Total Center Program Income by Center

IUCRC Evaluation Project @ NCSU ~ FY2020 ~ DO NOT COPY

NSF IUCRC Funding + Program Income by Year in Dollars

Total Funding by Source by Year in Dollars^

Millions

Legend:
- Non-Federal
- Other Federal
- State
- Other NSF
- Add'l Member
- Member Fees
- IUCRC

Industry/University Cooperative Research Centers

- Additional Center-Catalyzed Funding Support
- Program Income
- IUCRC Investment
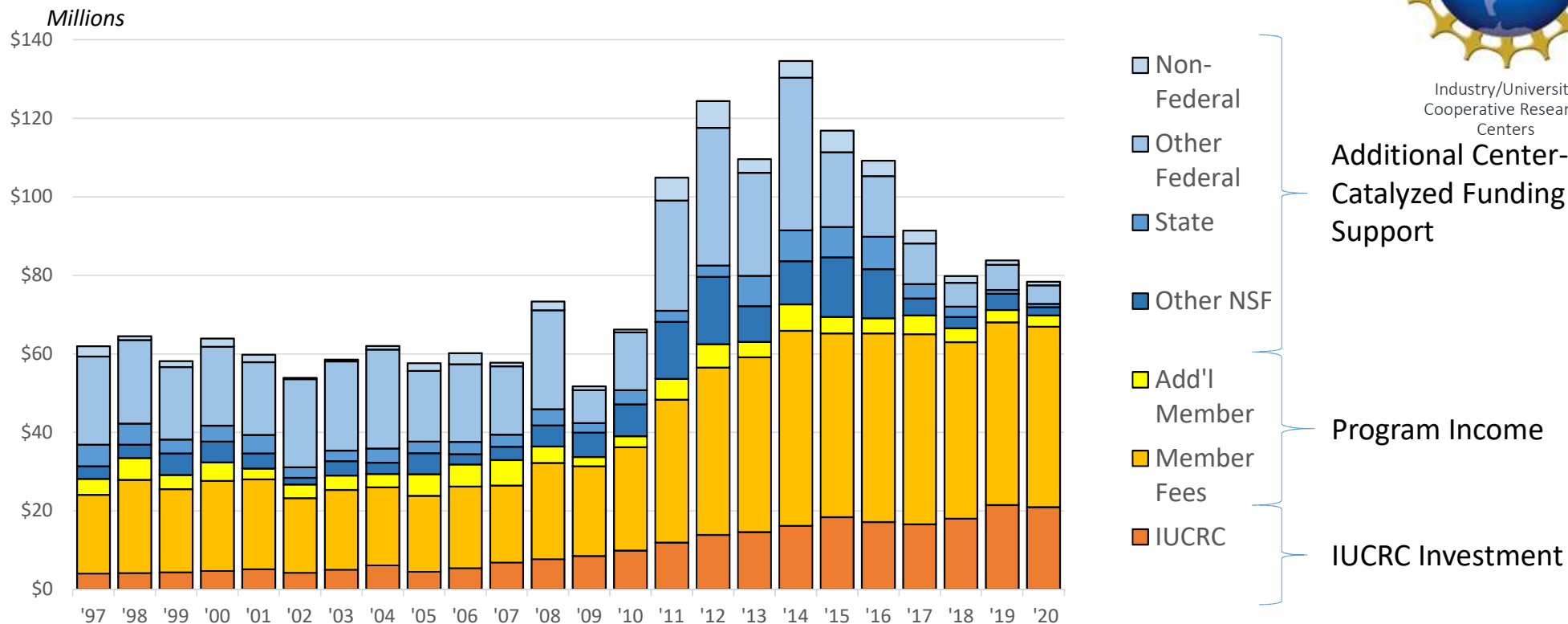
^University & Other Cash data collected prior to FY2016 is excluded.

Total Funding by Source by Year in Percentages^

Industry/University Cooperative Research Centers

Non-Federal

Other Federal

State

Other NSF

Add'l Member

Member Fees

IUCRC

Additional Center-Catalyzed Funding Support

Program Income

IUCRC Investment
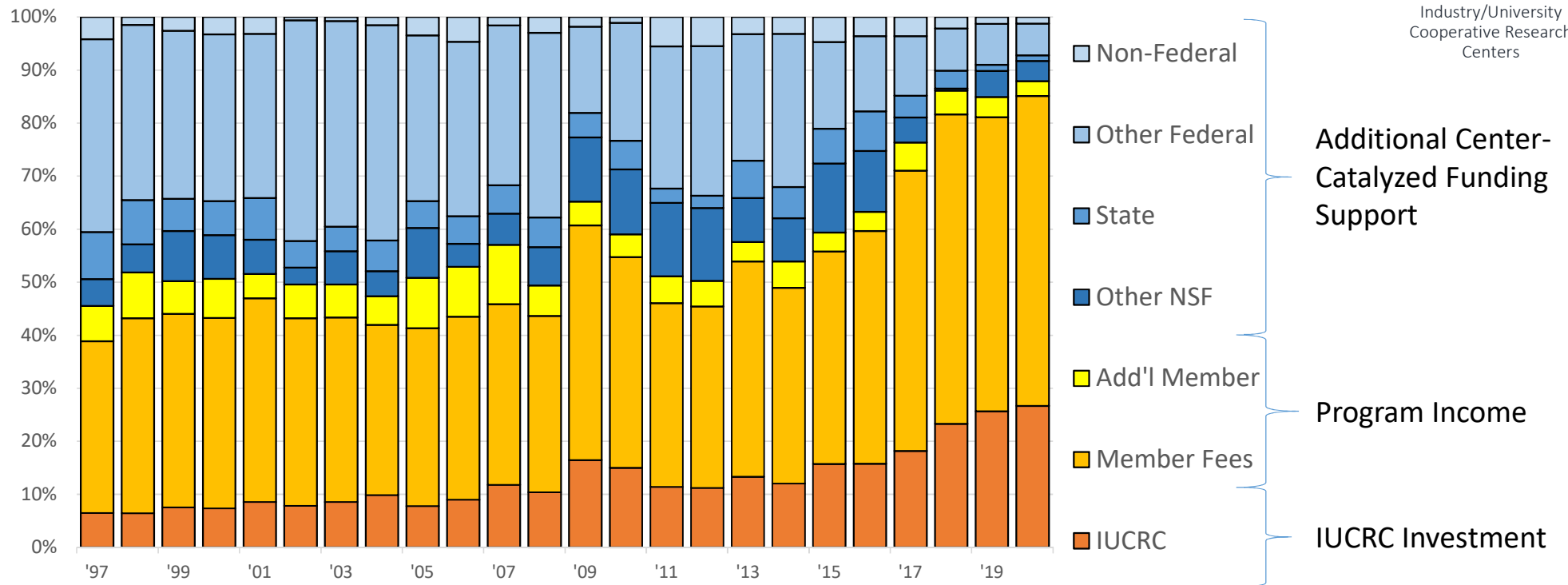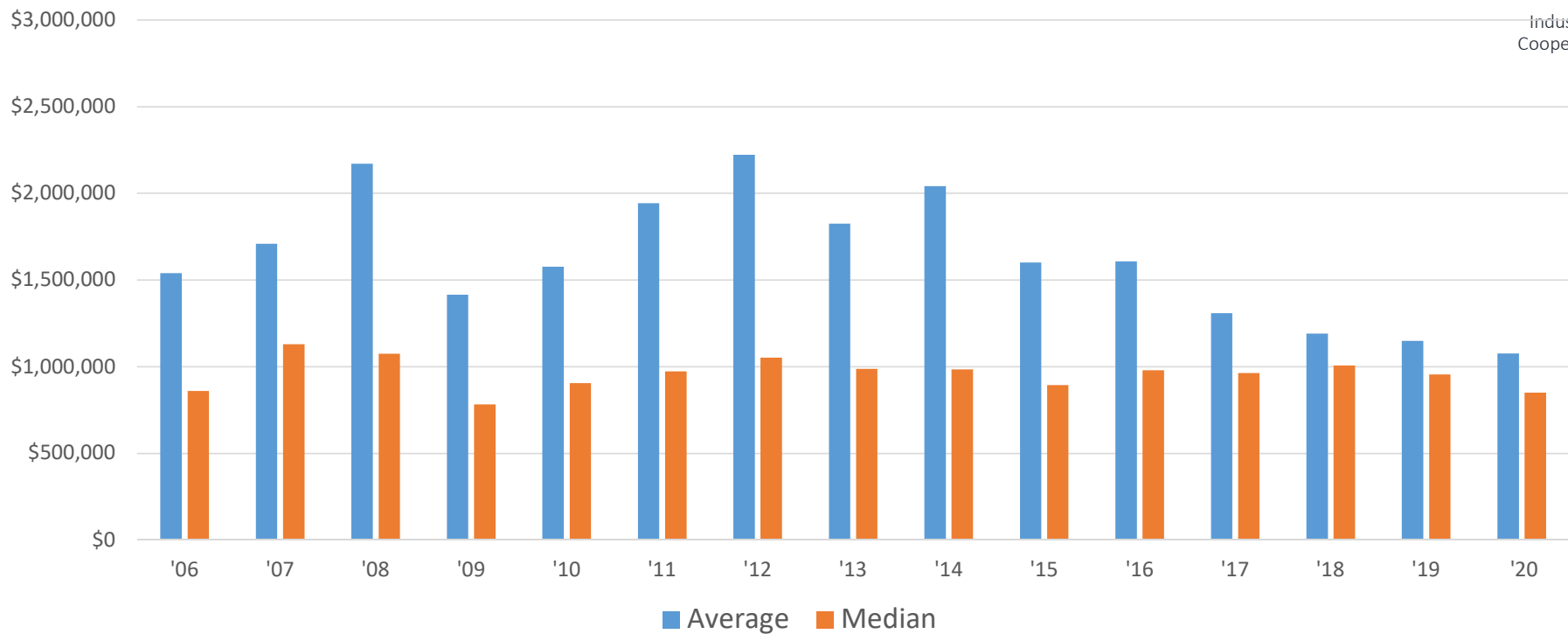
^Univ. & Other Cash data collected prior to FY2016 is excluded.

Average & Median Total Center Funding by Year^

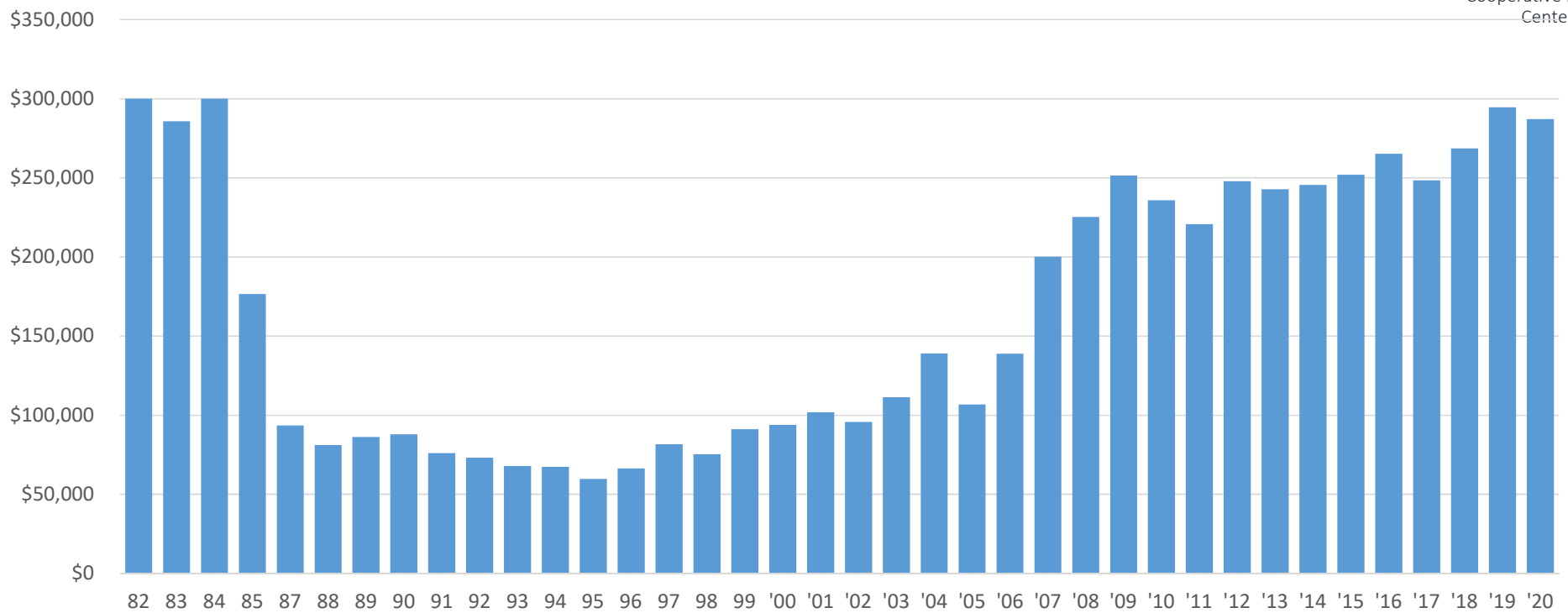
^Univ. & Other Cash data collected prior to FY2016 is excluded

Average NSF IUCRC Awards & Supplements per Center by Year

NSF IUCRC Investment to Program Income Leveraging Ratio by Year

For every dollar that the NSF IUCRC program invested in Centers in FY2020, Centers generated $2.40 in Program Income.
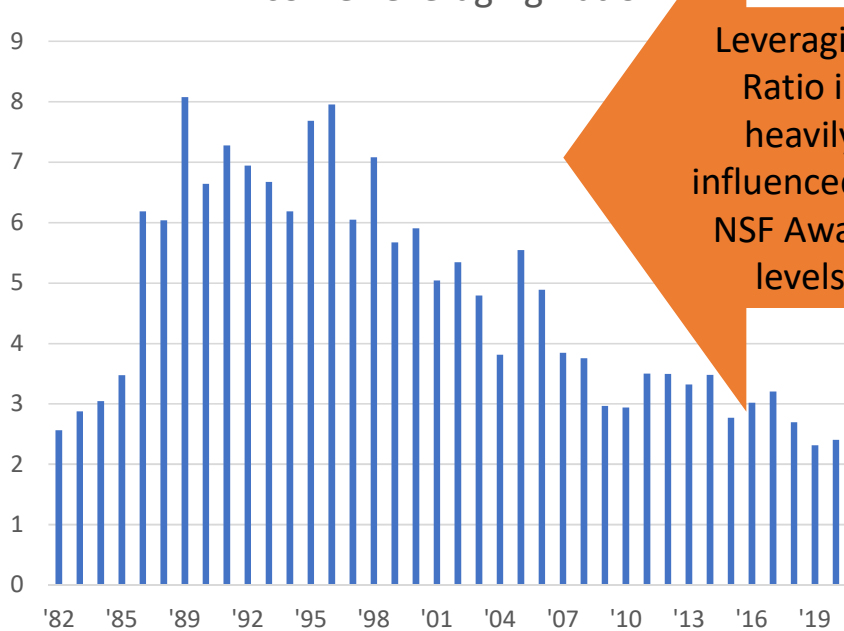The median Program Income Leveraging Ratio from 1980 to 2020 is $1:$3.82.
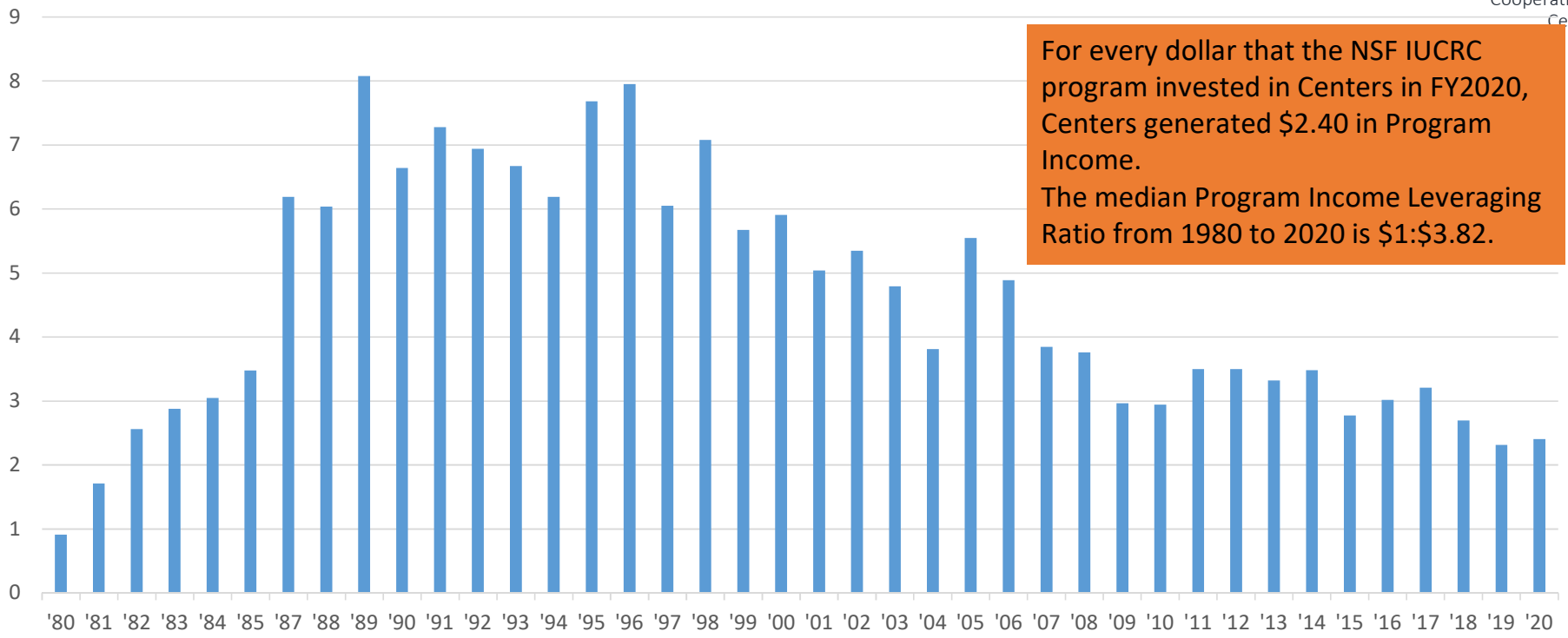
NSF IUCRC Investment to Program Income Leveraging Ratio Compared to IUCRC Award & Supplement per Center, by Year
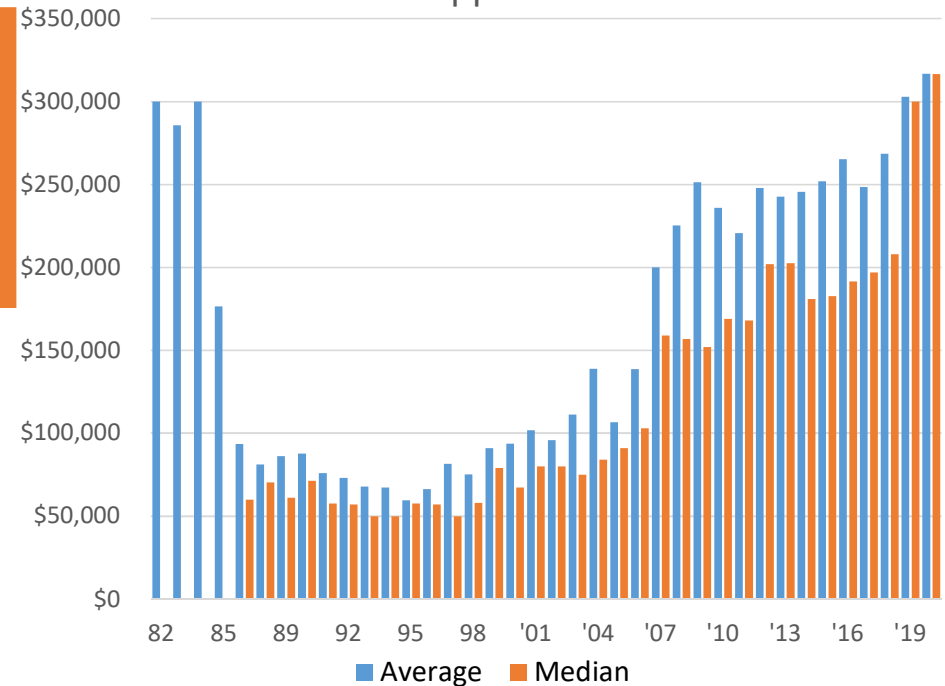
NSF IUCRC Investment to Program Income Leveraging Ratio

Center Average IUCRC Award & Supplements

Leveraging Ratio is heavily influenced by NSF Award levels

■ Average ■ Median

NSF : Total Funding (Excluding NSF IUCRC) Leveraging Ratios by Year^
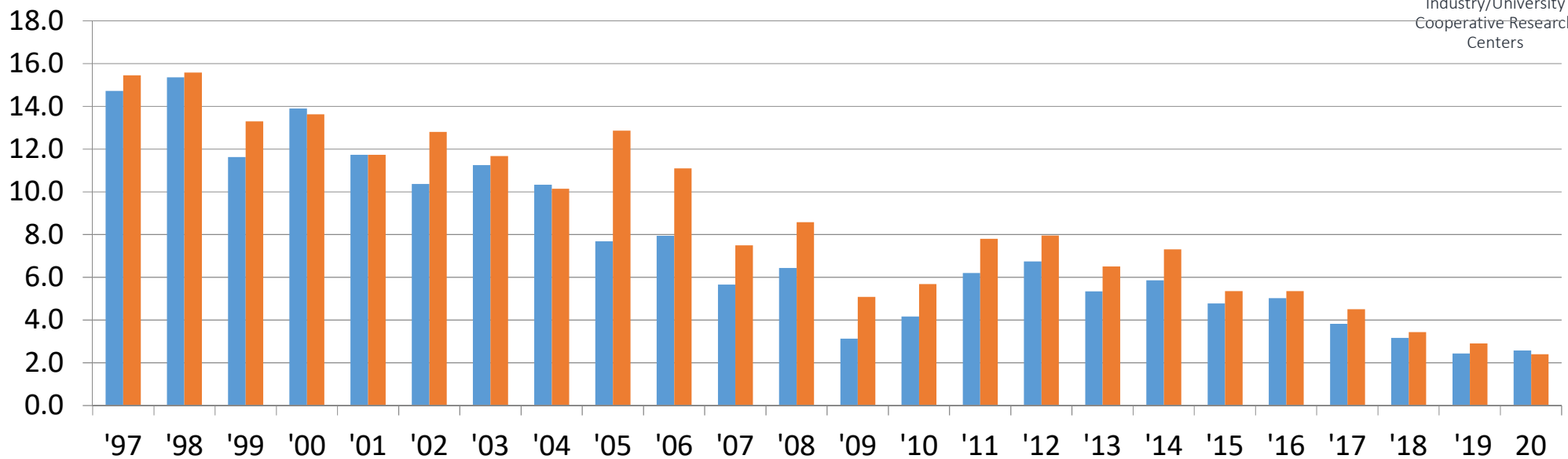
**NSF IUCRC Program Budget Leveraging Ratio** = Total Funding from all non-NSF-IUCRC Sources / NSF IUCRC Program Budget

NSF Awards Reported Leveraging Ratio = Total Funding from all non-NSF-IUCRC Sources / NSF IUCRC Awards and Supplements Reported

^Univ. & Other Cash data collected prior to FY2016 is excluded

Percentage of Center Budget allocated to Center Administration by Year
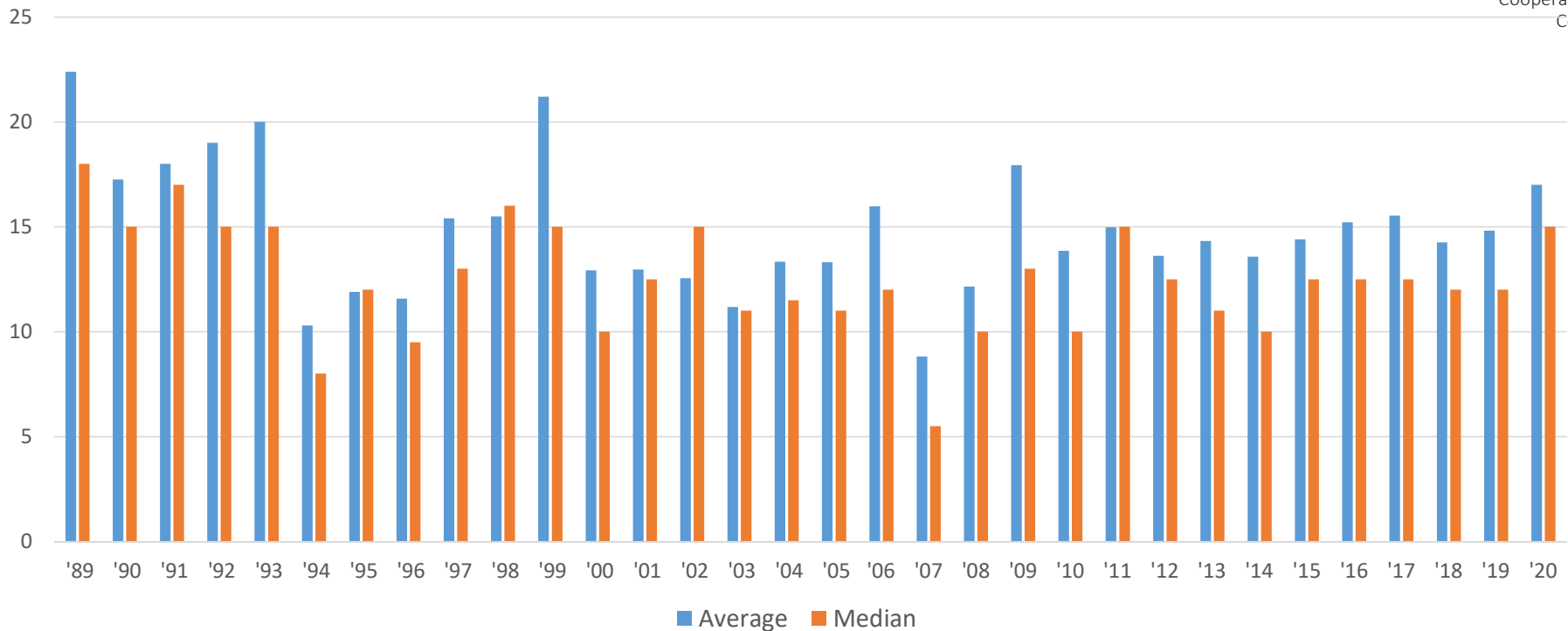
Membership

Membership Summary

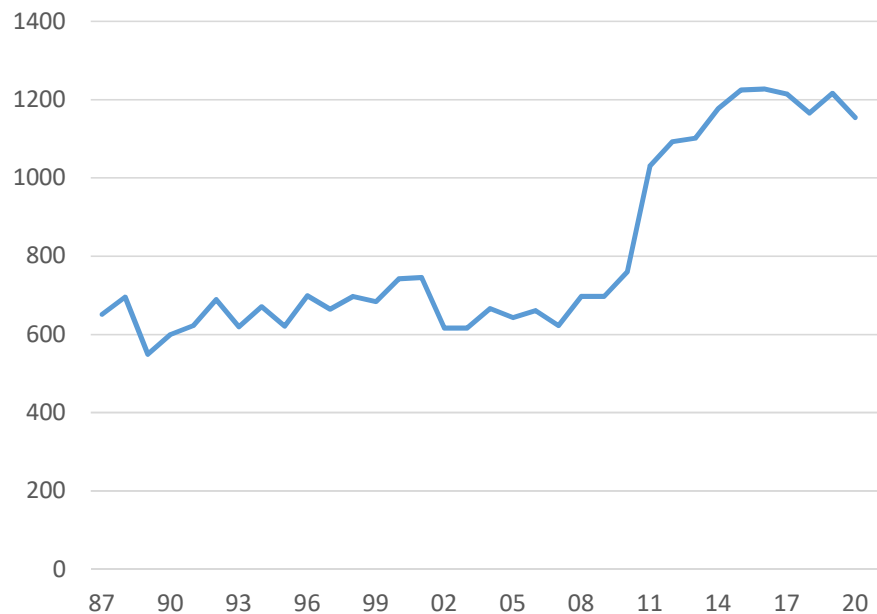|	Count	Percent
Total memberships	*1153*	*100%*
Industry: large firms (500 + employees)	579	50%
Industry: small firms (< 500 employees)	337	29%
US Government: Federal	145	13%
US Government: State or local	42	4%
Other	57	5%
# of organizations with memberships[1]	770	--

1. Many firms and agencies maintain more than 1 membership in the I/UCRC program. This count considers a firm or agency with multiple memberships as a single member. For example, the Army holds 20 memberships but is considered a single organization in this count.

Total Members and Average Memberships per Center by Year

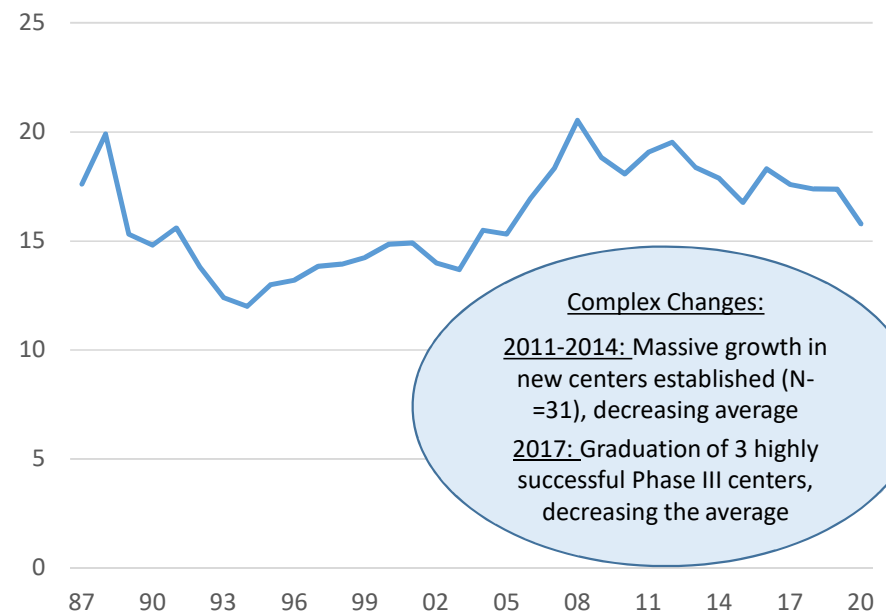*Total Number of Memberships*

Avg. Number of Memberships per Center

Complex Changes:

2011-2014: Massive growth in new centers established (N-=31), decreasing average

2017: Graduation of 3 highly successful Phase III centers, decreasing the average

Number of Memberships per Center by Year

Industry/University Cooperative Research Centers
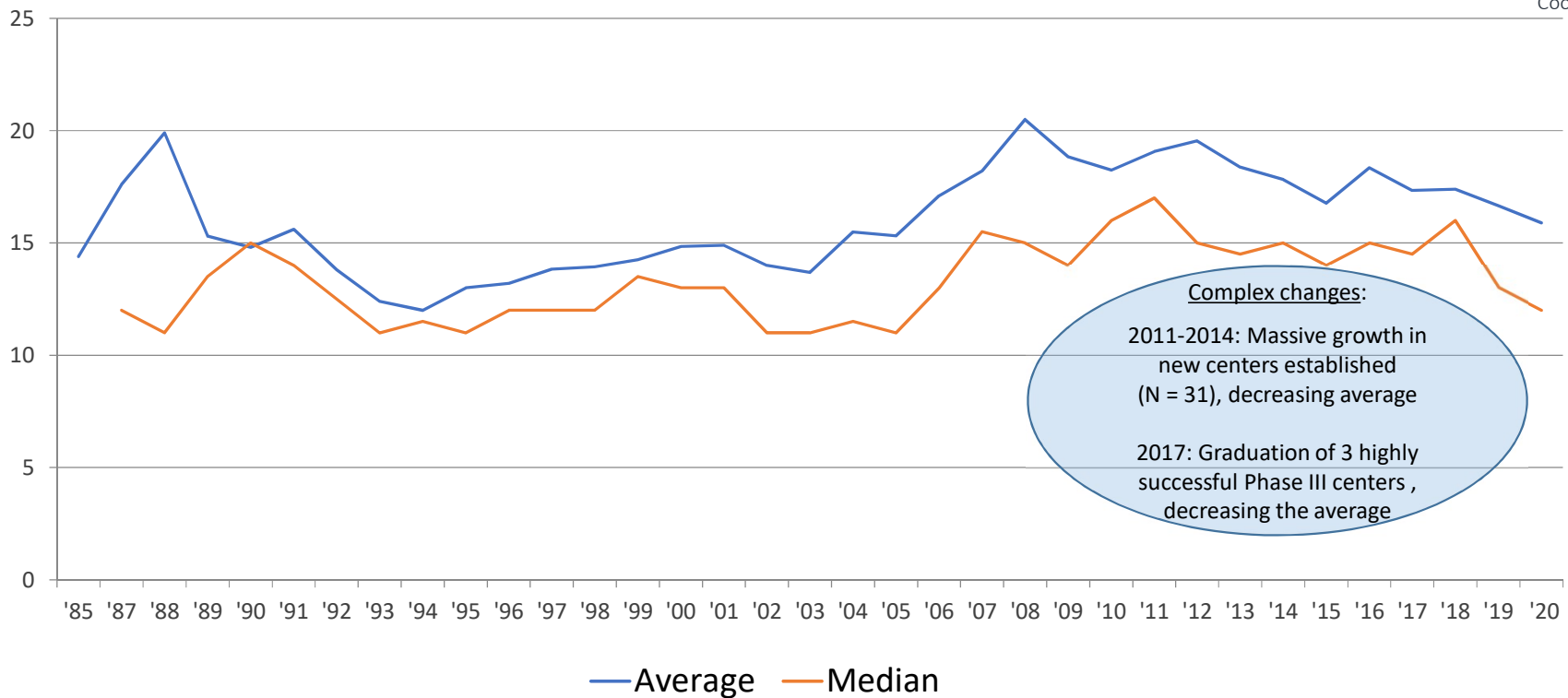
Complex changes:

2011-2014: Massive growth in new centers established (N = 31), decreasing average

2017: Graduation of 3 highly successful Phase III centers , decreasing the average

—— Average   —— Median

Unique Members and Total Memberships Over Time

Growing gap between unique members and total memberships – primarily fueled by growth in firms with memberships in multiple centers
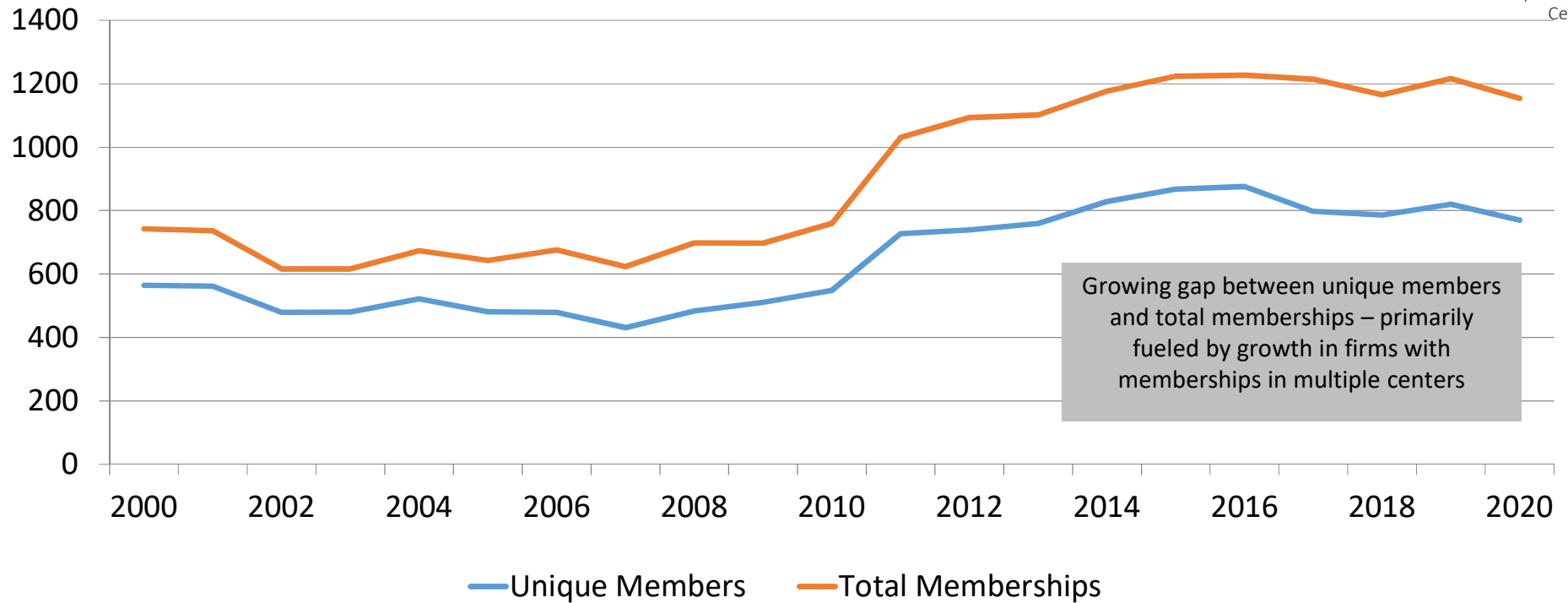
Legend: Unique Members, Total Memberships

Membership:
Organizations with the Most Memberships

N Memberships	Organizations
26	Army
25	Air Force
21	DoE
18	NASA
12	Raytheon
10	Honda
9	NSA
8	DoD, Lockheed Martin
6	Alphacore Inc., Boeing, Cisco Systems, Inc., Corning Inc, Corteva Agriscience, DHS, Hancock Timber Resource Group, Navy+
5	BASF, ERPI, Ford Motor Company, Honeywell, IBM, Intel Corporation, Merck, NIST, Samsung, Shell, Toyota, Weyerhaeuser

21% of all memberships from these organizations

34

Organizations with the Most Memberships Over Time

1995		2000		2005		2010		2015		2020	
N	**Name**	**N**	**Name**	**N**	**Name**	**N**	**Name**	**N**	**Name**	**N**	**Name**
10	Dow Chem.	10	Motorola	17	DoE	26	**Army**	25	**Army**	26	**Army**
9	DuPont	9	**Army**	13	**Army**	18	DoE	20	**Air Force,** DoE	25	Air Force
8	3M, Motorola, Ford	8	Lucent Tech., DoE	10	**Boeing**	15	**Lockheed Martin**	15	**NASA**	21	**DoE**
7	GM	7	**Boeing**, IBM, **Honeywell**	8	Intel, **Air Force**	13	**Boeing**, NASA	14	**DoD**	18	**NASA**
6	Amoco, **Boeing**, Texas Inst.	6	Daimler Chrysler	7	**Raytheon**, HRL, **DoD**	11	**Air Force**	12	**Lockheed Martin, Raytheon**	12	**Raytheon**
		5	Ford	6	**Honeywell, Navy**	10	GM, IBM	11	Intel	10	Honda
				5	Dow Chem., Siemens	7	Intel, **Raytheon**	10	Honda	9	NSA
						5	**DoD, Navy**	9	Navy	8	DoD Lockheed Martin
								5-8	Alphacore Inc., **Boeing**, Corning, Cisco, **DHS**, EPRI, Ford, Hewlett-Packard, Honeywell, Huawei, IBM, **NSA**, L3 Communications, **Northrop Grumman**, Samsung, Weyerhaeuser	5-6	Alphacore Inc., BASF, Boeing, Cisco Systems, Inc., Corning Inc, Corteva Agriscience, DHS, ERPI, Ford Motor Company, Honeywell, IBM, Intel Corporation, Merck, NIST, Samsung, Shell, Toyota, Weyerhaeuser Hancock Timber Resource Group, Navy+

Increased Defense / Defense Contractors →

Overall Increase in Firms with Multiple Memberships →

|											
Dropped		*Dow Chem., DuPont, 3M, GM, Amoco, Texas Inst., EPA, Navy*		*Motorola, LucentTech., IBM, Daimler Chrysler, Ford*		*HRL, Honeywell, Dow Chem., Siemens*		*Hancock Forest Management, Merck, QualComm, Bayer, Campbell Global, Dell, DuPont, Rayonier, Toyota*		*Northrop Grumman, L3 Communications, Hewlett-Packard, Huawei*	
New		*Lucent Tech., IBM, Honeywell, Daimler Chrysler, DoD*		*Intel, Air Force, Raytheon, HRL Labs, Dow Chem., Siemens, Navy*		*Lockheed Martin, NASA, GM, IBM*		*Alphacore Inc.*		BASF, Corteva Agriscience, Merck, NIST, Shell, Toyota, Hancock Timber Resource Group,	

Membership Composition by Year*

Industry/University Cooperative Research Centers
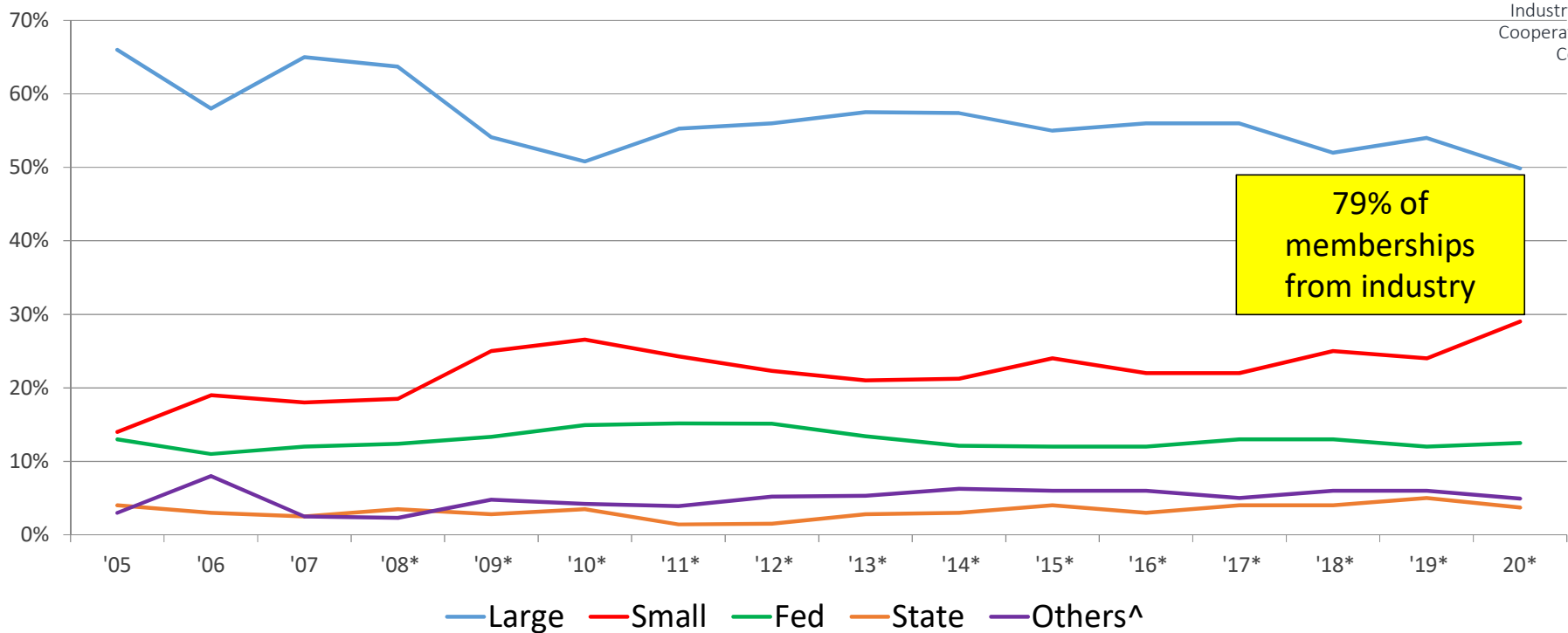
79% of memberships from industry

Legend: Large — Small — Fed — State — Others^

*Years Advanced Forestry excluded as a small business outlier: '08=36, '09=49, '10=57, `11=66, '12=71, '13=77, '14=86, '15=71, '16=69, 17 = 91, '18=53, '19=86, '20=73.

^ Categories comprising Others include: non-profit, non-US gov't, and other org.

Leveraged Dollars per Dollar of Membership Fee per Center by Year

Legend: ■ Mean membership fee leveraging ratio   ■ Median membership fee leveraging ratio
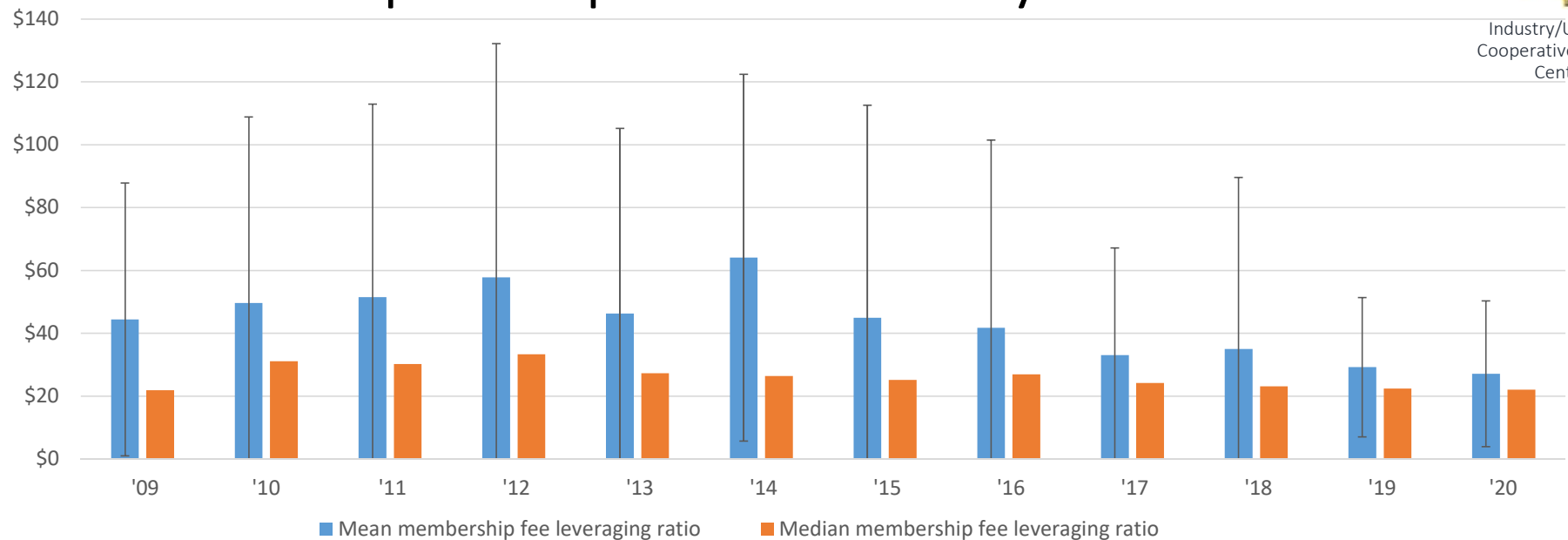
- Membership fee leveraging refers to the amount of center funding leveraged by each dollar of membership fees.
- In FY2020, for every dollar a member invested in the center, they leveraged $29 in center research funding.
- Membership fee leveraging = (total center budget / (total membership fees/number of memberships))-1

FY2020 Total Center Memberships by Center
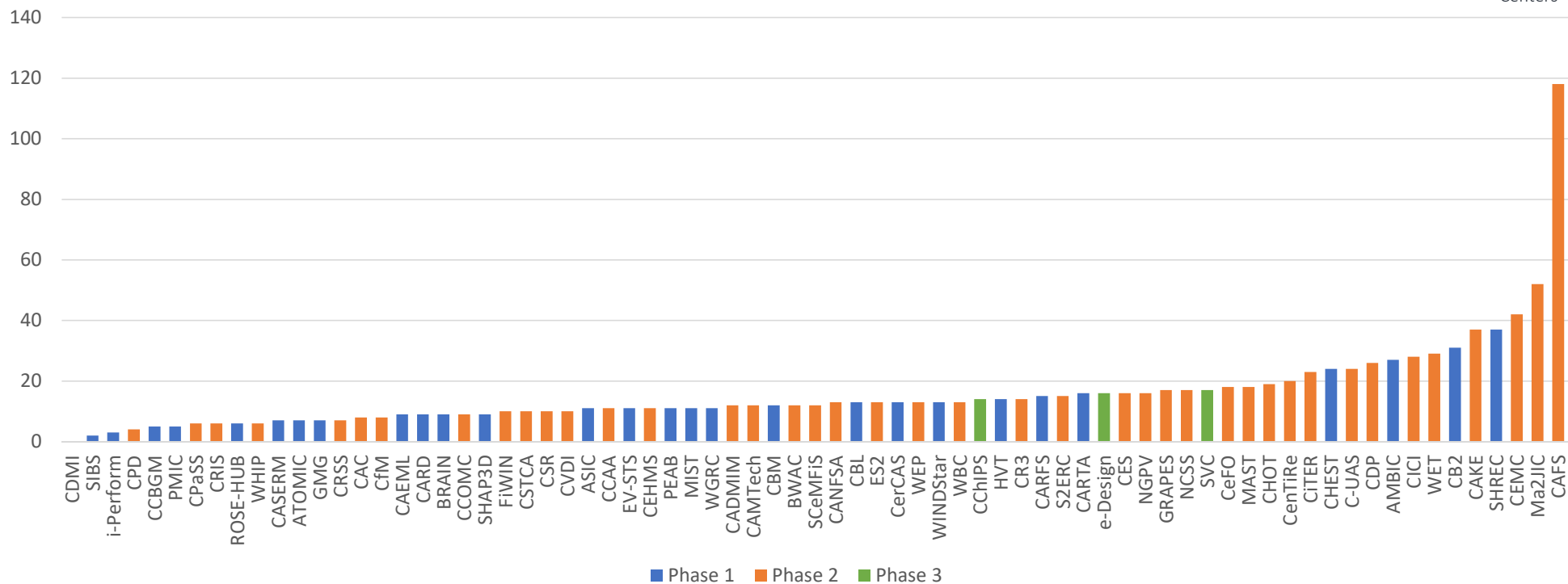
Interpreting Membership Changes Over Time

Interpreting Membership Changes Over Time

- Changes in Membership numbers over time are influenced by changes at different levels:
  - Members: Individual members will leave a center and new members will be added
  - Centers: Mature centers will graduate (and their members will be dropped) and new centers will be created (and their members added)
  - Sites: New sites (and their members) are added to existing centers
  - Changes in the national and international economy can also have an impact

- Changes in program totals and averages per center can be due to any combination of these factors

Example: 2012 IUCRC System Changes
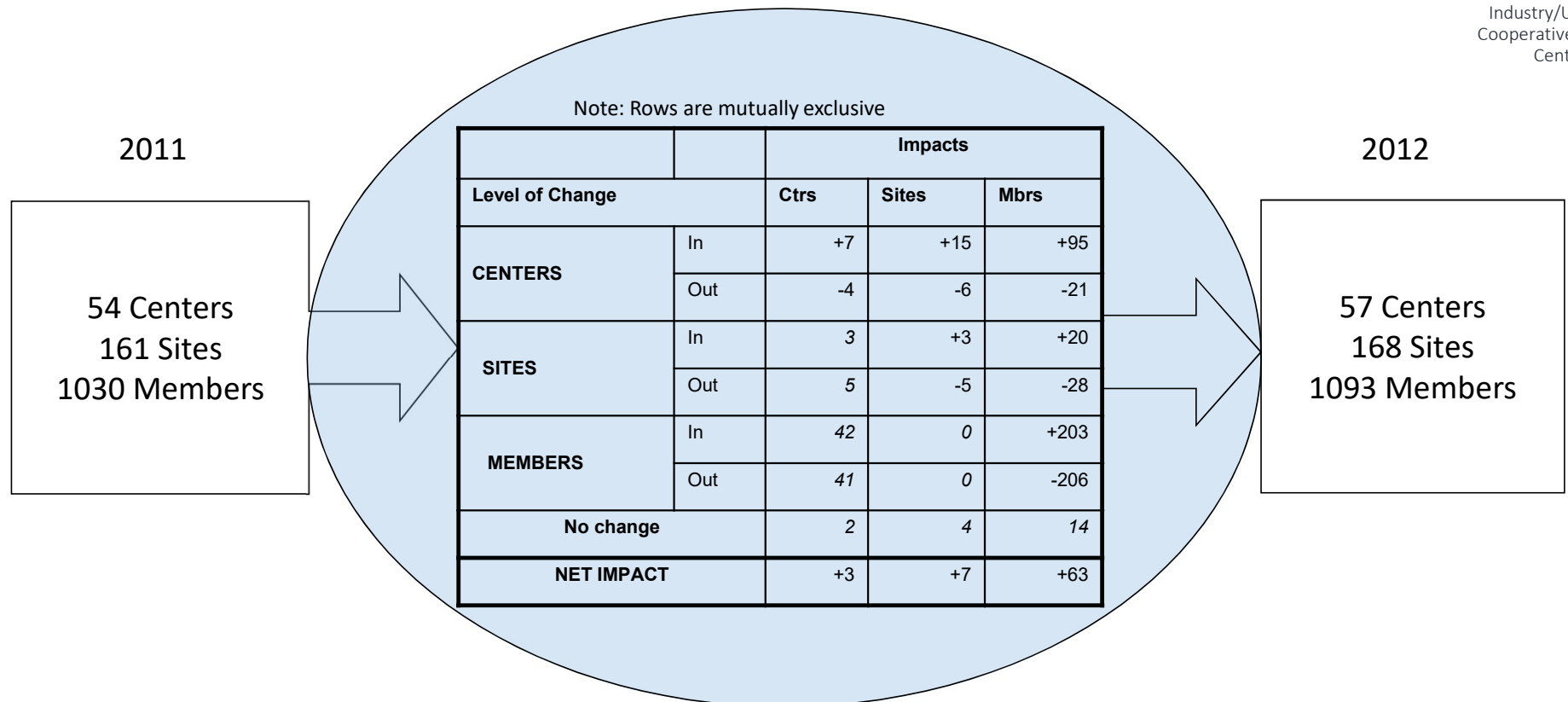
2011

54 Centers
161 Sites
1030 Members

Note: Rows are mutually exclusive

Level of Change		Impacts		
		Ctrs	Sites	Mbrs
CENTERS	In	+7	+15	+95
	Out	-4	-6	-21
SITES	In	3	+3	+20
	Out	5	-5	-28
MEMBERS	In	42	0	+203
	Out	41	0	-206
No change		2	4	14
NET IMPACT		+3	+7	+63

2012

57 Centers
168 Sites
1093 Members

Industry/University
Cooperative Research
Centers

Membership Turnover Variables and Indicators

- **Members added:** number of members center reports adding during past year (may include new individual members or members from added site)
  - Does not include addition of new centers
- **Members left:** number of members a center reports leaving the center during past year (would only include site-level loss if site left center)
- **Member Net Gain/Loss**: the relative gain or loss of members (members added – members left) centers experience during each calendar year
- **Member Turnover:** percentage of a center's members from year x that leave the center the following year (year x + 1)
- Aside: Other membership indicators we've looked at:
  - Dwell time, turnover by center fidelity to IUCRC model, membership for single vs. multi-site centers, private vs public sector membership, fortune ranking of members, defense membership, phase based growth and retention, firms with multiple memberships, Chinese firm membership

Average Membership Gain/Loss

Membership Turnover Rate

New normal: Centers lose 15-20% of their memberships from one year to the next.

Industry/University Cooperative Research Centers

Turnover % = Members terminated in year X+1 / Total members in year X

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44

Average Number of Memberships Added & Dropped by Year

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Median Number of Memberships Added & Dropped by Year

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Average Membership Turnover Rate by Year

Industry/University Cooperative Research Centers

New normal: Centers lose ~15% of their memberships from one year to the next.
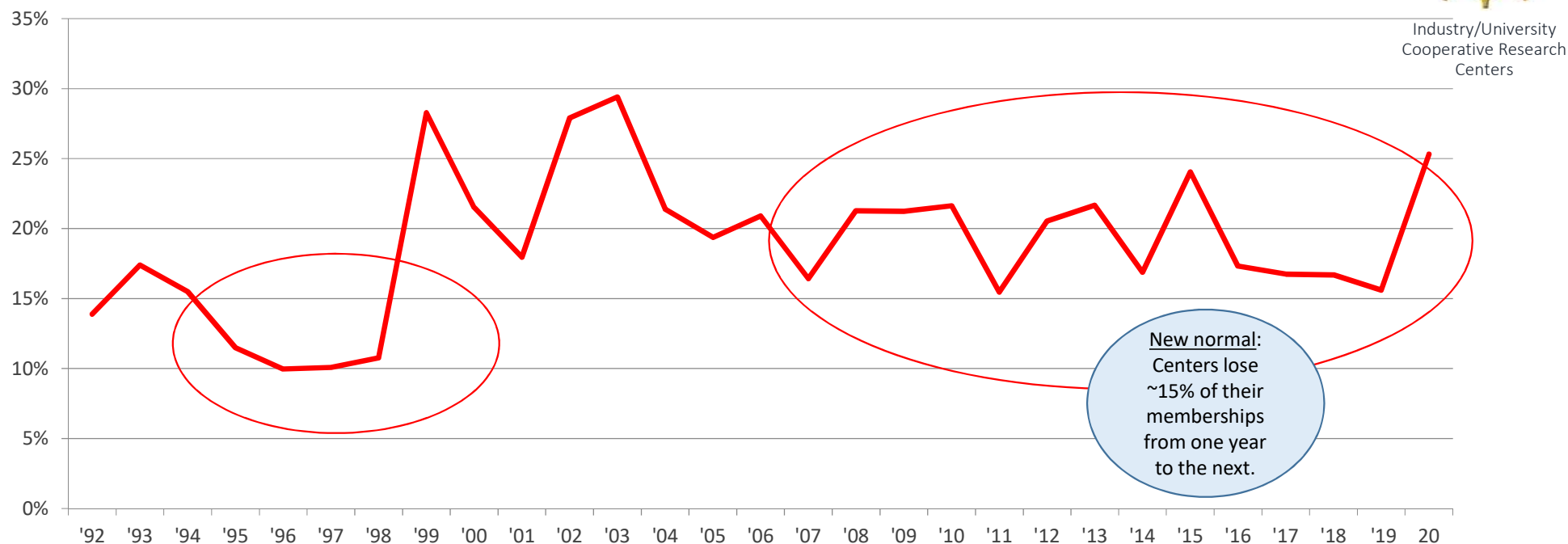
Turnover % = Memberships terminated in "year X+1" / Total memberships in "year X"

Conclusions: Turnover

- **Membership growth and stability**
  - Average number of members has been relatively stable, decreasing slightly, over the last 5 years; ~16 members/center
  - Member turnover rate is at a new normal of 15-20% over the last 10+ years
  - However, this years much higher rate of 25% is likely due to a) COVID-19 economic uncertainties b) rising number of NCE sites

- **Membership is dynamic**
  - Program level picture positive based on continuous growth in new centers and sites
  - Most fluctuations attributable to initiation of Phase 3 funding opportunity and graduation of Phase 3 mega-centers
  - Membership picture is volatile
    - Causal factors are hard to pin down
    - Explanations may reside with center level variables like leadership, technology salience, as well as structural issues like the churn of old and new centers, site transitions, etc.
    - Useful both as a measure of overall program health and to benchmark center performance relative to program level norms

Outputs and Outcomes

Industry/University
Cooperative Research
Centers

Number of Researchers per Center by Year
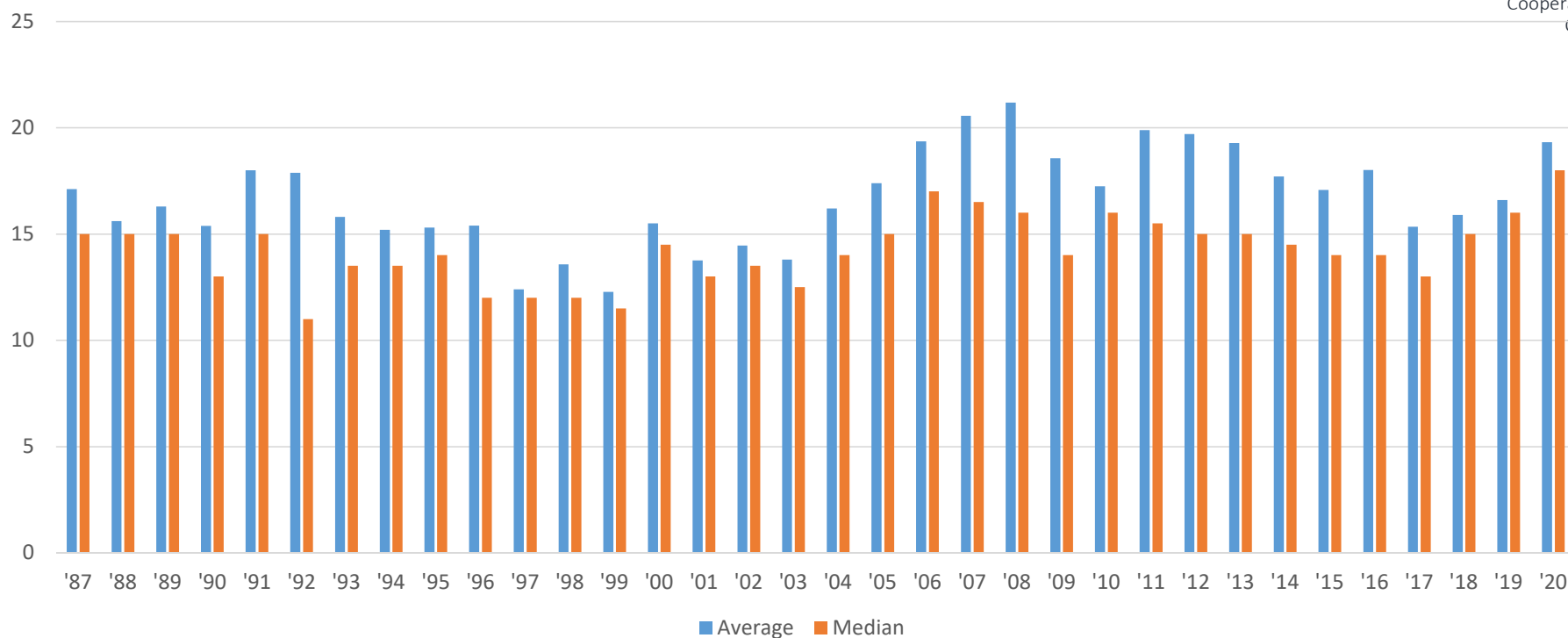
Number of Center Funded Projects per Center by Year

Mean N of Projects   Median N of Projects

Total Number of Intellectual Property & Commercialization Events by Year

*Invention Disclosures Outliers: 2014: CVDI = 40, BSAC = 20, E-Design = 12, CITeR = 17. 2015: BSAC = 32, 2016: BSAC = 31., 2017: BSAC = 18, CVDI = 12.
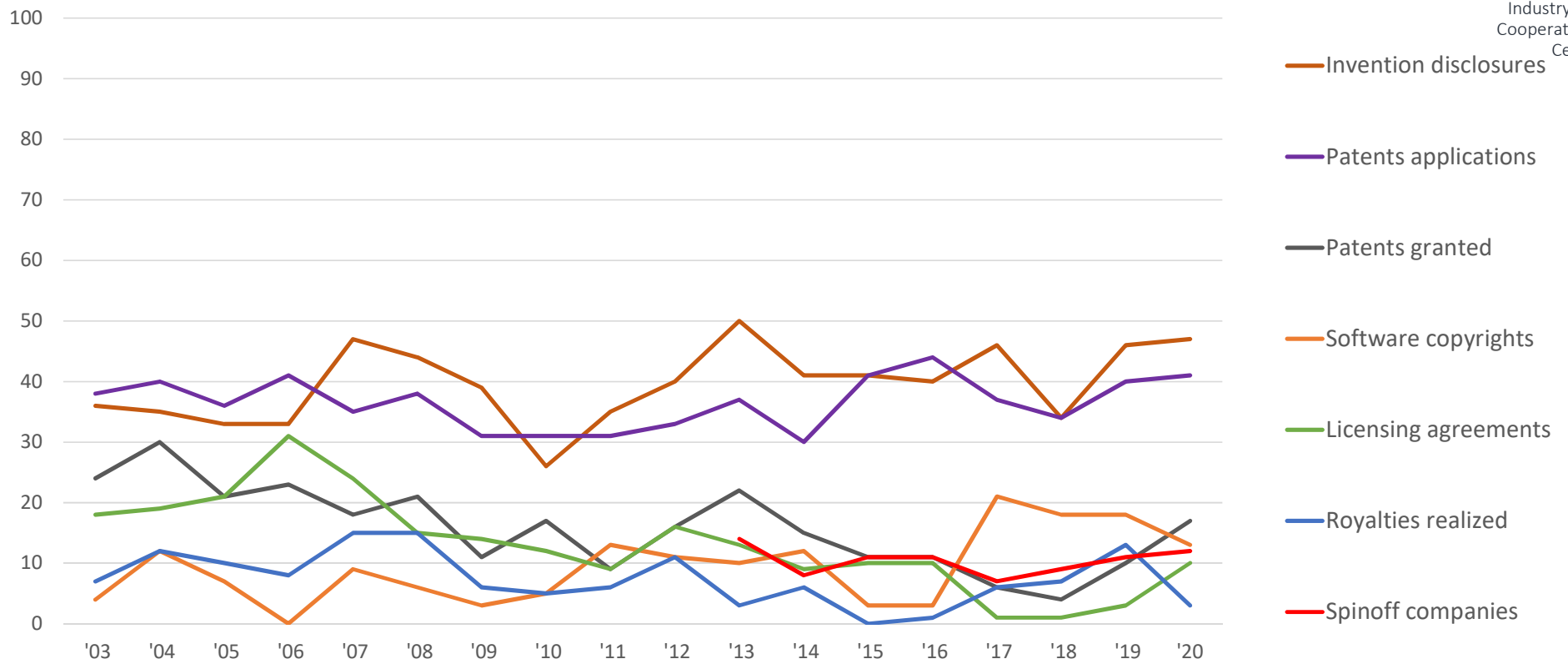**Patent Applications Outliers: 2016: BSAC = 25, DDA = 9, 2017: BSAC = 25, 2020: CVDI=11; SVC=19
*** Patents Granted Outliers: 2016: BSAC = 6, DDA = 11., 2020: CAKE=9

Number of Intellectual Property & Commercialization Events per Center by Year

Average Number of IP & Commercialization Events
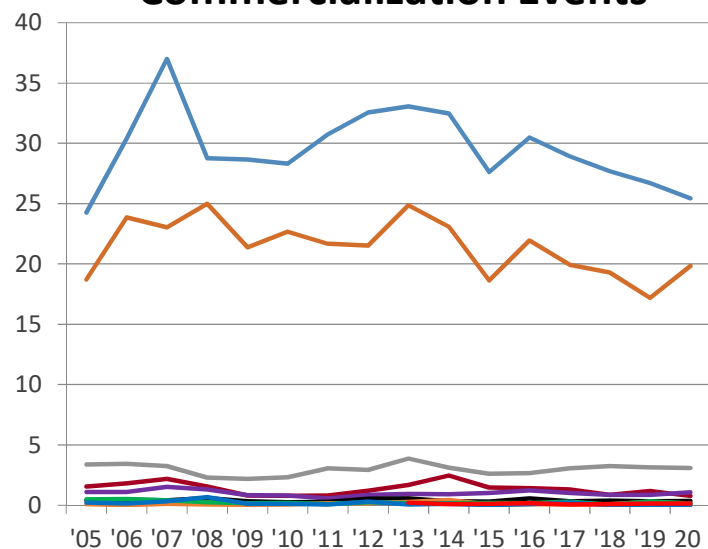
Legend:
- Presentations
- Publications
- Pubs w/IAB
- *Invention Disclosures
- **Patent Applications
- ***Patents Granted
- Software Copyrights
- Licensing Agreements
- Royalties Realized
- Spinoff Companies

Median Number of IP & Commercialization Events
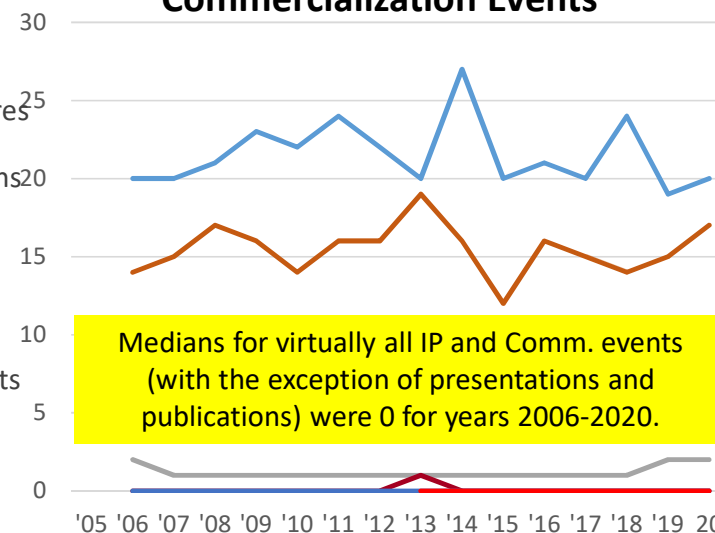
Medians for virtually all IP and Comm. events (with the exception of presentations and publications) were 0 for years 2006-2020.

*Invention Disclosures Outliers: 2014: CVDI = 40, BSAC = 20, E-Design = 12, CITeR = 17. 2015: BSAC = 32, 2016: BSAC = 31., 2017: BSAC = 18, CVDI = 12.
**Patent Applications Outliers: 2016: BSAC = 25, DDA = 9, 2017: BSAC = 25, 2020: CVDI=11; SVC=19
*** Patents Granted Outliers: 2016: BSAC = 6, DDA = 11., 2020: CAKE=9

Percentage of Centers Reporting IP & Commercialization Events by Year

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Total Number of Students Trained by Year
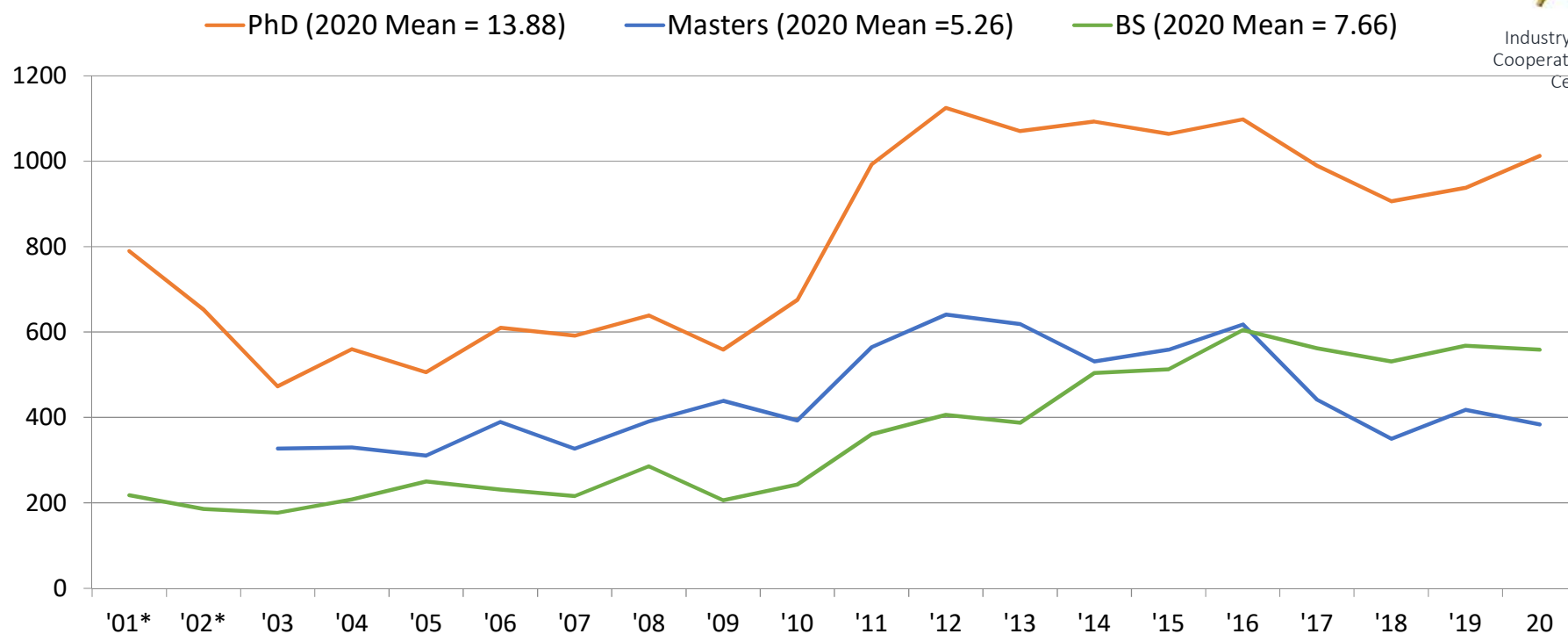
PhD (2020 Mean = 13.88) — Masters (2020 Mean =5.26) — BS (2020 Mean = 7.66)

Number of Students Trained per Center by Year

Average per Center

Median per Center

Legend: PhD — Masters — BS
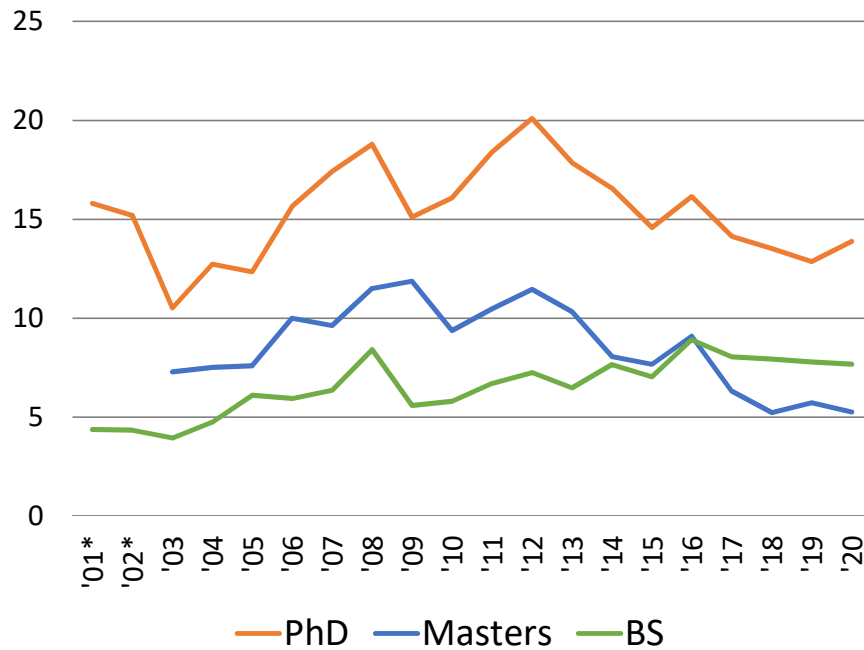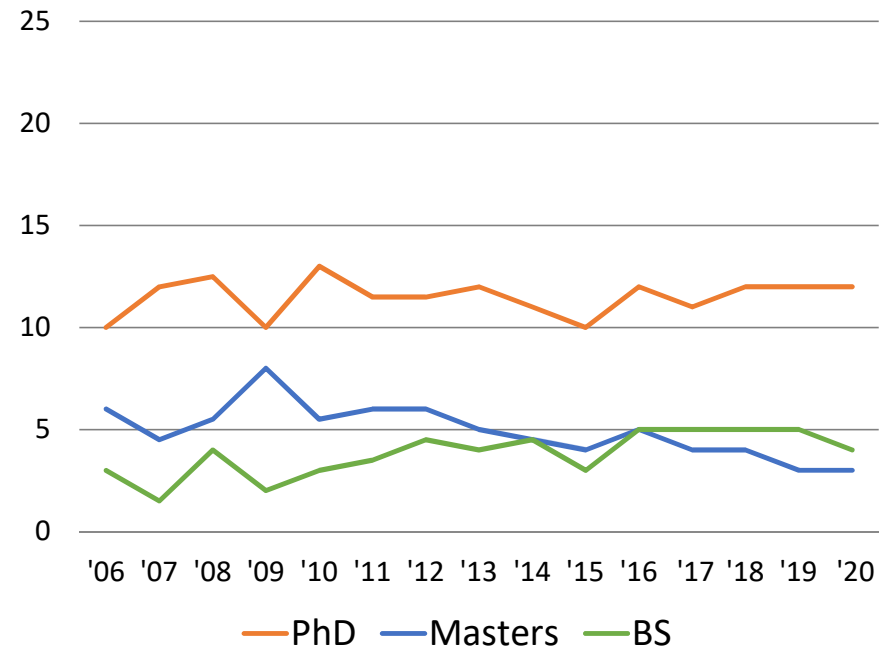
Total Number of Students Graduated by Year
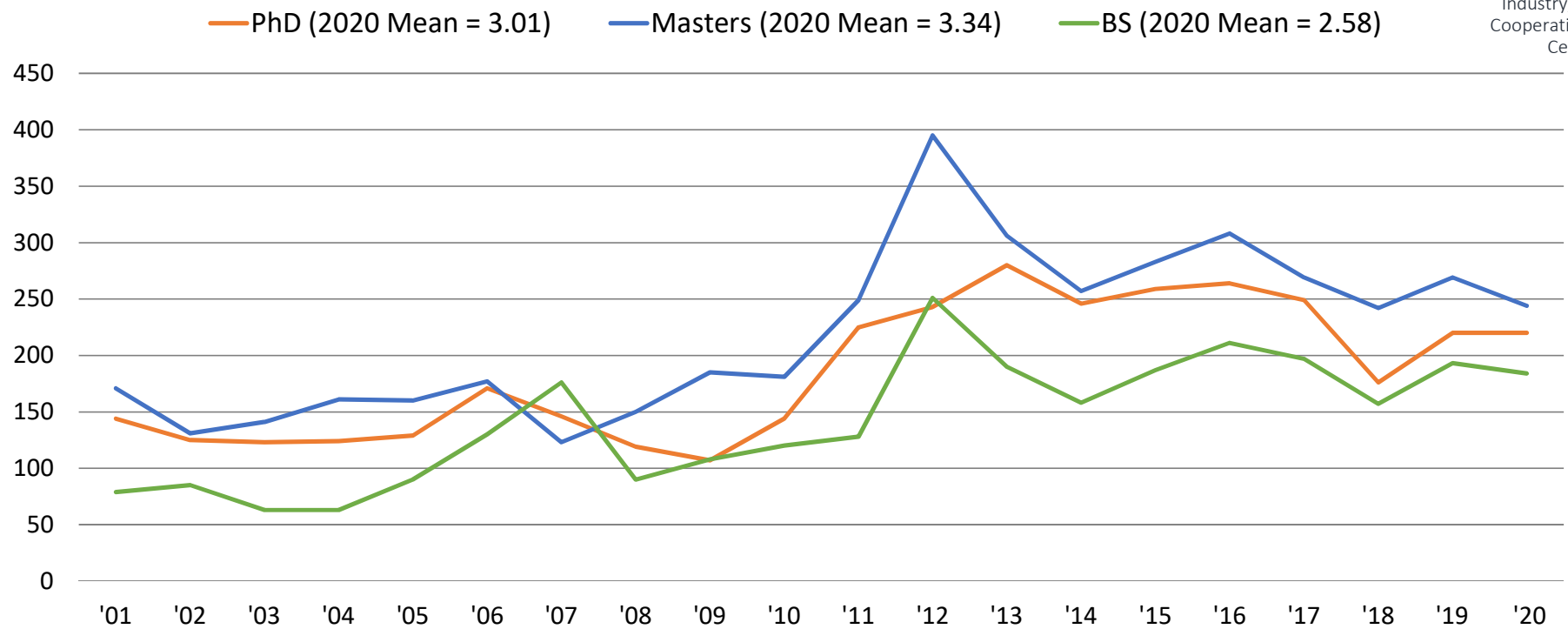
PhD (2020 Mean = 3.01) — Masters (2020 Mean = 3.34) — BS (2020 Mean = 2.58)

Number of Students Graduated per Center by Year

Average per Center

Median per Center

Total Graduates Hired by Industry & Government Members by Year

Legend: PhD (2020 Mean = .51), Masters (2020 Mean = .48), BS (2020 Mean = .22)
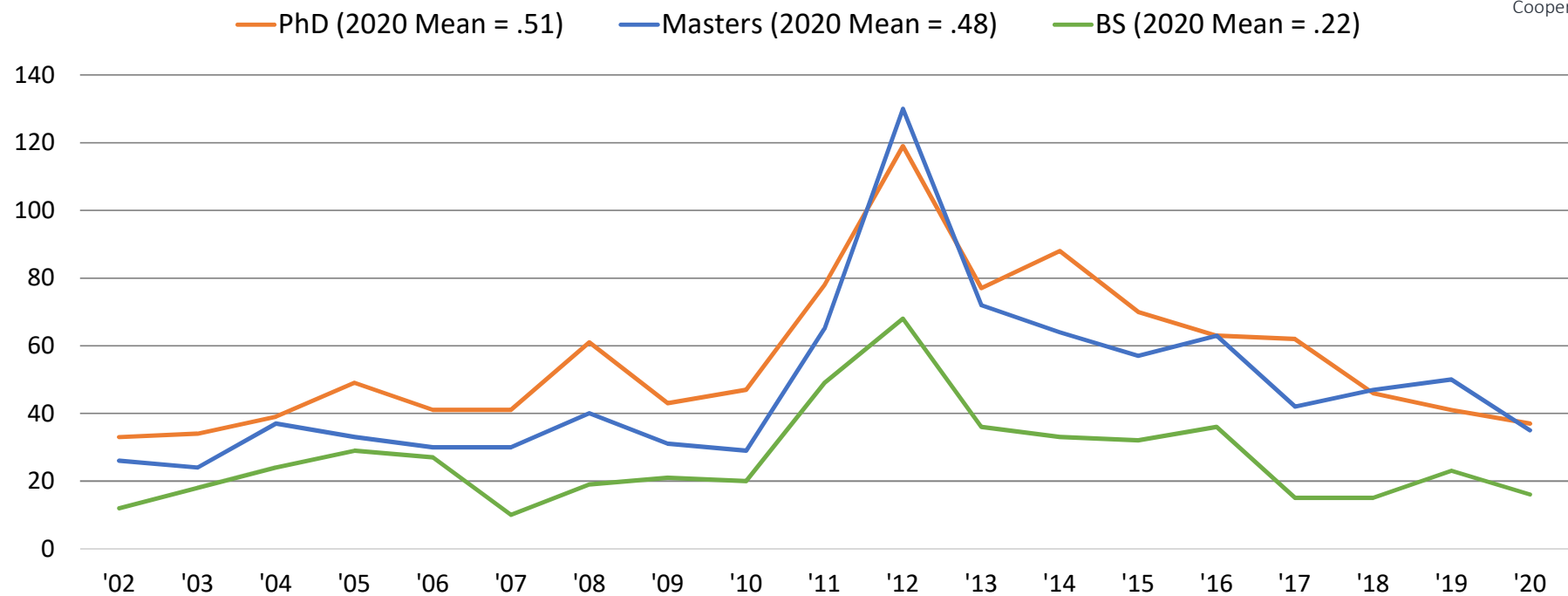
Average Graduates Hired by Industry & Government Members

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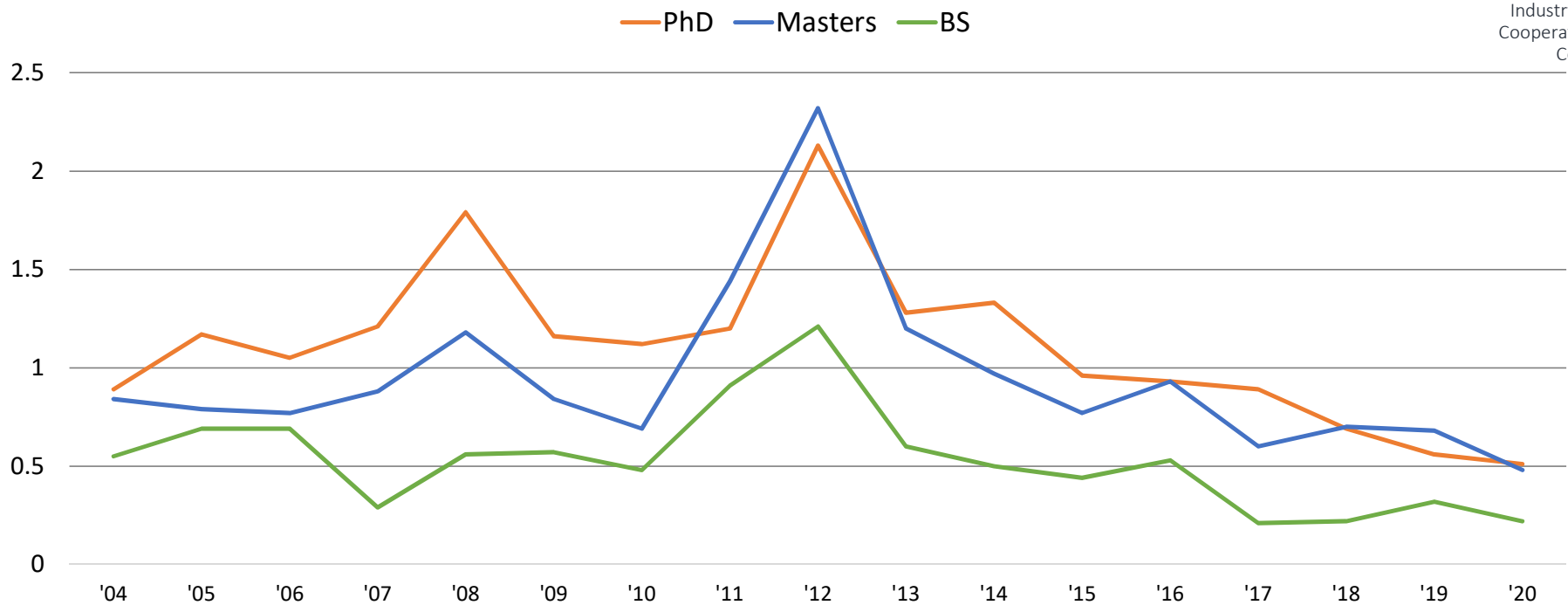
IUCRC Alumni Career Outcomes:
Total Number of FY2020 Graduates Hired
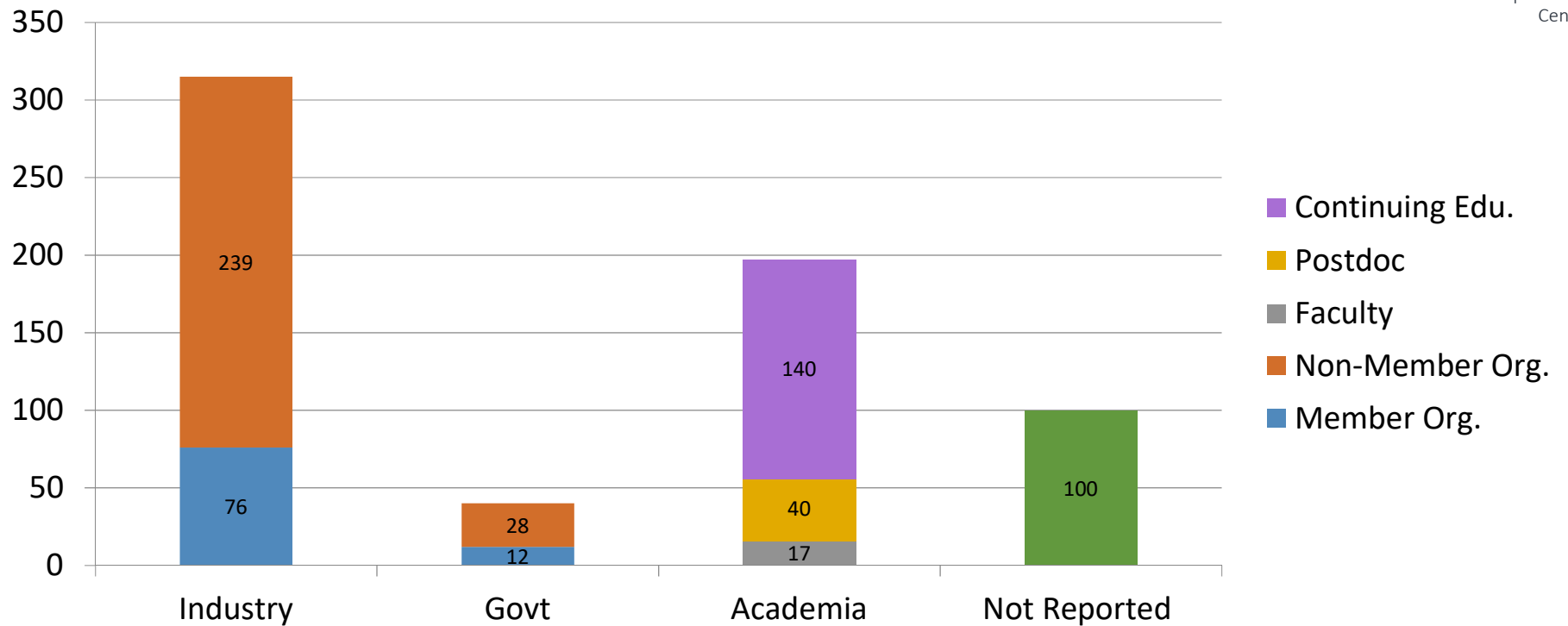
IUCRC Alumni Career Outcomes:
Total Number of Graduates Hired Over Time
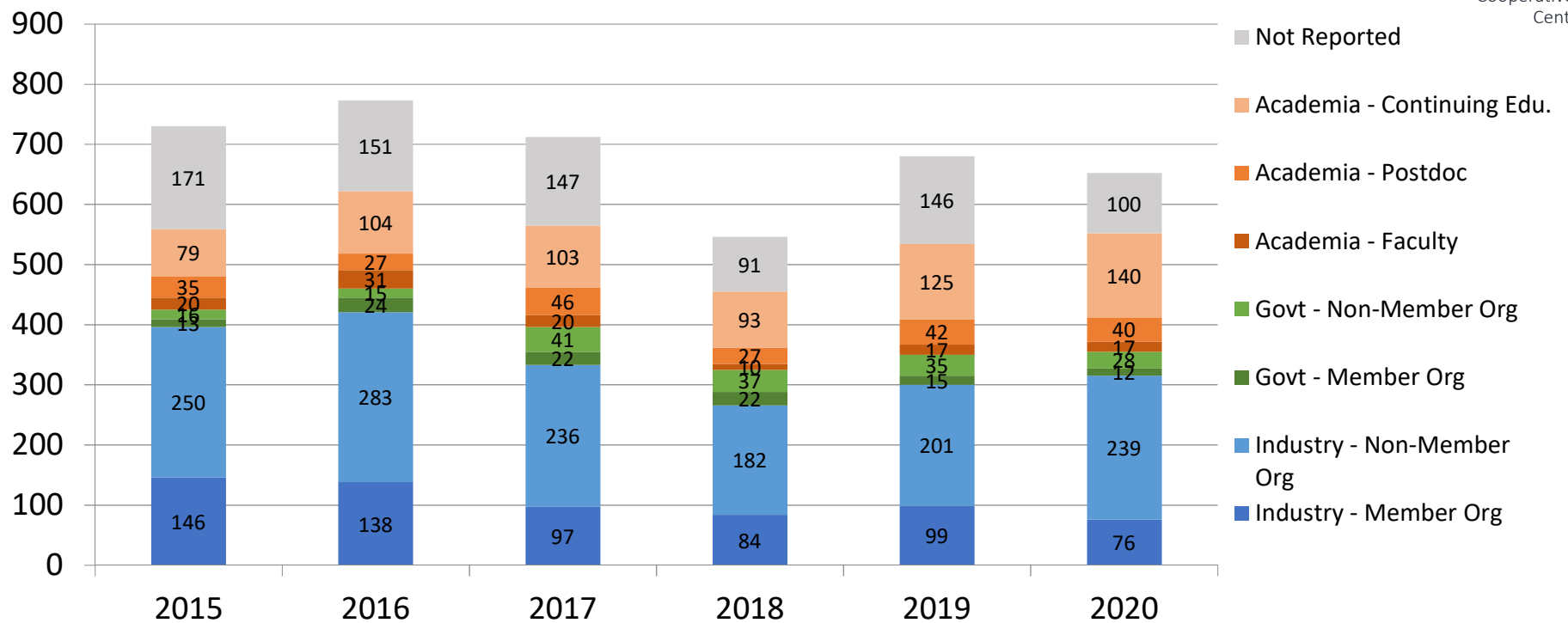
Legend:
- Not Reported
- Academia - Continuing Edu.
- Academia - Postdoc
- Academia - Faculty
- Govt - Non-Member Org
- Govt - Member Org
- Industry - Non-Member Org
- Industry - Member Org

2015: 146, 250, 13, 16, 20, 35, 79, 171
2016: 138, 283, 24, 15, 31, 27, 104, 151
2017: 97, 236, 22, 41, 20, 46, 103, 147
2018: 84, 182, 22, 37, 10, 27, 93, 91
2019: 99, 201, 15, 35, 17, 42, 125, 146
2020: 76, 239, 12, 28, 17, 40, 140, 100

IUCRC Alumni Career Outcomes: Percent of FY2020 Graduates Hired

Legend:
- Continuing Edu.
- Postdoc
- Faculty
- Non-Member Org.
- Member Org.

Industry: 48%
- Non-Member Org. 36.7%
- Member Org. 11.7%

Govt: 7.3%
- Non-Member Org. 4.3%
- Member Org. 1.8%

Academia: 27%
- Continuing Edu. 21.5%
- Postdoc 6.1%
- Faculty 2.6%

Not Reported: 15.3%
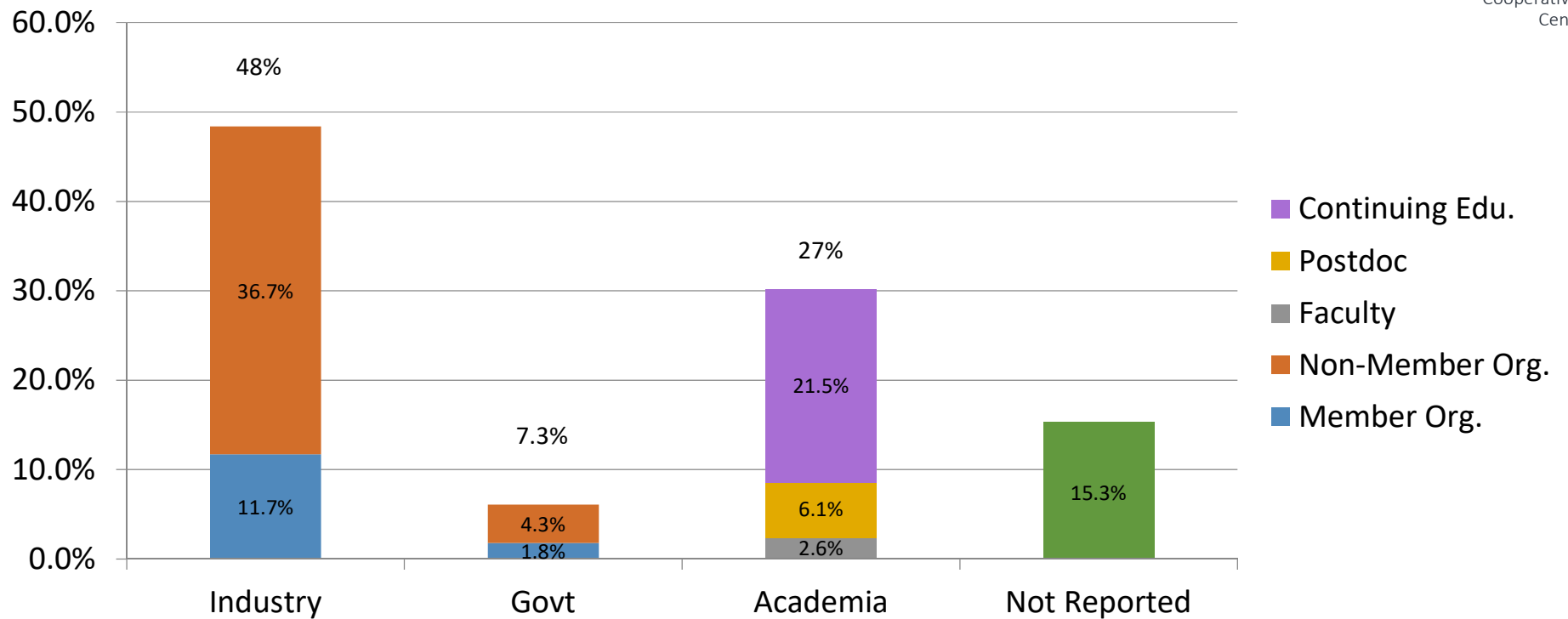
IUCRC Alumni Career Outcomes: Percent of Graduates Hired Over Time
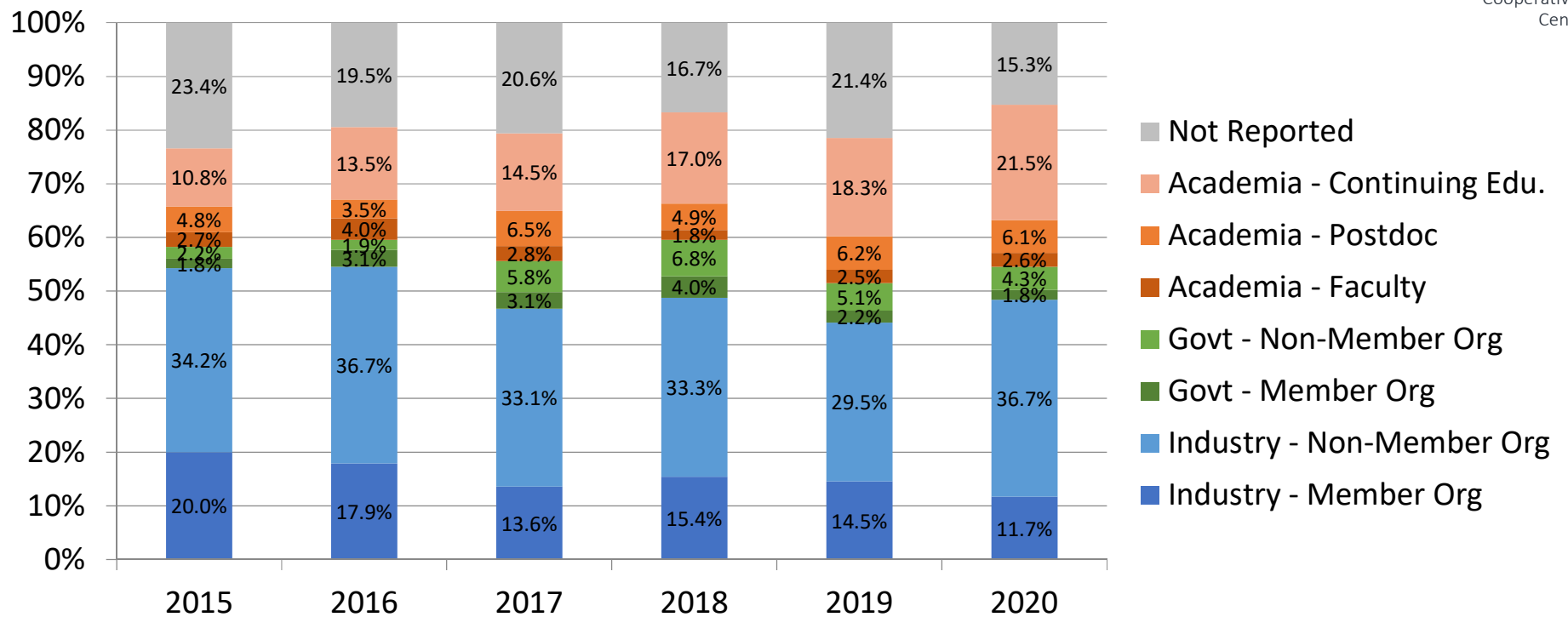
IUCRC Alumni Career Outcomes: Number of FY2020 Graduates Hired per Center

Average per Center
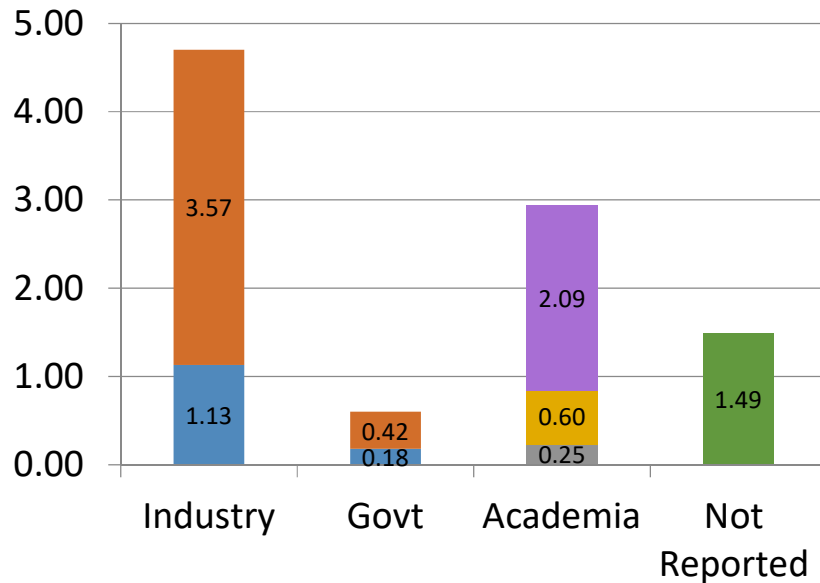
Median per Center
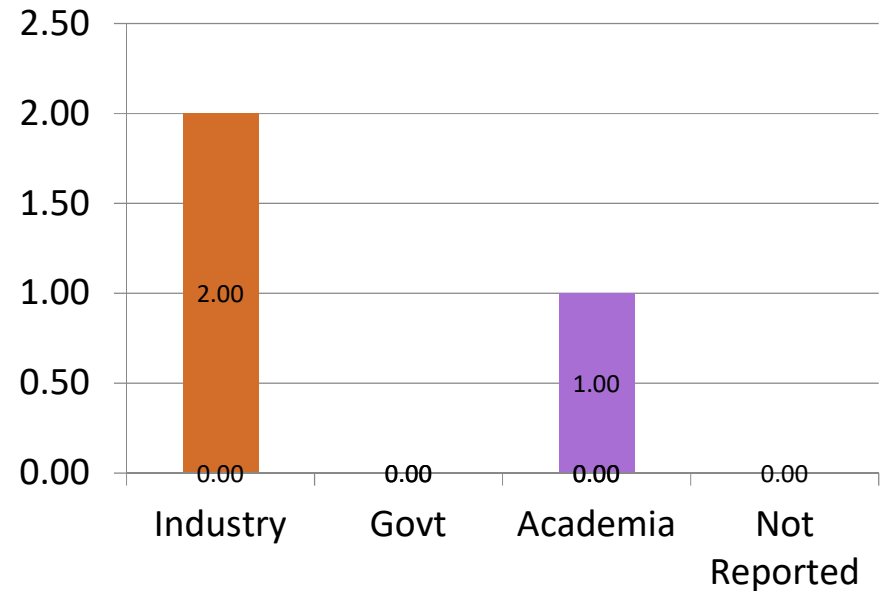
Legend: Member Org. | Non-Member Org. | Faculty | Postdoc | Continuing Edu.

IUCRC Alumni Career Outcomes: Average Number of FY2020 Graduates Hired per Center Over Time
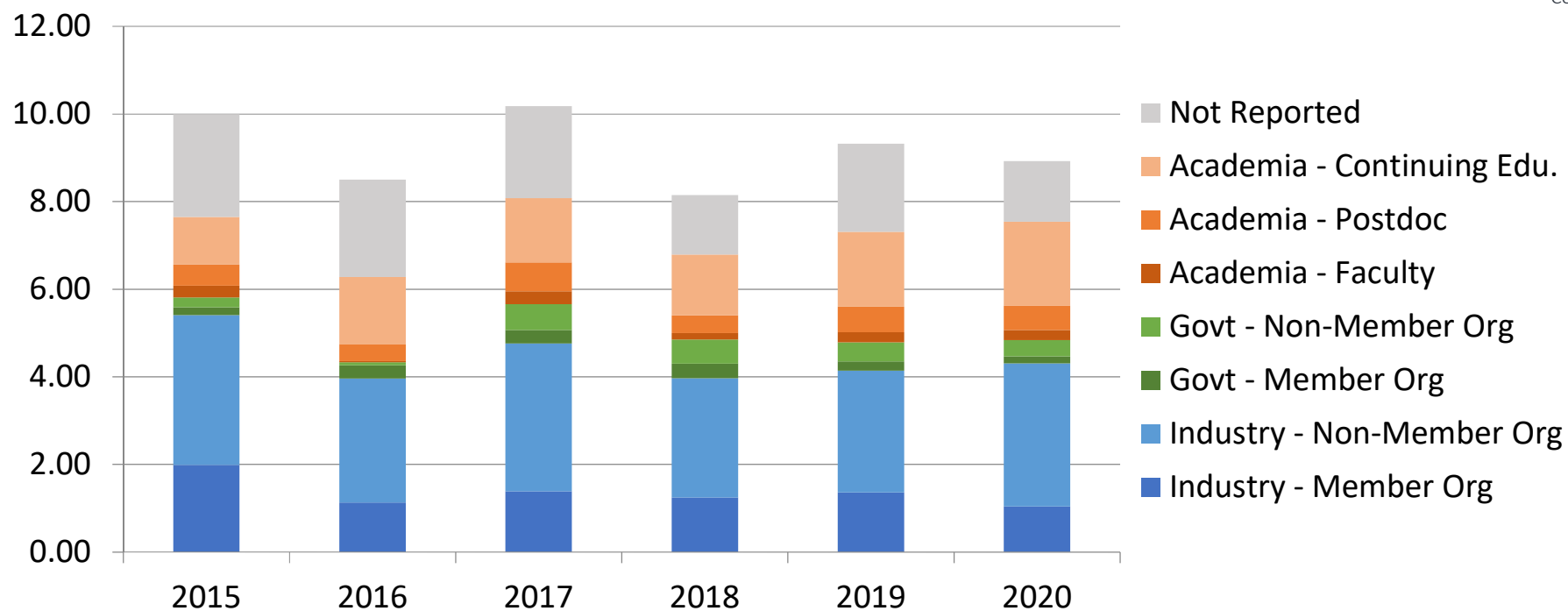
IUCRC Alumni Career Outcomes:
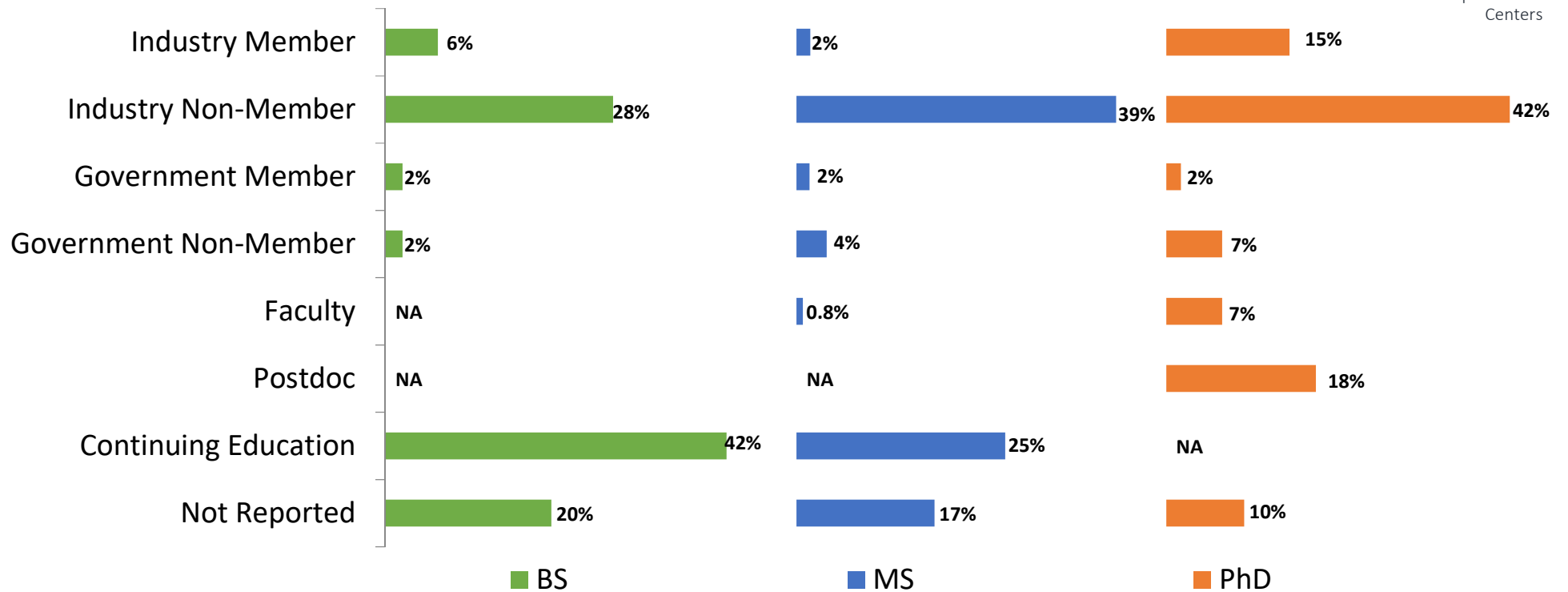# Total Number of FY2020 Graduates Hired by Degree Level

Career Outcome	BS	MS	PhD
Industry Member	12	31	33
Industry Non-Member	52	95	92
Government Member	4	4	4
Government Non-Member	4	9	15
Faculty	NA	2	15
Postdoc	NA	NA	40
Continuing Education	78	62	NA
Not Reported	38	41	21

■ BS   ■ MS   ■ PhD

IUCRC Alumni Career Outcomes:
Percent of FY2020 Graduates Hired by Degree Level

	BS	MS	PhD
Industry Member	6%	2%	15%
Industry Non-Member	28%	39%	42%
Government Member	2%	2%	2%
Government Non-Member	2%	4%	7%
Faculty	NA	0.8%	7%
Postdoc	NA	NA	18%
Continuing Education	42%	25%	NA
Not Reported	20%	17%	10%
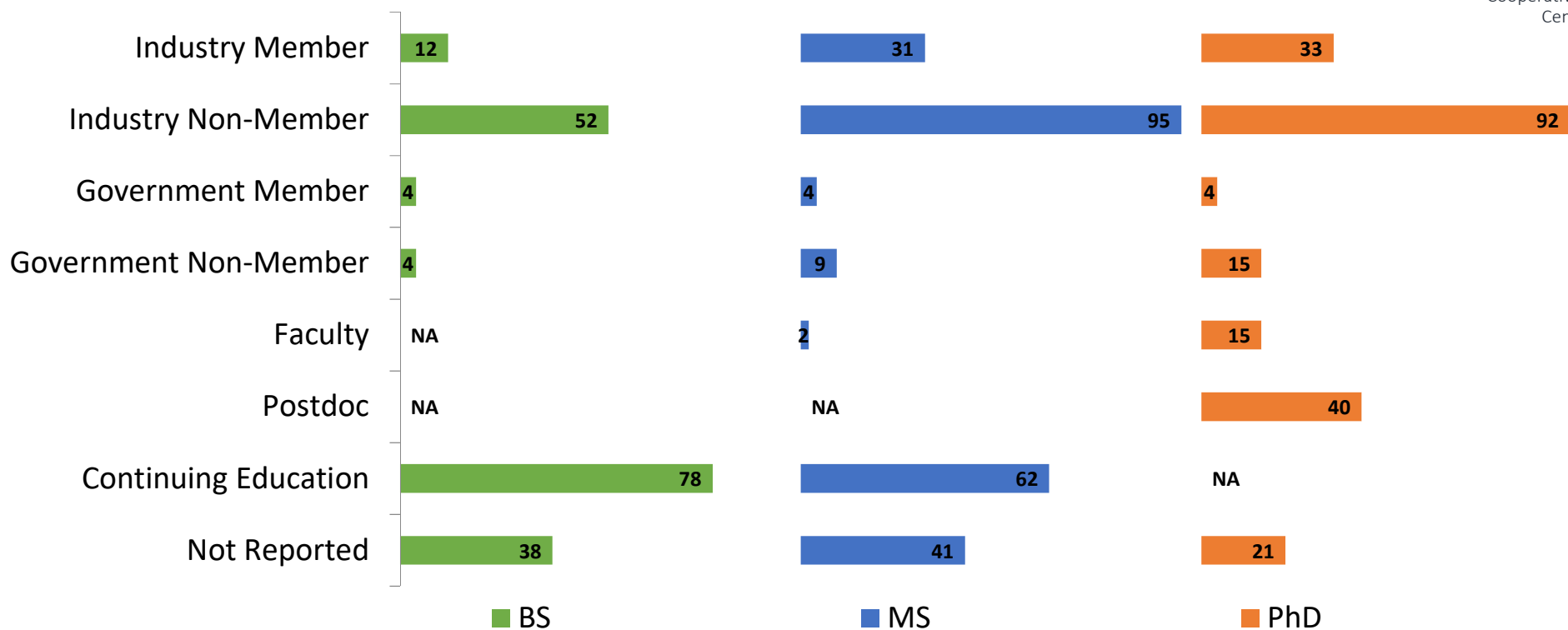
CISE & ENG Partnership

Some Comparisons and Recent Trends

Number of CISE & ENG Centers by Year
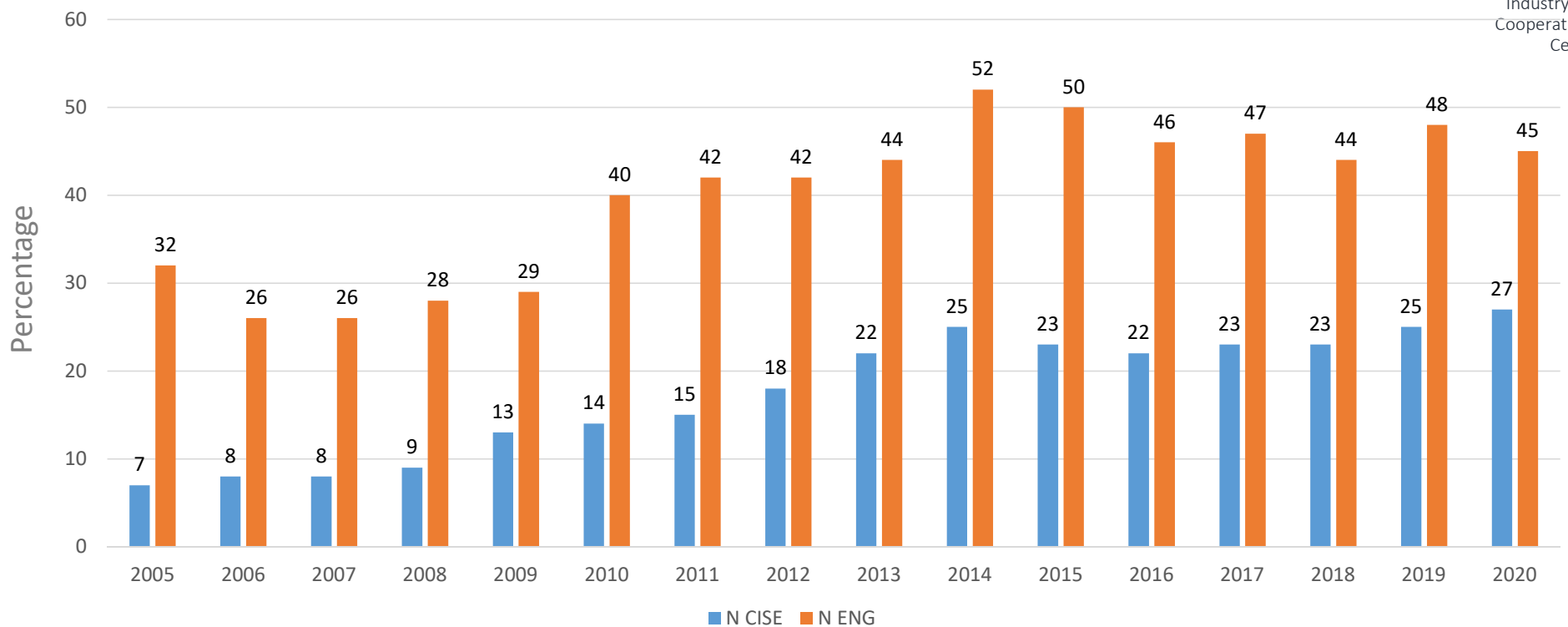
Number of CISE & ENG Single & Multi-Site Centers by Year
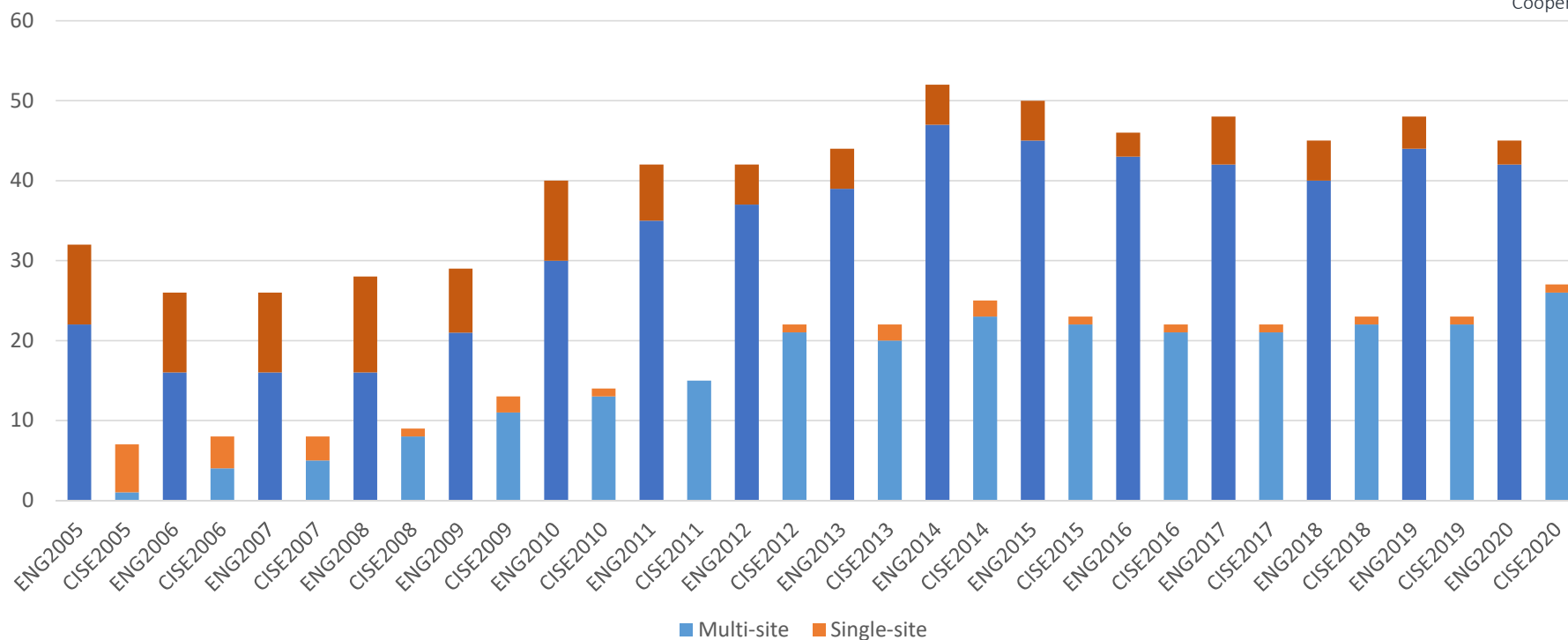
FY2020 CISE & ENG: Funding by Source

Total Dollars
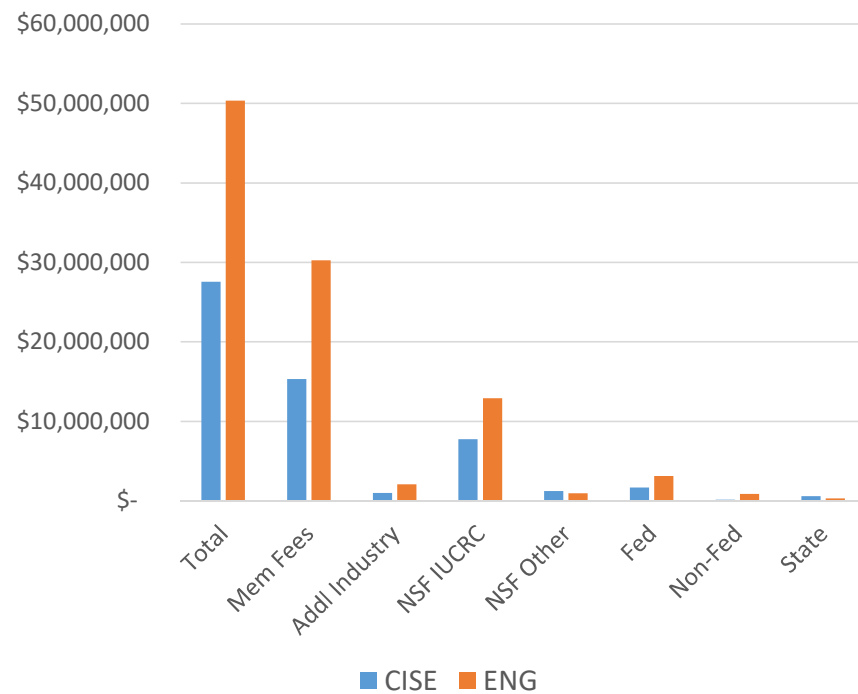
Average Dollars
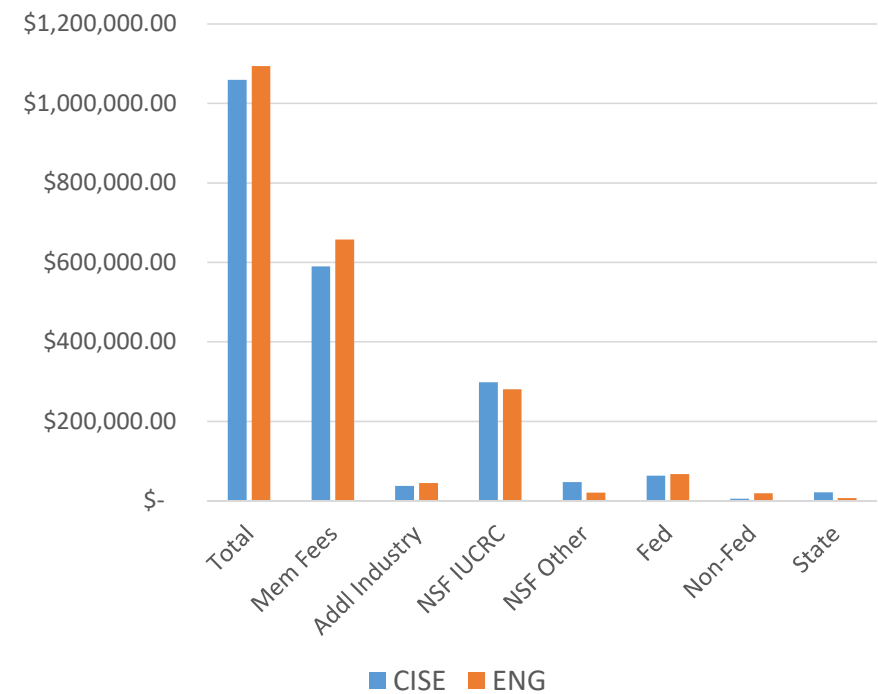
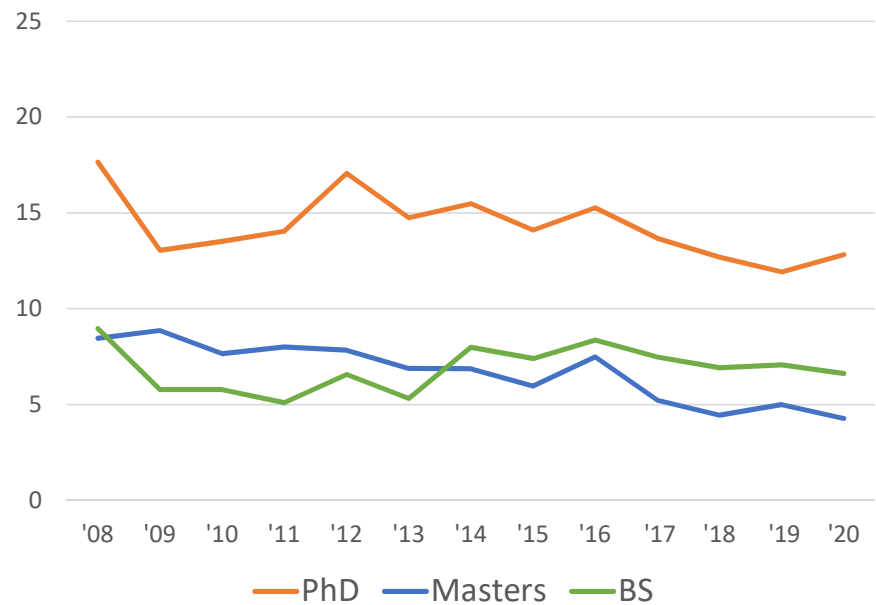# CISE & ENG: Average Number of Students Trained per Center by Year

CISE & ENG: Average Number of Students Graduated per Center by Year

CISE

ENG

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CISE & ENG: Average Number of Students Hired by Members Per Center by Year

CISE

ENG
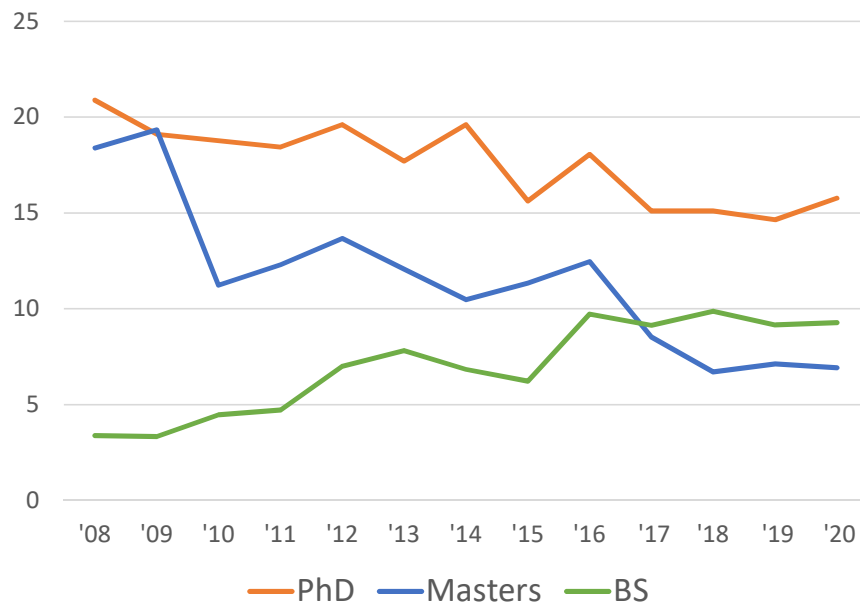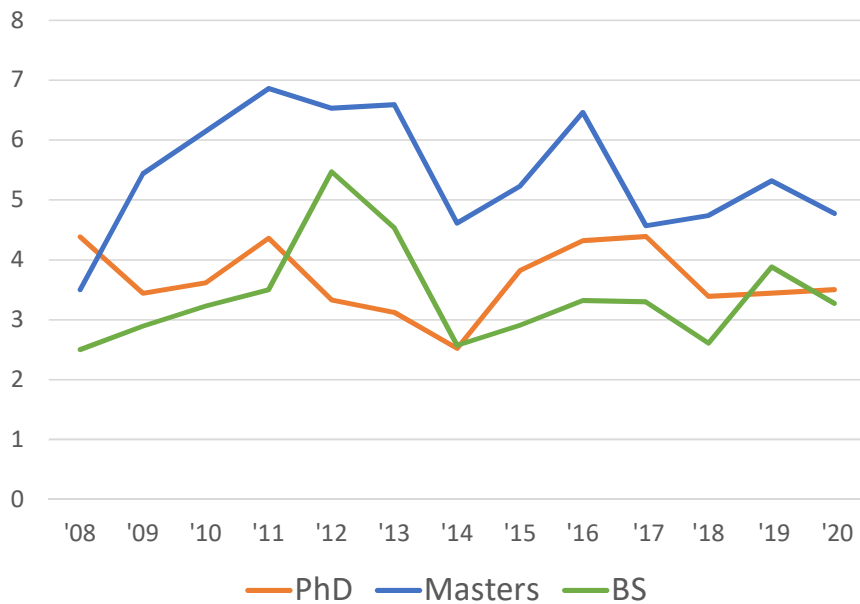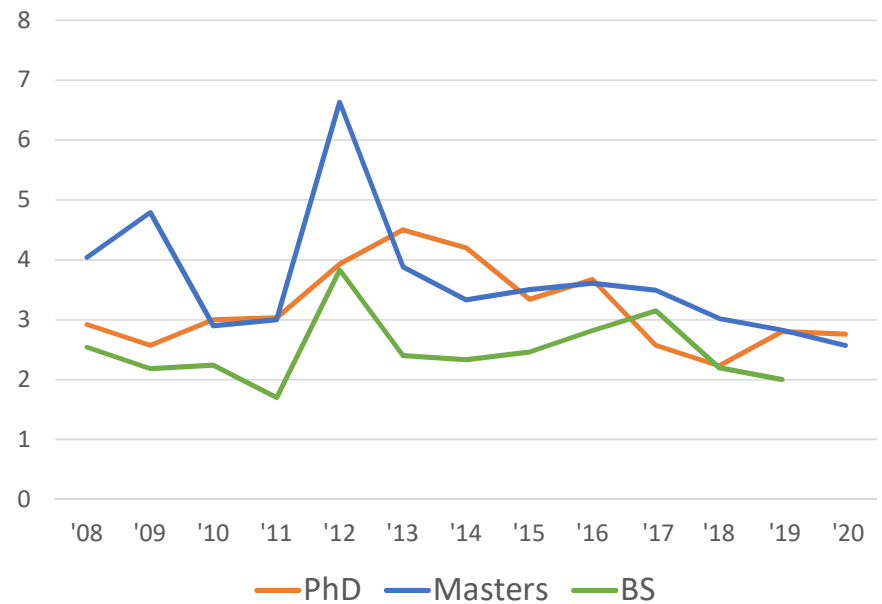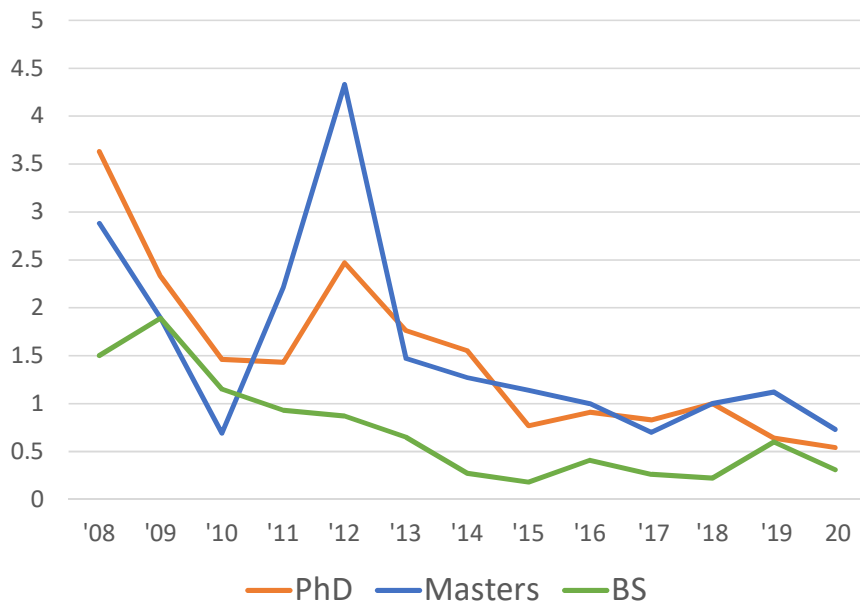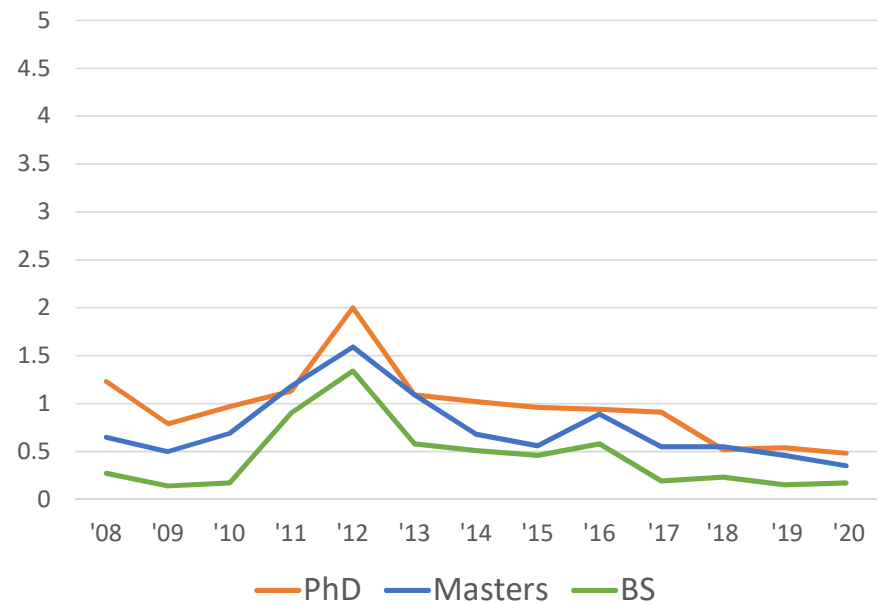
CISE & ENG: Total Number of Intellectual Property & Commercialization Events by Year

CISE
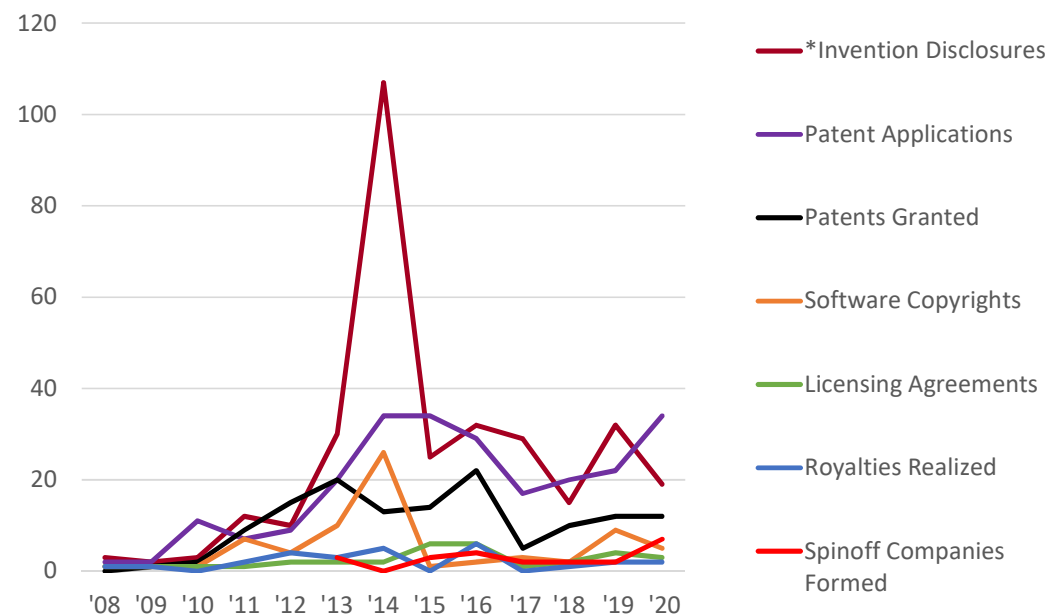
ENG
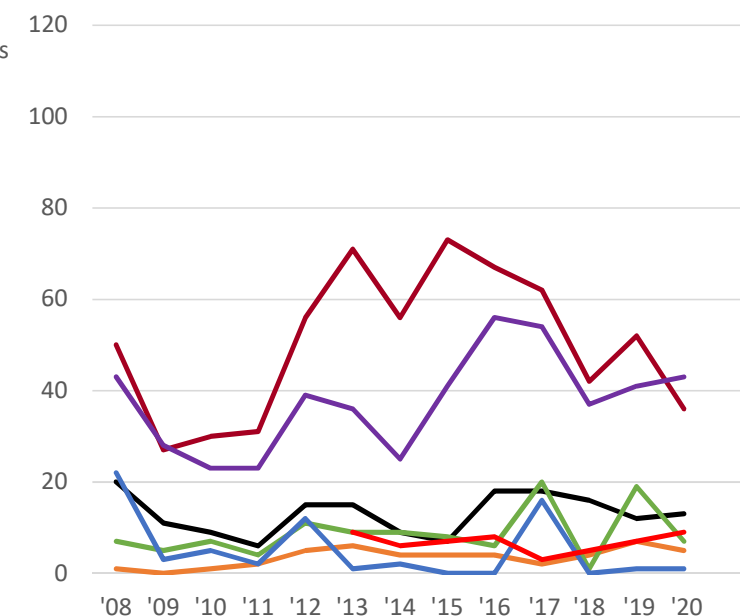
Legend:
- *Invention Disclosures
- Patent Applications
- Patents Granted
- Software Copyrights
- Licensing Agreements
- Royalties Realized
- Spinoff Companies Formed

*Invention Disclosures Outliers: CISE 2014: CVDI = 40, CITeR = 17, E-Design = 12. ENG 2014: BSAC = 20. ENG 2015: BSAC = 32, ENG 2016: BSAC = 25.

CISE & ENG: Average Intellectual Property & Commercialization Events

CISE

ENG

Legend:
- *Invention Disclosures
- Patent Applications
- Patents Granted
- Software Copyrights
- Licensing Agreements
- Royalties Realized
- Spinoff Companies Formed

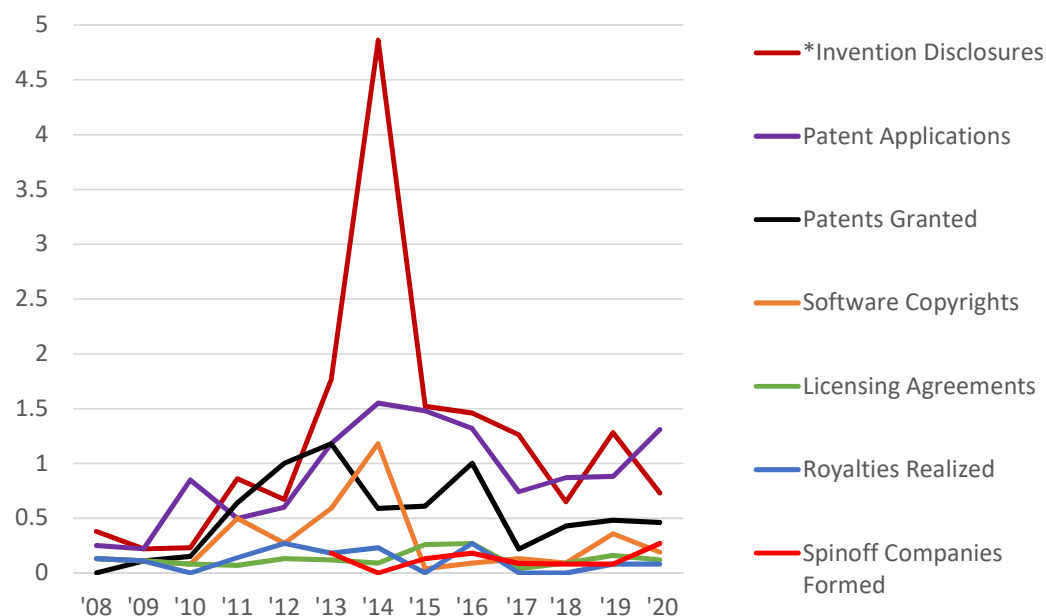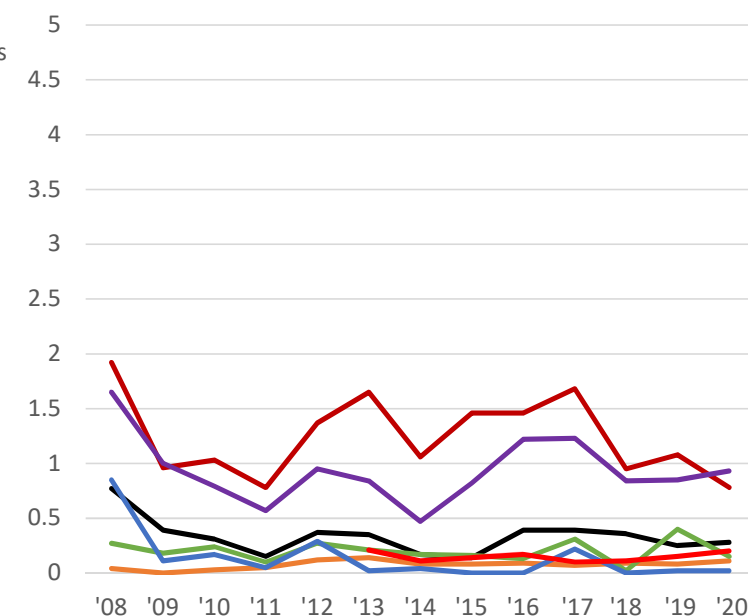*Invention Disclosures Outliers: CISE 2014: CVDI = 40, CITeR = 17, E-Design = 12. ENG 2014: BSAC = 20. ENG 2015: BSAC = 32, , ENG 2016: BSAC = 25.
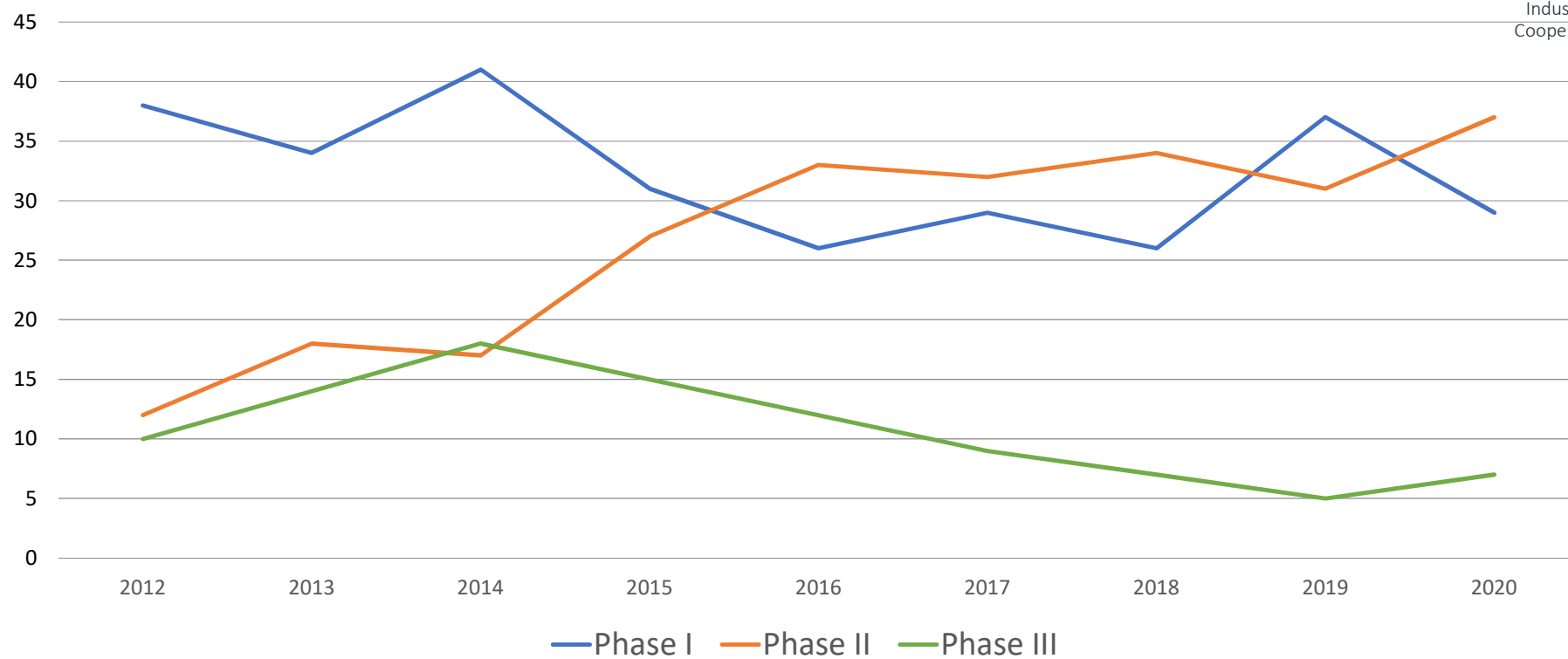
FY2020 Phase-based comparison

Numbers of Centers by Phase by Year

Total Center Funding by Phase by Year

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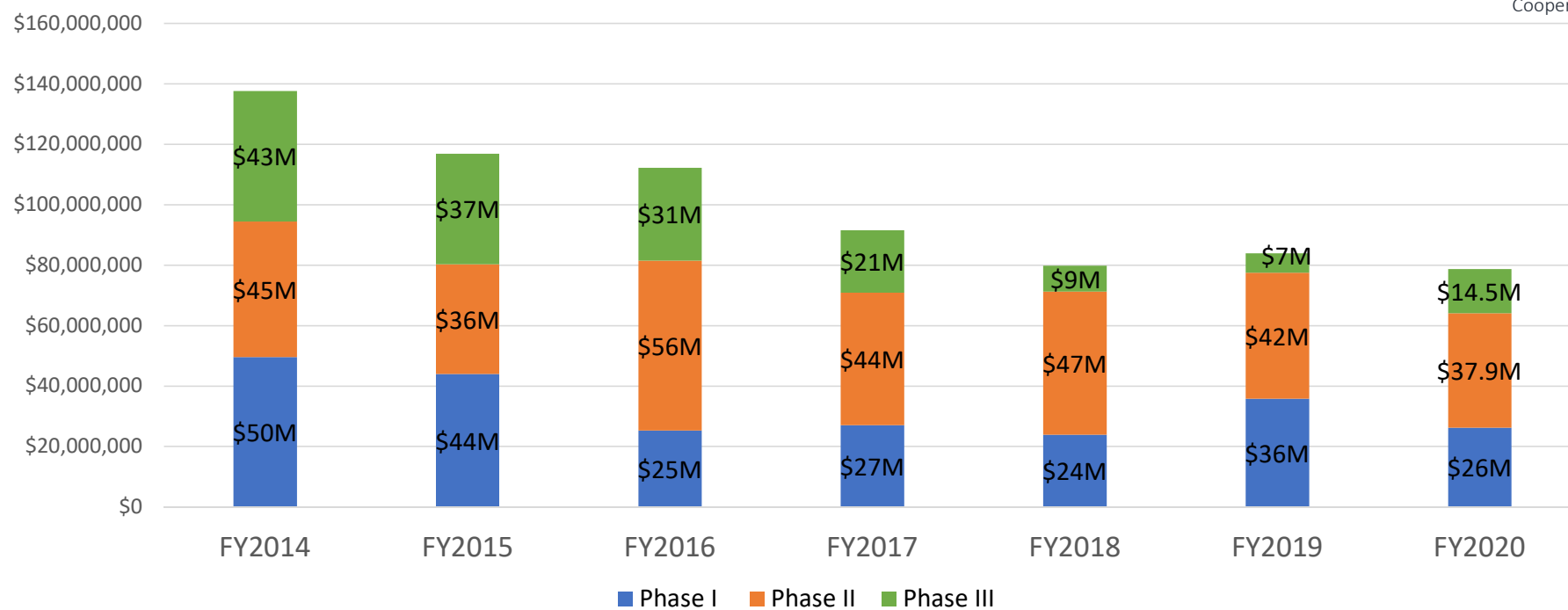
FY2020 Average & Median Total Center Funding by Phase

Bar chart: Average & Median Total Center Funding by Phase

Phase	Average	Median
Phase I (N=29)	$508,389	$400,000
Phase II (N=37)	$560,221.83	$520,000
Phase III (N=7)	$1,503,158.00	$849,095

Legend: ■ Average ■ Median
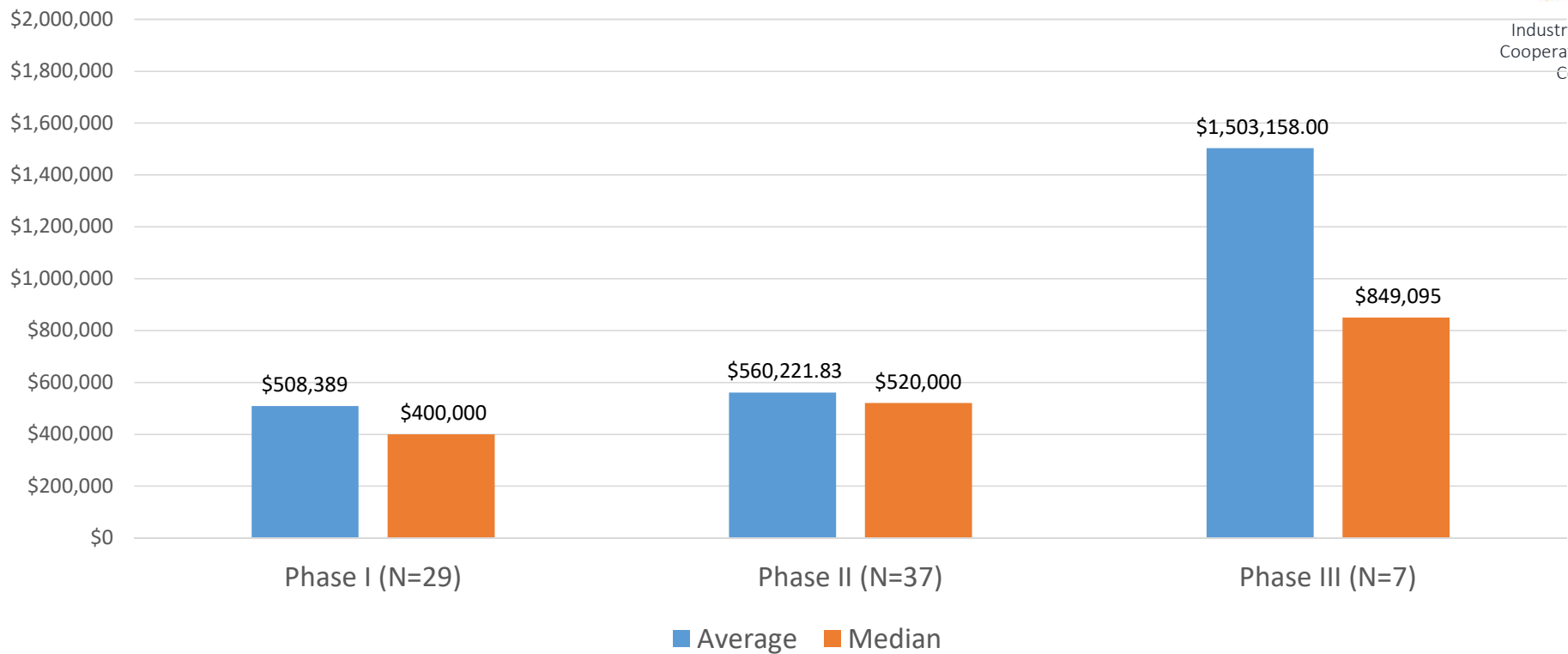
FY2020 Total Center Funding by Source by Phase in Percentages

Industry/University Cooperative Research Centers

Source	Phase I (N=29)	Phase II (N=37)	Phase III (N=7)
Mem. Fees	56%	55%	72%
Addl Industry	1%	3%	11%
NSF IUCRC	39%	23%	15%
NSF Other	2%	4%	1%
Fed	0%	12%	0%
Non-Fed	0%	2%	0%
State	0%	2%	0%

■ Phase I (N=29) ■ Phase II (N=37) ■ Phase III (N=7)
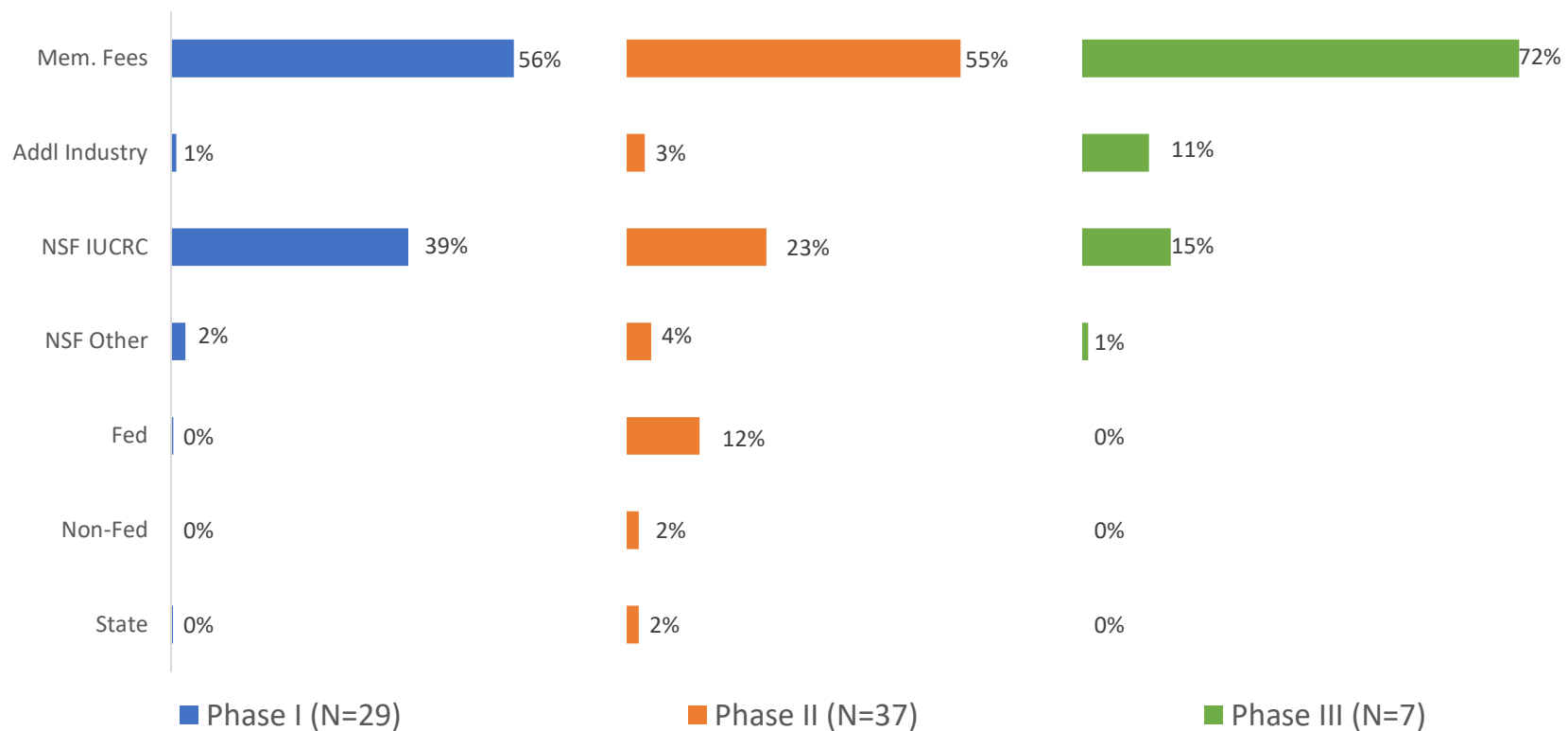
Center Memberships by Phase by Year

Total Number of Memberships
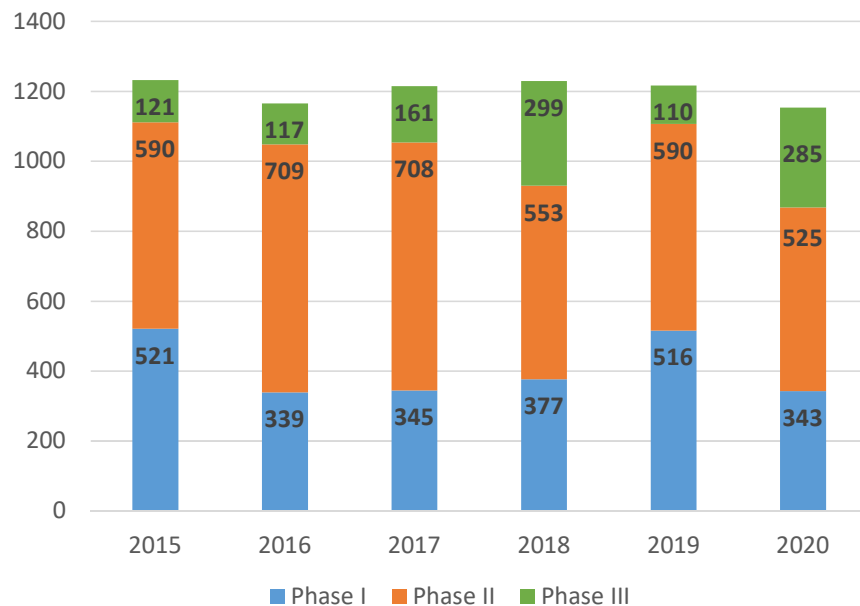
Average Number of Memberships
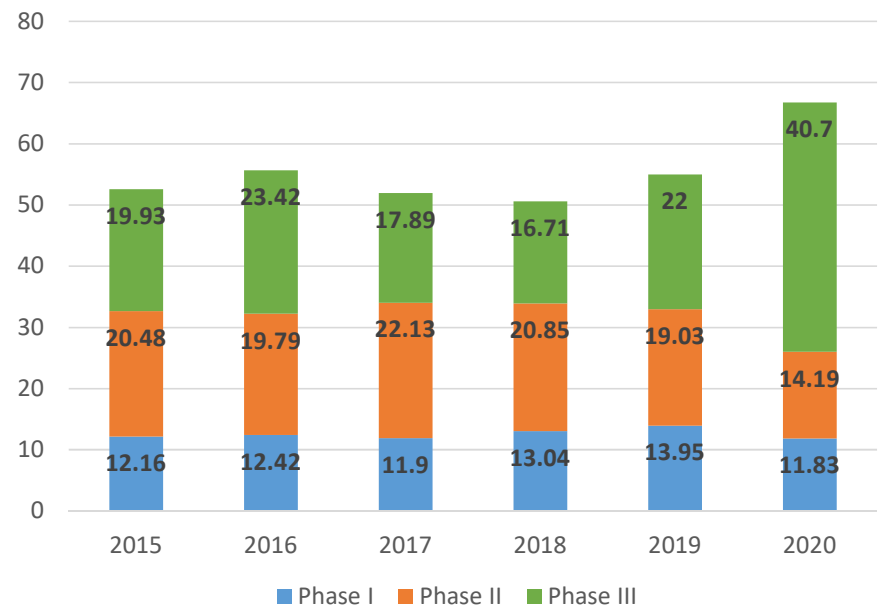
FY2020 Average Number of Membership Added & Dropped by Phase
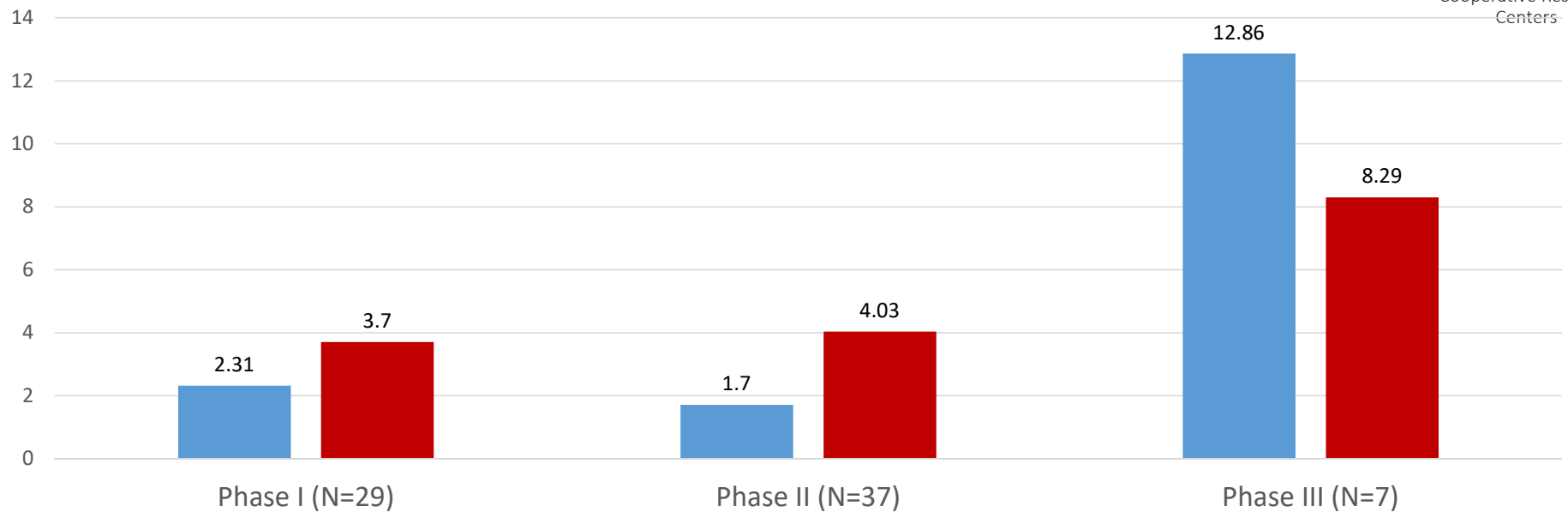
*Newly funded Centers' members are not counted as Members Added.
Phase 3 Membership turnover outlier: Advanced Forestry Systems, 52 new memberships and 23 terminated memberships
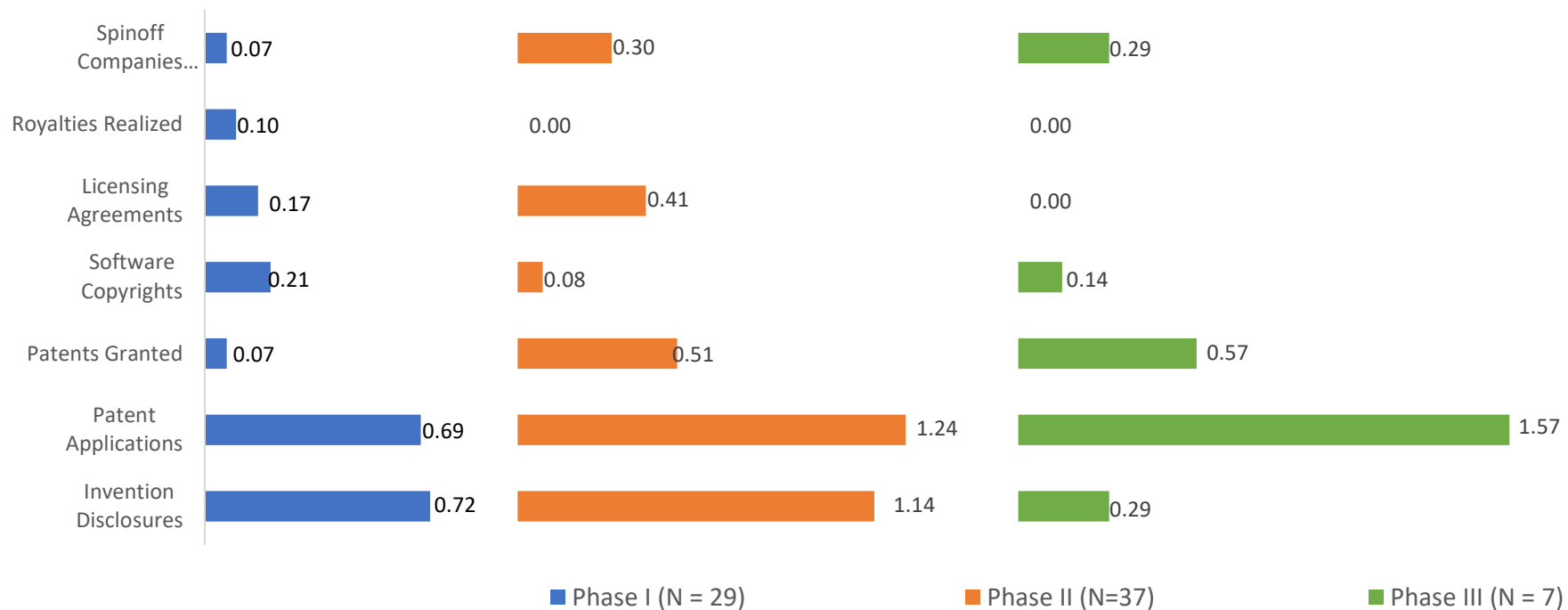
Membership Turnover Rate by Phase by Year
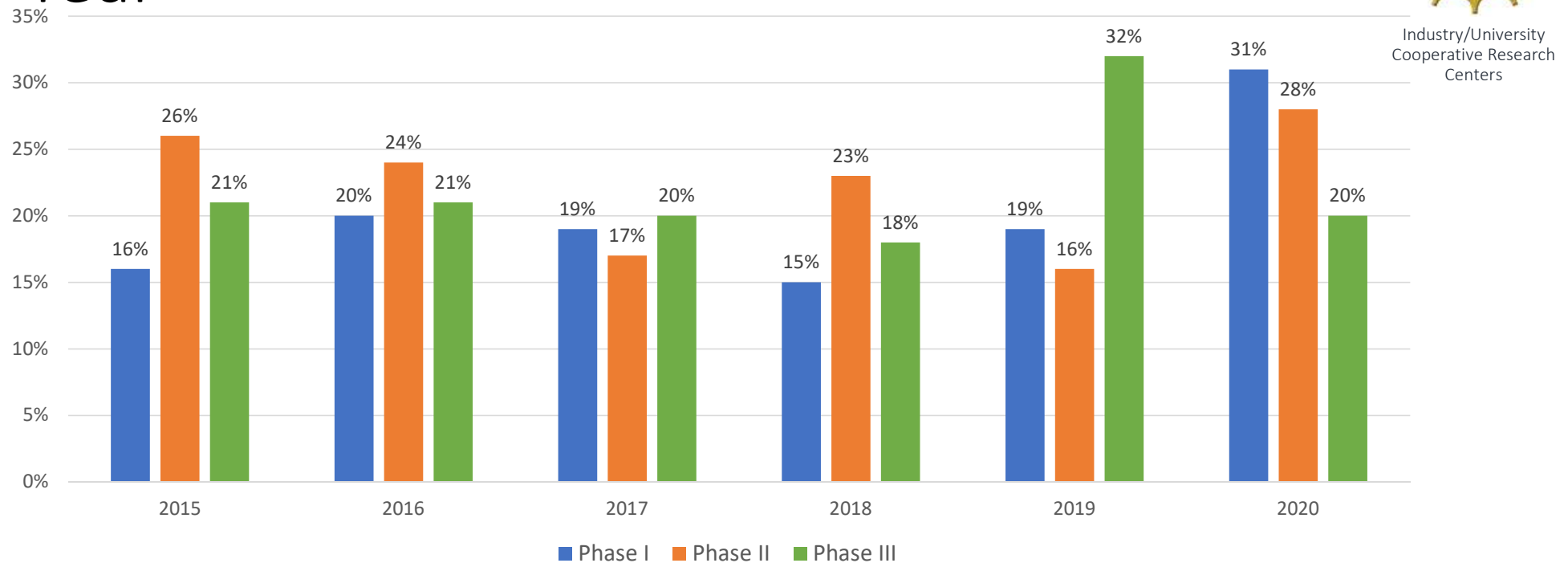
Turnover % = Members terminated in "year X+1" / Total members in "year X"

Membership turnover outliers: Advanced Forestry Systems New = 52, Left = 23

FY2020 Average Number of Intellectual Property & Commercialization Events per Center by Phase

Spinoff Companies... — Phase I: 0.07, Phase II: 0.30, Phase III: 0.29

Royalties Realized — Phase I: 0.10, Phase II: 0.00, Phase III: 0.00

Licensing Agreements — Phase I: 0.17, Phase II: 0.41, Phase III: 0.00

Software Copyrights — Phase I: 0.21, Phase II: 0.08, Phase III: 0.14

Patents Granted — Phase I: 0.07, Phase II: 0.51, Phase III: 0.57

Patent Applications — Phase I: 0.69, Phase II: 1.24, Phase III: 1.57

Invention Disclosures — Phase I: 0.72, Phase II: 1.14, Phase III: 0.29

- Phase I (N = 29)
- Phase II (N=37)
- Phase III (N = 7)

FY2020 Average Number of Students Graduated per Center by Phase

FY2020 Average Number of Students Hired by Members per Center by Phase

Legend:
- ■ Phase I (N=29)
- ■ Phase II (N=37)
- ■ Phase III (N=7)

Degree	Phase I	Phase II	Phase III
PhD	0.48	0.49	0.71
Masters	0.31	0.4	1.57
BS	0.17	0.19	0.57