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COMPARATIVE ECONOMIC OUTCOMES FROM SBIR FUNDING: 'UNDERSERVED' VERSUS HIGH-AWARD STATES

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This study analyzes the comparative economic outcomes of the U.S. Department of Defense (DoD) Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR) programs, conducting an analysis to determine if high-award states or low-award states are more effective at commercializing technology as a direct result of the DoD SBIR/STTR programs. Three common definitions of underserved states are used for this analysis — states that receive fewer awards (underserved), states that receive relatively fewer awards when adjusted for population, and states participating in the National Science Foundation's Established Program to Stimulate Competitive Research. The data used in these analyses represent the economic outcomes of the entire survey population of DoD SBIR Phase II awards on which information was obtained (a total of 96 percent of the 16,959 awards in the study). The findings indicate that commercialization success of DoD SBIR Phase II projects in underserved states was superior to those in high-award states. Sixty different measures were used to compare the relative success of these different states and awardees. Analysis showed that underserved states consistently outperformed high-award states in commercializing the outcomes of their DoD SBIR Phase II projects. For 47 of the 60 different measures — 30 of which were statistically significant for low-award states — the low-award states outperformed the high-award states. On only 10 of the 60 measures did the high-award states show superior results. These results support the argument that SBIR program efforts to assist firms in low-award states are a sound investment. However, the findings call for additional research as to why states with fewer awards, fewer awards per capita, and other disadvantages have more commercial success with their awards than select counterparts.

Key words: Comparative states; Economics; SBIR/STTR

INTRODUCTION

The U.S. federal government's well-known Small Business Innovation Research (SBIR) and related Small Business Technology Transfer (STTR) programs (both subsequently referred to as SBIR) originated with the Small Business Innovation Development Act of 1982. Congress passed this legislation expressly to harness the innovativeness of U.S. small businesses — both to help the federal government address high-priority technology needs as well as to stimulate the national economy. Since 1982, the federal government has awarded approximately $50

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billion in SBIR funds to over 27,000 small businesses. Currently, it provides approximately $2.6 billion per year to companies to stimulate innovation and generate new technologies.

In order to expand the nation's innovation economy to the entire United States and also to ensure that SBIR funding is equitably distributed, Congress has directed all SBIR-funding agencies to attempt to engage companies located in underserved states. These are the states that historically have received fewer SBIR awards than the other states. Most are more rural states with smaller populations, many in the interior of the country — the so-called flyover states. Approximately half of the states fall into this category although what constitutes underserved has varied over time and by federal agency.

In response to congressional direction, federal agencies have developed active SBIR outreach programs. The primary purpose of these outreach programs is to help companies in underserved states (and in underserved socio-economic communities) to compete successfully for SBIR awards and commercialize the resulting SBIR-developed innovations. The Small Business Administration (SBA), which is the coordinating agency for the SBIR programs, and the SBIR-granting federal agencies themselves have commonly used several key statistics to evaluate SBIR success. These include the number of SBIR applications, proposal success rates, total award numbers, participation by women and minorities, the percentage of first-time awardees, and the distribution of awards by state.

Other attempts to evaluate SBIR success include government-sponsored surveys and research by university-based social scientists. A large number of federally commissioned surveys have been conducted to determine SBIR success. These surveys have particularly focused on how well the programs have resulted in commercialization of SBIR-funded innovations. They include the seminal studies by the General Accounting Office in the 1990s and an ongoing series of reports issued by the National Academies of Sciences, Engineering and Medicine (NASEM) and its operating arm, the National Research Council (NRC), beginning in 2008 (11-20). Together, these federally commissioned surveys have generated a voluminous body of evidence that the SBIR/STTR programs are indeed meeting their objectives.

Efforts by university researchers to evaluate SBIR success have frequently drawn on the volumes of data generated by the government-sponsored surveys and focused on certain key indicators of success. These include a study of SBIR program success that used growth in the number of employees as the key indicator (4); one that focused on new firm formation (22); one that used patenting as a proxy for success (6); and another that examined multiple indicators: patent output, growth in the number of employees, and success in attracting venture capital (2).

Other social scientists have evaluated the importance of factors that determine or contribute to SBIR company success. Factors examined include university involvement in the SBIR project (24); private equity investment in the firm (8); prior research and development (R&D) experience with the technology being funded, the firm size, the size of the award, the principal investigator's gender, and any university connections (7); the maturity of the firm, whether nascent or established (5); the commercial complexity of the technology being developed (23); and the business background and gender of the company founder (1).

However, one shortcoming of most of the above-mentioned research is its reliance on data obtained from surveys with relatively low response rates and effectively non-random samples. For example, in its first series of studies, the NRC started by randomly selecting 6,410 Phase II awards out of the more than 11,000 issued by the five major agencies from 1992 to 2001. However, information was obtained on only 30 percent of the random sample and less than 17 percent of the total number of Phase II awards (14). The second series of NRC/NAS studies used a similar methodology and, again, because of relatively low response rates, obtained effectively non-random information on only a fraction of the target population of SBIR awards — 16 percent to 22 percent (11-20). Random sampling is a well-established method of surveying large populations. However, the effectiveness of this approach is undermined by low responses from the randomly selected population, such as those obtained in the NRC/NAS studies. These low, non-random response rates introduce potential biases that can seriously compromise

the validity of the survey results.

One set of federally commissioned surveys that avoids this problem is a unique series of economic impact surveys undertaken by TechLink on behalf of the U.S. Department of Defense (DoD) and the National Cancer Institute (25-28). These studies surveyed the entire target population of SBIR/STTR Phase II awardees and achieved response rates exceeding 90 percent.

In the most recent of these studies, featured in this article, TechLink completed a study in 2019 on the outcomes and impacts of nearly 17,000 DoD SBIR Phase II awards dating back to 1995 (25). This effort involved contacting all 4,412 companies that had received these Phase II awards and inquiring about the outcomes. It achieved a very high response rate, obtaining conclusive information on the commercialization levels of 96 percent of the DoD SBIR Phase II projects in the survey population.

In analyzing the survey data, the research team noted that the underserved states appeared to be just as successful in commercializing the results of their SBIR research as the non-underserved states. This surprising observation stimulated the follow-up research presented in this article. To undertake this research, the TechLink team re-analyzed the DoD SBIR survey data and conducted an in-depth comparison of the SBIR commercialization results of companies in the underserved states to those in the high-award states. TechLink previously published a brief summary of the initial findings (29). Further research and extensive statistical analysis have elucidated and strengthened those findings. This research reveals that, by most measures, underserved states *consistently outperformed* the high-award states. The full results of this analysis are presented here.

DEFINITIONS AND METHODOLOGIES

Defining Underserved States

Despite their emphasis on engaging underserved states in SBIR research, neither Congress nor SBA has ever officially defined this term. In the absence of any official definition, we have evaluated the comparative commercialization outcomes of low-award versus high-award states using three commonly used definitions of underserved:

1) **States that receive relatively fewer awards.** We ranked all 50 states in terms of the total number of SBIR awards they received from FYs 2000 through 2018. The 25 states at the bottom of this list — the bottom 50 percent — were considered underserved. We refer to these states in this paper as low-award states. All others are labeled high-award states.

2) **States that receive relatively fewer awards, adjusted for population.** Because underserved states have smaller populations, they tend to have fewer small technology businesses applying for SBIR awards. To adjust for population differences, we ranked the 50 states by dividing each state's 2018 population by the total number of SBIR awards it had received from FYs 2000 through 2018. The bottom 25 states using this approach — those with the highest numbers of inhabitants per award — were considered underserved. We refer to these as population-adjusted low-award states. All others are labeled high-award states.

3) **EPSCoR states.** The National Science Foundation's Established Program to Stimulate Competitive Research (EPSCoR) (formerly known as the Experimental Program to Stimulate Competitive Research), created in 1979 to address the unequal distribution nationwide of federal R&D grants, targets underserved states for additional funding. It represents the federal government's original list of the nation's underserved states and is often used by Congress and federal policymakers in drafting science and technology policy. Since its origin, the EPSCoR list of participant states has periodically changed. We refer to these states as EPSCoR states and all others as high-award states.

Table 1 shows the list of states that can be considered underserved using each of the three definitions. As this table demonstrates, 15 states qualify as underserved under all three definitions: Alaska, Arkansas, Idaho, Kansas, Kentucky, Louisiana, Maine, Mississippi, Nebraska, Nevada, North Dakota, Oklahoma, South Dakota, South Carolina, and West

Table 1. Underserved States Defined by Total Awards, Population-Adjusted Awards, and EPSCoR Status

State	Low-Award States	Population-Adjusted Low-Award States	EPSCoR States
Alabama			x
Alaska	x	x	x
Arizona			
Arkansas	x	x	x
California			
Colorado			
Connecticut			
Delaware	x		x
Florida		x	
Georgia		x	
Hawaii	x		x
Idaho	x	x	x
Illinois		x	
Indiana	x	x	
Iowa	x	x	
Kansas	x	x	x
Kentucky	x	x	x
Louisiana	x	x	x
Maine	x	x	x
Maryland			
Massachusetts			
Michigan			
Minnesota			
Mississippi	x	x	x
Missouri	x	x	
Montana	x		x
Nebraska	x	x	x

Nevada	x	x	x
New Hampshire			x
New Jersey			
New Mexico			x
New York			
North Carolina		x	
North Dakota	x	x	x
Ohio			
Oklahoma	x	x	x
Oregon			
Pennsylvania			
Rhode Island	x		x
South Carolina	x	x	x
South Dakota	x	x	x
Tennessee	x	x	
Texas		x	
Utah			
Vermont	x		x
Virginia			
Washington			
West Virginia	x	x	x
Wisconsin		x	
Wyoming	x		x

Virginia.

Table 2 shows how the 50 states rank in terms of the total number of SBIR awards received during the FY 2000 to 2018 period. The 25 states highlighted at the bottom of the list, the low-award states with the fewest SBIR awards, are the underserved states. California, the top SBIR recipient state, received 36,806 awards. By contrast, Alaska, at the very bottom of the list, received only 93 SBIR awards. All the underserved states received fewer than 1,500 awards.

Table 2. Underserved States Defined by Total SBIR Awards

State	Total SBIR/STTR Award Count	Total SBIR/STTR Award Value
California	36,806	$ 11,171,223,451
Massachusetts	23,562	$ 7,050,165,138
Virginia	10,421	$ 3,118,712,735
Maryland	8,723	$ 2,640,325,340
New York	7,935	$ 2,526,281,545
Colorado	7,894	$ 2,350,536,895
Texas	7,326	$ 2,156,207,360
Ohio	6,656	$ 2,017,635,676
Pennsylvania	6,603	$ 2,125,374,345
New Jersey	4,666	$ 1,323,355,834
Florida	4,415	$ 1,318,095,107
Washington	4,001	$ 1,224,555,341
Michigan	3,771	$ 1,203,683,780
Alabama	3,392	$ 1,033,299,688
Connecticut	3,389	$ 903,347,783
Illinois	3,359	$ 986,587,310
Arizona	3,188	$ 899,966,395
North Carolina	3,124	$ 1,157,682,611
New Mexico	2,847	$ 761,280,565
Minnesota	2,523	$ 759,752,144
Oregon	2,273	$ 783,457,285
New Hampshire	2,205	$ 745,901,511
Utah	1,954	$ 554,089,929
Georgia	1,888	$ 620,710,538
Wisconsin	1,685	$ 578,324,729
Tennessee	1,460	$ 411,222,704
Indiana	1,377	$ 422,641,631
Missouri	1,032	$ 300,278,571
Delaware	825	$ 240,173,760
Montana	750	$ 226,338,509
Hawaii	715	$ 220,929,509
Kentucky	678	$ 252,630,474
Oklahoma	612	$ 184,012,651
South Carolina	594	$ 206,569,171
Rhode Island	562	$ 182,287,463
Kansas	517	$ 138,093,275
Arkansas	506	$ 152,628,359
Maine	483	$ 119,128,099
Vermont	480	$ 144,323,819
Iowa	472	$ 147,546,093
Nevada	457	$ 135,105,730
Louisiana	444	$ 110,547,462
Idaho	316	$ 79,678,610
Nebraska	300	$ 95,422,010
Mississippi	254	$ 54,784,662
West Virginia	253	$ 78,261,216
Wyoming	246	$ 66,289,656
South Dakota	174	$ 38,535,247
North Dakota	153	$ 35,780,437
Alaska	93	$ 19,323,592

Note: Statistically significant outcomes are bolded.

Table 3 shows how the 50 states rank when each state's population is divided by the total number of SBIR awards received during the FY 2000 to 2018 period. These are the **population-adjusted low-award states**. States with smaller populations tend to have fewer technology firms eligible to compete for SBIR awards. Therefore, the number of inhabitants per award may provide a more accurate measure of whether a state is underserved than its total number of awards.

Table 3. Underserved States Defined by Total SBIR Awards per Population

State	Total SBIR Award Count	Population, 2018	Inhabitants per SBIR Award
Massachusetts	23,562	6,902,149	293
New Hampshire	2,205	1,356,458	615
Maryland	8,723	6,042,718	693
Colorado	7,894	5,695,564	722
New Mexico	2,847	2,095,428	736
Virginia	10,421	8,517,685	817
Connecticut	3,389	3,572,665	1,054
California	36,806	39,557,045	1,075
Delaware	825	967,171	1,172
Vermont	480	626,299	1,305
Montana	750	1,062,305	1,416
Alabama	3,392	4,887,871	1,441
District of Columbia	474	702,455	1,482
Utah	1,954	3,161,105	1,618
Ohio	6,656	11,689,442	1,756
Oregon	2,273	4,190,713	1,844
Rhode Island	562	1,057,315	1,881
Washington	4,001	7,535,591	1,883
New Jersey	4,666	8,908,520	1,909
Pennsylvania	6,603	12,807,060	1,940
Hawaii	715	1,420,491	1,987
Minnesota	2,523	5,611,179	2,224
Arizona	3,188	7,171,646	2,250
Wyoming	246	584,290	2,375
New York	7,935	19,542,209	2,463
Michigan	3,771	9,995,915	2,651
Maine	483	1,338,404	2,771
North Carolina	3,124	10,383,620	3,324
Wisconsin	1,685	5,813,568	3,450
Illinois	3,359	12,741,080	3,793

Texas	7,326	28,701,845	3,918
Tennessee	1,460	6,770,010	4,637
Florida	4,415	21,299,325	4,824
Indiana	1,377	6,691,878	4,860
North Dakota	153	760,077	4,968
South Dakota	174	882,235	5,070
Idaho	316	1,754,208	5,551
Georgia	1,888	10,519,475	5,572
Kansas	517	2,911,505	5,632
Missouri	1,032	6,126,452	5,936
Arkansas	506	3,013,825	5,956
Nebraska	300	1,929,268	6,431
Oklahoma	612	3,943,079	6,443
Kentucky	678	4,468,402	6,591
Nevada	457	3,034,392	6,640
Iowa	472	3,156,145	6,687
West Virginia	253	1,805,832	7,138
Alaska	93	737,438	7,929
South Carolina	594	5,084,127	8,559
Louisiana	444	4,659,978	10,495
Mississippi	254	2,986,530	11,758

Note: Statistically significant outcomes are bolded.

Selecting Metrics

Defining underserved was one methodological challenge that this project faced in comparing the commercialization outcomes of the low-award versus the high-award states. A second challenge was determining the criteria to be used to evaluate commercialization success.

The NRC and NAS addressed this problem in their extensive series of reports on the major federal SBIR programs (10-14). They concluded that the best approach was to use multiple criteria to address different components of SBIR commercial success. These included the percentage of SBIR projects that had "reached the market" — i.e., resulted in sales of new technology. For SBIR projects that had resulted in sales, they calculated the median and average sales as well as the percentage of projects falling into different tiers of sales (e.g., under $100,000; $100,000 to $499,000; $500,000 to $1 million; and over $1 million). Finally, the NRC/NAS studies distinguished between commercial sales to the private sector, sales to the federal government (including the U.S. military in the case of the DoD SBIR program), and follow-on R&D funding for further development of the SBIR-developed innovation.

The present analysis follows the basic NRC/NAS approach and employs multiple criteria to compare the commercialization success of underserved versus high-award states. These criteria include the percentage of SBIR projects resulting in product or service sales, the median and average sales amounts, the percentage of commercialized projects with sales of at least $10 million, and the percentage with sales of at least $50 million. Median and average sales amounts were selected as criteria to capture the

central tendencies of the award outcomes. Sales of at least $10 million and $50 million were selected to capture the incidence of positive outliers — the most successful SBIR projects.

This analysis also breaks out the sales results into four key categories: 1) total cumulative sales of new products and services based on the SBIR-developed technology; 2) sales to the private sector; 3) sales to the U.S. military, either directly or through defense contractors; and 4) sales of R&D services to further develop the SBIR technology:

In sum, this paper uses 60 different measures to compare the DoD SBIR commercialization results of

- **Total cumulative sales** are the best single measure for determining overall commercialization success from an SBIR project.
- **Sales to the private sector** provide an important measure of how the SBIR-developed technology is benefiting the U.S. economy.
- **Sales to the U.S. military** are also important given that this analysis is focusing on the DoD SBIR program, which emphasizes developing new technologies for DoD use.
- **Sales of R&D services** to further develop the SBIR technology are another important measure of commercialization. The vast majority of the businesses receiving SBIR awards are small technology firms that sell their R&D services for specialized applications.

companies in the underserved states to those in the high-award states. The measures used include three different definitions of underserved, four different categories of sales for each definition, and five different sales criteria.

Statistical Methods for Comparisons

The data used in these analyses represent the economic outcomes of the entire survey population of DoD SBIR Phase II awards on which information was obtained (a total of 96 percent of the 16,959 awards in the survey pool) rather than a random sample from a larger population. As a result, any difference between two metrics, no matter how small, is statistically significant. However, the data used represent the outcomes of the DoD SBIR/STTR Phase II awards issued from 1995 to 2018. In that sense, it is a sample of the larger universe of DoD SBIR Phase II awards established since the SBIR program was launched in 1983. It is important to note that the actual probability associated with any observed difference within the surveyed population is 100 percent. The statistical analysis helps us to understand how likely it is that these outcomes will also be found in similar populations.

Median sales amounts were compared using Mood's median test, which employs contingency tables and the chi-squared statistic to determine whether any of the medians differ significantly from their expected values. Average sales amounts were compared using a student's *t*-test with log10 transformed data because the distribution of all sales data were approximately log-normal. Variances were compared using an *F*-test. However, when a high *p*-value indicated little evidence against equal variances, a *t*-test assuming equal variances was performed.

The 95 percent confidence limits for proportions were calculated for each metric expressed as a percentage. The confidence limits are reported as X +/- Y%, where the +/- amount is the range within which 95 percent of the observations from a random sample would be expected to fall. It is not always true that if two percentages are significantly different, their confidence limits do not overlap. However, this is a suitable indicator of differences for the purposes of this analysis.

RESULTS

In this section, we analyze the commercialization outcomes of underserved versus high-award states for each of the following categories and criteria:

Low-Award States

The low-award states identified in Table 2 are

- **Definition of Underserved:** Low-award states, population-adjusted low-award states, and EPSCoR states
- **Types of Sales Categories:** Total cumulative sales of new products and services based on the SBIR-developed technology; sales of new products and services to the commercial sector; sales of new products and

services to the U.S. military, either directly or through defense contractors; and sales of R&D services to further develop the SBIR technology

- **Commercialization Level and Sales Criteria:** The percentage of SBIR projects resulting in sales and, for these projects, the median sales amount, the average sales amount, the percentage with sales of at least $10 million, and the percentage with sales of at least $50 million

the 25 states that received the fewest SBIR/STTR awards from all federal agencies between FY2000 and FY2018. In the TechLink study, these 25 states received a total of 997 Phase II SBIR/STTR awards from the DoD, which was 5.9 percent of those awarded during that period. It should be noted that in Table 4, there are 991, and not 997, awards listed. Six awards were removed due to incomplete data. Table 4 compares the number of DoD SBIR Phase II awards that achieved sales in the low-award states to the high-award states.

Table 5 shows that, by all five sales criteria, DoD SBIR projects in low-award states performed better than those in high-award states. A higher percentage resulted in sales — 63 percent versus 59 percent. The median sales amount in the low-award states was 45 percent higher than in the high-award states, and the average sales figure was 50 percent higher. Remarkably, the percentage of projects with sales of at least $10 million was 55 percent higher in the low-award states and the percentage having sales of at least $50 million was four times higher. All five of these measures were statistically significant.

Table 6 shows that 35 percent of the awards in the low-award states achieved commercial sales versus 30 percent in the high-award states. The median sales amount in the low-award states was 140 percent higher; the average sales amount was 53 percent higher. The percentage of awards in the low-award states with sales of at least $10 million was 150 percent greater; the percentage of awards with sales of at least $50 million was 3.5 times greater. All of these results were statistically significant.

Table 7 data indicate that approximately 30 percent of the DoD SBIR projects in the low-award states achieved sales to the U.S. military versus 27 percent in the high-award states. In addition, the median and average sales amounts in the low-award states were greater as were the percentage of awards generating sales of at least $10 million and $50 million. The findings again indicate that low-award states are outperforming high-award states from a commercialization perspective. Among these findings, however, only the percent of awards with sales of at least $10 million was statistically significant.

Table 4. SBIR Awards with Sales by Low-Award States Compared to High-Award States by Sales Category

	Low-Award States	**High-Award States**
Total SBIR Awards	**991**	**15,813**
Awards with total cumulative sales	622	9,307
Awards with sales to the private sector	345	4,713
Awards with sales to the U.S. military	297	4,347
Awards with sales of R&D services	424	6,260

Note: Statistically significant outcomes are bolded.

Table 5. Total Cumulative Sales Outcomes for High-Award and Low-Award States

Total Cumulative Sales					
	High Award		Low Award		
Metric	**Outcomes**	**Range**	**Outcomes**	**Range**	***p* (no difference)**
Resulting in Sales (%)	**59%**	**+/-0.8%**	**63%**	**+/-3.0%**	**95%**
Median Sales Amount	**1,042,000**		**1,516,239**		**2.20E-06**
Average Sales Amount	**11,853,887**		**17,785,643**		**1.63E-05**
% with Sales of $10M+	**11%**	**+/-0.5%**	**17%**	**+/-2.3%**	**95%**
% with Sales of $50M+	**2%**	**+/-0.2%**	**8%**	**+/-1.7%**	**95%**
Number with Sales	9,307		622		
Total Survey Population	15,813		991		

Note: Statistically significant outcomes are bolded.

Table 6. Commercial Sales Outcomes for High-Award and Low-Award States

Total Cumulative Sales					
	High Award		Low Award		
Metric	**Outcomes**	**Range**	**Outcomes**	**Range**	***p* (no difference)**
Resulting in Sales (%)	**59%**	**+/-0.8%**	**63%**	**+/-3.0%**	**95%**
Median Sales Amount	**1,042,000**		**1,516,239**		**2.20E-06**
Average Sales Amount	**11,853,887**		**17,785,643**		**1.63E-05**
% with Sales of $10M+	**11%**	**+/-0.5%**	**17%**	**+/-2.3%**	**95%**
% with Sales of $50M+	**2%**	**+/-0.2%**	**8%**	**+/-1.7%**	**95%**
Number with Sales	9,307		622		
Total Survey Population	15,813		991		

Note: Statistically significant outcomes are bolded.

Table 7. Sales to the U.S. Military for High-Award and Low-Award States

Total Cumulative Sales					
	High Award		Low Award		
Metric	**Outcomes**	**Range**	**Outcomes**	**Range**	***p* (no difference)**
Resulting in Sales (%)	**59%**	**+/-0.8%**	**63%**	**+/-3.0%**	**95%**
Median Sales Amount	**1,042,000**		**1,516,239**		**2.20E-06**
Average Sales Amount	**11,853,887**		**17,785,643**		**1.63E-05**
% with Sales of $10M+	**11%**	**+/-0.5%**	**17%**	**+/-2.3%**	**95%**
% with Sales of $50M+	**2%**	**+/-0.2%**	**8%**	**+/-1.7%**	**95%**
Number with Sales	9,307		622		
Total Survey Population	15,813		991		

Note: Statistically significant outcomes are bolded.

Table 8. R&D Sales Outcomes for High-Award and Low-Award States

Sales of R&D Services					
	High Award		Low Award		
Metric	**Outcomes**	**Range**	**Outcomes**	**Range**	***p* (no difference)**
Resulting in Sales (%)	40%	+/-0.3%	43%	+/-3.1%	95%
Median Sales Amount	**694,137**		**870,877**		**0.00**
Average Sales Amount	2,190,483		2,678,295		0.18
% with Sales of $10M+	4.0%	+/-0.8%	5.9%	+/-1.5%	95%
% with Sales of $50M+	0.3%	+/-1.0%	0.5%	+/-0.4%	95%
Number with Sales	6,260		424		
Total Survey Population	15,813		991		

Note: Statistically significant outcomes are bolded.

Table 8 compares the sales of R&D services resulting from DoD SBIR awards in the low-award and high-award states. Low-award states continued to outperform the high-award states by all measures. However, the differences are minimal. Only the difference in the median sales amounts — $870,877 in the low-award states versus $694,137 in the high-award states — is statistically significant.

Population-Adjusted Low-Award States

The population-adjusted low-award states identified in Table 3 are the 25 states that received the fewest SBIR awards from all federal agencies between FY2000 and FY2018 adjusted by population. To develop the list of states in Table 3, the research team ranked the 50 states by dividing each state's 2018 population by the total number of SBIR awards it had received from FYs 2000 through 2018. The list of underserved states using this approach has 19 states in common with the basic low-award states.

Table 9 shows the number of awards in each sales category for which companies reported any amount of sales. The low-award states cohort, using a population-adjusted definition, includes 2,549 awards — significantly more than the 991 within the 25 basic low-award states category. This comparison shows the value of using different definitions of underserved in this analysis.

Table 10 shows that commercialization rates were statistically the same — 59 percent in the high-award states versus 58 percent in the low-award states. However, in all other measures, the population-adjusted low-award states outperformed the high-award states by substantial and statistically significant margins.

Table 11, focusing on commercial sector sales, reveals a similar pattern. High-award states commercialized at a slightly higher rate, but this difference was not statistically significant. By all other measures, low-award states outperformed the high-award states. Differences were both substantial and statistically significant for the median and average sales of low-award states compared to high-award states. The same was true for the percentages of awards with sales of at least $10 million and $50 million.

Table 12 reveals that 28 percent of the awards in each group led to sales to the U.S. military. Low-award states achieved greater median and average sales; however, the difference in both cases was not statistically significant. With regard to the percentages of

Table 9. SBIR Awards with Sales by Sales Category for Population-Adjusted Low-Award and High-Award States

	Low-Award States	High-Award States
Total Awards	**2,549**	**14,255**
Awards with total cumulative sales	1,488	8,441
Awards with sales to the private sector	743	4,315
Awards with sales to the U.S. military	708	3,936
Awards with sales of R&D services	1,009	5,675

Note: Statistically significant outcomes are bolded.

Table 10. Total Cumulative Sales Outcomes for Population-Adjusted High-Award and Low-Award States

Total Cumulative Sales					
	High Award		**Low Award**		
Metric	**Outcomes**	**Range**	**Outcomes**	**Range**	***p* (no difference)**
Resulting in Sales (%)	59%	+/-0.8%	58%	+/-1.9%	95%
Median Sales Amount	**1,028,502**		**$ 1,300,000**		**0.00**
Average Sales Amount	**11,461,990**		**$ 16,556,546**		**0.01**
% with Sales of $10M+	**10%**	**+/-0.5%**	**16%**	**+/-1.4%**	**95%**
% with Sales of $50M+	**2%**	**+/-0.2%**	**7%**	**+/-1.0%**	**95%**
Number with Sales	8,441		1,488		
Total Survey Population		14,255		2,549	

Note: Statistically significant outcomes are bolded.

Table 11. Commercial Sales Outcomes for Population-Adjusted High-Award and Low-Award States

Commercial Sector Sales					
	High Award		**Low Award**		
Metric	**Outcomes**	**Range**	**Outcomes**	**Range**	***p* (no difference)**
Resulting in Sales (%)	30%	+/-0.8%	29%	+/-1.7%	95%
Median Sales Amount	**422,487**		**750,000**		**1.45E-06**
Average Sales Amount	**15,129,225**		**18,518,091**		**1.83E-04**
% with Sales of $10M+	**7%**	**+/-0.4%**	**19%**	**+/-1.6%**	**95%**
% with Sales of $50M+	**1%**	**+/-0.2%**	**10%**	**+/-1.2%**	**95%**
Number with Sales	4,315		743		
Total Survey Population		14,255		2,549	

Note: Statistically significant outcomes are bolded.

Table 12. Sales to the U.S. Military for Population-Adjusted High-Award and Low-Award States

Sales to the U.S. Military					
	High Award		**Low Award**		
Metric	**Outcomes**	**Range**	**Outcomes**	**Range**	***p* (no difference)**
Resulting in Sales (%)	28%	+/-0.7%	28%	+/-1.7%	95%
Median Sales Amount	556,591		655,000		0.27
Average Sales Amount	4,833,509		11,966,863		0.12
% with Sales of $10M+	**8%**	+/-0.4%	**11%**	**+/-1.2%**	**95%**
% with Sales of $50M+	**1%**	+/-0.2%	**3%**	**+/-0.7%**	**95%**
Number with Sales	3,936		708		
Total Survey Population		14,255		2,549	

Note: Statistically significant outcomes are bolded.

Table 13. R&D Sales Outcomes for Population-Adjusted Low-Award and High-Award States

Sales of R&D Services					
	High Award		**Low Award**		
Metric	**Outcomes**	**Range**	**Outcomes**	**Range**	***p* (no difference)**
Resulting in Sales (%)	40%	+/-0.8%	40%	+/-1.9%	95%
Median Sales Amount	**675,062**		**800,000**		**0.00**
Average Sales Amount	**2,192,663**		**2,383,212**		**0.02**
% with Sales of $10M+	4.1%	+/-0.3%	5%	+/-0.8%	95%
% with Sales of $50M+	0.3%	+/-0.1%	0%	0	95%
Number with Sales	5,675		1,009		
Total Survey Population		14,255		2,549	

Note: Statistically significant outcomes are bolded.

Table 14. Awards with Sales by Sales Category for EPSCoR and High-Award States

	EPSCoR	High-Award States
Total Awards	**1,627**	**15,177**
Awards with total cumulative sales	1,083	8,846
Awards with sales to the private sector	669	4,389
Awards with sales to the U.S. military	523	4,121
Awards with sales of R&D services	727	5,957

awards with sales of at least $10 million and $50 million, low-award states outperformed the high-award states by small but statistically significant margins.

Table 13, focusing on sales of R&D services, shows that 40 percent of the awards in each cohort achieved sales. Low-award states outperformed high-award states in median sales, average sales, and sales of at least $10 million. Among these three measures, the differences in median and average sales were statistically significant. High-award states slightly outperformed low-award states on awards with sales of more than $50 million (in fact, there were no low-award states in this category); however, this difference was not statistically significant.

EPSCoR States

The EPSCoR program currently includes 24 states compared to 25 in the other two underserved state definitions. Table 14 compares the number of awards in the TechLink study in the EPSCoR and high-award states, showing the number of awards in each sales category for which companies reported any amount of sales. The EPSCoR states cohort includes 1,627 awards — significantly less than the 2,549 awards in the population-adjusted low-award states category but more than the 991 awards in the basic low-award states. Again, this highlights the value of using different definitions of underserved for analytical purposes.

Table 15 shows that EPSCoR States had a significantly higher percentage of SBIR awards that achieved sales — 67 percent versus 58 percent. By contrast, the average sales amount for high-award states was higher and the difference was statistically significant. There were no significant differences between the two groups for median sales or sales of at least $10 million. By contrast, EPSCoR states had nearly twice as many awards with sales of at least $50 million — a difference that was statistically significant.

Table 16 data reveal that EPSCoR states achieved significantly higher rates of awards with commercial sector sales of any amount and sales of at least $50 million. High-award states had higher median sales although the difference was not statistically significant. High-award states also had greater average sales, and this difference was statistically significant. There was no statistically significant difference between the two groups in terms of sales of at least $10 million although the EPSCoR states percentage was slightly higher.

Table 17 compares sales to the U.S. military for awards in both EPSCoR and high-award states. EPSCoR states outperformed high-award states by a statistically significant margin for awards resulting in sales. In all other measures, high-award states outperformed EPSCoR states although only the difference in average sales was statistically significant.

Table 18, which focuses on sales of R&D services,

Table 15. Total Cumulative Sales Outcomes for EPSCoR and High-Award States

Total Cumulative Sales					
	High Award (non-EPSCoR)		**Low Award (EPSCoR)**		
Metric	**Outcomes**	**Range**	**Outcomes**	**Range**	***p* (no difference)**
Resulting in Sales (%)	**58%**	**+/-0.8%**	**67%**	**+/-2.3%**	**95%**
Median Sales Amount	1,050,000		1,253,000		0.06
Average Sales Amount	**12,347,800**		**11,226,374**		**0.00**
% with Sales of $10M+	11%	+/-0.5%	12%	+/-1.6%	95%
% with Sales of $50M+	**2%**	**+/-0.2%**	**4%**	**+/-1.0%**	**95%**
Number with Sales	8,846		1,083		
Total Survey Population	15,177		1,627		

Note: Statistically significant outcomes are bolded.

Table 16. Commercial Sales Outcomes for EPSCoR and High-Award States

Commercial Sector Sales					
	High Award (non-EPSCoR)		**Low Award (EPSCoR)**		
Metric	**Outcomes**	**Range**	**Outcomes**	**Range**	***p* (no difference)**
Resulting in Sales (%)	**29%**	**+/-0.7%**	**41%**	**+/-2.4%**	**95%**
Median Sales Amount	473,378		300,000		0.13
Average Sales Amount	**16,128,359**		**12,338,086**		**0.00**
% with Sales of $10M+	9%	+/-0.5%	10%	+/-1.5%	95%
% with Sales of $50M+	**2%**	**+/-0.2%**	**5%**	**+/-1.1%**	**95%**
Number with Sales	4,389		669		
Total Survey Population	15,177		1,627		

Note: Statistically significant outcomes are bolded.

Table 17. Sales to the U.S. Military for EPSCoR and High-Award States

Sales to the U.S. Military					
	High Award (non-EPSCoR)		**Low Award (EPSCoR)**		
Metric	**Outcomes**	**Range**	**Outcomes**	**Range**	***p* (no difference)**
Resulting in Sales (%)	**27%**	**+/-0.7%**	**32%**	**+/-2.3%**	**95%**
Median Sales Amount	594,000		500,000		0.06
Average Sales Amount	**6,132,099**		**4,257,841**		**.051**
% with Sales of $10M+	9%	+/-0.5%	7%	+/-1.5%	95%
% with Sales of $50M+	2%	+/-0.2%	1%	+/-0.5%	95%
Number with Sales	4,121		523		
Total Survey Population		15,177		1,627	

Note: Statistically significant outcomes are bolded.

Table 18. R&D Sales Outcomes for EPSCoR and High-Award States

Sales of R&D Services					
	High Award		**Low Award**		
Metric	**Outcomes**	**Range**	**Outcomes**	**Range**	***p* (no difference)**
Resulting in Sales (%)	40%	+/-0.3%	43%	+/-3.1%	95%
Median Sales Amount	**694,137**		**870,877**		**0.00**
Average Sales Amount	2,190,483		2,678,295		0.18
% with Sales of $10M+	4.0%	+/-0.8%	5.9%	+/-1.5%	95%
% with Sales of $50M+	0.3%	+/-1.0%	0.5%	+/-0.4%	95%
Number with Sales	6,260		424		
Total Survey Population		15,813		991	

Note: Statistically significant outcomes are bolded.

shows that EPSCoR states had a statistically significant and substantially higher commercialization rate — 45 percent versus 39 percent. In all other measures, EPSCoR states performed as well or better than high-award states but not by statistically significant amounts.

CONCLUSION

This research project has compared the commercialization success of DoD SBIR Phase II projects in underserved states to those in high-award states. To undertake this study, the research team drew on data generated by the comprehensive 2019 TechLink economic impact study of the DoD SBIR program. A total of 60 different measures were used to compare the relative success of the two different cohorts. These measures included three different definitions of underserved (low-award states, population-adjusted low-award states, and EPSCoR states) four different categories of sales for each definition (total cumulative sales, sales to the commercial sector, sales to the U.S. Military, and sales of R&D services), and five different sales criteria (percent of SBIR projects resulting in sales, median sales amount, average sales amount, percent with sales of at least $10 million, and percent with sales of at least $50 million).

Analysis showed that underserved states consistently outperformed high-award states in commercializing the outcomes of their DoD SBIR Phase II projects. In fact, on 47 of the 60 different measures — 30 of which were statistically significant for low-award states — the low-award states outperformed the high-award states. On only 10 of the 60 measures did the high-award states show superior results, and only three of these results were statistically significant. (The two groups were tied in three cases.)

Moreover, under all three definitions of underserved, the low-award states outperformed the high-award states. They also generally outperformed the high-award states in all four sales categories. The underserved states also had larger median and average sales per award as well as greater numbers of awards achieving sales in the outlier range — those with sales of at least $10 million and of at least $50 million. In fact, in 20 of the 24 comparisons of the two cohorts in terms of awards achieving these high-level sales, the underserved states were superior.

These results strongly support the argument that SBIR program efforts to assist firms in low-award states are a sound investment. However, they also highlight the need for further research. In particular, why do states with fewer awards, fewer awards per capita, and the disadvantages that qualify them for underserved status perform better at converting their SBIR awards into commercial success? One possible answer is that in more sparsely populated states, with fewer technology firms in the overall population, economic development and SBIR outreach efforts (both federal and state) are more likely to exist and can be more effectively focused.

A second possible explanation is that in recent years, support mechanisms from the SBA and the Economic Development Administration have resulted in additional assistance and success for companies in underserved states. For example, it's quite possible that the SBIR/STTR Road Tours in underserved regions and states drive economic development for companies residing in these regions. Furthermore, online resources (such as the digitalization of SBIR outreach) might have resulted in additional economic developments and impacts though that analysis was beyond the scope and resources of this study.

The results of this research project also have important implications for theories of innovation. For example, "innovation cluster" theory (21) emphasizes the competitive advantages of certain favored locations — those with geographic concentrations of interconnected technology firms located near major research centers and ready access to venture capital, suppliers, customers, and complementary industries. This widely accepted theory would seemingly predict that the high-award states would outperform the rest. The results of the present research project suggest that, for still unknown reasons, innovation cluster theory does not fully capture innovation occurring in the United States today.

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