State of Oklahoma
Incentive Evaluation Commission
Draft Applied Research Support Program Evaluation

September 30, 2018

PFM Group Consulting LLC
BNY Mellon Center
1735 Market Street
43rd Floor
Philadelphia, PA 19103

Contents

Key Findings and Recommendations 3
Introduction 7
Industry Background 9
Program Usage and Administration 16
Economic and Fiscal Impact 24
Program Benchmarking 27
Appendices 32

Key Findings and Recommendations

Overview

Administered by the Oklahoma Center for the Advancement of Science and Technology (OCAST), the Oklahoma Applied Research Support (OARS) Program invests in research and development (R&D) of innovative technologies with commercial potential. Funding (which is made available through appropriation) totals $2.5 million in FY2018 and is designed to increase investment in the research and development of new technologies that will ultimately bring value to the State of Oklahoma and help grow and diversify the State's economy.

The OARS program provides two distinct funding categories:

- **Proof of Concept Applied R&D funding** supports early stage applied R&D projects such as proof and concept research and technical development projects, exploratory development and product definition. Awards are made for up to $45,000 per year for one or two years.

- **Accelerated Applied R&D funding** supports later stage applied R&D projects where the product is defined, the market opportunity is well assessed, commercial opportunities are clearly identified and a commercial entity is defined. Awards are made for up to $300,000 and may be made for one to three years.

Recommendation: Based on its analysis of available data, the project team recommends retaining the Oklahoma Applied Research Support Program.

Key Findings Related to Established Criteria for Evaluation

- **Oklahoma surpasses most states on investment in R&D activities.** Investing $33.5 million in R&D in FY2016, Oklahoma ranked 11th among all states and Washington D.C., both in total R&D expenditures and on a per capita basis ($8.63). Among the states immediately surrounding Oklahoma, only Texas made a larger investment (equal to $9.46 per resident).

- **Oklahoma R&D performed, as a share of State GDP, lags most states.** At 0.62 percent of state GDP, Oklahoma ranked 46th nationally, higher only than Wyoming, Louisiana, Alaska and Arkansas (and tied with South Dakota). Among its surrounding states, Oklahoma performed better only than Arkansas, which ranked 48th.

- **Statewide employment in the scientific R&D services industry decreased from 2,543 employees in 2001 to 1,586 in 2017 – an overall decline of 37.6 percent, or a compound annual growth rate (CAGR) of -2.6 percent.**[1] Nationwide, industry employment increased by 23.5 percent, or a CAGR of 1.3 percent, during this time. Additionally, across all private industries in Oklahoma, employment increased by 7.6 percent between 2001 and 2017 – a CAGR of 0.5 percent.

- **Utility patents granted in the State of Oklahoma between 1963 and 2015 peaked in 1966 at 937 and have trended downward over time (a CAGR of -0.3 percent during the time period).** A total of 532 utility patents were issued in the state in 2015. Relative to its surrounding states and the U.S. as a whole, Oklahoma's patent activity is lagging; all other states analyzed experienced an increase in patents over the time period, and the nation as a whole saw an increase of 2.1 percent annually.

- **Since the program's inception, OCAST has provided $96.4 million in OARS awards.** Peaking at nearly $8 million in 1990, funding has decreased over time; the number of projects funded peaked in

[1] Scientific R&D per North American Industry Classification System (NAICS) code 5417, scientific research and development services.

1990 at 57 but since that point has averaged just over 19. In 2017, 12 projects received OARS funding, for a total award of $2.5 million.

- **Private companies currently account for more than half of all OARS awards made.** In the earliest years of the program (until around 2000), the primary recipients of funding were colleges and universities, accounting for an average of 77.4 percent of total award dollars and 78.5 percent of projects funded. Since that time, a shift has occurred, whereby more private companies are receiving funding. Between 2001 and 2017, private industry represented an average of 58.9 percent of funding and 56.1 percent of projects funded.

- **A total of 160 new or retained jobs are attributable to 53 OARS awards made between 2012 and 2016.** The average pay associated with those jobs is estimated to be nearly $60,000. Including benefits, total compensation is estimated to be $7.6 million.[2]

- **Other economic impacts appear to be significant.** Among 63 award recipients responding, 17 reported startups/spin-out companies attributable to the receipt of OARS funding; 28 reported developing new products, 5 reported that patents have been granted and 3 reported receiving royalties or licensing fees. Additional capital investment, gross sales and subsequent funding data is also provided in this evaluation.

- **The OARS program's matching requirement has leveraged significant additional funding.** A total of $30.2 million in matching funds has been committed since 2001, with the bulk of the funds levered during the past six years.

- **Since the program's inception, it has provided funding to nearly 600 collaborative projects in 21 counties.** There have been more than 100 collaborative projects in Payne, Oklahoma and Cleveland Counties (likely due to the high concentration of colleges and universities), as well as private industry.

Other Findings

- **At $10.1 million funding in 2016, OCAST was the second-largest contributor to State-funded R&D.**[3] OCAST funding accounted for 30.1 percent of total state agency expenditures; only the Tobacco Settlement Endowment Trust (at $11.7 million) made a larger investment.[4]

- **A total of eight states were found to have comparable applied research incentive programs.** None of the states with comparable programs border Oklahoma. With an appropriation of $2.5 million in FY2018, Oklahoma's funding for OARS projects is comparable to – even competitive with – other states providing similar programs.

- **Grantees are required by contract to respond to a program survey for a period of five years.** While it is beneficial for OCAST to collect program information, certain issues exist. For instance, the fact that respondents are required to reply for five years and then can drop off can lead to fluctuations in the data over time as one grantee's impact data is removed from totals (despite the project still being in existence). Additionally, the fact that recipients self-report the data can lead to variances in the way information is reported. The 2017 OCAST Impact Survey is provided in **Appendix A**.

[2] Based on PFM analysis of OCAST annual survey data. It is possible that survey responses may contain errors. Figures do not include data for award recipients that did not respond to the survey.
[3] $10.1 million represents total OCAST investment and is not specific to the OARS program.
[4] The Oklahoma Tobacco Settlement Endowment Trust (TSET) is a State grant-making trust devoted to preventing cancer and cardiovascular disease via grants to schools, communities, state agencies and partner organizations. It also funds research and emerging opportunities in the public and private sectors.

Recommended Program Modifications

- **OCAST should collect more detailed information from current and former grant recipients to allow for consistent analysis.** The collection of additional information, such as the NAICS code associated with each project and a more detailed accounting of the jobs created or retained (e.g. position titles) will likely enable supplemental analysis of the OARS program's impacts. Additionally, each respondent should fill out a separate survey for each project, rather than aggregating the impact into a single response.

- **For programs that invest in early stage firms or research activities, it is critical to track business activity and funding sources prior to obtaining the state financial support and after the state monies have been spent to measure the long-term effect of the program.** In addition, if a business has multiple products being sold and developed, the data collection should detail these different functional activities to isolate the program receiving state funds.

- **If a successful product or company is developed, the location for where the product is sold, supported, and manufactured should be identified.** Given the failure rate of early stage companies and associated research, evaluations for these types of incentive programs tend to focus on a few highly successful companies, rather than individual recipients. These success stories can often generate enough economic activity and tax revenue to justify a program.

- **In order to correctly and accurately perform an economic impact analysis, the following information would be required on an annual basis.** It is preferable that this information be collected by project funding year cohort, since the awards most often last for multiple years. This would enable the analysis of impact from year to year (which is not currently possible).

    - Jobs data (including how many jobs existed prior to OCAST funding and how much other funding has been raised);
    - Payroll data;
    - Economic activity data (including gross sales and additional funding raised as a direct result of OARS funding);
    - Success or failure rate of each recipient; and
    - Industry sector information.

Introduction

Incentive Evaluation Commission Overview

In 2015, HB2182 established the Oklahoma Incentive Evaluation Commission (the Commission). It requires the Commission to conduct evaluations of all qualified state incentives over a four-year timeframe. The law also provides that criteria specific to each incentive be used for the evaluation. The first set of 11 evaluations were conducted in 2016, and an additional 12 were conducted in 2017.

The Oklahoma Applied Research Support (OARS) Program is one of 11 incentives scheduled for review by the Commission in 2018. Based on this evaluation and their collective judgment, the Commission will make recommendations to the Governor and the State Legislature related to this incentive.

Industry and Incentive Background

According to the National Science Foundation (NSF), applied research is "aimed at gaining knowledge or understanding to determine the means by which a specific, recognized need may be met. In the industry, applied research includes investigations oriented to discovering new scientific knowledge that has specific commercial objectives with respect to products, processes or services."[5] Because applied research is used to increase scientific knowledge and develop innovative technologies, it plays an important role in solving everyday problems that may have a positive impact for the State and its residents.

Administered by the Oklahoma Center for the Advancement of Science and Technology (OCAST), the OARS Program invests in R&D supporting innovative technologies with commercial potential. Funding is designed to increase investment in the R&D of new technologies that will ultimately bring value to the State and help grow and diversify its economy.

Criteria for Evaluation

A key factor in evaluating the effectiveness of incentive programs is to determine whether they are meeting the stated goals as established in state statute or legislation. In the case of this program, the goal is to assist in the accelerated development of technology in the State by supporting applied research activities in existing and emerging technical areas.

To assist in a determination of program effectiveness, the Commission has adopted the following criteria:

- Commercially successful products developed as a result of program funding;
- Economic activity associated with program funding;
- Number and types of collaborative projects associated with program funding;
- Comparison of collaborative projects before and after the program; and
- State return on investment.

The criteria focus on what are generally considered key goals of incentive programs (such as the generation of economic activity). Ultimately, incentive programs have to weigh both the benefits (outcomes related to achieving policy goals and objectives) and the costs, and that is also a criterion for evaluation (State return on investment). These will be discussed throughout the balance of the evaluation.

[5] National Science Foundation – Directorate for Social, Behavioral and Economic Sciences, U.S. definitions and resource surveys, 1996. Accessed electronically at https://www.nsf.gov/statistics/fedfunds/glossary/def.htm

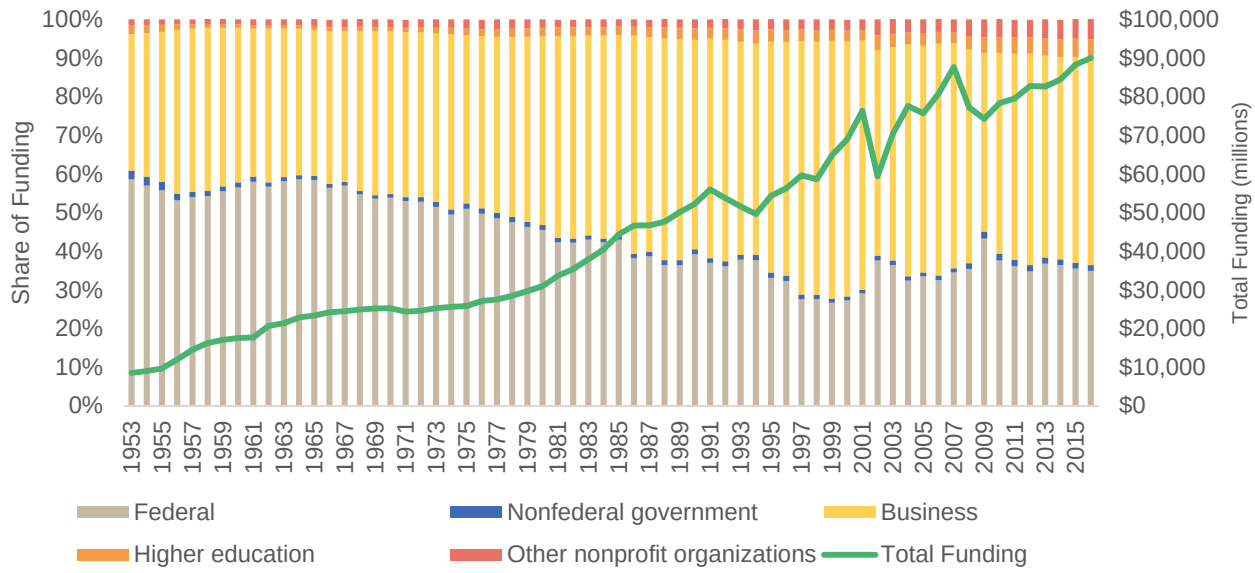
Industry Background

Applied Research Background

According to the NSF, applied research is "aimed at gaining knowledge or understanding to determine the means by which a specific, recognized need may be met. In the industry, applied research includes investigations oriented to discovering new scientific knowledge that has specific commercial objectives with respect to products, processes or services."[6] Because applied research is used to increase scientific knowledge and develop innovative technologies, it plays an important role in solving everyday problems that may have a positive impact on the State of Oklahoma and its residents.

The federal government and private industry have consistently been the primary funders of applied research in the U.S. While providing nearly 60 percent of funding for applied research in 1953, the federal government's share has decreased over the past six decades. As of 2016, the federal government contributed just under 35 percent of all funds for applied research. The business/private industry share of funding has increased significantly – from 35 percent in 1953 to more than 53 percent in 2016. All other sources (i.e. nonfederal government, higher education and other nonprofit organizations) have consistently played a smaller role in the funding of applied research, though higher education and other nonprofits have begun to play a larger role in recent years. Despite the considerable shift in funding makeup, overall applied research support has increased over time; total investment grew from $8.5 billion in 1953 to $90.0 billion in 2016.

Figure 1: U.S Applied Research Expenditures by Source of Funds, 1953-2016 (in constant 2009 $)[7]



Source: National Science Foundation, National Center for Science and Engineering Statistics, National Patterns of R&D Resources (annual series)

Applied Research Performers

Private industry has consistently been the principal performer of applied research, accounting for at least half of all research conducted since 1953 and 58.0 percent in 2016. Federal intramurals (which are organizations outside the federal sector that perform R&D with federal funds under contract, grant or cooperative agreement) accounted for 26.9 percent in 1953 but just 9.0 percent in 2016. Higher education has become a more significant

[6] National Science Foundation – Directorate for Social, Behavioral and Economic Sciences, U.S. definitions and resource surveys, 1996. Accessed electronically at https://www.nsf.gov/statistics/fedfunds/glossary/def.htm

[7] Some data for 2015 are preliminary and may later be revised; the data for 2016 are estimates and will later be revised.

performer over time, as have, to a lesser extent, federally-funded R&D centers (FFRDCs) and other nonprofit organizations. Nonfederal governments did not conduct applied research until 2006 and play a minor role today.

Table 1: Share of U.S. Applied Research by Performer, 1953-2016[8]

Year	Business	Federal Intramural	Higher Education	FFRDC	ONP	Nonfederal Government
1953	56.3%	26.9%	10.4%	3.7%	2.7%	0.0%
2016	58.0%	9.0%	19.0%	8.0%	6.0%	1.0%

Source: National Science Foundation, National Center for Science and Engineering Statistics, National Patterns of R&D Resources (annual series)

R&D Investment by State[9]

In 2016, states expended a total of $2,317 million in support of R&D activities. Of that amount, nearly $870 million (37.5 percent) was provided to academic institutions, $636 million (27.4 percent) was spent on research performed by a department or agency's own employees, $482 million (20.8 percent) was allocated to companies and individuals (including those under contract for R&D projects), and $331 million (14.3 percent) was provided to the federal government, nonprofit organizations, other state governments, and city, county, regional or other local governments.[10]

Investing $33.5 million in R&D in FY2016, Oklahoma ranked 11th among all states and Washington, D.C. both in total R&D expenditures and on a per capita basis ($8.63). Among the states immediately surrounding Oklahoma (Arkansas, Colorado, Kansas, Missouri, New Mexico and Texas), only Texas made a larger investment (equal to $9.46 per resident).

Table 2: State Government Expenditures for R&D, FY2016

State	FY2016 R&D Expenditures	Rank	FY2016 R&D Expenditures per Capita	Rank
Oklahoma	$33,460,991	11	$8.63	11
Arkansas	$17,242,823	24	$5.81	21
Colorado	$16,647,592	27	$3.11	36
Kansas	$6,391,816	41	$2.21	42
Missouri	$14,723,621	29	$2.43	38
New Mexico	$4,772,978	43	$2.29	41
Texas	$255,132,755	3	$9.46	9

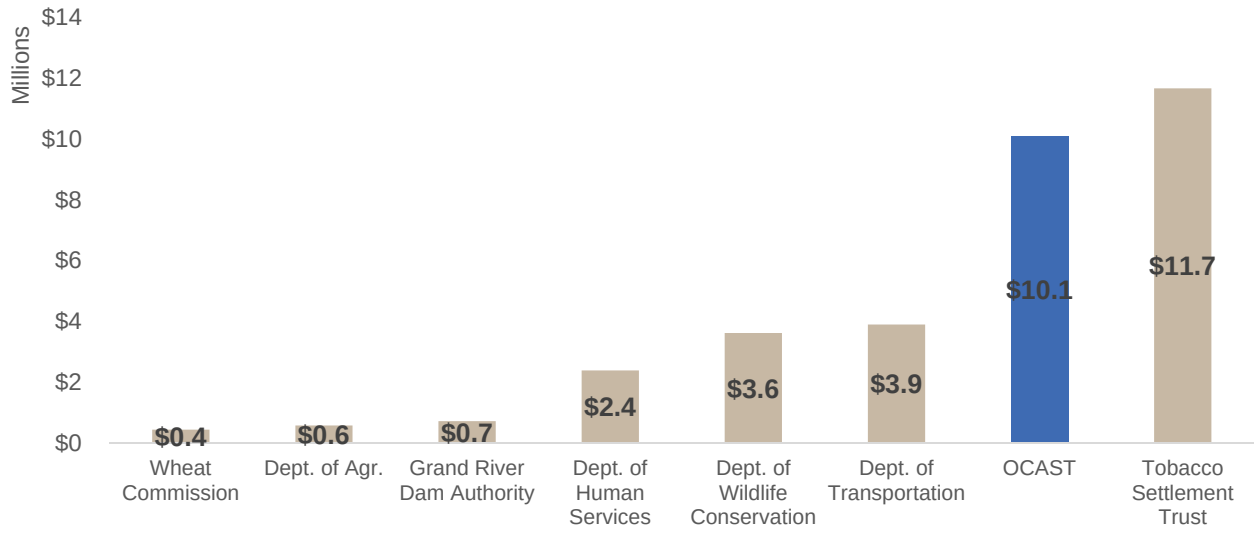
Source: National Science Foundation, National Center for Science and Engineering Statistics, National Patterns of R&D Resources (annual series); U.S. Census Bureau American Community Survey

[8] The data for 2016 are estimates and will be revised by the NSF at a later date. Numbers do not add to 100 percent due to rounding.
[9] Analysis is for research and development generally (not specific to applied research) and is meant to serve as a proxy for applied research.
[10] Amounts do not include plant expenditures (acquisition of land, facilities, major equipment and major building renovations intended primarily for R&D use. Source: National Science Foundation, National Center for Science and Engineering Statistics: Survey of State Government Research and Development, FY2016.

Oklahoma's investment was primarily made at academic institutions (66.3 percent). The remaining total was invested in 'other' performers of research, including nonprofit organizations, other departments or agencies within the State, other state governments, local governments and the federal government (16.5 percent); companies and individuals (10.0 percent) and internal staff (7.2 percent).[11]

OCAST was the second largest contributor to State-funded R&D (more than $10 million in 2016), accounting for 30.1 percent of total state agency expenditures. As shown in the following figure, only the Tobacco Settlement Endowment Trust (at $11.7 million) made a larger investment.

Figure 2: Source of Oklahoma State-Funded R&D, 2016 (in Millions)[12]



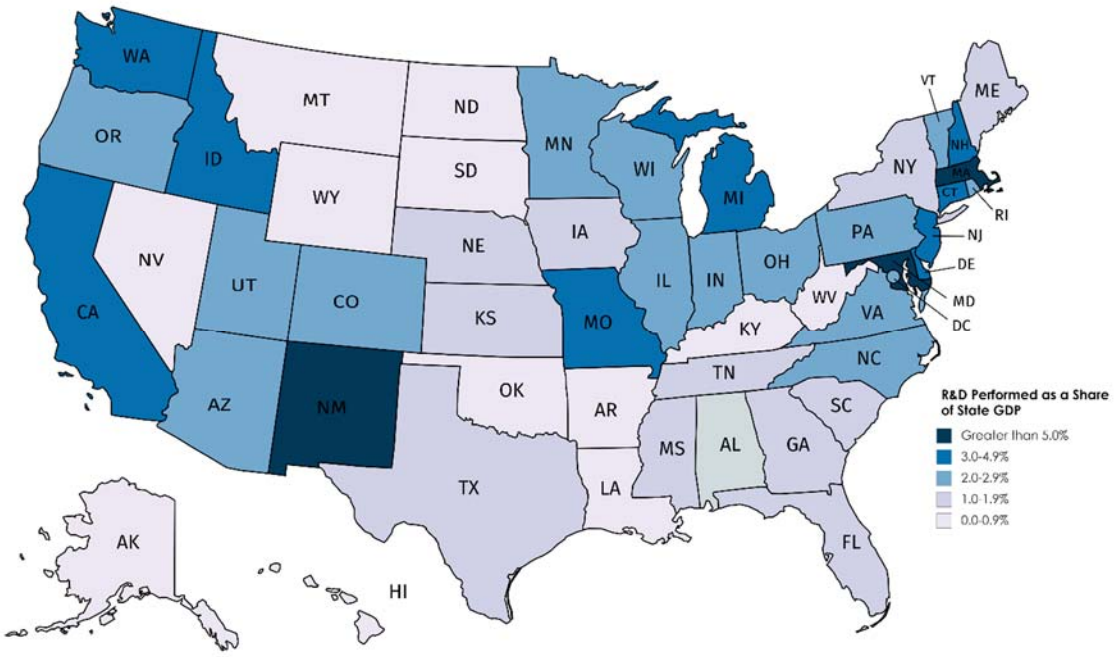
Source: NSF NCSES Survey of State Government R&D, FY2016

R&D as a Share of GDP by State

It can be useful to compare each state's share of R&D as a percentage of gross domestic product (GDP). The national value of R&D performed as a share of GDP between 1991 and 2012 was 2.71 percent, while state values ranged from 0.26 percent to 6.69 percent. This wide variation in state values, illustrated in the following map, is indicative of large differences in state R&D activity.

[11] Ibid.
[12] The Department of Health ($9,553) and Sorghum Commission ($40,000) are not displayed due to their relatively small investments as a share of the total.

Figure 3: R&D as a Percentage of GDP by State, 1991-2012



Source: National Science Foundation, National Center for Science and Engineering Statistics, National Patterns of R&D Resources; Bureau of Economic Analysis, Gross Domestic Product data; United Nations Statistics Division

At 0.62 percent of state GDP, Oklahoma's R&D investment ranked 46th nationally, higher only than Wyoming (0.26 percent), Louisiana (0.44 percent), Alaska (0.50 percent), and Arkansas (0.56 percent), and tied with South Dakota. Among the states surrounding Oklahoma, only Arkansas had a smaller share, ranking 48th. New Mexico has a relatively large amount of federal R&D activities (likely due to the presence of two national laboratories) and a relatively small GDP, resulting in the highest share among all states (6.69 percent).

R&D Industry Employment and Associated Payroll

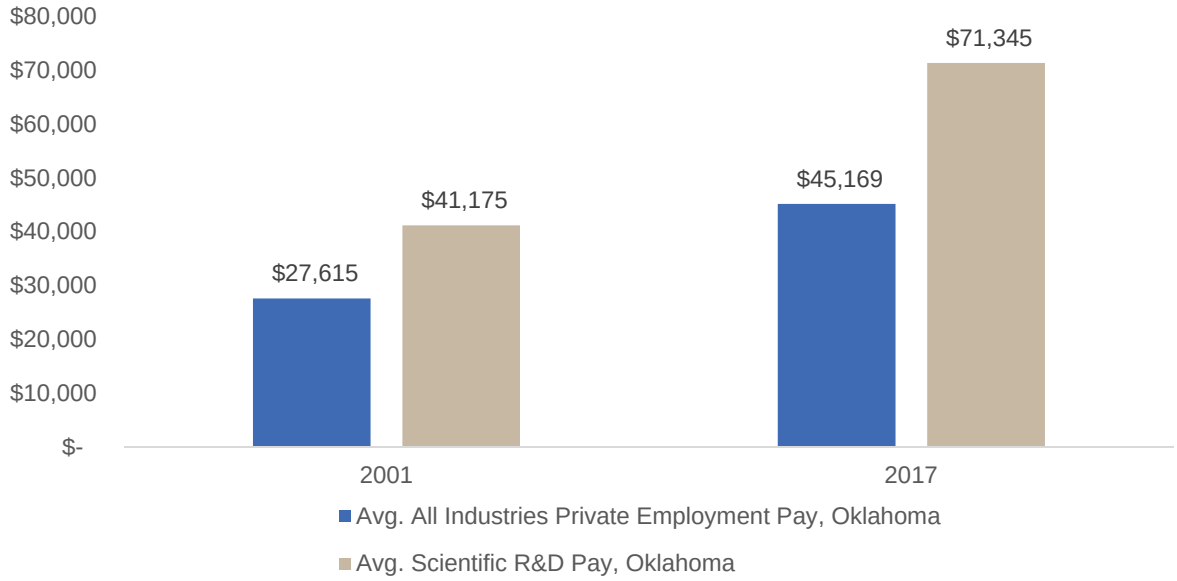
According to the U.S. Census Bureau, the scientific R&D services industry group (NAICS code 5417) comprises "establishments engaged in conducting original investigation undertaken on a systematic basis to gain new knowledge (research) and/or the application of research findings or other scientific knowledge for the creation of new or significantly improved products or processes (experimental development). The industries within this industry group are defined on the basis of the domain of research; that is, on the scientific expertise of the establishment."[13]

Oklahoma employment in this industry decreased from 2,543 employees in 2001 to 1,586 in 2017 – an overall decline of 37.6 percent and a CAGR of -2.6 percent. Nationwide, industry employment increased by 23.5 percent, a CAGR of 1.3 percent during the same time period. As a point of comparison, across all private industries in Oklahoma, employment increased by 7.6 percent between 2001 and 2017 – a CAGR of 0.5 percent. In other words, over the last 17 years, the scientific R&D services industry has declined as a share of all private industry employment in Oklahoma.

[13] U.S. Census Bureau – Industry Statistics Portal: 2012 NAICS 5417, Scientific Research and Development Services. Accessed electronically at https://www.census.gov/econ/isp/sampler.php?naicscode=5417&naicslevel=4#

The average scientific R&D industry annual pay in Oklahoma is consistently much higher than for all private industries in the aggregate. Scientific R&D services industry average pay was $41,175 in 2001 – significantly higher than the average private wage in the state ($27,615). And in fact, that gap has continued to increase over time; in 2017, the average private wage was $45,169, compared to $71,345 in the scientific R&D industry.

Figure 4: Average Annual Pay in Oklahoma, 2001 and 2017[14]



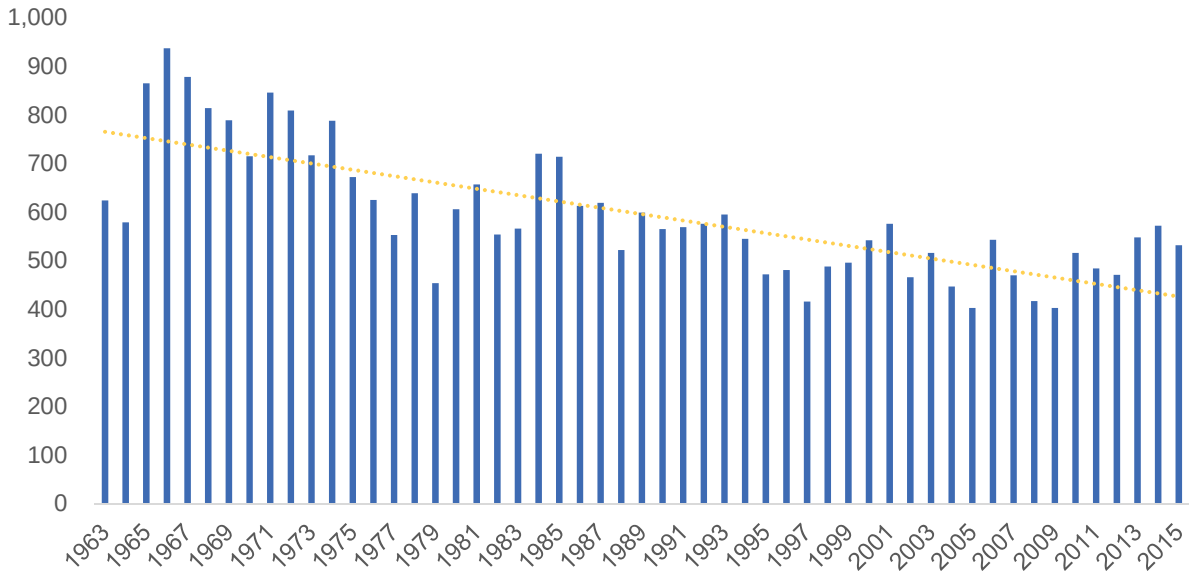
Source: U.S Bureau of Labor Statistics Quarterly Census of Employment and Wages

Commercially Successful Product Development

It can be useful to analyze patent data made available by the U.S. Patent and Trademark Office as an indicator of the development of commercially successful products. Utility patents, specifically, are granted to anyone who invents or discovers any new and useful process, machine, article of manufacture, or composition of matter, or any new and useful improvement. The amount of utility patents granted annually in the State of Oklahoma between 1963 and 2015 peaked in 1966 at 937 and have trended downward slowly over time; a total of 532 utility patents were issued in the State in 2015.

[14] Scientific R&D per NAICS 5417, scientific research and development services.

Figure 5: Utility Patents Issued in Oklahoma, 1963-2015



Source: U.S Patent and Utility Office

Relative to its surrounding states and the U.S. as a whole, Oklahoma's patent activity is lagging. Each of Oklahoma's neighboring states experienced an increase in utility patents over the time period. With a CAGR of 4.5 percent between 1965 and 2015, Colorado experienced the most significant growth, while Missouri's growth was the least pronounced (but still outperformed Oklahoma). The nation as a whole saw an increase of 2.1 percent annually over the time period.

Table 3: Utility Patents Issued in Select States, 1965-2015

	1965	1975	1985	1995	2005	2015	CAGR 1965-2015
Oklahoma	865	672	714	472	403	532	-1.0%
Arkansas	85	72	63	106	126	233	2.0%
Colorado	333	545	534	1,097	1,853	3,045	4.5%
Kansas	270	315	207	246	380	915	2.5%
Missouri	685	635	479	670	628	1,082	0.9%
New Mexico	108	112	157	254	265	427	2.8%
Texas	1,578	2,111	2,362	3,887	5,260	9,934	3.7%
United States	**50,315**	**46,694**	**39,542**	**55,717**	**74,604**	**140,928**	**2.1%**

Source: U.S Patent and Trademark Office

Program Usage and Administration

Program Characteristics

The OARS Program satisfies OCAST's statutory mandate of supporting applied research and technology development with significant commercial potential by allocating resources according to merit, promoting collaborations and leveraging federal and private resources. The program provides funding to assist the research and development of innovation in Oklahoma by supporting applied research activities in existing and emerging technical areas in which the results:

- Lead to innovation, new knowledge or technology and have a high probability of leading to commercially successful products, processes or services within a reasonable period of time;
- Are technically sound, will produce a measurable result and have a commercial application; and
- Have reasonable probability to enhance employment opportunities within Oklahoma.

OARS awards provide a maximum of $1.00 of funding for each non-state $1.00 of matching funds. The awards encourage collaborative projects among Oklahoma firms, Oklahoma universities and colleges and Oklahoma non-profit research organizations. These awards assist Oklahoma businesses in developing their R&D capability and expanding their capacity for technological innovations. These awards also facilitate technology transfer and research involving Oklahoma colleges, universities and businesses and commercialization activities that benefit the State of Oklahoma.

The OARS program provides two distinct funding categories:

- **Proof of Concept Applied R&D funding** supports early stage applied R&D projects, such as proof and concept research and technical development projects, exploratory development and product definition. Awards are made for up to $45,000 per year for up to two years.

- **Accelerated Applied R&D funding** supports later stage applied R&D projects where the product is defined, the market opportunity is well assessed, commercial opportunities are clearly identified and a commercial entity is defined. Awards are made for up to $300,000 and for up to three years.

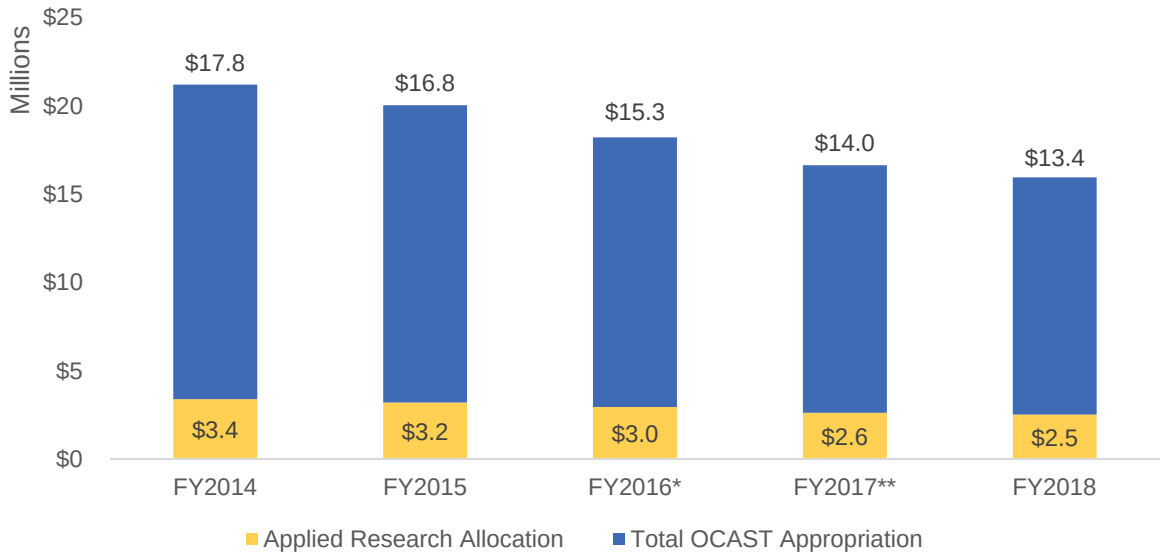
OCAST Appropriation

OCAST is required by statute to recommend an appropriate level of funding for its programs that will "make these programs nationally competitive with those of other states and to adopt…a threshold funding level for each of the programs…that is great enough to have a significant impact and carry out the intent" of the statute.[15] After the Governor and Legislature approve the OCAST appropriation, staff and board members develop a business plan for the application of available resources, abiding by the directives and constraints on the spending articulated in the signed appropriation bills.[16]

Over the past five years, the total OCAST appropriation has decreased by a CAGR of -6.8 percent. The OARS program allocation decreased by a CAGR of -7.1 percent between FY2014 and FY2018 but consistently accounts for roughly 19 percent of the total OCAST appropriation, as shown in the following figure.

[15] 74 O.S., Section 5060.22
[16] OCAST FY2018 Business Plan

Figure 6: OCAST Appropriation and Applied Research Allocation, FY2014-2018 (in Millions)

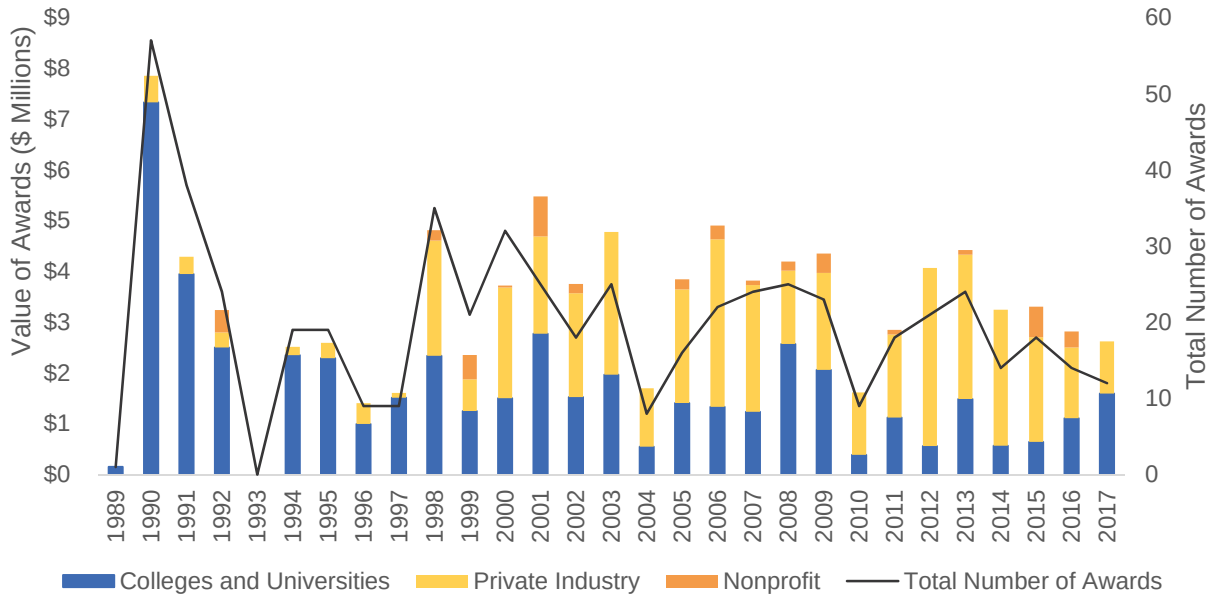


Source: OCAST 2018 Business Plan
** Initial OCAST appropriation in FY2016 was $16.0 million; it was reduced to $14.9 million due to budget cuts. The legislature returned $0.4 million in September 2016, increasing the FY2016 appropriation to $15.3 million.*
*** Initial OCAST appropriation in FY2017 was $14.1 million; final appropriation $14.0 million.*

Historic Use of the Program

Since the program's inception, OCAST has provided $96.4 million in OARS awards. In the earliest years of the program (until around 2000), the primary recipients of funding were colleges and universities, accounting for an average of 77.4 percent of total award dollars and 78.5 percent of projects funded. Since that time, a shift has occurred, and more private companies are receiving funding. Between 2001 and 2017, private industry represented an average of 58.9 percent of funding and 56.1 percent of projects funded. In total, the number of projects funded peaked in 1990 at 57 but since has averaged just over 19. In 2017, 12 projects received OARS funding.

Figure 7: OARS Funding by Project Start Year and Recipient Type, 1989-2017

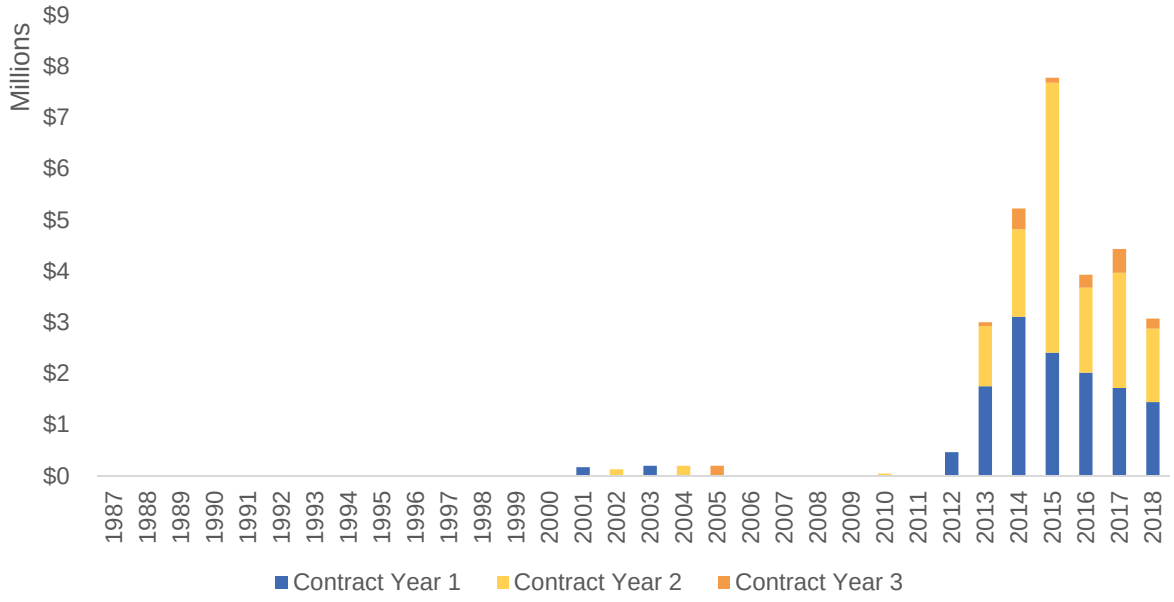


Source: OCAST data

Matching Funds

OARS awards provide a maximum of $1.00 of funding for each non-state $1.00 of matching funds, and this matching requirement has leveraged a significant amount of funding. A total of $30.2 million in matching funds has been committed since 2001, with the bulk of the funds levered during the past six years.

Figure 8: Matching Funds by Project Start Year, 1987-2017

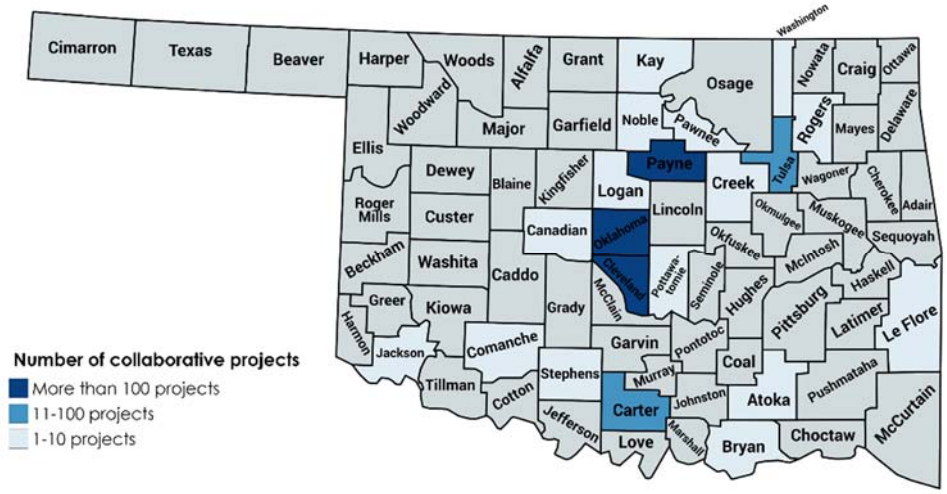


Source: OCAST data

Project Collaboration

The OARS program encourages collaboration among Oklahoma firms, universities and colleges and non-profits. Since the program's inception, it has funded nearly 600 collaborative projects in 21 counties. There have been more than 100 collaborative projects in Payne, Oklahoma and Cleveland Counties (likely due to the high concentration of colleges and universities as well as private industry). The following figure illustrates the distribution of collaborate projects across the state.

Figure 9: Number of Collaborative OARS Projects by County



Source: OCAST data

OARS Program Administration

OCAST administers the OARS program under the governance of the Oklahoma Science and Technology Research and Development (OSTRaD) Board. The Board is responsible for establishing an Applied Research Committee (ARC) that acts in an advisory capacity to the OSTRaD Board and staff in the development of program specifications, organization and evaluation of peer reviews, awarding of contracts and on-going evaluation of contract performance. The Board approves all specifications of the Program, including the ARC's recommended funding allocation for each competition. Administration of the program includes the following components:

Eligibility Determination – Matching Funds

In order to qualify for funding, the applicant organization must provide documentation verifying that not less than 50 percent of the total direct cost of the proposed project will be provided by sources other than OCAST and other than state-appropriated money. Funds received from federal or private grants or contracts may be used as matching funds. For higher education or nonprofit institutions, machinery or equipment **may** be considered as part of the matching funds. For private enterprises, in-kind services **may not** be considered as part of the matching funds. The following table summarizes OARS program fund matching requirements by applicant type.

Table 4: OARS Program Fund Matching Requirements

Applicant Type	Salary	In-Kind Services	Indirect Costs	Non-State Grants or Contracts	Cash
Public Institutions of Higher Education	Yes, if salary does not originate from State funds	Yes	No	Yes	Yes
Private Institutions of Higher Education	Yes	Yes	Yes, up to 50%	Yes	Yes
Nonprofit Research Foundations	Yes	Yes	Yes, up to 50%	Yes	Yes
Private Companies	Yes	Yes, if from third party	Yes, up to 50%	Yes	Yes

Review and Award Process

In order to be considered for an award, each application must include:

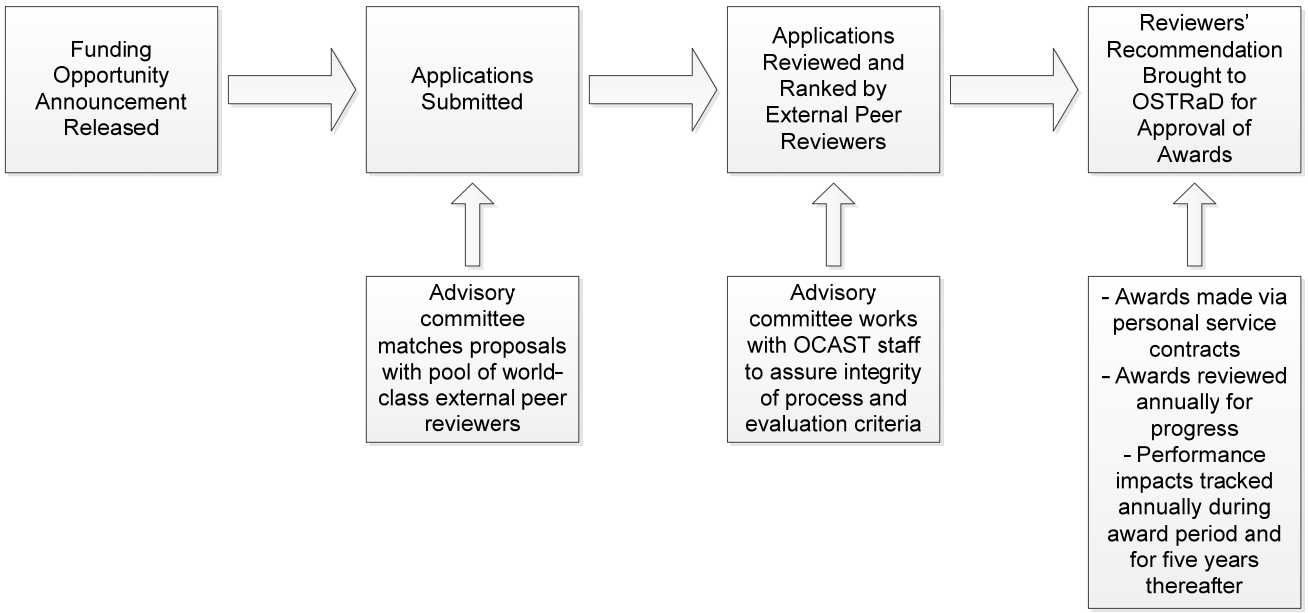
- A description of the potential commercial application of the applied research project and the potential to enhance employment opportunities in Oklahoma;
- A recommendation from the application organization; and
- Other information that may be required by the OSTRaD Board.

Following the application deadline, a panel reviews and ranks all applications for funding according to criteria specified in the solicitation. The peer reviewers, the majority of whom reside outside of the State, are nominated and approved by the ARC. The panel's recommendations are then approved by the OSTRaD Board.

The length of a contract may be no shorter than one year; the maximum period is recommended by the ARC and approved by the OSTRaD Board. A contract is not awarded until documentation that the matching funds and/or machinery or equipment to be matched by OCAST has been received by the applicant organization.

The review and award process is illustrated in the following figure.

Figure 10: OCAST Review and Award Process



Program Evaluation and Reporting

Annually, OCAST produces an 'Impact Report' detailing a summary of "success stories" and the following performance measures attributable to each of its programs:

- Number of new companies formed;
- Number of jobs created or retained;
- Total payroll;
- Patents granted;
- Annual licenses and royalties value;
- Gross sales;
- Capital investments;
- Cost avoidance; and
- Total financial impact and leverage.

OCAST administers a survey of current and former award recipients in order to collect this information. Grantees are required by contract to respond to the survey for a period of five years from the time the first round of funding is received.

While data collection regarding any incentive program is indisputably a best practice, and this process is undoubtedly beneficial to OCAST and its stakeholders, the OCAST data as currently collected is not presented in a manner conducive for accurately calculating economic impact. Of primary concern is that the surveys cover multiple award years in the aggregate, with OARS recipients dropping in and out of the survey. This can often lead to significant fluctuations in the aggregate program data over time. Additionally, the fact that recipients self-report the data can lead to variances in the way information is reported and is subject to error. In addition, it is not clear when revenue is reported or where it is generated (i.e. in Oklahoma or another state).

To accurately perform an economic impact analysis, the following information would be required on an annual basis – preferably for each class of recipients by group or cohort, since the awards most often last for multiple years.

- Jobs data (including how many jobs existed prior to OCAST funding and how much other funding has been raised);
- Payroll data;
- Economic activity data (including gross sales and additional funding raised as a direct result of OARS funding);
- Success or failure rate of each recipient; and
- Industry sector information.

Economic and Fiscal Impact

Introduction

As discussed in the prior chapter, OCAST annually administers a survey of current and former award recipients in order to collect information for use in its yearly Impact Report. While the data currently collected as part of this process cannot be used to measure economic and fiscal impact in the traditional sense, it can provide insight into possible impacts of the program.

The following discusses the project team's analysis of responses to the 2017 OCAST survey (administered to 2012-2016 award recipients). It should be noted that survey responses may be erroneous, and the figures do not include data for award recipients that did not respond to the survey. A list of the questions included in the 2017 OCAST Impact Survey is provided in **Appendix A**.

State Investment

Sixty-three awards totaling $11.1 million were issued to respondents, as illustrated in the following table. It is notable that the project team was unable to reconcile award totals for seven projects; in these instances, the minimum award amount of $45,000 was used (though funding amounts can be up to $300,000). It is also noteworthy that the amounts listed below do not comprise all awards made in the years provided; instead, they represent the award amounts received by those grantees responding to the 2017 survey.

Table 5: 2017 OCAST Survey OARS Recipient Responses, Award Summary[17]

Project Start Year	Project Count	Award Amount
2012	9	$1,094,998
2013	13	$2,176,122
2014	12	$2,104,383
2015	15	$2,699,160
2016	14	$3,065,250
Total	**63**	**$11,139,913**

Source: PFM analysis of 2017 Impact Report survey data

Employment and Payroll

As reported by survey respondents, a total of 159.5 jobs were created or retained as a result of 53 OARS projects, resulting in an average of three jobs per project. The remaining 10 projects did not report any jobs in response to the survey. The total annual payroll (plus benefits) was estimated at $7.7 million, and the average annual wage among all companies in the aggregate was calculated to be nearly $60,000 – considerably higher than the average private industry annual wage ($45,169 in 2017).

Additionally, 80 interns were hired to support 34 OARS projects, and representatives of 30 of those projects (88.2 percent) reported that they would hire their interns upon graduation if feasible.

Startup/Spin-Out Businesses and New Products

Among the 63 projects, 17 (27.0 percent) reported startups/spin-out companies attributable to the receipt of OARS funding. The focus of these companies includes (but is not limited to) the commercialization of antibiotic alternatives, the manufacture of semiconductor devices, the provision of critical safety solutions for homeland

[17] The project team was unable to reconcile project award amounts for seven projects; in these instances, the minimum award of $45,000 was used.

security and laboratory safety, the supply of cold chain packaging systems to the life sciences industry and venture capital.

Twenty-eight of the 63 award recipients (44.4 percent) reported developing new products as a result of OARS funding. These new products range from all-composite tanks for cryogenic fuel storage to experimental golf grass to 3D printing optical engines.

Patents, Royalties and Licenses

A total of five patents have been awarded to the respondent group. These patents have an aggregate estimated value of $22.1 million. In addition, representatives of three projects reported receiving royalties or licensing fees as a result of OARS funding, for a total estimated dollar value of $300,000.

Capital Investment

Twenty-nine respondents (46.0 percent) indicated that capital investment resulted from OARS funding – for a total investment of $12.3 million. On average, this equates to more than $0.4 million per OARS project.

Gross Sales

Fifteen respondents (23.8 percent) reported more than $70 million in gross sales attributable to the receipt of OARS funding – equal to nearly $4.7 million per project.

Additional Funding Obtained

Finally, representatives of 38 projects (60.3 percent) indicated that a total of $20.9 million in additional funding was obtained as a result of the initial OARS funding – equal to nearly $0.5 million per project.

Summary

While a traditional economic impact analysis cannot be performed due to the data collection issues described previously, the $11.1 million OCAST investment in support of the projects summarized above indicate that the investment results in significant economic activity.

OARS Success Stories

In light of the preceding discussion, there may be a question as to whether these companies may have been successful in the absence of OARS funding. Case studies can provide testimony in support of the “but for” argument – that is, that the company would not succeed (or even exist) “but for” the receipt of OARS funding. The following OARS funding case study was provided in the 2018 OCAST Impact Report.

> *“Weather Decision Technologies (WDT) was founded nearly 20 years ago by weather industry professionals. OCAST awarded WDT a $300,000 OARS grant in 2001 that “helped [them] start a number of products, license technology from the university at get things running operationally.” Today, the company has six U.S. patents, 85 employees (including 79 at its Norman headquarters) and clients around the world. WDT ‘brings millions of dollars in revenue annually into the state. Only five percent of its [revenue] is generated in Oklahoma, while 15 percent comes from international clients and 80 percent from the continental U.S.’ The company credits OCAST’s early investment for its continued growth.”*

Program Benchmarking

Program Benchmarking

A detailed description of comparable state programs is provided in **Appendix B.**

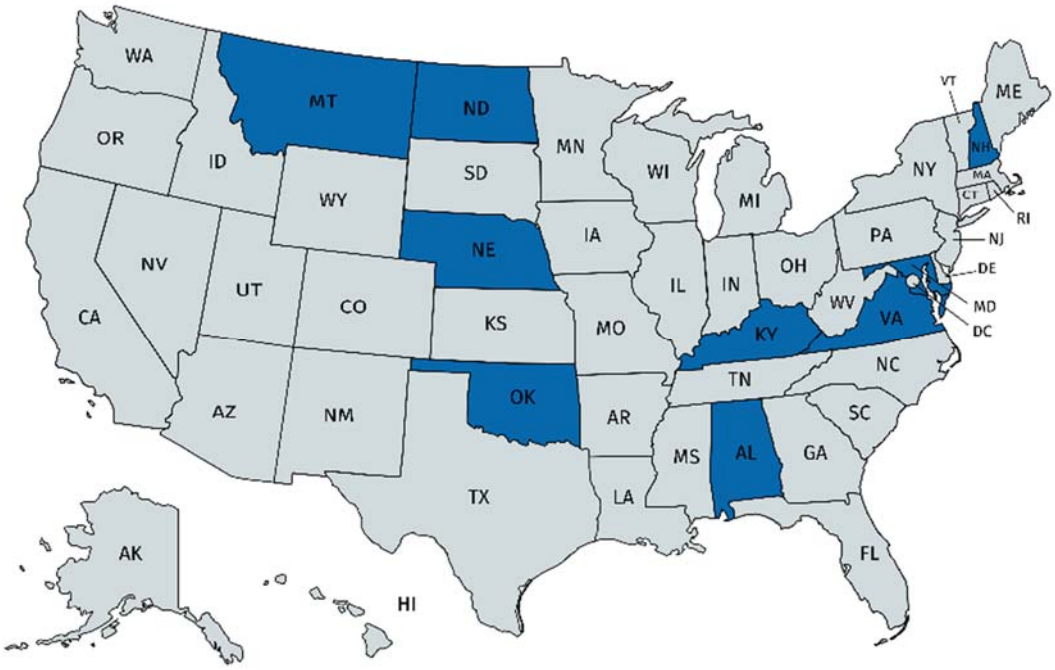
For evaluation purposes, benchmarking provides information related to how peer states use and evaluate similar incentives. At the outset, it should be understood that no states are 'perfect peers' – there will be multiple differences in economic, demographic and political factors that will have to be considered in any analysis; likewise, it is exceedingly rare that any two state incentive programs will be exactly the same.[18] These benchmarking realities must be taken into consideration when making comparisons – and, for the sake of brevity, the report will not continually re-make this point throughout the discussion.

The process of creating a comparison group for incentives typically begins with bordering states. This is generally the starting point, because proximity often leads states to compete for the same regional businesses or business/industry investments. Second, neighboring states often (but not always) have similar economic, demographic or political structures that lend themselves to comparison.

However, the comparison group for certain incentives will be broader than just the neighboring states. In this case, the industry the program seeks to impact (applied R&D) is not specific to any region of the U.S.

As displayed in the following map, a total of eight additional states were found to have comparable applied research incentive programs; none of the states with comparable programs border Oklahoma. The following discusses some of the key characteristics of these programs.

Figure 11: Map of Comparable State Programs



[18] The primary instances of exactly alike state incentive programs occur when states choose to 'piggyback' onto federal programs.

State Program Background[19]

The **Alabama** Innovation Fund (AIF) leverages annual R&D expenditures by public colleges and universities to generate high tech resources which can be used to support economic development activities. There are two components to the program: the Renewal Program receives 60 percent ($2.4 million) of the total AIF allocation for the purpose of renewing the high tech infrastructure of the most successful research universities in the state; the Research Program (which is more comparable to Oklahoma's program) receives 40 percent ($1.6 million) of the total AIF allocation and the funds are distributed to universities and colleges according to a competitive review process that determines the most meritorious proposals.

Kentucky's Research and Development Excellence (RDE) Program makes proactive investments through a peer-reviewed competitive selection process in five specific research areas as established by the Commonwealth. The program funds Emerging Ideas (i.e. research activity undertaken as a preliminary work on high-risk, untested, novel ideas to advance basic research) and Emerging Technology Development (which encompasses several stages of research on the way toward developing a product or process that will likely be packaged as a new technology).

The **Maryland** Industrial Partnerships (MIPS) Program accelerates the commercialization of technology in Maryland by jointly funding collaborative R&D projects between companies and University of Maryland faculty. The program provides funding, matched by participating companies, for university-based research projects that help companies develop new products. Types of projects include R&D in engineering, computer science, physical sciences and life sciences and those projects designed to help a company plan and develop industrial training programs for its employees.

The **Montana** Board of Research and Commercialization Technology provides a predictable and stable source of funding for research and commercialization projects to be conducted at research and commercialization centers in the state.

Nebraska's Research and Development Grant Program provides an opportunity for the State to partner with Nebraska businesses, colleges and universities to fund R&D activities that lead to new or better products, processes and innovations that might not result without State assistance. Grant funding may be used for applied research, new product development or new uses of intellectual property already generated by a private or public college or university in the state. Of its funding, 40 percent is targeted for projects that best alleviate chronic economic distress in distressed areas of Nebraska.

New Hampshire's Granite State Technology Innovation Grants fund partnerships between certain industries and academic institutions. For each dollar the program awards, the company must match one dollar in company cash or in-kind.

North Dakota's Research ND Program promotes the development and commercialization of products and processes through industry/university research partnerships. The program provides matching funds to help companies pay for university research.

The **Virginia** Center for Innovative Technology's Strategic Investments in Research Commercialization Program invests in research and commercialization at Virginia colleges and universities, companies, federal labs and other research institutions in their efforts to advance technology and drive economic growth in the Commonwealth. The program is closely aligned with the Commonwealth Research and Technology Strategic Roadmap, a strategic planning tool that identifies key industry sectors with commercial promise that are worthy of institutional focus and economic development for Virginia.

[19] Information in this section is provided by the Council for Community and Economic Research's State Business Incentives Database.

Program Funding Levels

With an appropriation of $2.5 million in FY2018, Oklahoma's funding for OARS projects is comparable to – even competitive with – other states providing similar programs. Total annual awards range from up to $0.5 million (New Hampshire) to $4.0 million (Nebraska, North Dakota).

Matching Requirements

Among comparable state programs, matching requirements are most frequently one-to-one (Oklahoma, Nebraska, New Hampshire, North Dakota, Virginia), while in Montana, at least 25 percent of total project costs must be from non-state sources. Maryland bases its matching requirement on the size of the applicant firm: large and medium firms must match project funding with 50 percent cash and 25 percent in-kind; small firms must provide 35 percent cash and 30 percent in-kind; and start-up firms must provide 10 percent cash and 35 percent in-kind. Among states with comparable programs, only Alabama and Kentucky have no matching requirements.

Other State Program Evaluations

Maryland Industrial Partnerships (MIPS) Program

In October 2017, the Jacob France Institute of the University of Baltimore released a study of the economic impact of the Maryland Industrial Partnerships (MIPS) Program.[20] The report found that since the program's inception 30 years earlier, state funding of $46.2 million has been augmented by $24.1 million in company research support and matching funds and $120.6 million in in-kind support. The $2.4 million in state funding in 2017 generated $4.8 million in economic activity in the state, supported 24 jobs earning $1.8 million in labor income, and generated approximately $180,000 in combined state and local government revenue. Further, based on economic analysis, the technology products developed and commercialized in collaboration with the MIPS program generated over $4.7 billion in product sales and supported 7,150 jobs in Maryland – and generated an estimated $166.1 million in estimated state revenues in 2017 alone.

Montana Board of Research and Commercialization Technology Trust Fund

In March 2014, the University of Montana's Bureau of Business and Economic Research released a report regarding the economic impact of Montana's program.[21] The study found that the program has produced a "larger, more prosperous and more populous state economy since 2000 than would have existed in its absence." Over the lifespan of the program, an average of $22.5 million in additional income was received by Montana households annually, Montana-based businesses realized an average of $51 million per year in increased gross sales and the State of Montana's tax and non-tax revenues (excluding property taxes) were an average of $4.7 million higher each year – all as a result of the existence of the program.

Key Takeaways for Oklahoma

- Maryland takes a similar approach when quantifying the economic impact of the MIPS program. The program's evaluators analyzed the impact of matching funds and in-kind support in addition to more common economic impact indicators, such as the creation of jobs, total labor income and aggregate

[20] The Jacob France Institute – An Analysis of the Impacts of MIPS Program Spending and the Commercialization of MIPS Funded Projects on the State of Maryland (October 2017). Accessed electronically at http://www.mips.umd.edu/documents/Jacob-France-MIPS-Impact-Report-2017-V2.pdf

[21] University of Montana Bureau of Business and Economic Research – The Economic Impact of the Montana Board of Research and Commercialization Technology (March 2014). Accessed electronically at http://www.bber.umt.edu/pubs/Econ/MBRCT%20Report.pdf

state and local government revenue. Of note for Oklahoma is that the Maryland analysis found that the product development and commercialization aspect of the program effectively (and handily) more than paid for the program.

Appendices

Appendix A: 2017 OCAST Impact Survey

1. Project Type.
    a. Health Research
    b. OARS
    c. Intern
    d. ONAP
    e. SBIR/SBRA
    f. Plant Science
2. Project Number.
3. Name.
4. Please list the number of jobs created or retained as a result of this project.
5. Please report the total annual payroll (including benefits) of jobs created or retained by this project.
6. List the total dollar amount of contracts, grants or additional follow-on funding awarded that can be attributed in whole or part to OCAST funding. Do not include any OCAST awards, OCAST-required matching funds or any state-appropriated funds.
7. What is the average annualized wage of the jobs created/retained by this project? Annualized wages can be determined by multiplying the hourly wage by 2,080.
8. Has a start-up or spin-out company formed that can be attributed to this OCAST-funded project?
9. Please list the nature of the spin-out company, the company name, approximate number of employees and the approximate annual payroll.
10. Have any new products or services resulted from your project?
11. Since you answered yes to the previous question, please name the type of product or service, the industries that will likely benefit from the product or service and the date/estimated date the product was/will be commercialized.
12. Have you submitted an application for, or been granted, a patent for a product or service resulting from this project?
13. Number of patent applications submitted.
14. Number of patents awarded.
15. Dollar value of patents awarded.
16. Have you received any royalties or licensing fees from a product or service resulting from this project?
17. Dollar amount of royalties or licensing fees received.
18. Please estimate the total dollar impact on capital investments this project has had.
19. Please estimate the total dollar impact on gross sales this project has had.
20. Were any student interns hired/retained as a part of this project?
21. How many students were hired/retained as a result of this project?
22. If the opportunity presents itself, do you intend to hire any of these interns full-time after the intern earns his or her degree?
23. As a result of this project, have there been any collaborations with a business or other academic entity? If so, please describe.
24. Please describe in lay terms the most significant impact of this project to date.
25. Please feel free to provide any other significant impacts, financial or otherwise, that were not covered in this survey.
26. Please feel free to provide any additional comments, including your thoughts on the ease of use of this survey.

Appendix B: Comparable State Programs

Oklahoma Applied Research Program						
State	**Program Name**	**Program Type**	**Program Start**	**Program Funding Provisions**	**Matching Requirement?**	**Annual Funding**
Oklahoma	Oklahoma Applied Research Support (OARS)	Grant	1987	**Proof-of-Concept Applied Research and Development:** funding supports early stage applied R&D. Yearly awards are up to $45,000 per year for up to two years. **Accelerated Applied Research and Development:** funding supports later stage applied R&D. Total awards are up to $300,000 for up to three years.	Yes - 1:1	$2.6 million (2017)
Alabama	Alabama Innovation Fund	Grant	2012	**Renewal Program**: receives 60% of the total allocation. These funds are distributed through grants to each public university with the allocation based on the level of each public university's total federally financed R&D expenditures for the last three years. **Research Program:** receives 40% of the total allocation and the funds are distributed to universities according to a competitive review process that determines the most meritorious proposals.	None	$2.4 million (2018)
Kentucky	Research and Development Excellence Program (RDE)	Grant	2000	**Emerging Ideas:** May be awarded from $15,000 to $50,000 per year and award period is not to exceed one year. This program is only open to Kentucky universities and colleges. **Emerging Technologies:** May be awarded from $20,000 to $50,000 per year and award period is not to exceed one year. This program is open to Kentucky universities, colleges and small businesses.	None	None identified

Oklahoma Applied Research Program						
State	**Program Name**	**Program Type**	**Program Start**	**Program Funding Provisions**	**Matching Requirement?**	**Annual Funding**
Maryland	Maryland Industrial Partnerships Program (MIPS)	Grant	1987	- Program provides matching funds to help MD companies pay for university research. - Maximum award for any single project is $100,000 per year for large and small companies, and $90,000 for start-up firms.	Yes - Large and medium firms: cash (at least 50%), in-kind (25%); small firms: cash (35%), in-kind (30%); start-up cash (10%), in-kind (35%)	$2.4 million (2017)
Montana	Montana Board of Research and Commercialization Technology Trust Fund	Grant	2000	- Grant awards between 2014 and 2017 ranged from $25,000 to $210,000 - The average grant award during that time was just over $90,000 - Program funded 33 projects during that 4-year span	Yes - 1:4	$0.8 million (2019)
Nebraska	Nebraska Research and Development Grant Program	Grant	2011	**Phase I R&D:** awards are capped at $100,000. **Phase II R&D:** awards are capped at $400,000. Businesses are eligible to apply for Phase II awards if they have successfully completed a Phase I award as determined by the Department. Each phase to be completed within 24 months of award.	Yes - 1:1 (value-added agriculture projects 1:4)	Up to $4.0 million annually
New Hampshire	Granite State Technology Innovation Grant	Grant	1991	Program typically contributes $20,000-$125,000 in grant funding per project.	Yes - 1:1 (cash or in-kind)	Up to $0.5 million annually

Oklahoma Applied Research Program						
State	**Program Name**	**Program Type**	**Program Start**	**Program Funding Provisions**	**Matching Requirement?**	**Annual Funding**
North Dakota	Research ND	Grant	2013	- Funds may be used for commercialization of new technologies, research and development of new products and improvement of existing products or processes. - Funds may be granted up to $300,000 per project. However, funds could be requested and approved up to $500,000, given there is a strong justification for exceeding more than $300,000.	Yes - 1:1	$4.0 million (2017-2019 biennium)
Virginia	Commonwealth Research Commercialization Fund	Grant	2011	**Private Sector programs**: include Commercialization, Small Business Innovation Research (SBIR) matching funds and Small Business Technology Transfer (STTR) matching funds in which organizations can apply to receive one award and be awarded up to $50,000. **Academia and Other Nonprofit Research Institutions programs**: include Matching Funds in which organizations applying to Matching Funds may be awarded up to $100,000 each and receive up to 4 awards. For the Eminent Researcher Recruitment Program, organizations can apply to receive one award and be awarded up to $250,000.	Yes - 1:1	$2.5 million (2018)